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

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Executive Summary

Summary of Changes in Assessment Inputs

Changes in the input data:

1) The catch data have been revised and updated through October 17, 2018.
2) Biomass and variance estimates from the 2016 and 2018 Aleutian Islands (AI) trawl survey and the 2016 Eastern Bering Sea slope survey were added to the model input data.

Changes in the assessment methodology:

The assessment methodology has not changed since the last full assessment in 2014.

Summary of Results

The recommended 2019 ABC and OFL for BSAI shortraker rockfish are 541 t and 722 t, respectively. This represents an increase of 8% from last year's values. A summary of the recommended ABCs and OFLs for 2019 and 2020 relative to the ABC and OFL specified last year is shown below.

	As estimated or *specified last* year for:		As estimated or *recommended this* year for:	
Quantity	2018	2019	2019	2020
M (natural mortality rate)	0.03	0.03	0.03	0.03
Tier	5	5	5	5
Biomass (t)	22,191	22,191	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)	666	666	722	722
maxABC (t)	499	499	541	541
ABC (t)	499	499	541	541
	As determined *last* year for:		As determined *this* year for:	
Status	2016	2017	2017	2018
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 2017-2020.

Year	Biomass	OFL	ABC	TAC	Catch
2017	22,191	666	499	125	161
2018	22,191	666	499	150	203[1]
2019	24,055	722	541		
2020	24,055	722	541		

[1] Catch as of October 17, 2018.

Responses to SSC and Plan Team Comments on Assessments in General

None pertaining to this assessment.

Responses to SSC and Plan Team Comments Specific to this Assessment

October 2014 SSC meeting: The Plan Team recommended and the SSC agrees that the random effects model be included in the November assessment anticipating that this will be the Team's preferred model for use in setting ABC and OFL.

Authors' response: The 2014 assessment is based on the random effects model. Results using the surplus production model, last year's approved model, are presented in an appendix.

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 1988-2018 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 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 1994-2018 have been variable, with the largest catches occurring in the EBS in 1978 and 1979 (Table 15.2). From 2004 to 2018, 42% of the shortraker catch occurred in the EBS, with 22%, 24%, and 13% in the central, western, and eastern AI areas respectively. Catches in the western AI averaged 35 t from 2004-2010, then increased in 2011-2013 to an average of 164 t, and decreased to an average of 19 t from 2014-2018. Catch as of October 17, 2018 was 26 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 2004-2018 have ranged from 10% to 50%, and were 36% in 2017 and 34% for 2018 (through October 17).

Shortraker rockfish in the AI have been primarily taken in the rockfish trawl fishery (63%), and the Atka mackerel fishery (11%), as well as the flatfish (10%) and sablefish (10%) longline fisheries, with lesser catches from the halibut (6%) and Pacific cod (5%) fisheries (Table 15.5). Catches of shortraker rockfish from 2004-2018 in the EBS were caught largely in the midwater pollock trawl fishery (22%), flatfish trawl fishery (20%), rockfish bottom trawl (18%), cod longline (18%), and the halibut (10%) and flatfish (8%) 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 eastern Bering Sea 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 70 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	2005	1,352
1991	576	2006	1,464
1992	413	2007	1,730
1993	736	2008	702
1994	125	2009	1,346
1995	306	2010	2,156
1996	114	2011	1,158
1997	138	2012	709
1998	226	2013	835
1999	2,000	2014	1,137
2000	1,630	2015	1,260
2001	373	2016	493
2002	576	2017	234
2003	413	2018	259
2004	736		

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 518 and 519) 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, Figure 15.2a). The 2018 catch in the WAI is the highest since 2013, as of October 17, 2018. Catch of shortraker rockfish in the SBS is variable, ranging from 0-40 t from 2003-2018 (Table 15.3). Biomass in that region appears to be decreasing, and the current year 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

Biomass estimates for other red rockfish were produced from cooperative U.S.-Japan trawl surveys from 1979-1985 on the EBS Bering Sea 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.

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 eastern AI (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.

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 rockish 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 15.8 and 15.9).

