15. Assessment of the shortraker rockfish stock in the Bering Sea and Aleutian Islands

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November 2020

Executive Summary

Summary of Changes in Assessment Inputs

Changes in the input data:

1) The catch data have been revised and updated through October 25, 2020.
2) There were no survey updates this year for the Aleutian Islands (AI) trawl survey or the eastern Bering Sea slope survey.

Changes in the assessment methodology:

The assessment methodology has not changed since the last full assessment in 2014. Please see Spies et al. (2018) for more details on the 2018 assessment (available online at: https://apps-afsc.fisheries.noaa.gov/REFM/Docs/2018/BSAI/BSAIshortraker.pdf).

Summary of Results

The summarized results of the risk table exercise for shortraker rockfish are in the table below. All scores of Level 1 suggests no need to set the ABC below the maximum permissible. Further details for each category of this risk table are provided in the *Harvest Recommendations* section.

Assessment-related considerations	*Population dynamics considerations*	*Environmental/ ecosystem considerations*	*Fishery Performance considerations*
Level 1: Normal	**Level 1:** Normal	**Level 1:** Normal	**Level 1:** Normal

Reference values for shortraker rockfish are summarized in the following table. The recommended 2021 ABC and OFL for Bering Sea and Aleutian Islands (BSAI) shortraker rockfish are 541 t and 722 t, respectively. This is a roll over from last year's ABC and OFL since there were no new surveys this year for the Aleutian Islands (AI) or eastern Bering Sea (EBS). The stock is not being subject to overfishing.

Quantity	As estimated or *specified last* year for: 2020	2021	As estimated or *recommended this* year for: 2021	2022
M (natural mortality rate)	0.03	0.03	0.03	0.03
Tier	5	5	5	5
Biomass (t)	24,055	24,055	24,055	24,055
F_{OFL}	0.03	0.03	0.03	0.03
$maxF_{ABC}$	0.0225	0.0225	0.0225	0.0225
F_{ABC}	0.0225	0.0225	0.0225	0.0225
OFL (t)	722	722	722	722
maxABC (t)	541	541	541	541
ABC (t)	541	541	541	541
Status	As determined *last* year for: 2018	2019	As determined *this* year for: 2019	2020
Overfishing		n/a		n/a

Summaries for the Plan Team

The following table gives the recent biomass estimates, catch, harvest specifications, and projected biomass, OFL and ABC for 2019-2022.

Year	Biomass	OFL	ABC	TAC	Catch
2019	24,055	722	541	358	380
2020	24,055	722	541	375	194[1]
2021	24,055	722	541		
2022	24,055	722	541		

[1] Catch as of October 25, 2020.

Responses to SSC and Plan Team Comments on Assessments in General

"*The SSC considers the risk table approach an efficient method to organize and report this information and worthy of further investigation…The SSC recommends that one additional column be added to include concerns related to fishery/resource-use performance and behavior, considering commercial as well as local/traditional knowledge for a broader set of observations. This additional column should not include socio-economic considerations, but rather indications of concern such as inability to catch the TAC, or dramatic changes in spatial or temporal distribution that could indicate anomalous biological conditions. The SSC requests that all authors fill out the risk table in 2019, and that the PTs provide* *comment on the author's results in any cases where a reduction to the ABC may be warranted (concern levels 2-4).*" (SSC, December 2018)

"*Given that the risk table and ESP are clearly in development and are likely to evolve in important ways, the SSC suspends its requests for "OK-ness" and "inference of impending decline" for individual stock authors of all assessments…The SSC would like to see how these new processes and products develop to determine if they are able to provide the type of information needed to provide an early detection of ecosystem change. In addition, risk tables only need to be produced for groundfish assessments that are in a "full" year in the cycle.*" (SSC, June 2019)

"*The SSC recommends the authors complete the risk table and note important concerns or issues associated with completing the table.*" (SSC, October 2019)

"*The Teams recommended that authors continue to fill out the risk tables for full assessments.*

The Teams recommended that adjustment of ABC in response to levels of concern should be left to the discretion of the author, the Team(s), and/or the SSC, but should not be mandated by the inclusion of a >1 level in any particular category. The Teams request clarification and guidance from the SSC regarding the previously noted issues associated with completing the risk table, along with any issues noted by the assessment authors." (Joint Groundfish Plan Team, November 2019)

"*The SSC recommends dropping the overall risk scores in the tables as these provided no additional information relative to ABC-setting and seemed to cause confusion. They simply report the maximum value of risk for the four factors, which is redundant information.*

The SSC noted that the table ranking descriptions (e.g., description of what the scores mean) were not included in all the SAFE reports. The SSC requests that the table explanations be included in all the assessments which include a risk table for completeness.

The SSC notes that the risk tables provide important information beyond ABC-setting which may be useful for both the AP and the Council and welcomes feedback to improve this tool going forward."

(SSC, December 2019)

The comments that pertain to the risk table have been grouped together. Since this is a full assessment year for BSAI shortraker rockfish, we provide a risk table as recommended by the SSC without the overall risk score in the table and the table ranking descriptions for completeness. Following the completion of this exercise, the highest score for this stock is a Level 1 and the authors do not recommend that the ABC be reduced below maximum permissible ABC. Please see the *Harvest Recommendations* section for further details for each category of this risk table.

"*The SSC recommends thinking beyond the current (2020) situation to develop methods for making stock assessment analyses more robust to possible future survey reductions/loss. These may include:*

- *Renewed investigation of data conflicts in the assessment models, perhaps addressed through data weighting and/or identification of un-modelled processes, or occasional anomalous data points.*
- *Model-based survey time series (e.g., vector-autoregressive spatio-temporal (VAST) models) that can accommodate incomplete data, changes in survey design, or alternative survey platforms and still produce indices of abundance with statistical variance estimates. These may be particularly*

- *helpful for stocks (e.g., Tier 4 crab and Tier 5 groundfish) where harvest levels are informed directly by trends in survey data rather than solely by the results of the stock assessment.*
- *Exploration of harvest control rules that are explicitly linked to survey and assessment uncertainty and the lag between surveys and assessments.*"

(SSC, October 2020)

We plan to explore the utility of model-based survey time series (e.g., VAST model) as a way to integrated the several potential surveys available for use in the BSAI shortraker rockfish model. We provide the current estimates of the AFSC longline survey and the IPHC survey for shortraker rockfish in the *Data* section below as a start at this investigation.

Responses to SSC and Plan Team Comments Specific to this Assessment

No new comments specific to this assessment.

Introduction

Shortraker rockfish (*Sebastes borealis*) are distributed along the continental slope in the north Pacific from Point Conception in southern California to Japan, and are commonly found between eastern Kamchatka and British Columbia (Love et al. 2002). Shortraker rockfish are among the longest-lived animal species in the world, reaching ages > 150 years. The species is viviparous with spawning believed to occur throughout the spring and summer (Westerheim 1975, McDermott 2004). Little is known of shortraker rockfish early life history and habitat preferences, as immature fish are rarely observed. Love et al. (2002) indicates the species is found at shallower depths during early life history. Adults occur in a narrow range of depths on the continental slope centered at ~350 m (Rooper 2008), often in areas of steep slope (Rooper and Martin 2012). In bottom trawl survey data, shortraker rockfish are most common through the Aleutian Islands (AI) and the central Gulf of Alaska (GOA). Studies of habitat preferences in the GOA indicate shortraker rockfish may be more abundant in boulder patches with associated *Primnoa* coral (Krieger and Ito 1999, Krieger and Wing 2002). Shortraker rockfish consume large benthic or near-bottom prey, including myctophids, shrimp and squid (Yang et al. 2006).

Several types of research can be used to infer stock structure of shortraker rockfish, including larval distribution patterns and genetic studies. In 2002, an analysis of archived *Sebastes* larvae was undertaken by Dr. Art Kendall using data collected in 1990 off southeast Alaska (650 larvae) and the AFSC ichthyoplankton database (16,895 *Sebastes* larvae, collected on 58 cruises from 1972 to 1999, primarily in the GOA). The southeast Alaska larvae all showed the same morph, and were too small to have characteristics that would allow species identification. A preliminary examination of the AFSC ichthyoplankton database indicated that most larvae were collected in the spring, the larvae were widespread in the areas sampled, and most were small (5-7 mm). The larvae were organized into three size classes for analysis: <7.9 mm, 8.0-13.9 mm, and >14.0 mm. A subset of the abundant small larvae was examined, as were all larvae in the medium and large groups. Species identification based on morphological characteristics is difficult because of overlapping characteristics among species, as few rockfish species in the north Pacific have published descriptions of the complete larval developmental series. However, all of the larvae examined could be assigned to four morphs identified by Kendall (1991), where each morph is associated with one or more species. Most of the small larvae examined belong to a single morph, which contains the species *S. alutus* (Pacific ocean perch), *S. polyspinus* (northern rockfish), and *S. ciliatus* (dusky rockfish). Some larvae (18) belonged to a second morph which has been identified as *S. borealis* (shortraker rockfish) in the Bering Sea. The locations of these larvae were near Kodiak Island, the Semidi Islands, Chirkof Island, the Shumagin Islands, and near the eastern end of the AI.

Population structure for shortraker rockfish has been observed in microsatellite data (Matala et al. 2004), with the geographic scale consistent with current management regions (i.e., GOA, AI, and EBS). The most efficient partitioning of the genetic variation into non-overlapping sets of populations identified three groups: a southeast Alaska group, a group extending from southeast Alaska to Kodiak Island, and a group extending from Kodiak Island to the central AI (the western limit of the samples). The available data are consistent with a neighborhood genetic model, suggesting that the expected dispersal of a particular specimen is much smaller than the species range. A parallel study with mtDNA revealed weaker stock structure than that observed with the microsatellite data. It is not known how shortraker in the EBS or western AI relate to the large population groups identified by Matala et al. (2004) due to a lack of samples in these areas.

Spatial differences in life-history characteristics, such as growth rates and age at maturity, could also provide information on stock structure. However, little data is available on these processes, in part because of the difficulty of aging shortraker rockfish. Production aging of shortraker rockfish is currently impeded by the lack of consistent age criteria. Recent, ^{14}C age validation studies appeared promising, but additional testing regarding the accuracy of ages may be needed before initiating production aging.

Fishery

Catches of shortraker rockfish have been reported in a variety of species groups in the foreign and domestic Alaskan fisheries. Foreign catch records did not report shortraker rockfish by species, but in categories such as "other species" (1977, 1978), "POP complex" (1979-1985, 1989), and "rockfish without POP" (1986-1988). Shortraker rockfish were managed in the domestic fishery as part of the “other red rockfish” from 1991-2000 and the “shortraker/rougheye” complex from 2001-2003. The ABCs, TACs, and catches by management complex from 1988-2020 are shown in Table 15.1a and 15.1b. Since 2003, the catch accounting system (CAS) has reported catch of shortraker rockfish by species and area. From 1991-2002, shortraker rockfish catch was reconstructed by computing the harvest proportions within management groups from the North Pacific Foreign Observer Program database, and applying these proportions to the estimated total catch obtained from the NOAA Fisheries Alaska Regional Office “blend” database. This reconstruction was conducted by estimating the shortraker catch for each area (i.e., the EBS and each of the three Aleutian Island areas, the central (CAI), Western (WAI), and Eastern Aleutian Islands (EAI)) and gear type (trawl and longline) from 1994-2002. For 1991-1993, the Regional Office blend catch data for the AI was not reported by AI subarea, and the AI catch was obtained using the observer harvest proportions by gear type for the entire AI area. Similar procedures were used to reconstruct the estimates of catch from the 1977-1989 foreign and joint venture fisheries. Estimated domestic catches in 1990 were obtained from Guttormsen et al. 1992. Catches from the domestic fishery prior to the domestic observer program were obtained from PACFIN records. Catches of shortraker rockfish since 1977 are shown in Table 15.2. Catches were relatively high during the late 1970s, declined during the late 1980s as the foreign fishery was reduced, increased in the early 1990s, and declined in the mid-1990s.

