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) Catch data from 2015 and 2016 through October 19, 2016 have been updated.
2) The biomass estimates from the 2016 Aleutian Islands (AI) and 2016 Eastern Bering Sea (EBS) slope trawl surveys were added to the model input data.

Changes in the assessment methodology:
There were no changes in the assessment methodology.

Summary of Results

The recommended 2017 ABC and OFL for BSAI shortraker rockfish are 499 t and 666 t, respectively. Biomass is estimated to be 22,191 t, which is <4% lower than the last full assessment, and ABC and OFL are slightly lower as well. A summary of the estimated biomass and reference points is shown below.

	As estimated or *specified last* year for:		As estimated or *recommended this* year for:	
Quantity	2016	2017	2017	2018
M (natural mortality rate)	0.03	0.03	0.03	0.03
Tier	5	5	5	5
Biomass (t)	23,009	23,009	22,191	22,191
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)	690	690	666	666
maxABC (t)	518	518	499	499
ABC (t)	518	518	499	499
	As determined *last* year for:		As determined *this* year for:	
Status	2014	2015	2015	2016
Overfishing		n/a		n/a

Responses to SSC and Plan Team Comments on Assessments in General

October 2016 SSC

The SSC reminds groundfish and crab stock assessment authors to follow their respective guidelines for SAFE preparation.

Authors' response: Noted.

October 2016 SSC

The SSC requests that stock assessment authors bookmark their assessment documents and commends those that have already adopted this practice.

Authors' response: Noted.

Responses to SSC and Plan Team Comments Specific to this Assessment

None.

Summary for the Plan Team

The following table gives the recent biomass estimates, catch, harvest specifications, and projected biomass, OFL and ABC for 2015-2018.

Year	Biomass	OFL	ABC	TAC	Catch
2015	23,009	690	518	250	153
2016	23,009	690	518	200	88[1]
2017	22,191	666	499		
2018	22,191	666	499		

[1] Catch as of October 19, 2016.

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). As adults the species occurs 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). Love et al. (2002) indicates the species is found at shallower depths during early life history. In bottom trawl survey data, the species is most common through the Aleutian Islands (AI) and northern Gulf of Alaska (GOA). In the Bering Sea they are found on the slope survey but not on the shelf survey.

This species is 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. 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 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. The larvae were assigned to four morphs identified by Kendall (1991), where each morph was associated with one or more species. Most of the small larvae examined belong to a single morph, which contained 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 was 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 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 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. 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. In 2004, rougheye and shortraker rockfishes were managed by species in the BSAI area. Shortraker rockfish has been assessed as a single species since 2008.

The ABCs, TACS, and catches by management complex from 1988-2016 are shown in Table 1. 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 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 1994-2016 have been variable, with the largest catches often occurring in the EBS (Table 3). From 2013 to 2016, 34% of the shortraker catch occurred in the EBS, with 40%, 30%, and 30% in the western, central, and eastern AI areas respectively. Catches in the western AI increased in 2011-2013 to an average of 164 t, as compared to an average of 34 t from 2003-2010, which resulted in

the proportion of catch in the western AI in 2011-2013 increasing to an average of 47% of the total eastern Bering Sea/Aleutian Islands (BSAI) catch for those years. Catch in 2014-2016 has remained at or below 26 t in the WAI.

Estimates of discarding by species complex are shown in Table 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 2004-2016 have ranged from 10% to 50%, and were 27% in 2015 and 26% for 2016 (through October 19).

Catches of shortraker rockfish from 2010-2016 in the AI management area occurred primarily in the rockfish bottom trawl fishery (67%), followed by Atka mackerel bottom trawl fisheries (10%) and sablefish longline (7%) (Table 5). Catches of shortraker rockfish from 2010-2016 in the EBS were caught largely in the midwater pollock trawl fishery (2%), Pacific cod longline (19%), Greenland turbot longline (7%), halibut longline (15%), arrowtooth flounder (18%), and rockfish trawl fisheries (31%); these fisheries contributed 92% of the total EBS catch (Table 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 6).

Data

Fishery:

The length composition from observer sampling of the domestic fishery (Figure 1), indicate relatively consistent length distributions with the bulk of the sampled fish generally between 30 and 70 cm. Length frequencies from 1991-2001 indicated more fish over 70 cm than were subsequently observed. There were no apparent trends in the size distribution from 2003 to present. The number of length observations taken by fishery observers in the BSAI is shown in Table 7.

The catch data are the estimates of single species catch described above and shown in Table 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 1980, 1983, 1986, 1991, 1994, 1997, 2000, 2002, 2004, 2006, 2010, 2012, 2014, and 2016 in the AI (Table 8). The 2008 AI survey and 2006, 2014 EBS slope survey 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 from the EBS slope are available from 2002-2016.