More shortraker rockfish are present in the Aleutian Islands than the Eastern Bering Sea. The random effects model results estimated 6,157 t in the Eastern Bering Sea and 17,899 t in the Aleutian Islands 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 0.75*M,* respectively:

2018	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

Data Gaps and Research Priorities

Validating aging techniques of shortraker rockfish, and obtaining ages from archived samples, remains research priorities and are required for age-structured population modeling. More information on the genetic population structure within the BSAI area is needed. Little is known regarding most aspects of the biology of shortraker rockfish, including the reproductive biology and distribution, duration, and habitat requirements of various life-history stages. 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 2018 in the Bering Sea and Aleutian Islands management area. Source: AKFIN NMFS AKRO BLEND/Catch Accounting System. *Estimated removals through October 17, 2018.

Year	OFL	ABC	TAC	Catch
2004	701	526	526	242
2005	794	596	596	170
2006	774	580	580	213
2007	564	424	424	323
2008	564	424	424	133
2009	516	387	387	184
2010	516	387	387	303
2011	524	393	393	334
2012	524	393	393	344
2013	493	370	370	372
2014	493	370	370	198
2015	690	518	250	156
2016	690	518	200	109
2017	666	499	125	161
2018*	666	499	150	203*

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, 1977-2018 (through October 17, 2018*).

	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			119			123	242
2005			108			62	170
2006			47			165	212
2007			114			210	323
2008			41			91	133
2009			69			116	184
2010			161			139	300
2011			106			227	333
2012			117			227	344
2013			105			268	372
2014			96			102	198
2015			76			79	156
2016			55			55	109
2017			95			66	161
2018*			123*			80*	203*

* Estimated removals through October 17, 2018.

Table 15.3. Area-specific catches of shortraker rockfish (t) in the BSAI area from 1994-2018 (through October 17, 2018*). 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	5	114	242
2005	27	17	18	5	103	170
2006	39	103	23	2	45	212
2007	23	145	43	6	108	323
2008	40	35	17	12	29	133
2009	34	41	41	15	54	184
2010	48	40	51	7	154	300
2011	162	37	28	21	85	333
2012	168	32	27	40	77	344
2013	163	68	37	12	93	372
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	30	65	161
2018*	26*	29*	24*	39*	83*	203*

* Estimated removals through October 17, 2018.

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, 1993-2018 (through October 17, 2018*). 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	41.1%
		2005	129	40	170	23.9%
		2006	130	82	212	38.7%
		2007	163	161	323	49.7%
		2008	102	31	133	23.3%
		2009	136	48	184	26.2%
		2010	230	70	300	23.4%
		2011	299	34	333	10.2%
		2012	290	54	344	15.8%
		2013	262	111	372	29.8%
		2014	107	92	198	46.27%
		2015	112	44	156	28.21%
		2016	77	32	109	29.63%
		2017	104	57	161	35.53%
		2018*	135*	68*	203*	33.61%*

* Estimated removals through October 17, 2018.

Table 15.5. Aleutian Islands sum of total catch (t) of shortraker rockfish by management area and target fishery from 2004-2018. Source: AKFIN NMFS AKRO BLEND/Catch Accounting System.

		Management area				
Target Fishery	Gear	541	542	543	Total	% of Total
Pacific Cod	Longline	49.17	34.77	16.72	100.66	5.58%
Halibut	Longline	53.86	34.86	9.95	98.68	5.47%
Rockfish	Longline	0.02	4.09	0.61	4.72	0.26%
Other species	Longline	0.00	6.18	0.00	6.18	0.34%
Flatfish	Longline	2.52	177.62	0.00	180.13	9.98%
Sablefish	Longline	72.27	80.85	21.11	174.23	9.65%
Atka Mackerel	Bottom Trawl	48.51	108.15	39.33	195.99	10.86%
Flatfish	Bottom Trawl	58.12	0.00	0.00	58.12	3.22%
Kamchatka Fl.	Bottom Trawl	38.87	0.00	0.00	38.87	2.15%
Pacific Cod	Bottom Trawl	0.93	6.49	0.02	7.44	0.41%
Pollock	Bottom Trawl	0.47	0.22	0.00	0.69	0.04%
Rockfish	Bottom Trawl	104.82	296.46	740.20	1,141.48	63.24%
Pacific Cod	Pot	0.00	0.73	0.00	0.73	0.04%
Rockfish	Pot	0.01	0.00	0.00	0.01	0.00%
Sablefish	Pot	4.96	1.73	0.00	6.68	0.37%
Pollock	Pelagic Trawl	0.49	0.00	0.00	0.49	0.03%
	Total	435.02	752.14	827.93	1,804.86	100.00%