The catches by area from 1994-2020 have been variable, with the largest catches occurring in the EBS in 1978 and 1979 (Table 15.2). From 2004 to 2020, 46% of the shortraker catch occurred in the EBS, with 22%, 20%, and 12% in the WAI, CAI, and EAI areas respectively. Catches in the WAI averaged 35 t from 2004-2010, then increased in 2011-2013 to an average of 164 t, and decreased to an average of 24 t from 2014-2020. Catch as of October 25, 2020 was 51 t in the Western AI (Table 15.3).

Estimates of discarding by species complex are shown in Table 15.4. Estimates of discarding of the other red rockfish complex in the EBS were generally above 55% from 1993 to 2000, with the exception of 1993 and 1995 when discarding rates were less than 26%. The variation in discard rates may reflect different species compositions of the other red rockfish catch. Discard rates of EBS shortraker/rougheye (SR/RE) complex from 2001 to 2003 were below 52%, and discard rates of AI SR/RE complex from 1993-2003 were below 41%. In general, the discard rates of EBS SR/RE are less than the discard rates of EBS other red rockfish in most years, likely reflecting the relatively higher value of rougheye and shortraker rockfishes over other members of the complex. Discard rates of BSAI shortraker rockfish from 2004-2020 have ranged from 10% to 50%, and were 25% in 2019 and 21% for 2020 (catch taken through October 25, 2020).

Shortraker rockfish in the AI have been primarily taken in the rockfish trawl fishery (56%), and the Atka mackerel fishery (11%), as well as the flatfish (8%) and sablefish (8%) longline fisheries, with lesser catches from the halibut (5%) and Pacific cod (6%) fisheries (Table 15.5). Catches of shortraker rockfish from 2004-2020 in the EBS were caught largely in the midwater pollock trawl fishery (24%), flatfish trawl fishery (22%), rockfish bottom trawl (21%), Pacific cod longline (14%), and the halibut (8%) and flatfish (6%) longline fisheries (Table 15.6). Catches of shortraker rockfish in the EBS management area were concentrated in areas 517 and 521, the areas occupying much of the EBS slope (Table 15.6).

Shortraker rockfish and four other species of rockfish (Pacific ocean perch, northern rockfish, rougheye rockfish, *S. aleutianus*; and sharpchin rockfish, *S. zacentrus*) were managed as a complex in the EBS and AI management areas from 1979 to 1990. Known as the POP complex, these five species were managed as a single entity with a single TAC (total allowable catch) within each management area. In 1991, the North Pacific Fishery Management Council enacted new regulations that changed the species composition of the POP complex. For the EBS slope region, the POP complex was divided into two subgroups: 1) Pacific ocean perch, and 2) shortraker, rougheye, sharpchin, and northern rockfishes combined, also known as “other red rockfish” (ORR). For the AI region, the POP complex was divided into three subgroups: 1) Pacific ocean perch, 2) shortraker/rougheye rockfishes, and 3) sharpchin/northern rockfishes. In 2001, the other red rockfish complex in the EBS was split into two groups, shortraker/rougheye and sharpchin/northern, matching the complexes used in the AI. These subgroups were established to protect Pacific ocean perch, shortraker rockfish, and rougheye rockfish (the three most valuable commercial species in the assemblage) from possible overfishing. Additionally, separate TACs were established for the EBS and AI management areas, but the overfishing level (OFL) pertained to the entire BSAI area. In 2002, sharpchin rockfish were assigned to the “other rockfish” category, leaving only northern rockfish and the shortraker/rougheye complex as members of other red rockfish. In 2004, rougheye and shortraker rockfishes were managed by species in the BSAI area. Shortraker rockfish has been assessed separately since 2008.

Data

Fishery

The length composition from observer sampling of the domestic fishery (Figure 15.1), indicate relatively consistent length distributions with the bulk of the sampled fish generally between 30 and 75 cm. There are no apparent trends in the size distribution. The number of length observations taken by fishery observers in the BSAI is shown in the following table.

Year	Number of fishery length observations	Year	Number of fishery length observations
1990	373	2006	1,464
1991	576	2007	1,730
1992	413	2008	702
1993	736	2009	1,346
1994	125	2010	2,156
1995	306	2011	1,158
1996	114	2012	709
1997	138	2013	835
1998	226	2014	1,137
1999	2,000	2015	1,260
2000	1,630	2016	493
2001	373	2017	234
2002	576	2018	434
2003	413	2019	600
2004	736	2020	152
2005	1,352		

The catch data are the estimates of single species catch described above and shown in Table 15.2. However, given the history of previously managing EBS rockfish as separate stock complexes, and recent information on genetic population structure for other BSAI rockfish species, it is prudent to examine how area-specific exploitation rates compare to F_{ABC} and F_{OFL} reference points. Area-specific exploitation rates for a given year were obtained by dividing the yearly catch by the estimate of biomass for the subarea. The subareas considered here are the 3 AI subareas, the southern Bering Sea (i.e., areas 517 and 518) and the EBS (i.e., the remainder of the EBS management area minus the southern Bering Sea). The subarea biomass for each year was estimated by the random effects model.

Exploitation rates in the CAI and EAI have been below M and generally low from 2004-2018 (Figure 15.2). Increases in the catch in the western AI in 2011-2013 resulted in the exploitation rates in this area exceeding area-specific F_{ABC} and F_{OFL} (Table 15.3). The 2020 catch in the WAI is the highest since 2013, as of October 25, 2020. Catch of shortraker rockfish in the SBS is variable, generally ranging from 0-50 t, but increased to the highest in the time series in 2019 and has dropped again to 45 t in 2020 as of October 25, 2020 (Table 15.3). Biomass in that region appears to be decreasing, and the 2018 estimate of 13 t is the lowest on record (Table 15.7, Figures 15.3 and 15.4). The exploitation rate for the entire BSAI has remained below F_{ABC} and F_{OFL} since 2004 (Figure 15.2).

Removals from sources other than those that are included in the Alaska Region's official estimate of catch are presented in Appendix 1.

Survey

AFSC Bottom Trawl Survey

Biomass estimates for other red rockfish were produced from cooperative U.S.-Japan trawl surveys from 1979-1985 on the EBS slope, and from 1980-1986 in the AI. U.S domestic trawl surveys were conducted in 1988, 1991, 2002, 2004, 2008, 2010, 2012, and 2016 on the EBS slope, and in 1991, 1994, 1997, 2000, 2002, 2004, 2006, 2010, 2012, 2014, 2016, and 2018 in the AI (Table 15.7). The 2008 AI survey and 2006, 2010, 2018 EBS slope surveys were canceled. The 2002 EBS slope survey represents the initiation of a new survey time series distinct from the previous surveys in 1988 and 1991. EBS slope and the AI surveys were used to compute biomass estimates in this assessment. The EBS slope survey was initiated in 2002; therefore, biomass estimates are available from 2002-2016. The 2020 AI survey and EBS slope survey were cancelled due to the COVID-19 pandemic.

In contrast to the fishery length compositions, the survey length compositions reveal fewer large fish (Figure 15.5). In surveys from 1994 to 2018, fish lengths from survey samples generally occurred between 30 cm and 65 cm.

The AI surveys from 1980 to 2018 indicated higher abundances in the Western (543) and Central (542) than in the EAI (541) (Figure 15.3), with the SBS area having the lowest abundance (Figure 15.4). Biomass in the SBS has shown a consistent decline in biomass estimated by the survey since 1983.

The biennial EBS slope survey was initiated in 2002. The most recent slope survey prior to 2002, excluding some preliminary tows in 2000 intended for evaluating survey gear, was in 1991. The survey biomass estimates of shortraker rockfish from the 2002-2016 EBS slope surveys have ranged between 2570 t (2004) and 9,284 t (2012), with CVs between 0.22 and 0.57.

AFSC Longline Survey

The domestic longline survey is conducted annually by the AFSC over the continental slope region of the BS/AI and the GOA The GOA stations are sampled each year while the Bering Sea is sampled on odd years and the Aleutian Islands in even years. This survey provides data on the relative abundance of shortraker rockfish and computes relative population numbers (RPNs) and relative population weights (RPWs) for fish on the continental slope as indices of stock abundance. Relative population abundance indices are computed annually using survey catch per unit of effort (CPUE) rates that are multiplied by the area size of the stratum within each geographic area. These relative population indices are available by numbers (RPN) and weights (RPW) for a given species (Rodgveller et al. 2011). The survey is primarily directed at sablefish, but also catch considerable numbers of shortraker rockfish. Results for this survey concerning rockfish, however, should be viewed with some caution, as the RPNs and RPWs do not take into account possible effects of competition for hooks with other species caught on the longline, especially sablefish. An analysis of the survey data indicated there was a negative correlation between catch rates of sablefish and shortraker rockfish in the GOA, and that there was likely competition for hooks between species in the surveys (Rodgveller et al. 2008). The study concluded that further research and experiments are needed to better quantify the effects of hook competition and to compute adjustment factors for the survey catch rates. Recently, another study compared catch rates of shortraker and rougheye rockfish on survey longline gear with observed densities of these fish around the longline from a manned submersible also in the GOA (Rodgveller et al. 2011). Results for shortraker and rougheye combined showed a catchability coefficient (q) of 0.91. There was a tendency for longline catch rates of the two species to be related to the observed densities, but this relationship was not significant. Again, this study concluded that additional research is needed on the longline catching process for shortraker rockfish to better determine the suitability of using longline survey results for assessment of this species.

The AFSC longline survey has been conducted annually since 1988, and RPNs and RPWs have been computed for each year and are available since 1996 for shortraker rockfish (Table 15.8). RPNs in the Aleutian Islands have ranged from a low of ~15,400 t in 2009 to a high of ~43,800 in 2007 and in the Bering Sea from a low of ~1,900 t in 2010 to a high of ~21,500 t in 2004. The Aleutian Islands time series appears to exhibit a strong saw tooth pattern up until about 2016 when the series seems to stabilize somewhat (Figure 15.6). The Bering Sea time series seems to be somewhat stable after about 2005. Definite trends in these data over the years are difficult to discern, and the BSAI values of RPN fluctuate considerably between adjacent years. This same pattern is evident in the GOA time series for shortraker rockfish. Some of the fluctuations may be related to changes in the abundance of sablefish, as discussed in the previous paragraph regarding competition for hooks among species. The 2020 longline survey RPN value for shortraker rockfish is down about 13% from 2019 (Figure 15.6). This is about 10% below the historical average. Longline survey results show that the abundance of shortraker rockfish is generally higher in the Aleutians than the Bering Sea, with the exception of 2003-2004 when the RPN values were similar (Figure 15.6).

Length data are also collected for shortraker rockfish during longline surveys and compositions are available since 1996 (Figure 15.7). A clear difference in size between the Aleutian Islands (sampled in even years) and the Bering Sea (sampled in odd years) exists with larger fish sampled in the Bering Sea. In surveys from 1996 to 2020, fish lengths from the Bering Sea were similar to the fishery samples and generally occurred between 50 cm and 80 cm, while fish lengths from the Aleutian Islands were similar to survey samples and generally occurred between 30 cm and 65 cm. This may be simply because the majority of bottom trawl survey samples are from the Aleutian Islands survey. The habitat between the two regions is quite different and the biomass estimates on the bottom trawl survey and the RPNs on the longline survey are larger for the Aleutian Islands than the Bering Sea.