The survey length compositions reveal fewer large fish than the fishery length compositions (Figure1, Figure 2). The Aleutian survey typically encounters similar lengths of shortraker rockfish (Figure 2a) as the slope survey (Figure 2b). In surveys from 1980 to 2016, fish lengths from survey samples generally occurred between 30 cm and 65 cm, while fishery length composition generally sample between 30 cm and 80 cm.

The AI surveys from 1980 to 2016 indicated higher abundances in the WAI (543) and CAI (542) than in the EAI (541) (Figure 3), with the SBS area having the lowest abundance (Figure 4). Biomass in the SBS has shown a consistent decline in biomass estimated by the survey since 1983. Investigating whether shortraker rockfish in the SBS represents a distinct population from the eastern Aleutian Islands and the EBS slope should be a research priority. The survey biomass estimates of shortraker rockfish from the 2002-2016 EBS slope surveys have remained relatively stable, and have ranged between 2570 t (2004) and 9,299 t (2012), with CVs between 0.22 and 0.57 (Figure 4; Table 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).

Random effect estimates of biomass were made using the 1980-2016 AI (including the Southern Bering Sea) and 2002-2016 EBS slope survey time series for biomass and estimates of uncertainty, with data from the two surveys run separately (Table 9). This is similar to the methodology in the 2014 model. This method was preferable to combining data from the AI and the EBS slope survey prior to running the random effects model because this would have used data points from only five years, 2002, 2004, 2010, 2012, and 2016. The coefficient of variation (CV) for each model run was converted to variance and summed, then converted back to a CV for the entire BSAI for the purpose of calculating 95% confidence intervals.

Separate model runs for the EBS slope, the Southern Bering Sea, and the Central, Eastern, and Western AI were performed, and were used to estimate fishing mortality by region. 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 random effect model estimate of biomass for the subarea (Table 10). The subareas considered here are the three 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 obtained by applying the random effect model to survey estimates of biomass in each region.

Exploitation rates in the CAI and EAI have been below *M* and generally low from 2004-2016 (Figure 5a). Increases in the catch in the western AI in 2011-2013 resulted in the exploitation rates in this area exceeding F_{ABC} and F_{OFL} in these years (Table 3, Figure 5a). The 2014 – 2016 catches in the WAI are lower than previous years, and below fishery reference points. Catch of shortraker rockfish in the SBS is variable, ranging from 0-40 t from 2003-2016 (Table 3). Biomass in that region appears to be decreasing, with the past 4 years of survey estimates below 600 t, which is low compared to 9,000 t in 1983 and 6,000 t in 1986 (Table 8, Figure 4). Exploitation rates in the SBS have been higher than F_{OFL} (0.03), since 2007

(Figure 5a). The exploitation rate for the entire BSAI has remained below F_{ABC} and F_{OFL} since 2002 (Figure 5b).

Shortraker rockish in the BSAI are managed under Tier 5, where OFL = M * estimated 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 $\leq$ 0.75 * M * biomass. 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:

Parameter Estimates

Shortraker rockfish are assumed to have a natural mortality rate (M) of 0.03 (Heifetz and Clausen 1991). 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

Estimates of shortraker biomass in the BSAI are shown in Table 9 and Figure 6. Results from separate model runs for the EBS slope, the Southern Bering Sea, and the Central, Eastern, and Western AI are presented in Table 10.

Estimated shortraker rockfish biomass in the BSAI has been relatively stable since 2002. Biomass estimates have decreased slightly from 23,009 t in the 2014 assessment to 22,191 t in the current assessment (Figure 6a, Table 9). ABC and OFL are also slightly lower: 2017 ABC is 499 t vs. 518 t in 2016, 2017 OFL is 666 t vs. 690 t in 2016. Results from the random effect model estimate of biomass, as well as the survey estimates of biomass for the western, central, and eastern Aleutian Islands are shown in Figure 3. A similar plot for the Aleutian Islands, Eastern Bering Sea slope, and the Southern Bering Sea are shown in Figure 4. Biomass in the Southern Bering Sea has declined since the 1980s (Figure 4). It has been stable in the Western and Central, and Eastern Aleutian Islands. Biomass estimates in the EBS slope have been near 5,000 t since 2002.

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.

Shortraker rockfish	2016 biomass	M	ABC	OFL
	22,191 t	0.03	499 t	666 t

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. In particular, investigating whether shortraker rockfish in the Southern Bering Sea (SBS) represents a distinct population from the eastern Aleutian Islands and the EBS slope should be a research priority. Fishing pressure is higher in the SBS

than in other regions of the BSAI, and shortraker rockfish population sizes in this region have declined in recent years.

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Tables

Table 1. Total allowable catch (TAC), acceptable biological catch (ABC), and catch of the species groups used to manage shortraker rockfish from 1988 to 2016. 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. *Estimated removals through October 19, 2016.