Table 15.6. Eastern Bering Sea sum of total catch (t) of shortraker rockfish by management area and target fishery from 2004-2018. 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	0.00	0.00	0.00	2.06	1.92	0.16	73.48	28.98	1.21	7.53
Halibut	Longline	0.00	1.63	2.90	5.00	18.02	5.32	85.05	15.60	13.49	10.27
Other	Longline	0.00	0.00	0.00	0.00	0.00	0.00	0.35	4.24	0.00	0.32
Pacific Cod	Longline	0.01	0.08	0.00	17.58	0.54	18.85	176.54	45.23	0.03	18.09
Pollock	Longline	0.00	0.00	0.00	0.00	0.00	0.00	0.04	0.00	0.00	0.00
Rockfish	Longline	0.00	0.00	0.00	0.97	0.01	0.02	5.26	1.60	0.00	0.55
Sablefish	Longline	0.00	0.00	0.00	6.93	2.82	1.12	0.98	0.40	0.00	0.86
Atka Mackerel	Bottom Trw.	0.00	0.00	0.00	0.00	0.00	6.78	0.00	0.00	0.00	0.47
Flatfish	Bottom Trw.	0.05	0.24	0.00	118.16	18.49	22.99	122.52	7.94	1.63	20.41
Kamchatka Fl.	Bottom Trw.	0.00	0.00	0.00	0.07	11.02	0.63	0.10	0.37	0.36	0.88
Other species	Bottom Trw.	0.00	0.00	0.00	1.30	0.00	0.00	0.00	0.00	0.00	0.09
Pacific Cod	Bottom Trw.	0.00	0.00	0.00	0.18	0.00	4.83	0.87	0.00	0.00	0.41
Pollock	Bottom Trw.	0.00	0.00	0.00	1.05	1.00	0.30	1.38	0.00	0.00	0.26
Rockfish	Bottom Trw.	0.00	0.00	0.00	89.67	6.28	42.60	85.70	33.09	0.00	17.98
Sablefish	Bottom Trw.	0.00	0.00	0.00	0.08	0.00	0.55	0.00	0.00	0.00	0.04
Pacific Cod	Pot	0.00	0.00	0.00	0.05	0.00	0.04	0.00	0.00	0.00	0.01
Sablefish	Pot	0.00	0.00	0.00	0.15	1.45	0.91	0.00	0.00	0.00	0.18
Pollock	Pelagic Trw.	0.29	2.39	0.00	248.37	0.00	5.18	48.08	3.69	0.00	21.52
Rockfish	Pelagic Trw.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.18	0.00	0.01
Flatfish	Trawl	0.00	0.00	0.00	0.20	0.00	0.00	0.00	0.00	0.00	0.01
Total		0.4	4.3	2.9	493.2	61.6	110.3	600.3	141.3	16.7	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. Estimated biomass for shortraker rockfish from the 2014 and 2018 assessments. The current Bering Sea slope survey was initiated in 2002; therefore, the first estimate is for 2002.

Year	2014 Assessment			2018 Assessment		
	Biomass (t)	Lower CI	Upper CI	Biomass (t)	Lower CI	Upper CI
2002	23,938	16,262	31,613	23,706	18,212	30,857
2003	23,402	15,385	31,418	23,218	17,306	31,151
2004	22,906	14,977	30,836	22,826	16,954	30,730
2005	21,792	13,801	29,783	21,772	16,029	29,573
2006	20,896	12,276	29,515	20,932	15,200	28,826
2007	21,709	12,528	30,891	21,193	15,172	29,604
2008	22,641	13,511	31,770	21,829	15,757	30,241
2009	22,492	14,077	30,907	21,941	16,190	29,736
2010	22,356	15,454	29,259	22,119	17,087	28,634
2011	22,693	14,215	31,171	22,340	16,824	29,663
2012	23,093	13,278	32,909	22,710	17,212	29,963
2013	23,051	12,248	33,855	22,636	16,629	30,813
2014	23,009	11,554	34,464	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 15.9. 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