International Pacific Halibut Commission Survey

The International Pacific Halibut Commission (IPHC) conducts a longline survey each year to assess Pacific halibut. This survey differs from the AFSC longline survey in gear configuration and sampling design, but also catches shortraker rockfish. More information on this survey can be found in Soderlund et al. (2009). A major difference between the two surveys is that the IPHC survey samples the shelf consistently from 1-500 meters, whereas the AFSC longline survey samples the slope and select gullies from 200 to 1000 meters. Because the majority of effort occurs on the shelf in shallower depths, the IPHC survey may catch smaller and younger shortraker rockfish than the AFSC longline survey and similar to the AFSC bottom trawl surveys; however, lengths of shortraker rockfish are not taken on the IPHC survey.

RPNs have been computed for each year of the IPHC survey and are available since 1998 to 2019 for shortraker rockfish (Table 15.9). RPNs in the Aleutian Islands have ranged from a low RPN in 2018 to a high in 2011 and in the Bering Sea from a low in 2006 to a high in 2009. RPNs increased in 2019 compared to 2018 for both the Bering Sea and Aleutian Islands regions. The Bering Sea estimate is now 68% above the long-term average for the time series, but the Aleutian Islands estimate was 43% below the long-term average for that time series. Both the Aleutian Islands and Bering Sea time series appear to exhibit some fluctuation over the time period, possibly due to hook competition, but the pattern is not as clear as saw tooth pattern on the AFSC longline survey (Figure 15.8).

Analytic Approach

The random effects model was used to estimate biomass of shortraker rockfish in the BSAI. The random effects (RE) model is an approximation to the Kalman Filter approach. The process errors (step changes) from one year to the next are the random effects to be integrated over and the process error variance is a free parameter. The observations can be irregularly spaced; therefore this model can be applied to datasets with missing data. Large observation errors increase errors predicted by the model, which can provide a way to weight predicted estimates of biomass (http://www.afsc.noaa.gov/REFM/stocks/Plan_Team/2012/Sept/survey_average_wg.pdf).

Biomass estimates were made using the 1980-2018 AI and 2002-2016 EBS slope survey time series for biomass and estimates of uncertainty. The random effects models was fit to the 1980-2018 Aleutian Islands survey biomass data and CV, and the 2002-2016 Bering Sea slope survey biomass and CV time series separately. The most recent slope survey was conducted in 2016; therefore the best estimate of the past 2 years of slope biomass is the 2016 estimate. This method produces estimates of BSAI shortraker biomass from 2002-2018, which was used to calculate the ABC and OFL.

Shortraker rockfish in the BSAI are managed under Tier 5, where OFL = M * average survey biomass, where M represents natural mortality, and F_{ABC} is estimated by 0.75 * M. The acceptable biological catch (ABC) is obtained by multiplying F_{ABC} by the estimated biomass, ABC ≤ 0.75 * M * biomass.

Parameter Estimates

Shortraker rockfish are assumed to have a natural mortality rate (M) of 0.03. This estimate of natural mortality is consistent with estimates for north Pacific shortraker rockfish using the gonad somatic index, which ranged from 0.027 to 0.042 (McDermott 1994).

Results

Estimated shortraker rockfish biomass in the BSAI has been relatively stable since 2002. Biomass has decreased slightly from 20,932 t in 2006 to 24,055 t in 2018 (Figure 15.4d, Tables 15.10 and 15.11).

More shortraker rockfish are present in the AI than the EBS. The random effects model results estimated 6,157 t in the EBS and 17,899 t in the AI in 2018. These were calculated by combining the Southern Bering Sea area (517+518) that was surveyed on the Aleutian Islands survey with the Bering Sea slope data estimates of biomass. If a separate ABC and OFL were in place for the Aleutian Islands and the Bering Sea, they would be as shown in the Harvest Recommendation table below.

Harvest Recommendations

Shortraker rockfish are currently managed under Tier 5 of Amendment 56 of the NPFMC BSAI Groundfish FMP, which requires a reliable estimate of stock biomass and natural mortality rate. The estimate of M for shortraker rockfish was obtained from Heifetz and Clausen (1991), and for Tier 5 stocks, F_{OFL} and F_{ABC} are defined as M and 0.75M, respectively:

2020	Shortraker Rockfish
M	0.03
Biomass	24,055
LCI	(36,369)
UCI	(15,911)
F_{OFL}	0.03
$maxF_{ABC}$	0.0225
F_{ABC}	0.0225
OFL	722
maxABC	541
ABC	541
AI ABC	403
EBS ABC	138

Should the ABC be reduced below the maximum permissible ABC?

The SSC in its December 2018 minutes recommended that all assessment authors use the risk table when determining whether to recommend an ABC lower than the maximum permissible. The SSC also requested the addition of a fourth column on fishery performance, which has been included in the table below.

	Assessment-related considerations	*Population dynamics considerations*	*Environmental/ecosystem considerations*	*Fishery Performance*
Level 1: Normal	Typical to moderately increased uncertainty/minor unresolved issues in assessment.	Stock trends are typical for the stock; recent recruitment is within normal range.	No apparent environmental/ecosystem concerns	No apparent fishery/resource-use performance and/or behavior concerns
Level 2: Substantially increased concerns	Substantially increased assessment uncertainty/ unresolved issues.	Stock trends are unusual; abundance increasing or decreasing faster than has been seen recently, or recruitment pattern is atypical.	Some indicators showing an adverse signals relevant to the stock but the pattern is not consistent across all indicators.	Some indicators showing adverse signals but the pattern is not consistent across all indicators
Level 3: Major Concern	Major problems with the stock assessment; very poor fits to data; high level of uncertainty; strong	Stock trends are highly unusual; very rapid changes in stock abundance, or highly atypical recruitment	Multiple indicators showing consistent adverse signals a) across the same trophic level as the stock, and/or b) up or down trophic levels (i.e.,	Multiple indicators showing consistent adverse signals a) across different

	retrospective bias.	patterns.	predators and prey of the stock)	sectors, and/or b) different gear types
Level 4: Extreme concern	Severe problems with the stock assessment; severe retrospective bias. Assessment considered unreliable.	Stock trends are unprecedented; More rapid changes in stock abundance than have ever been seen previously, or a very long stretch of poor recruitment compared to previous patterns.	Extreme anomalies in multiple ecosystem indicators that are highly likely to impact the stock; Potential for cascading effects on other ecosystem components	Extreme anomalies in multiple performance indicators that are highly likely to impact the stock

The table is applied by evaluating the severity of four types of considerations that could be used to support a scientific recommendation to reduce the ABC from the maximum permissible. These considerations are stock assessment considerations, population dynamics considerations, environmental/ecosystem considerations, and fishery performance. Examples of the types of concerns that might be relevant include the following:

1. Assessment considerations—data-inputs: biased ages, skipped surveys, lack of fishery-independent trend data; model fits: poor fits to fits to fishery or survey data, inability to simultaneously fit multiple data inputs; model performance: poor model convergence, multiple minima in the likelihood surface, parameters hitting bounds; estimation uncertainty: poorly-estimated but influential year classes; retrospective bias in biomass estimates.
2. Population dynamics considerations—decreasing biomass trend, poor recent recruitment, inability of the stock to rebuild, abrupt increase or decrease in stock abundance.
3. Environmental/ecosystem considerations—adverse trends in environmental/ecosystem indicators, ecosystem model results, decreases in ecosystem productivity, decreases in prey abundance or availability, increases or increases in predator abundance or productivity.
4. Fishery performance—fishery CPUE is showing a contrasting pattern from the stock biomass trend, unusual spatial pattern of fishing, changes in the percent of TAC taken, changes in the duration of fishery openings.

Assessment considerations

The BSAI shortraker stock is a Tier 5 species, meaning only reliable biomass estimates are available to calculate ABCs. The BSAI shortraker assessment is one of few Tier 5 assessments in Alaska that is fit to multiple abundance indices (Aleutian Islands trawl survey and Bering Sea slope survey biomass estimates). While these two surveys have different trends and years sampled, the inclusion of these two data sources has allowed for increased stability of biomass estimates across time. Generally, the biomass estimates for shortraker rockfish have shown relatively moderate confidence intervals and low CVs. At this point, we rated the assessment-related concern as level 1, normal. However, the continued cancellation of bottom trawl surveys in the Aleutians and Bering Sea warrants an investigation in the potential to use the annually occurring longline surveys in the random effects model. The model for the shortraker rockfish stock in the GOA utilizes both the bottom trawl and the AFSC longline survey and we have potential to use this survey in the BSAI assessment following the GOA shortraker methodology. We may also consider using the IPHC survey within this framework.

Population dynamics considerations

In general, very little is known regarding the life history of shortraker rockfish, and current techniques do not produce reliable age estimates for the species. We are unable to estimate recruitment, and very few specimens of shortraker rockfish <35 cm have ever been caught in the BSAI. Any data collected during larval cruises lump all rockfish species together. Even with large annual variability in the individual bottom trawl surveys, biomass has been trending upward. Initial exploration of the longline data suggests that there were increases in both the AFSC and IPHC longline surveys from the 2018 estimates, suggesting the stock is increasing recently. Also, the longline survey length compositions show a slight increase in fish <35 cm in the 2020 samples which suggests a potential increase in recruitment in the Aleutian Islands where the biomass is highest. Overall we rated the population-dynamic concern as level 1, normal, due to the fact that little to no information exists on the population dynamics of this species but that biomass has been trending upward and has shown normal variability for this species.

Environmental/Ecosystem considerations

Due to lack of 2020 surveys and fieldwork, many ecosystem indicators were not measured this year. Thus, much of the ecosystem information available for this year is derived from remote sensing.

Shortraker are typically found in the Aleutians at temperatures between 3.6 - 4.6°C, at depths between 200 and 450 m. However, shortraker depth distribution has become shallower over time in the AI bottom trawl survey (Rooper et al., 2018 AI ESR). The National Centers for Environmental Prediction Global Ocean Data Assimilation System (GODAS) temperature anomalies for the 100-250m depth range show that significantly warmer temperatures have remained since 2016; the GODAS estimates are supported by the water column temperatures indicator for the AI (AI ESR Physical factors 2020). In general, higher ambient temperatures incur bioenergetic costs for ectothermic fish such that, all else being equal, consumption must increase to maintain fish condition. Thus, the persistent higher temperatures may be considered a negative indicator for shortaker. Increased bioenergetic demands may be mitigated by the shortraker's generalist diet.

As a generalist, shortraker feeds on a variety of fish including myctophids and sculpins, squids, shrimp and benthic amphipods among others; no consistent prey item dominates their diet. As shortraker does not rely on copepods or euphausiids, it does not compete with POP for prey. It shares similar prey items and depth distribution with rougheye rockfish and shortspine thornyheads which also consume general fish, myctophids and shrimp (rougheye) as well as sculpins, squid and shrimps (shortspine thornyheads). There are no recorded fish predators of shortraker in the Aleutian Islands.

The indicator most relevant to reflecting habitat disturbance is the estimated area disturbed by trawls from the fishing effects model (Olson et al, AI ESR). Trends in potential habitat disturbance are relevant for adult shortraker, although their primary habitat is steep slopes which are generally not targeted by bottom trawlers. The fishing effects model has not indicated large changes in habitat disturbance trends, and has remained below 3% for the Aleutian Islands (EAI, CAI and WAI) since 2009, so we assume that the level of habitat disturbance for shortraker has been stable.