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
2004	BSAI	Shortraker	526	526	242
2005	BSAI	Shortraker	596	596	170
2006	BSAI	Shortraker	580	580	213
2007	BSAI	Shortraker	424	424	323
2008	BSAI	Shortraker	424	424	133
2009	BSAI	Shortraker	387	387	184
2010	BSAI	Shortraker	387	387	298
2011	BSAI	Shortraker	393	393	333
2012	BSAI	Shortraker	393	393	344
2013	BSAI	Shortraker	370	370	377
2014	BSAI	Shortraker	370	370	195
2015	BSAI	Shortraker	518	250	153
2016*	BSAI	Shortraker	518	200	88*

Table 2. Catches of shortraker rockfish (t) in the BSAI area, obtained from the North Pacific Groundfish Observer Program, NMFS Alaska Regional Office, and PACFIN.

	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			137	300
2011			106			227	333
2012			117			227	344
2013			105			272	377
2014			97			97	195
2015			75			78	153
2016			41			47	88

* Estimated removals through October 19, 2016.

Table 3. Area-specific catches of shortraker rockfish (t) in the BSAI area from 1994-2016, obtained from the North Pacific Groundfish Observer Program, NMFS Alaska Regional Office. Abbreviations are: Western Aleutian Islands (WAI), Central Aleutian Islands (CAI), Eastern Aleutian Islands (EAI), Southern Bering Sea (SBS), Eastern Bering Sea – not including the SBS (EBS), and Bering Sea (BS).

Year	WAI	CAI	EAI	SBS	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	CAI	EAI	SBS	EBS	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	38	51	7	154	298
2011	163	37	28	21	85	333
2012	168	32	28	40	77	344
2013	162	69	40	12	93	377
2014	26	32	40	9	88	195
2015	13	38	27	11	64	153
2016*	14	22	11	9	32	88

* Estimated removals through October 19, 2016. Source: NMFS AKRO BLEND/Catch Accounting System.

Table 4. Estimated 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. Prior to 2001, ORR in the eastern Bering Sea was managed as a single complex.

Area	Species Group	Year	Catch (t) 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	SR	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	261	116	377	30.7%
		2014	107	88	195	45.2%
		2015	112	41	153	27.0%
		2016*	66	23	88	25.6%

* Estimated removals through October 19, 2016. Source: NMFS AKRO BLEND/Catch Accounting System.

Table 5. Aleutian Islands catch (t) of shortraker rockfish by management area and target fishery from 2010-2016.

		Management area			
Target Fishery	Gear	541	542	543	Percentage
arrowtooth flounder	Longline	0.04	0.05		0%
Greenland halibut	Longline	0.67	6.87		1%
halibut	Longline	30.12	8.12	2.13	4%
Pacific cod	Longline	18.71	28.68	3.92	5%
rockfish	Longline		0.33	0.38	0%
sablefish	Longline	29.35	31.12	14.29	7%
arrowtooth flounder	Bottom Trawl	37.03			3%
Atka mackerel	Bottom Trawl	28.21	69.38	12.33	10%
Greenland halibut	Bottom Trawl	0.67			0%
Kamchatka flounder	Bottom Trawl	33.58			3%
Pacific cod	Bottom Trawl	0.31			0%
pollock	Bottom Trawl	0.47			0%
rockfish	Bottom Trawl	44.55	123.19	560.68	67%
sablefish	Pot	0.37			0%

* Estimated removals through October 19, 2016. Source: NMFS AKRO BLEND/Catch Accounting System.

Table 6. Eastern Bering Sea catch (t) of shortraker rockfish by management area and target fishery from 2010-2016. Estimated removals through October 19, 2016. Source: NMFS AKRO BLEND/Catch Accounting System.

		Management area										
Target Fishery	Gear	508	509	513	514	517	518	519	521	523	524	Percentage
arrowtooth flounder	Longline					0.03			0.93	2.38		0.48%
Greenland turbot	Longline					0.04	1.28		38.79	8.18	0.59	6.98%
halibut	Longline			0.83	3.27	2.42	8.96	2.93	68.67	11.71	6.60	15.05%
other species	Longline									0.05		0.01%
Pacific cod	Longline		0.01	0.04		7.74	0.38	13.90	85.93	24.52	0.02	18.92%
pollock	Longline								0.04			0.01%
rockfish	Longline					0.94	0.01	0.02	3.61	0.06		0.66%
sablefish	Longline					0.15	0.65	1.41	0.11	0.03		0.34%
Pacific cod	Jig						0.01	0.02				0.00%
arrowtooth flounder	Bottom Trawl			0.24		47.00	5.47	4.79	65.82		1.30	17.79%
Atka mackerel	Bottom Trawl							6.16				0.88%
flathead sole	Bottom Trawl					5.60			0.52	3.27		1.34%
Greenland turbot	Bottom Trawl						0.15		0.72		0.01	0.13%
Kamchatka flounder	Bottom Trawl					0.02	10.33	0.63	0.10		0.24	1.62%
other species	Bottom Trawl					10.23		0.29				1.50%
Pacific cod	Bottom Trawl							0.72				0.10%
pollock	Bottom Trawl					1.05	1.00		0.65			0.39%
rock sole	Bottom Trawl		0.05			0.01						0.01%
rockfish	Bottom Trawl					86.51	6.18	41.41	55.88	27.87		31.10%
sablefish	Bottom Trawl					0.08						0.01%
Pacific cod	Pot					0.05		0.05				0.02%
sablefish	Pot					0.09	0.43	0.25				0.11%
pollock – bottom	Pelagic Trawl			0.08		0.46		0.13	0.07	0.33		0.15%
pollock – midwater	Pelagic Trawl		0.08	0.05		9.63		0.75	5.87	0.33		2.39%
other species	Trawl					0.20						0.03%