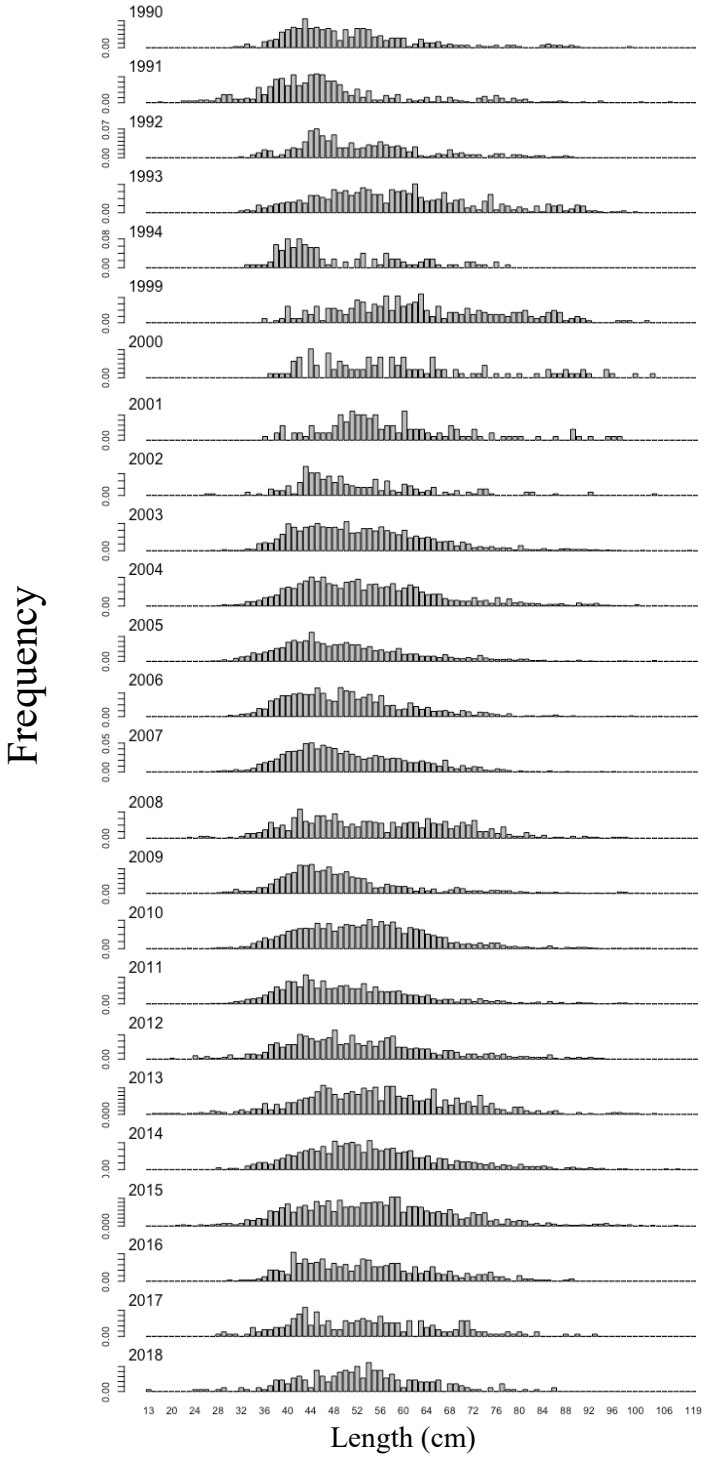


Figure 15.1. Length compositions from the US domestic fishery, 1990-2018. Source: AKFIN NMFS AFSC FMA Observer Debriefed Haul and Length tables.