Taken together, these indicators suggest no clear concerns for the shortraker stock aside from the recent stretch of increased temperatures. However, both the lack of ecological data relevant to the stock as well as lack of data in 2020 limits our assessment of potential recent ecosystem impacts on this stock. Given the mixed signals with the increasing temperature but the generalist diet and low habitat disturbance, we scored this category as Level 1, normal concern.

Fishery performance

There is no directed fishing of shortraker rockfish, and they can only be retained as “incidentally-caught.” Catch of shortraker rockfish fluctuates moderately by gear type and year, but trends are relatively stable by area and catch has always remained well below the ABC. Due to their moderately high value, discard rates of shortraker rockfish have generally been low and stable since 2014. There was an increase in catch in 2019 in the southern Bering Sea and Bering Sea in 2019 which led to the overall catch exceeding the TAC (but still well below the ABC) and the nonspecified TAC reserves allow for increasing the TAC during a given fishing year if the TAC is below ABC. This increase in catch seems to have mainly occurred due to increases in incidental catch in the pollock pelagic trawl fishery where they were fishing on the more on the bottom although still using pelagic gear (B target or less than 95% pollock). There were also increases in the flatfish and rockfish bottom trawl fisheries. The catch has decreased to near average levels in 2020, with very little taken in the pollock pelagic trawl fishery. The increase in 2019 may be due to shifts in fishing practices to avoid large increases of small sablefish in the Bering Sea. Overall, we rated the fishery performance concern as Level 1, normal, since the catch has returned to normal levels in the Bering Sea in 2020 and the biomass estimates from the longline and IPHC survey in 2020 increased from 2019.

Assessment-related considerations	*Population dynamics considerations*	*Environmental/ ecosystem considerations*	*Fishery Performance considerations*
Level 1: Normal	**Level 1:** Normal	**Level 1:** Normal	**Level 1:** Normal

All scores were Level 1 suggesting no need to consider an ABC below the maximum permissible.

Ecosystem Considerations

In general, a determination of ecosystem considerations for shortraker rockfish is hampered by the lack of biological and habitat information.

Ecosystem Effects on the Stock

Prey availability/abundance trends:

Similar to other rockfish species, stock condition of shortraker rockfish is probably influenced by periodic abundant year classes. Availability of suitable zooplankton prey items in sufficient quantity for larval or post-larval rockfish may be an important determining factor of year-class strength. Unfortunately, there is no information on the food habits of larval or post-larval rockfish to help determine possible relationships between prey availability and year-class strength. Moreover, visual identification to the species level for field-collected larval or post-larval rockfish is generally not reliable, although genetic techniques allow identification for larvae/post-larvae of many rockfish, including shortraker (Gharrett *et. al* 2001; Kondzela *et al.* 2007). Very few juvenile shortraker rockfish have ever been caught in Alaska, and therefore there is no information on their food items. Adult shortraker rockfish are apparently opportunistic feeders that in Alaska prey on shrimp, deepwater fish such as myctophids, and squid (Yang and Nelson 2000; Yang 2003; Yang *et al.* 2006). Little if anything is known about abundance trends of these rockfish prey items.

Predator population trends:

Rockfish are preyed on by a variety of other fish at all life stages, and to some extent by marine mammals during late juvenile and adult stages. Whether the impact of any particular predator is significant or dominant is unknown. Predator effects would likely be more important on larval, post-larval, and small juvenile shortraker rockfish, but information on these life stages and their predators is unknown. 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.

Changes in physical environment:

Strong year classes corresponding to the period around 1976-77 have been reported for many species of groundfish in the GOA, including Pacific ocean perch, northern rockfish, sablefish, and Pacific cod. Therefore, it appears that environmental conditions may have changed during this period in such a way that survival of young-of-the-year fish increased for many groundfish species, including slope rockfish. The environmental mechanism for this increased survival remains unknown. Changes in water temperature and currents could have an effect on prey item abundance and success of transition of rockfish from the pelagic to demersal stage. Rockfish in early juvenile stage have been found in floating kelp patches which would be subject to ocean currents.

Changes in bottom habitat due to natural or anthropogenic causes could affect survival rates by altering available shelter, prey, or other functions. Associations of juvenile rockfish with biotic and abiotic structure have been noted by Carlson and Straty (1981), Pearcy *et al.* (1989), Love *et al.* (1991), and Freese and Wing (2003). A study in the GOA based on observations from a manned submersible found that adult “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 were next to boulders with coral (Krieger and Wing 2002). Although the “large” rockfish could not be positively identified, it is likely based on location and depth that many were shortraker rockfish. The Essential Fish Habitat Environmental Impact Statement (EFH EIS) for groundfish in Alaska (NMFS 2005) concluded that the effects of commercial fishing on the habitat of groundfish is minimal or temporary based largely on the criterion that stocks were above the Minimum Stock Size Threshold (MSST). However, a review of the EFH EIS suggested that this criterion was inadequate to make such a conclusion (Drinkwater 2004). The trend in shortraker abundance suggests that any adverse effect has not prevented the stock from increasing since 1990.

Fishery Effects on the Ecosystem

Most of the catch in the Aleutian Islands is taken incidentally in trawl and longline fisheries, specifically the rockfish trawl fishery for Pacific ocean perch and for Atka mackerel, and the longline fisheries for sablefish and flatfish. Thus, the reader is referred to the discussions on “Fishery Effects” in those assessment chapters in this SAFE report.

Bottom trawl fisheries for shortraker and rougheye rockfish accounted for very little bycatch of HAPC biota. This low bycatch is likely explained by the fact that little targeted fishing occurs for these fish. Fishery-specific concentration of target catch in space and time relative to predator needs in space and time relative to spawning components are unknown. Fishery-specific effects on amount of large size target fish are unknown. Annual fishery discard rates since 2004 have been 20-50% for shortraker rockfish. The discard amount of species other than shortraker rockfish in hauls targeting shortraker rockfish is unknown. Fishery-specific effects on age-at-maturity and fecundity of the target fishery are unknown. Fishery-specific effects on EFH non-living substrate are unknown, but the heavy-duty “rockhopper” trawl gear commonly used in the rockfish fishery can move around rocks and boulders on the bottom.

Data Gaps and Research Priorities

Validating aging techniques of shortraker rockfish, and obtaining ages from archived samples are the primary research priorities for this stock and are required for age-structured population modeling. More information on the genetic population structure within the BSAI area is needed. Also, much additional research is needed on other aspects of shortraker rockfish biology and assessment. There is little to no information on larval, post-larval, or early stage juveniles of shortraker rockfish. In particular, information is lacking on juvenile shortraker rockfish, which are very seldom caught in any sampling gear. Habitat requirements for larval, post-larval, and early stages are mostly unknown. Habitat requirements for later stage juvenile and adult fish are mostly anecdotal or conjectural. While recent work has improved our understanding greatly (Du Preez and Tunnicliffe 2011, Laman et al. 2015), further research needs to be done on the bottom habitat of the fishing grounds, on what HAPC biota are found on these grounds, and on what impact bottom trawling has on the grounds. Investigation is needed on the distribution and abundance of shortraker rockfish in areas of rough bottom that cannot be sampled by trawl surveys. Little is known regarding the reproductive biology and given the relatively unusual reproductive biology of rockfish and its importance in establishing management reference points, data on reproductive capacity should be collected on a periodic basis.

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Tables

Table 15.1a Total allowable catch (TAC), acceptable biological catch (ABC), and catch (t) of the species groups used to manage shortraker rockfish from 1988 to 2003. The "other red rockfish" group includes, shortraker rockfish, rougheye rockfish, northern rockfish, and sharpchin rockfish. The "POP complex" includes the other red rockfish species plus POP. Sources: North Pacific Groundfish Observer Program, NMFS Alaska Regional Office, AKFIN, and PACFIN. Data for the Bering Sea (BS) and Aleutian Islands (AI) management areas are shown separately.

Year	Area	Management Group	ABC (t)	TAC (t)	Catch (t)
1988	BS	POP Complex	6,000		1,509
	AI	POP Complex	16,600		2,629
1989	BS	POP Complex	6,000		2,873
	AI	POP Complex	16,600		3,780
1990	BS	POP Complex	6,300		7,231
	AI	POP Complex	16,600		15,224
1991	BS	Other Red Rockfish	1,670	1,670	942
	AI	Shortraker/rougheye	1,245	1,245	388
1992	BS	Other Red Rockfish	1,400	1,400	467
	AI	Shortraker/rougheye	1,220	1,220	1,470
1993	BS	Other Red Rockfish	1,400	1,200	1,226
	AI	Shortraker/rougheye	1,220	1,100	1,139
1994	BS	Other Red Rockfish	1,400	1,400	129
	AI	Shortraker/rougheye	1,220	1,220	925
1995	BS	Other Red Rockfish	1,400	1,260	344
	AI	Shortraker/rougheye	1,220	1,098	559
1996	BS	Other Red Rockfish	1,400	1,260	207
	AI	Shortraker/rougheye	1,250	1,125	959
1997	BS	Other Red Rockfish	1,050	1,050	218
	AI	Shortraker/rougheye	938	938	1,043
1998	BS	Other Red Rockfish	267	267	112
	AI	Shortraker/rougheye	965	965	685
1999	BS	Other Red Rockfish	356	267	238
	AI	Shortraker/rougheye	1,290	965	514
2000	BS	Other Red Rockfish	259	194	253
	AI	Shortraker/rougheye	1,180	885	480
2001	BSAI	Shortraker/rougheye	1,028		
	BS	Shortraker/rougheye		116	72
	AI	Shortraker/rougheye		912	722
2002	BSAI	Shortraker/rougheye	1,028		
	BS	Shortraker/rougheye		116	105
	AI	Shortraker/rougheye		912	478
2003	BSAI	Shortraker/rougheye	967		
	BS	Shortraker/rougheye		137	124
	AI	Shortraker/rougheye		830	306

Table 15.1b Total allowable catch (TAC), acceptable biological catch (ABC), overfishing limit (OFL), and catch (t) of shortraker rockfish from 2004 to 2020 in the Bering Sea and Aleutian Islands management area. Source: AKFIN NMFS AKRO BLEND/Catch Accounting System. *Estimated removals through October 25, 2020.

Year	OFL	ABC	TAC	Catch
2004	701	526	526	242
2005	794	596	596	169
2006	774	580	580	215
2007	564	424	424	324
2008	564	424	424	133
2009	516	387	387	184
2010	516	387	387	300
2011	524	393	393	334
2012	524	393	393	344
2013	493	370	370	371
2014	493	370	370	198
2015	690	518	250	156
2016	690	518	200	109
2017	666	499	125	161
2018	666	499	150	248
2019	722	541	358	380
2020*	722	541	375	194

Table 15.2 Catches of shortraker rockfish (t) in the Bering Sea and Aleutian Islands management area, obtained from the North Pacific Groundfish Observer Program, NMFS Alaska Regional Office, AKFIN, and PACFIN, 1977-2020 (through October 25, 2020*).