Table 7. The number of fishery length observations of shortraker rockfish from 1991-2016.

Year	Number of observations
1991	576
1992	413
1993	736
1994	125
1995	0
1996	0
1997	0
1998	0
1999	306
2000	114
2001	138
2002	226
2003	2,000
2004	1,630
2005	1,352
2006	1,464
2007	1,730
2008	702
2009	1,346
2010	2,156
2011	1,158
2012	709
2013	779
2014	1,137
2015	1,260
2016	232

Table 8. Estimated biomass (t) of shortraker rockfish from the NMFS bottom trawl surveys, with the coefficient of variation (CV) shown in parentheses. The Aleutian Island survey data includes the Southern Bering Sea.

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)	9,299 (0.57)
2013						
2014	1,579	12,678	2,144	28	16,429 (0.38)	
2015						
2016	5,846 (0.74)	3,150 (0.15)	6030 (0.30)	74 (1.00)	15,099 (0.31)	6,258 (0.29)

Table 9. Biomass estimates for shortraker rockfish from the 2014 and 2016 assessments, based on the random effects model, which includes the Bering Sea slope and Aleutian Islands survey data. The standardized Bering Sea slope survey was initiated in 2002; therefore, estimates begin in 2002.

Year	2014 Assessment (95% confidence intervals)		2016 Assessment (95% confidence intervals)	
2002	23,938	(16,262, 31,613)	23,990	(18,719, 30,744)
2003	23,402	(15,385, 31,418)	23,486	(18,021, 30,608)
2004	22,906	(14,977, 30,836)	22,999	(17,624, 30,013)
2005	21,792	(13,801, 29,783)	22,030	(16,671, 29,111)
2006	20,896	(12,276, 29,515)	21,214	(15,734, 28,602)
2007	21,709	(12,528, 30,891)	21,774	(16,111, 29,429)
2008	22,641	(13,511, 31,770)	22,406	(16,717, 30,031)
2009	22,492	(14,077, 30,907)	22,360	(16,978, 29,447)
2010	22,356	(15,454, 29,259)	22,315	(17,519, 28,424)
2011	22,693	(14,215, 31,171)	22,433	(17,251, 29,174)
2012	23,093	(13,278, 32,909)	22,583	(17,319, 29,448)
2013	23,051	(12,248, 33,855)	22,486	(16,811, 30,075)
2014	23,009	(11,554, 34,464)	22,391	(16,603, 30,195)
2015			22,290	(16,251, 30,572)
2016			22,191	(16,114, 30,560)

Table 10. Random effect model biomass estimates in tons for Central Aleutian Islands (CAI), Western Aleutian Islands (WAI), Eastern Aleutian Islands (CAI), Southern Bering Sea (SBS), and Eastern Bering Sea (EBS) slope.

Year	CAI	WAI	EAI	SBS	EBS slope
1980	3,662		6,727	96	
1981	4,275		7,482	415	
1982	4,990		8,320	1,800	
1983	5,826	6,000	9,253	7,802	
1984	5,482	4,204	7,847	7,244	
1985	5,159	2,946	6,654	6,726	
1986	4,855	2,064	5,642	6,244	
1987	4,761	2,712	4,878	4,992	
1988	4,669	3,564	4,218	3,991	
1989	4,578	4,684	3,647	3,191	
1990	4,490	6,154	3,153	2,551	
1991	4,403	8,087	2,726	2,039	
1992	5,392	7,611	3,807	2,018	
1993	6,603	7,163	5,317	1,996	
1994	8,085	6,741	7,425	1,975	
1995	9,786	6,816	7,298	2,001	
1996	11,844	6,891	7,174	2,027	
1997	14,335	6,967	7,052	2,053	
1998	13,858	7,457	6,368	1,484	
1999	13,397	7,981	5,750	1,072	
2000	12,951	8,542	5,192	775	
2001	10,987	6,875	4,240	991	
2002	9,321	5,534	3,463	1,268	3,650
2003	8,819	6,109	4,183	944	3,432
2004	8,344	6,744	5,051	702	3,228
2005	6,847	4,455	4,746	834	3,650
2006	5,618	2,943	4,460	990	4,127
2007	5,920	3,391	4,341	440	4,666
2008	6,239	3,908	4,225	196	5,277
2009	6,575	4,504	4,113	87	5,210
2010	6,929	5,191	4,003	39	5,144
2011	6,866	4,410	3,843	108	5,519
2012	6,803	3,747	3,690	302	5,921
2013	6,564	2,604	3,331	111	5,975
2014	6,333	1,810	3,008	41	6,029
2015	4,656	2,456	3,893	52	6,084
2016	3,423	3,332	5,038	66	6,139