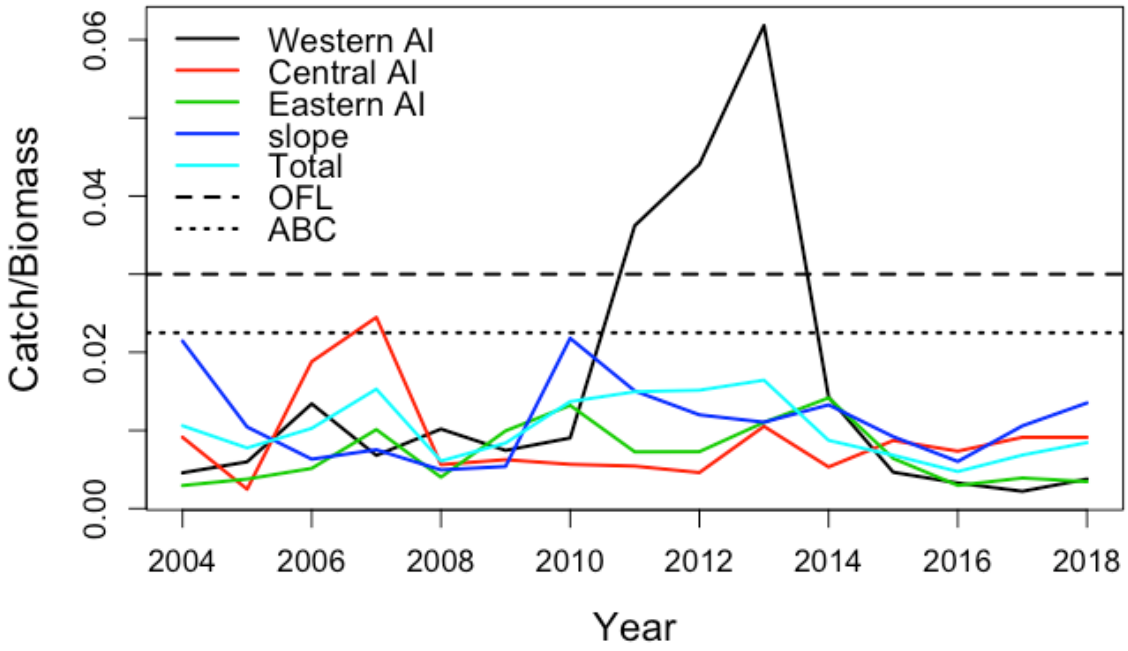
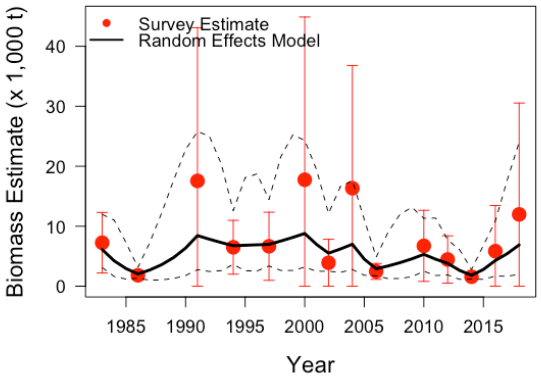
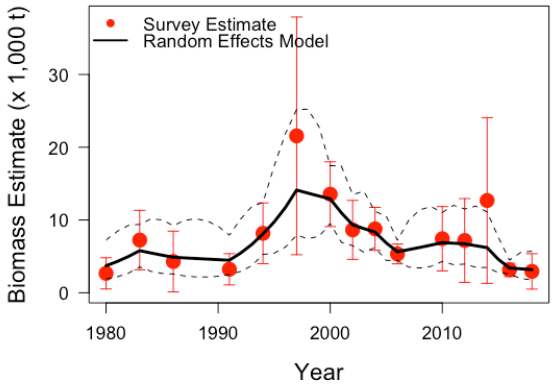


Figure 15.2. Area-specific exploitation rates for BSAI shortraker rockfish from 2003-2014, and for the entire BSAI. Abbreviations are: Western Aleutian Islands (WAI), Central Aleutian Islands (CAI), Eastern Aleutian Islands (EAI), Southern Bering Sea (SBS), Eastern Bering Sea (EBS), and Bering Sea (BS).