	Eastern Bering Sea			Aleutian Islands			
Year	Foreign	Joint Venture	Domestic	Foreign	Joint Venture	Domestic	Total
1977	0	0		27	0		27
1978	1,069	0		874	0		1,943
1979	279	0		3,008	0		3,286
1980	649	0		185	0		833
1981	441	0		381	0		821
1982	242	0		379	0		621
1983	145	0		89	1		235
1984	54	0		28	0		83
1985	19	0		1	0		21
1986	2	2	14	0	0	12	30
1987	0	0	28	0	0	36	64
1988	0	0	31	0	0	37	69
1989	0	0	58	0	0	130	188
1990			116			546	662
1991			205			251	456
1992			79			289	368
1993			221			216	437
1994			46			176	223
1995			49			164	213
1996			87			143	230
1997			36			90	126
1998			52			159	211
1999			66			129	195
2000			130			200	330
2001			57			172	229
2002			93			206	299
2003			107			131	239
2004			118			123	242
2005			108			61	169
2006			47			168	215
2007			114			211	324
2008			41			91	133
2009			69			116	184
2010			160			140	300
2011			107			227	334
2012			117			227	344
2013			103			268	371
2014			96			102	198
2015			76			79	156
2016			55			55	109
2017			95			66	161
2108			168			80	248
2019			298			82	380
2020*			91			104	194

Table 15.3 Area-specific catches of shortraker rockfish (t) in the BSAI area from 1994-2020 (through October 25, 2020*). Abbreviations are: Western Aleutian Islands (WAI), Central Aleutian Islands (CAI), Eastern Aleutian Islands (EAI), Southern Bering Sea (SBS), Eastern Bering Sea (EBS), and Bering Sea (BS). Since 2002, Bering Sea catch has been reported in the Southern Bering Sea and the remainder of the Bering Sea. The Bering Sea areas are all remaining NMFS areas not reported in the other categories. Source: AKFIN NMFS AKRO BLEND/Catch Accounting System.

Year	WAI (543)	CAI (542)	EAI (541)		BS	Total
1994	2	84	91		46	223
1995	7	44	113		49	213
1996	33	48	63		87	230
1997	47	14	29		36	126
1998	27	100	32		52	211
1999	23	63	43		66	195
2000	20	85	95		130	330
2001	58	87	27		57	229
2002	78	62	66		93	299
Year	WAI (543)	CAI (542)	EAI (541)	SBS (517+518)	BS	Total
2003	30	65	37	0	107	239
2004	32	76	15	50	69	242
2005	27	17	18	69	38	169
2006	39	106	23	21	26	215
2007	23	145	44	78	35	324
2008	40	35	17	15	26	133
2009	34	41	41	41	28	184
2010	48	39	53	48	112	300
2011	160	39	28	24	83	334
2012	168	31	27	46	71	344
2013	163	68	37	37	66	371
2014	26	33	43	16	80	198
2015	13	40	26	20	56	156
2016	14	25	16	18	37	109
2017	12	30	24	28	66	161
2018	26	29	25	77	91	248
2019	22	49	11	168	130	380
2020*	51	27	26	45	46	194

Table 15.4 Estimated catch retained (t), discarded (t), and percent discarded of other red rockfish (ORR) and shortraker/rougheye (SR/RE) from the eastern Bering Sea (EBS) and Aleutian Islands (AI) regions, 1993-2020 (through October 25, 2020*). Prior to 2001, Other Red Rockfish (ORR) in the eastern Bering Sea was managed as a single complex. Between 2001-2003, it was managed as a shortraker/rougheye rockfish complex (SR/RE). Source: AKFIN NMFS AKRO BLEND/Catch Accounting System.

Area	Species Group	Year	Catch Retained	Discard	Total	Percentage
EBS	ORR	1993	916	308	1226	25.2%
		1994	29	100	129	77.6%
		1995	273	70	343	20.4%
		1996	58	149	207	71.9%
		1997	43	174	217	80.0%
		1998	42	70	112	62.4%
		1999	75	162	238	68.4%
		2000	111	141	252	55.9%
EBS.	SR/RE	2001	27	16	43	34.7%
		2002	50	54	104	51.9%
		2003	66	58	124	46.8%
AI	SR/RE	1993	737	403	1,139	35.3%
		1994	701	224	925	24.2%
		1995	456	103	559	18.4%
		1996	751	208	959	21.7%
		1997	733	310	1,043	29.7%
		1998	447	238	685	34.8%
		1999	319	195	514	38.0%
		2000	285	196	480	40.8%
		2001	476	246	722	34.1%
		2002	333	146	478	30.4%
		2003	214	92	306	29.9%
BSAI	Shortraker	2004	143	99	242	41.0%
		2005	129	40	169	23.9%
		2006	130	85	215	39.5%
		2007	163	162	324	49.9%
		2008	102	31	133	23.3%
		2009	136	48	184	26.2%
		2010	228	72	300	23.9%
		2011	299	35	334	10.4%
		2012	290	54	344	15.6%
		2013	262	110	371	29.5%
		2014	107	92	198	46.3%
		2015	112	44	156	28.3%
		2016	77	32	109	29.5%
		2017	104	57	161	35.6%
		2018	181	68	248	27.2%
		2019	285	95	380	24.9%
		2020*	153	42	194	21.4%

Table 15.5 Aleutian Islands sum of total catch (t) of shortraker rockfish by management area and target fishery from 2004-2020. Source: AKFIN NMFS AKRO BLEND/Catch Accounting System.

		Management area				
Target Fishery	Gear	541	542	543	Total	% of Total
Pacific Cod	Longline	47.79	59.49	18.81	126.09	5.73%
Halibut	Longline	55.27	35.40	10.13	100.80	4.58%
Rockfish	Longline	0.02	4.09	0.64	4.75	0.22%
Other species	Longline		6.18		6.18	0.28%
Flatfish	Longline	2.52	177.62		180.13	8.18%
Sablefish	Longline	74.03	83.43	21.08	178.54	8.11%
Atka Mackerel	Bottom Trawl	57.40	125.05	68.23	250.68	11.38%
Flatfish	Bottom Trawl	58.85			58.85	2.67%
Kamchatka Fl.	Bottom Trawl	52.62			52.62	2.39%
Pacific Cod	Bottom Trawl	0.94	6.50	0.02	7.46	0.34%
Pollock	Bottom Trawl	0.48	0.22		0.69	0.03%
Rockfish	Bottom Trawl	117.79	329.57	779.24	1,226.61	55.70%
Pacific Cod	Pot	0.04	0.74		0.78	0.04%
Rockfish	Pot	0.01			0.01	0.00%
Sablefish	Pot	5.09	1.81		6.91	0.31%
Pollock	Pelagic Trawl	0.49			0.49	0.02%
	Total	473.77	830.09	898.15	2,202.01	100%

Table 15.6 Eastern Bering Sea sum of total catch (t) of shortraker rockfish by management area and target fishery from 2004-2020. Source: AKFIN NMFS AKRO BLEND/Catch Accounting System. Bottom trawl is abbreviated “Bottom Trw.”.

		Management Area									
Target	Gear	509	513	514	517	518	519	521	523	524	% of Total
Flatfish	Longline				2.06	0.64	0.16	74.03	30.87	1.22	5.86
Halibut	Longline		1.70	3.14	5.30	19.38	6.68	90.04	15.68	13.82	8.37
Other	Longline							0.39	4.24		0.25
Pacific Cod	Longline	0.01	0.08	0.01	17.74	0.88	18.63	176.98	44.63	0.03	13.92
Pollock	Longline							0			0.00
Rockfish	Longline				0.97	0.01	1.53	1.66	1.65		0.31
Sablefish	Longline				7.02	2.82	1.06	0.99	0.40	0.00	0.66
Atka Mackerel	Bottom Trw.						6.94				0.37
Flatfish	Bottom Trw.	0.05	0.24		209.00	18.49	24.19	141.48	19.27	4.08	22.40
Kamchatka Fl.	Bottom Trw.				13.51	11.96	0.63	0.14	4.27	1.58	1.72
Other species	Bottom Trw.				1						0.07
Pacific Cod	Bottom Trw.				0.18		4.83	1.37			0.34
Pollock	Bottom Trw.				1.25	1.00	0.31	1.69		0.31	0.24
Rockfish	Bottom Trw.				175.37	6.28	44.57	117.88	50.68		21.21
Sablefish	Bottom Trw.				8		0				0.43
Pacific Cod	Pot	0.00			0.14		0.05				0.01
Sablefish	Pot				0.15	1.50	0.91				0.14
Pollock	Pelagic Trw.	0.30	2.38		296.17		5.68	113.85	19.21	3.03	23.68
Rockfish	Pelagic Trw.								0		0.01
Flatfish	Trawl				0						0.01
Total		0.36	4.41	3.15	737.93	62.98	116.5	720.54	191.10	24.07	100.00

Table 15.7 Estimated biomass (t) of shortraker rockfish from the NMFS bottom trawl surveys, with the coefficient of variation (CV) in parentheses. Regions presented are the western Aleutian Islands (WAI), Central Aleutian Islands (CAI), Eastern Aleutian Islands (EAI), the Southern Bering Sea (SBS), and the Eastern Bering Sea (EBS) slope. The SBS is surveyed as part of the Aleutian Islands survey.

Year	WAI	CAI	EAI	SBS	AI survey (total)	EBS Slope survey
1979						1,391
1980	0	2,665	4,165	45	6,874 (0.55)	
1981						3,571
1982						5,176
1983	7,249	7,239	11,787	9,477	35,753 (0.19)	
1984						
1985						4,010
1986	1,821	4,291	5,554	6,485	18,153 (0.28)	
1987						
1988						1,260 (0.43)
1989						
1990						
1991	17,558	3,225	1,053	1,925	23,761 (0.64)	2,758 (0.38)
1992						
1993						
1994	6,493	8,164	11,627	1,959	28,244 (0.21)	
1995						
1996						
1997	6,658	21,560	7,840	2,428	38,487 (0.26)	
1998						
1999						
2000	17,746	13,543	5,863	645	37,797 (0.44)	
2001						
2002	3,906	8,639	2,797	1,463	16,805 (0.19)	4,851 (0.44)
2003						
2004	16,333	8,779	7,499	630	33,242 (0.37)	2,570 (0.22)
2005						
2006	2,471	5,335	3,975	1,180	12,961 (0.23)	
2007						
2008						7,308 (0.31)
2009						
2010	6,729	7,424	4,071	15	18,239 (0.23)	4,365 (0.28)
2011						
2012	4,455	7,182	4,031	562	16,230 (0.26)	9,284 (0.57)
2013						
2014	1,579	12,678	2,144	28	16,429 (0.38)	
2015						
2016	5,846	3,150	6,030	74	15,099 (0.31)	6,258 (0.29)
2017						
2018	11,970	2,933	11,417	13	26,333 (0.55)	

Table 15.8 Shortraker rockfish relative population numbers (RPN) and relative population weight (RPW) estimated from the AFSC longline survey by region for 1996-2020.

	Aleutian Islands		Bering Sea		BSAI	
	RPN	RPW	RPN	RPW	RPN	RPW
1996	16,381	18,325			16,381	18,325
1997	19,553	23,598	4,536	8,470	24,089	32,068
1998	18,770	20,854	5,777	10,063	24,548	30,918
1999	18,144	18,807	11,268	24,799	29,412	43,606
2000	26,480	22,664	14,094	32,430	40,573	55,094
2001	22,157	19,058	8,520	17,858	30,677	36,916
2002	17,354	15,437	6,251	12,486	23,605	27,924
2003	15,304	14,638	19,569	47,179	34,873	61,817
2004	21,961	18,230	21,454	47,413	43,415	65,642
2005	15,369	13,074	7,489	11,856	22,858	24,931
2006	31,612	30,028	10,267	15,339	41,879	45,367
2007	43,803	42,942	7,544	13,843	51,348	56,785
2008	15,447	13,370	7,034	12,380	22,481	25,750
2009	15,428	13,591	2,882	4,886	18,309	18,477
2010	27,009	20,252	1,970	3,162	28,979	23,414
2011	40,486	30,776	8,603	17,331	49,089	48,107
2012	21,971	19,855	6,416	13,538	28,387	33,392
2013	18,415	15,948	6,156	9,627	24,572	25,575
2014	25,994	23,787	8,563	14,586	34,557	38,373
2015	24,824	22,371	6,708	12,370	31,532	34,741
2016	16,429	13,640	4,918	9,419	21,348	23,059
2017	22,764	16,778	11,042	18,642	33,806	35,420
2018	18,156	16,321	8,677	14,518	26,833	30,838
2019	19,882	19,328	11,466	22,609	31,348	41,937
2020	17,232	15,759	9,980	20,011	27,212	35,770

Table 15.9 Shortraker rockfish relative population numbers (RPNs) and number of stations sampled from the IPHC longline survey by region for 1998-2019.