Figures

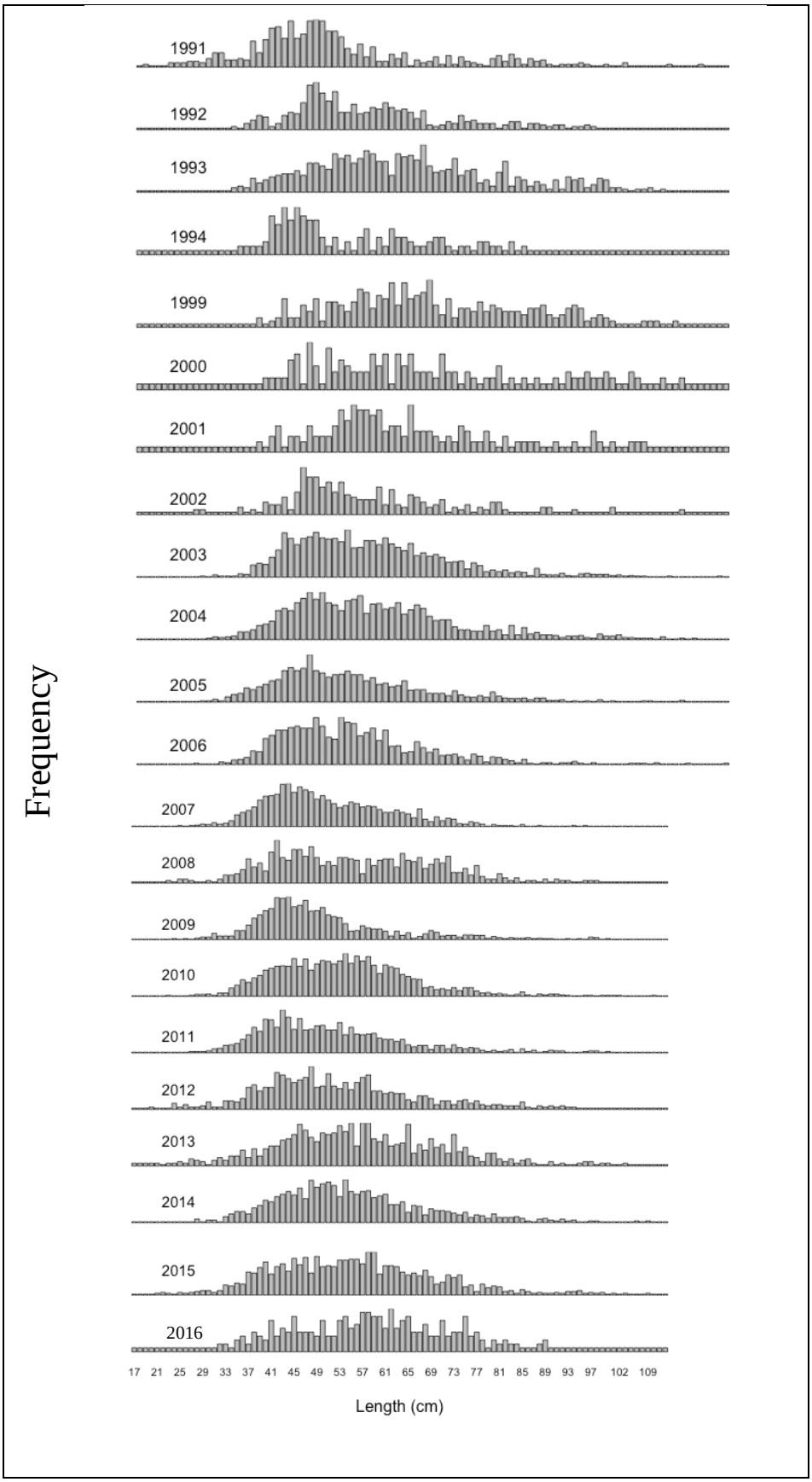
Frequency
1991
1992
1993
1994
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
17 21 25 29 33 37 41 45 49 53 57 61 65 69 73 77 81 85 89 93 97 102 109
Length (cm)

Figure 1. Length compositions from the US domestic fishery, 1991-2016.