Western Aleutian Islands



Central Aleutian Islands



Eastern Aleutian Islands

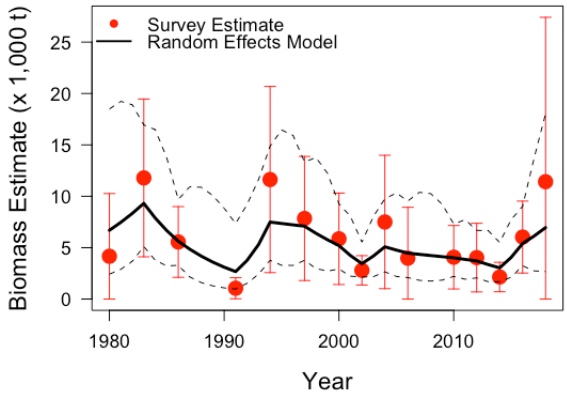
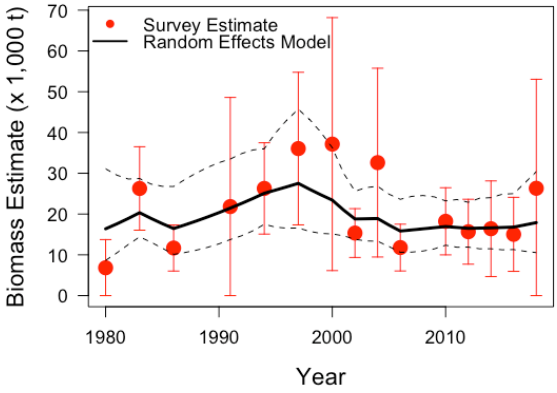
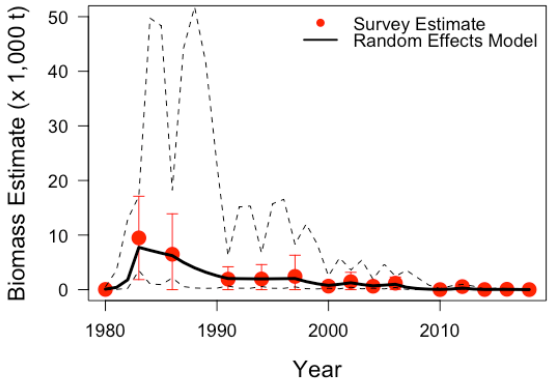


Figure 15.3. Random effects model estimates of Aleutian Islands shortraker rockfish: Western Aleutian Islands (upper panel), Central Aleutian Islands (middle), Eastern Aleutian Islands (lower panel). Observed survey biomass are shown (red data points with 95% confidence interval), and predicted survey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

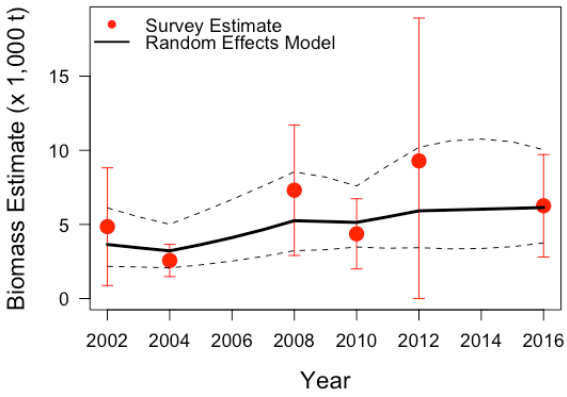
a. Aleutian Islands



b. Southern Bering Sea



c. Bering Sea slope



d. Bering Sea and Aleutian Islands (Total)

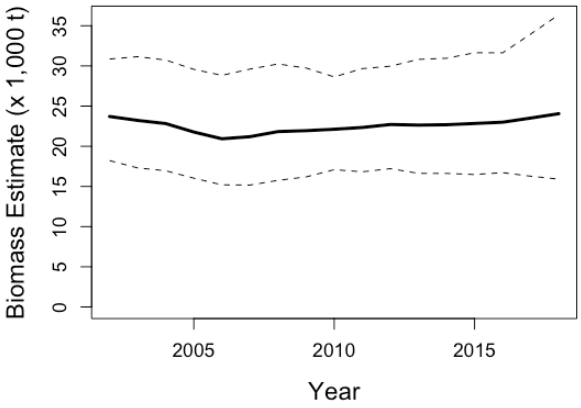


Figure 15.4. Observed survey biomass (red data points with 95% confidence interval), and predicted survey biomass estimates using the random effects model (black lines with 95% confidence intervals shown as dotted lines). Panel (a.) Aleutian Islands, (b.) Southern Bering Sea, (c.) Bering Sea slope, and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