	Aleutian Islands		Bering Sea		BSAI	
	RPN	# of stations	RPN	# of stations	RPN	# of stations
1998	113.88	78	46.75	48	160.63	126
1999	190.38	91	56.43	8	246.80	99
2000	146.74	98	87.97	95	234.71	193
2001	88.95	96	30.30	100	119.25	196
2002	77.76	96	51.99	100	129.74	196
2003	84.22	92	144.42	103	228.64	195
2004	183.34	93	107.20	103	290.55	196
2005	284.26	98	82.23	100	366.49	198
2006	210.74	97	24.90	214	235.64	311
2007	190.47	92	47.80	133	238.28	225
2008	118.53	95	68.16	130	186.70	225
2009	128.78	95	234.74	129	363.51	224
2010	249.96	93	123.05	130	373.01	223
2011	292.36	93	76.47	129	368.82	222
2012	63.10	95	73.61	133	136.71	228
2013	138.33	95	150.31	127	288.64	222
2014	78.57	114	33.55	180	112.12	294
2015	116.66	96	158.13	215	274.79	311
2016	103.78	92	48.67	216	152.44	308
2017	93.70	207	28.69	133	122.39	340
2018	2.90	95	31.14	128	34.04	223
2019	79.03	94	141.48	127	220.51	221

Table 15.10 Estimated biomass for shortraker rockfish from the 2018 assessments. The current Bering Sea slope survey was initiated in 2002; therefore, the first estimate is for 2002.

Year	2018 Assessment		
	Biomass (t)	Lower CI	Upper CI
2002	23,706	18,212	30,857
2003	23,218	17,306	31,151
2004	22,826	16,954	30,730
2005	21,772	16,029	29,573
2006	20,932	15,200	28,826
2007	21,193	15,172	29,604
2008	21,829	15,757	30,241
2009	21,941	16,190	29,736
2010	22,119	17,087	28,634
2011	22,340	16,824	29,663
2012	22,710	17,212	29,963
2013	22,636	16,629	30,813
2014	22,681	16,621	30,950
2015	22,837	16,484	31,638
2016	22,995	16,717	31,630
2017	23,512	16,274	33,970
2018	24,055	15,911	36,369

Table 15.11 Random effect estimates of biomass (t) for shortraker rockfish from 2002-2018, for the Eastern Bering Sea (Bering Sea slope and Southern Bering Sea), and the Aleutian Islands region.

Year	Eastern Bering Sea	Aleutian Islands	Total
2002	4,910	18,796	23,706
2003	4,369	18,849	23,218
2004	3,923	18,903	22,826
2005	4,470	17,302	21,772
2006	5,096	15,836	20,932
2007	5,088	16,105	21,193
2008	5,450	16,379	21,829
2009	5,284	16,658	21,941
2010	5,178	16,941	22,119
2011	5,622	16,717	22,340
2012	6,213	16,496	22,710
2013	6,081	16,555	22,636
2014	6,067	16,614	22,681
2015	6,128	16,709	22,837
2016	6,191	16,804	22,995
2017	6,169	17,343	23,512
2018	6,157	17,899	24,055

Figures

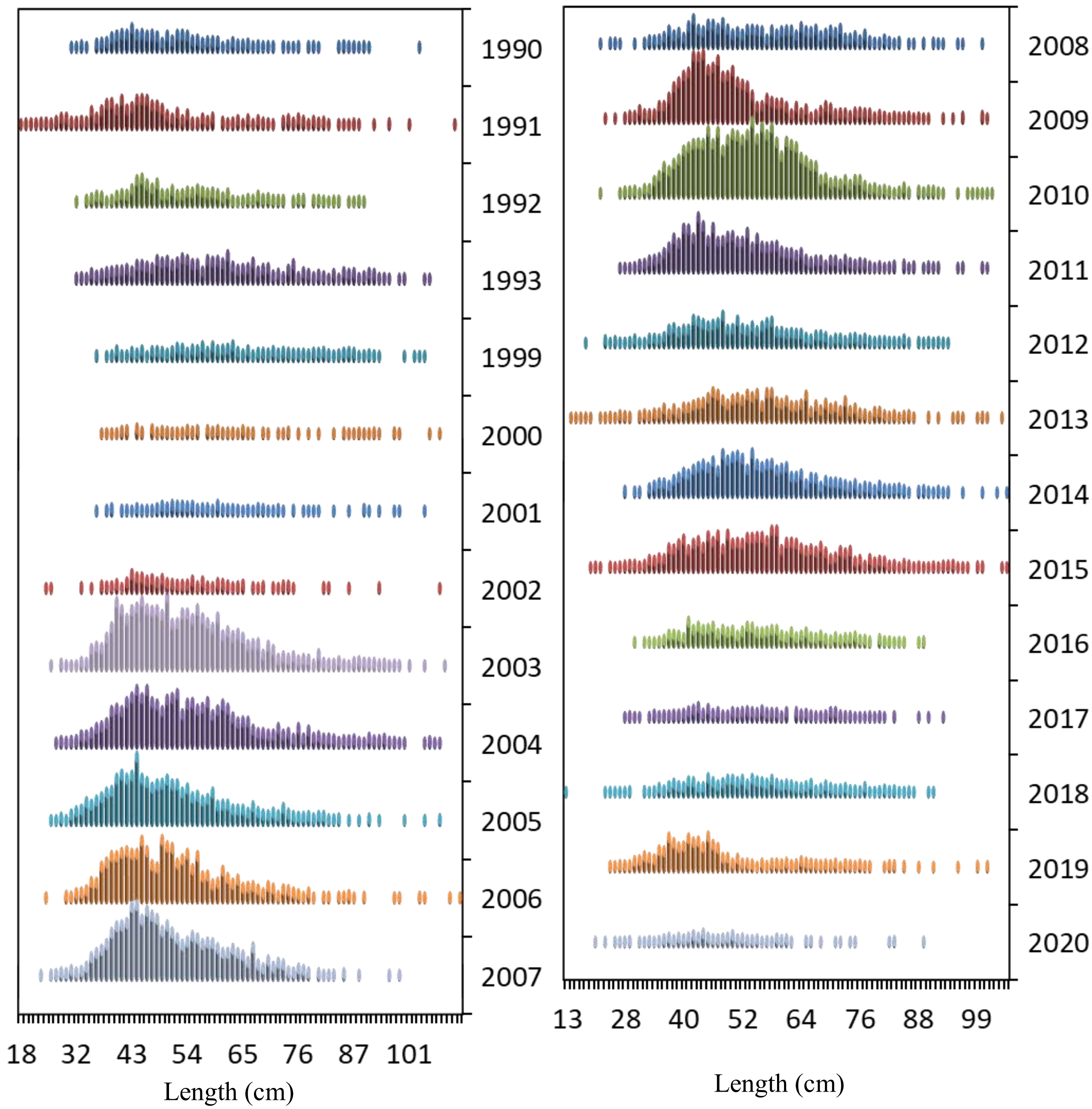


Figure 15.1 Lengths from the US domestic fishery, 1990-2020. Source: AKFIN NMFS AFSC FMA Observer Debriefed Haul and Length tables.

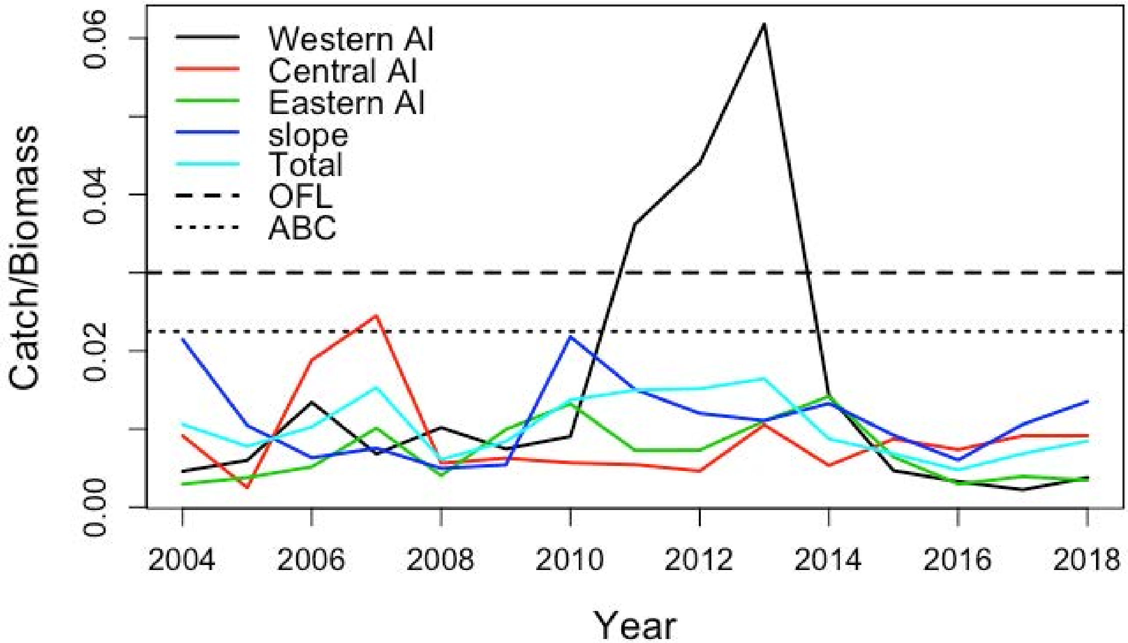
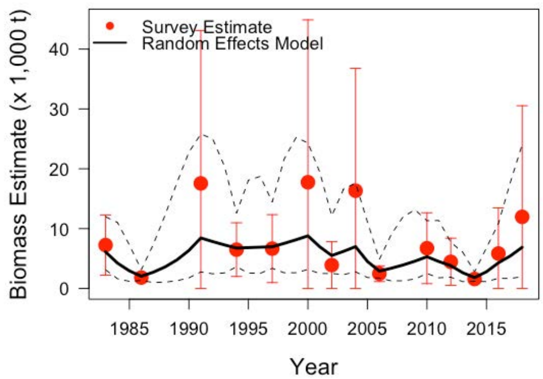
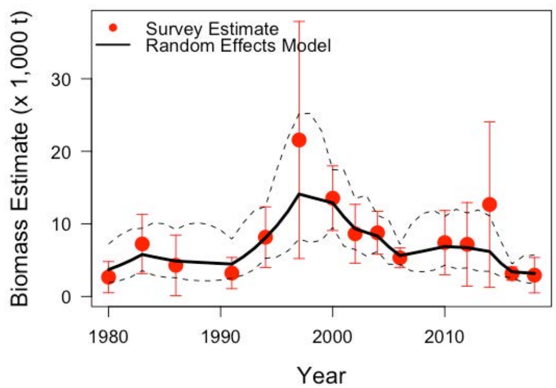


Figure 15.2 Area-specific exploitation rates for BSAI shortraker rockfish from 2003-2018, and for the entire BSAI. Abbreviations are: Western Aleutian Islands (AI), Central Aleutian Islands (AI), Eastern Aleutian Islands (AI), Southern Bering Sea slope (slope), and Bering Sea (BS).