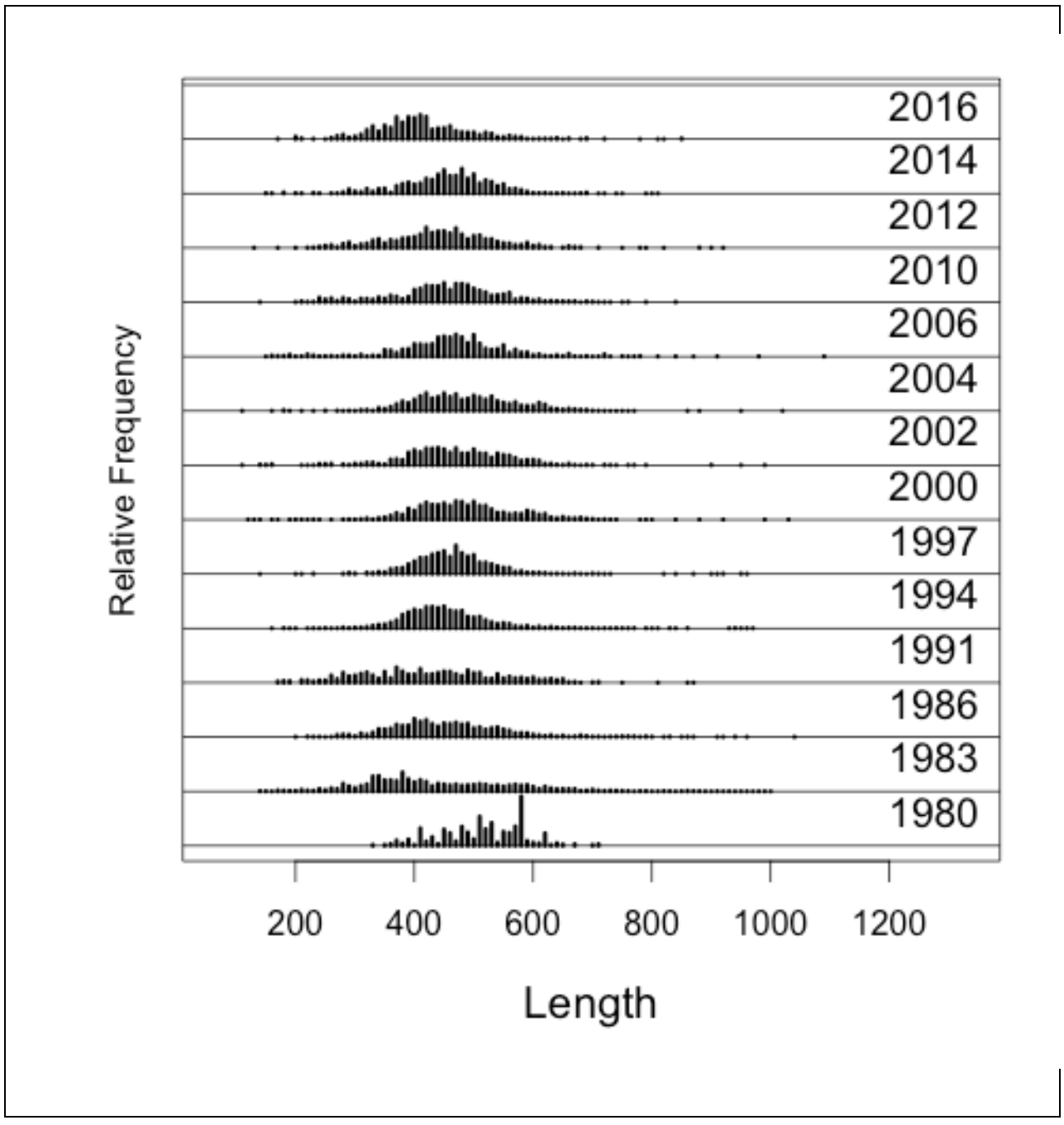

Figure 2a. Length compositions (mm) from the Aleutian Islands trawl surveys, 1980-2016.