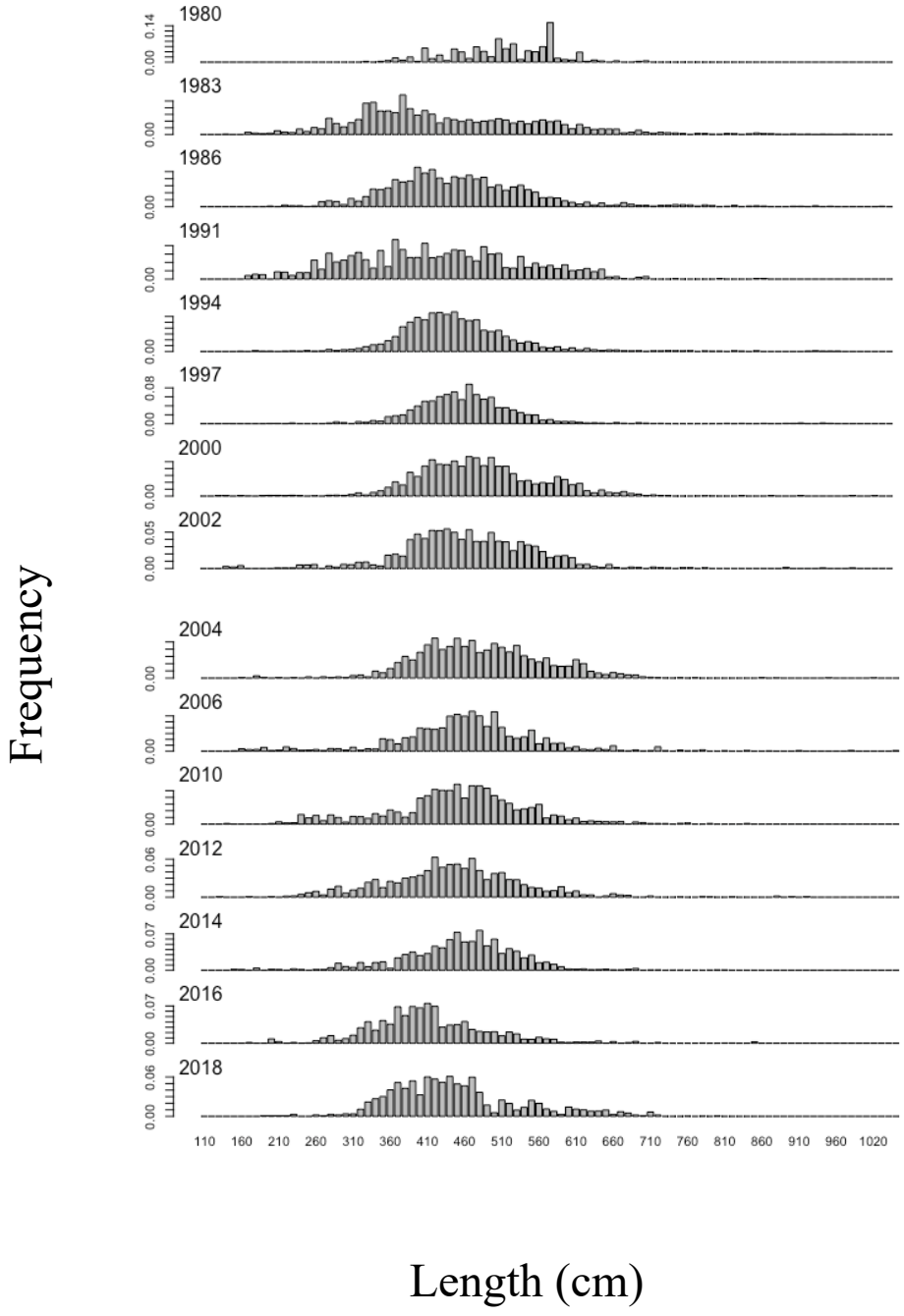


Figure 15.5. Length compositions from the Aleutian Islands trawl surveys, 1980-2018.

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 2018; therefore data is presented through 2017. 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 4 t and 3 t in 2016 and 2017, 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						
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	NMFS-AFSC survey databases					
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, 2005-2017. Data from 2018 is not yet available.

Year	Aleutian Islands Survey	Bering Sea Longline Survey	Bering Sea slope survey	IPHC Longline survey	Total
2005	0	1,299	0	0	1,299
2006	0	1,186	0	0	1,186
2007	0	1,307	0	0	1,307
2008	0	650	0	0	650
2009	0	1,706	0	0	1,706
2010	1,397	961	1,367	1,595	5,320
2011	0	1,424	0	1,120	2,544
2012	2,009	689	1,176	561	4,435
2013	0	1,205	0	509	1,714
2014	1,571	883	0	851	3,305
2015	0	1,499	0	1,062	2,561
2016	1,564	675	967	541	3,748
2017	0	1,978	0	972	2,950