Western Aleutian Islands



Central Aleutian Islands



Eastern Aleutian Islands

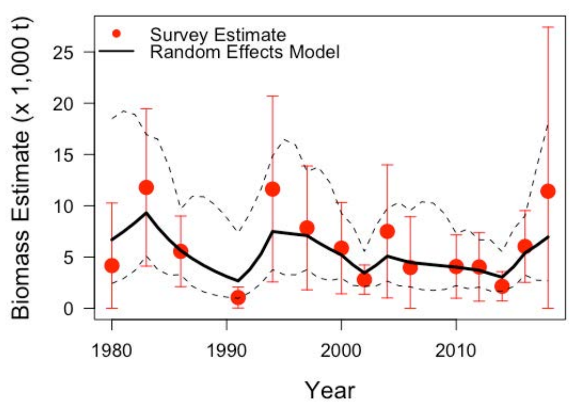


Figure 15.3 Random effects model estimates of Aleutian Islands shortraker rockfish: Western Aleutian Islands (upper panel), Central Aleutian Islands (middle), Eastern Aleutian Islands (lower panel). Observed survey biomass are shown (red data points with 95% confidence interval), and predicted survey biomass estimates using the random effects model (black lines with 95% confidence intervals are shown as dotted lines).

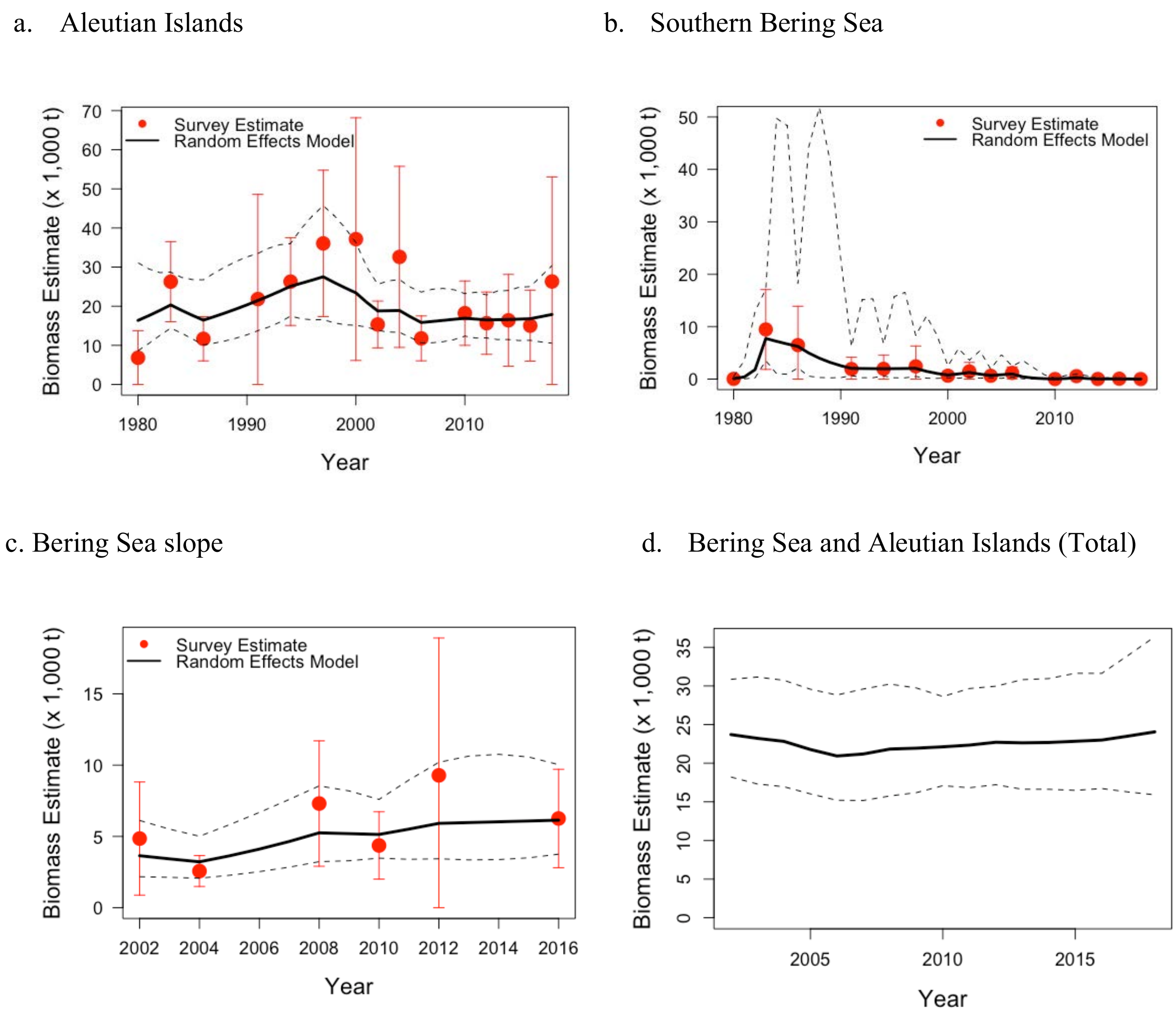


Figure 15.4 Observed survey biomass (red data points with 95% confidence interval), and predicted survey biomass estimates using the random effects model (black lines with 95% confidence intervals shown as dotted lines). Panel (a.) Aleutian Islands, (b.) Southern Bering Sea, (c.) Bering Sea slope, and (d.) total estimate for the Bering Sea and Aleutian Islands.

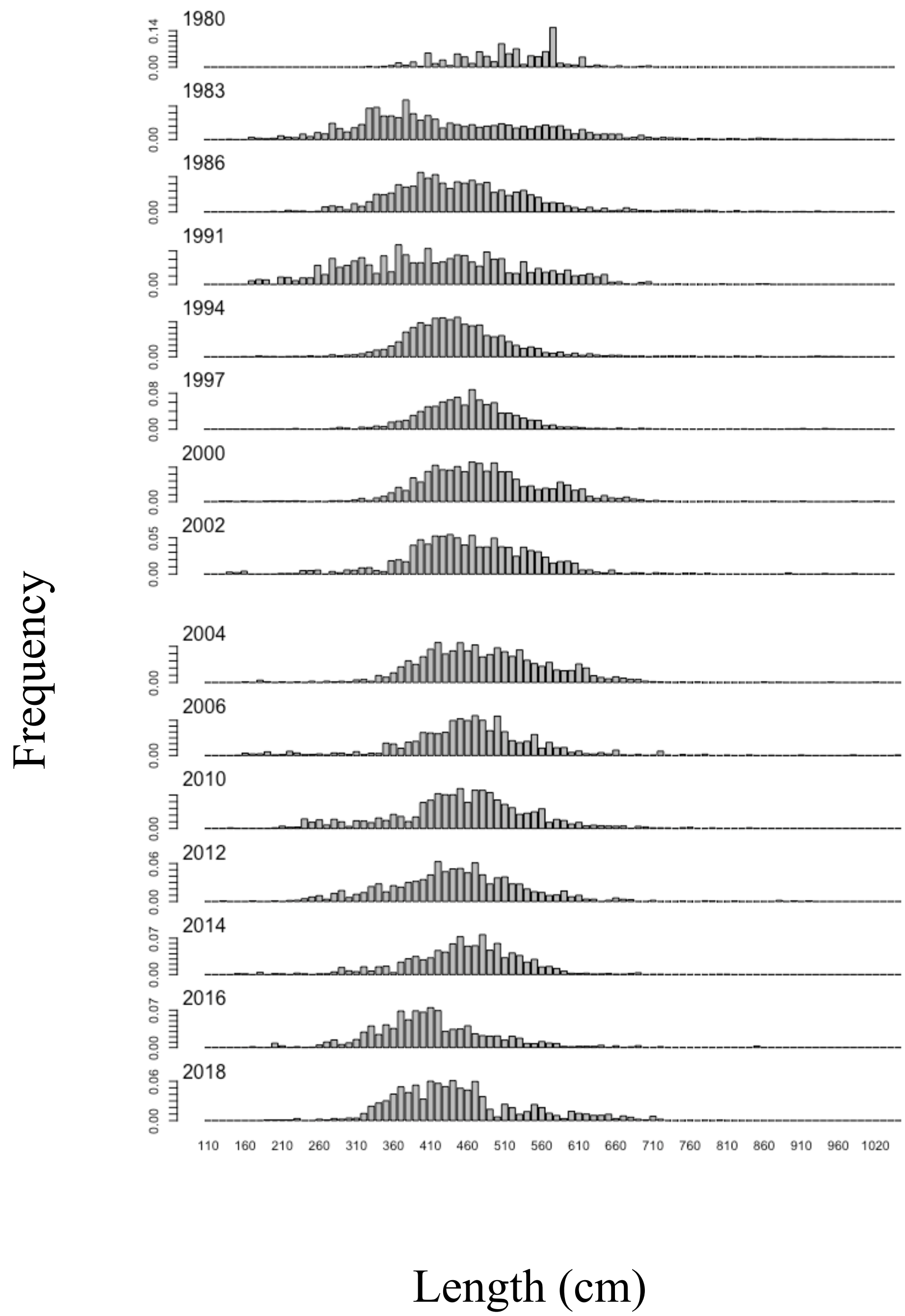


Figure 15.5 Length compositions from the Aleutian Islands trawl surveys, 1980-2018.

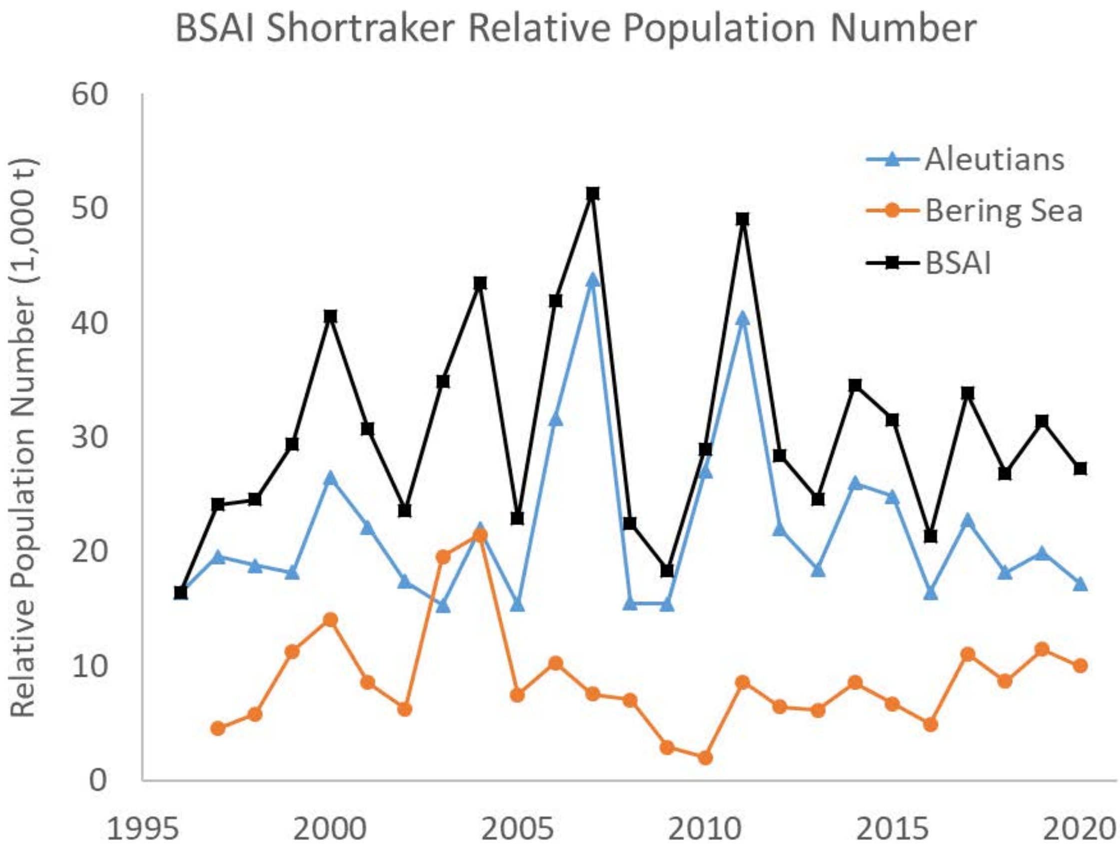


Figure 15.6 AFSC Longline survey index for shortraker rockfish in the Bering Sea and Aleutian Islands, 1996-2020. Source: AKFIN NMFS AFSC Longline Survey Web Areas table.