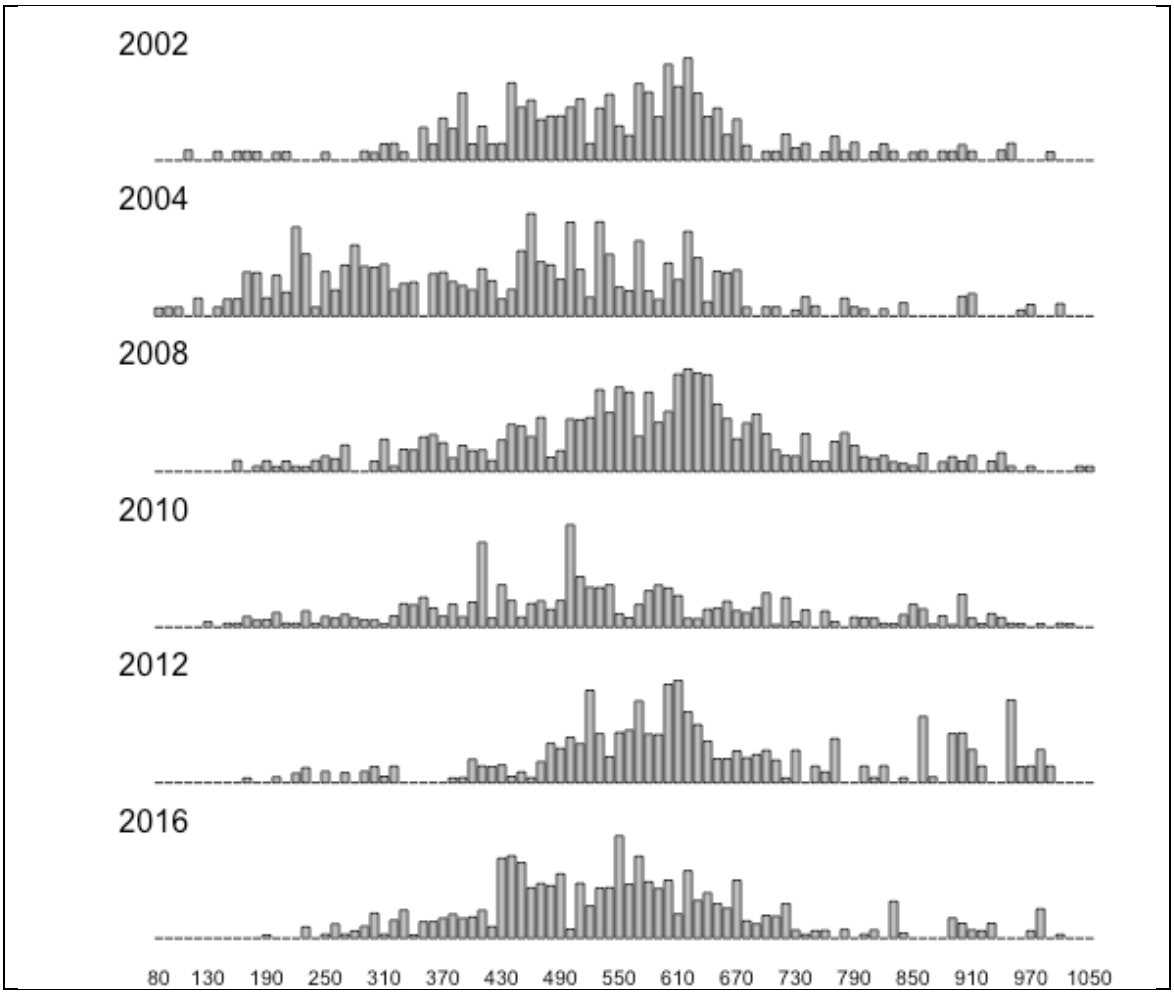

Figure 2b. Length compositions (mm) from the Aleutian Islands trawl surveys, 2002-2016.