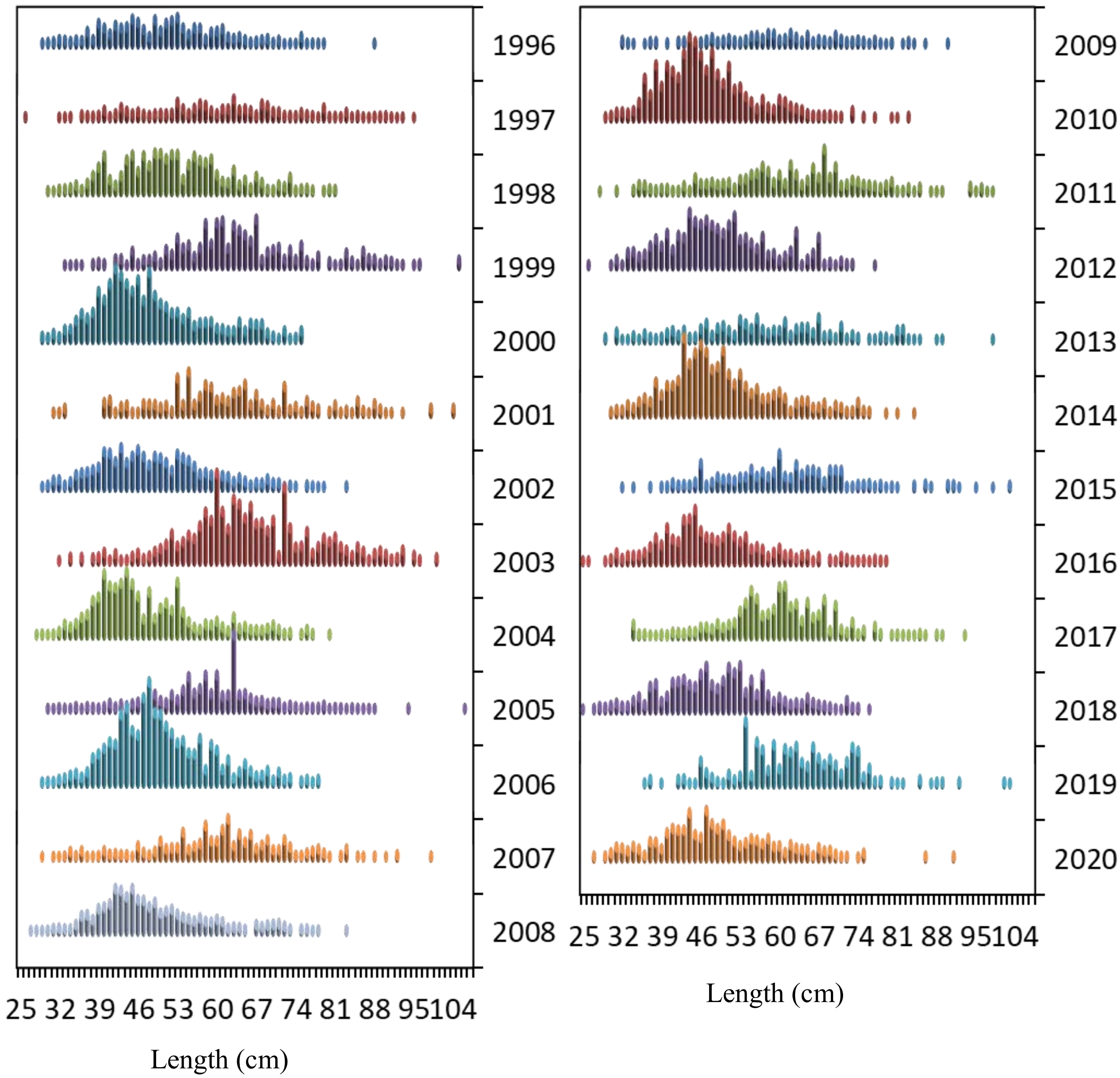


Figure 15.7 Length compositions from the AFSC domestic longline survey, 1996-2020. Source: AKFIN NMFS AFSC Longline Survey Length Frequencies Strata 3-7 table.

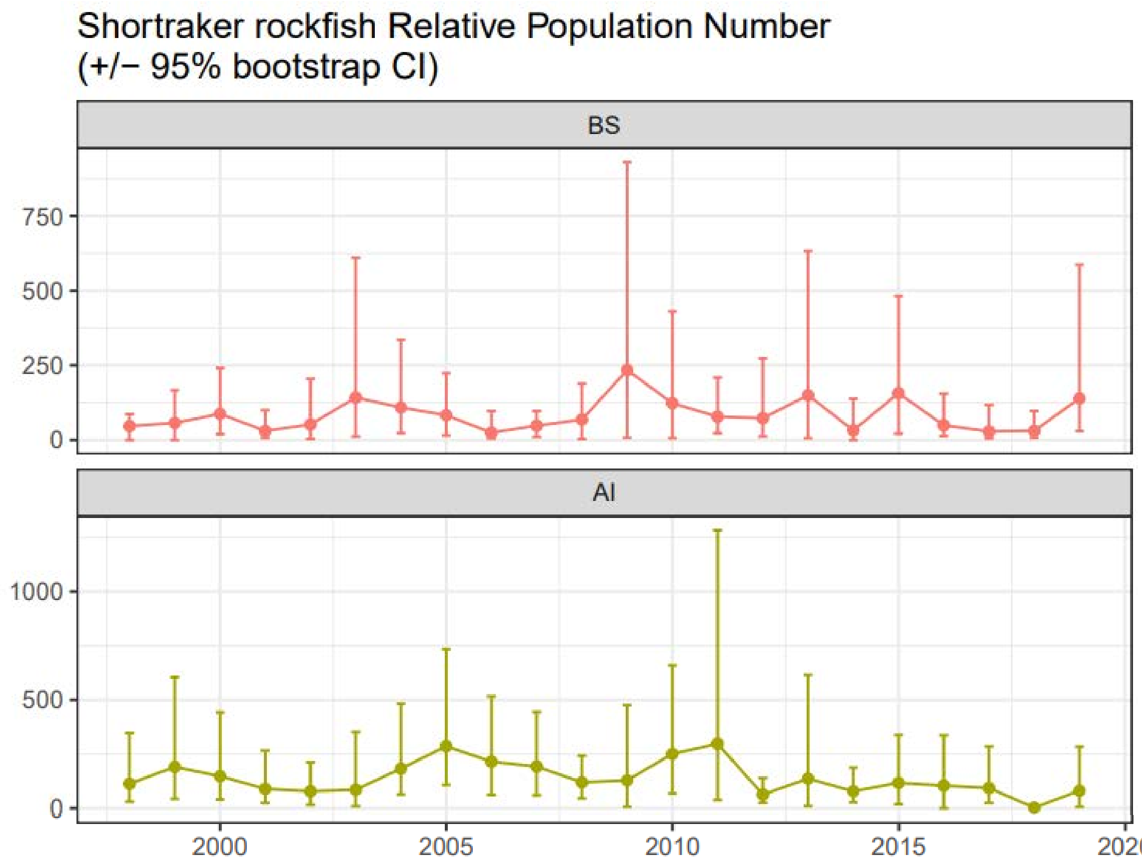


Figure 15.8 International Pacific Halibut Commission survey index for shortraker rockfish in all Alaska regions, 1998-2019.

Appendix 1. Supplemental Catch Data

Here we present non-commercial removals, estimates of total removals that do not occur during directed groundfish fishing activities, in order to comply with the Annual Catch Limit (ACL) requirements (Tables A1.1 and A1.2). Data is not available for 2020; therefore data is presented through 2019. This includes removals incurred during research, subsistence, personal use, recreational, and exempted fishing permit activities, but does not include removals taken in fisheries other than those managed under the groundfish FMP. These estimates represent additional sources of removals to the existing Catch Accounting System estimates. For Bering Sea/Aleutian Islands (BSAI) shortraker rockfish, these estimates can be compared to the trawl research removals reported in previous assessments. Shortraker rockfish research removals are small relative to the fishery catch. The majority of removals are taken by the Alaska Fisheries Science Center's (AFSC) biennial bottom trawl survey which is the primary research survey used for assessing the population status of BSAI shortraker rockfish. Other research activities that harvest shortraker rockfish include other trawl research activities and minor catches occur in longline surveys conducted by the International Pacific Halibut Commission and the AFSC. Some catches in the AFSC longline survey are reported as shortraker/rougheye. Total removals of shortraker and "shortraker/rougheye" rockfish were less than 3 t and 2 t in 2018 and 2019, respectively, which represent less than 1% of the ABC in these years. Research harvests in even years beginning in 2000 (excluding 2008, when the Aleutian Islands (AI) trawl survey was canceled) are higher due to the biennial cycle of the AFSC bottom trawl survey in the AI. These catches have varied between 1 and 15 t (in 1983).

Table 15.A.1 Removals (t) of BSAI shortraker rockfish from activities other than groundfish fishing, 1977-2004. Trawl and longline include research survey and occasional short-term projects. "Other" is recreational, personal use, and subsistence harvest.

		Shortraker			Shortraker/Rougheye	
Year	Source	Trawl	Longline	Other	Trawl	Longline
1977	NMFS-AFSC survey databases					
1978						
1979		0.933				
1980		5.707				
1981		4.972				
1982		7.646				
1983		15.496				
1984						
1985		9.246				
1986		9.151				
1987						
1988		0.336				
1989						
1990						
1991		3.437				
1992						
1993		0.008				
1994		4.604				
1995						
1996						
1997		5.824				
1998			0.830			2.174
1999		0.017	1.198			0.494
2000		6.348	0.973			2.066
2001		0.010	1.258			0.422
2002		3.875	0.785			1.649
2003			2.138			0.376
2004		5.367	0.691			1.680

Table 15.A.2 Removals (kg) of BSAI shortraker rockfish from activities other than groundfish fishing, 2005-2019. Data from 2020 is not yet available.

Year	Aleutian Islands Survey	Bering Sea Longline Survey	Bering Sea slope survey	IPHC Longline survey	Total
2005	0	1,300	0	0	1,300
2006	0	1,154	0	0	1,154
2007	0	1,323	0	0	1,323
2008	0	647	0	0	647
2009	0	1,708	0	0	1,708
2010	1,397	974	1,367	1,595	5,333
2011	0	1,424	0	1,120	2,544
2012	2,009	690	1,176	561	4,436
2013	0	1,239	0	509	1,748
2014	1,571	904	0	851	3,326
2015	0	1,496	0	1,062	2,558
2016	1,564	700	967	541	3,772
2017	0	2,260	0	972	3,232
2018	1,318	709		303	2,331
2019		1,000		1,007	2,007