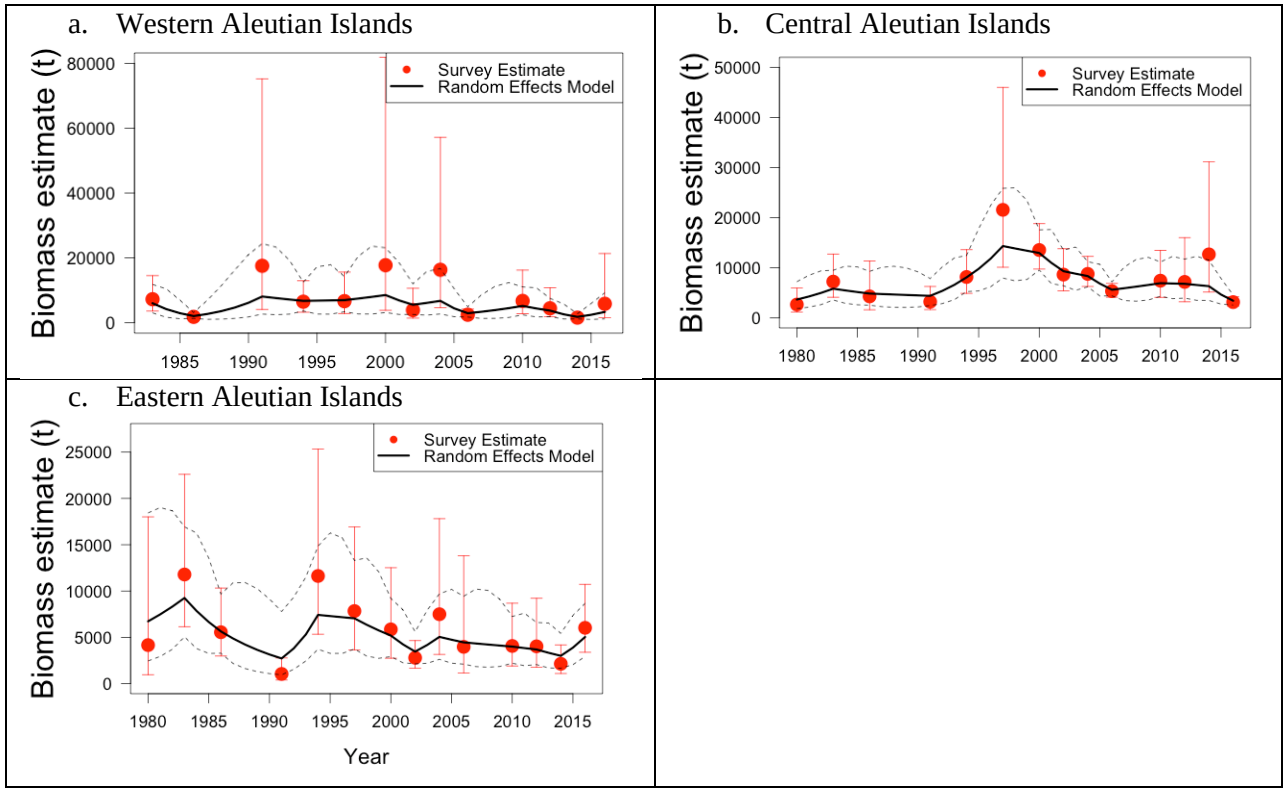

Figure 3. Survey and random effect model estimates of biomass in the Western Aleutian Islands (WAI), Central Aleutian Islands (CAI), and Eastern Aleutian Islands (EAI),.

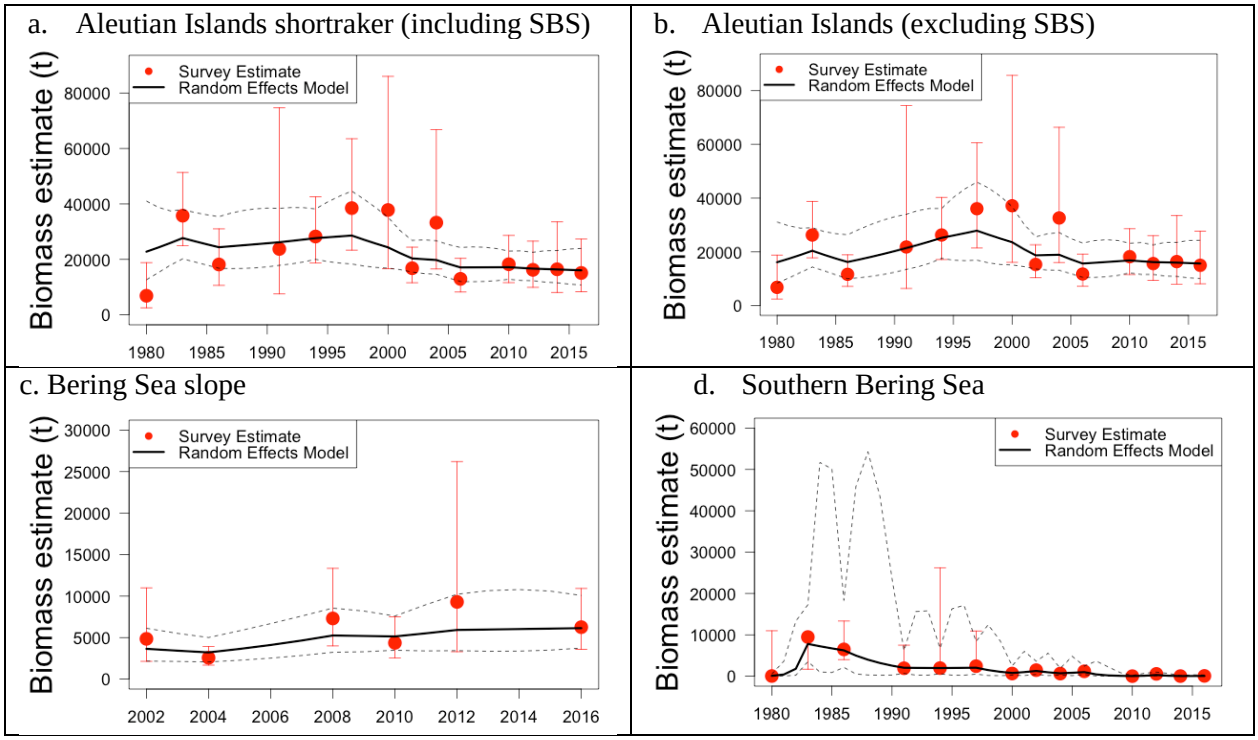

Figure 4. Observed survey biomass (red data points +/- 2 standard deviations), and predicted survey biomass estimates using the random effects model (black lines with 95% confidence intervals shown as dotted lines). Panel (a.) Aleutian Islands (AI), including the Southern Bering Sea (SBS), (b.) AI, excluding the SBS, (c.) Bering Sea slope, and (d.) the SBS.

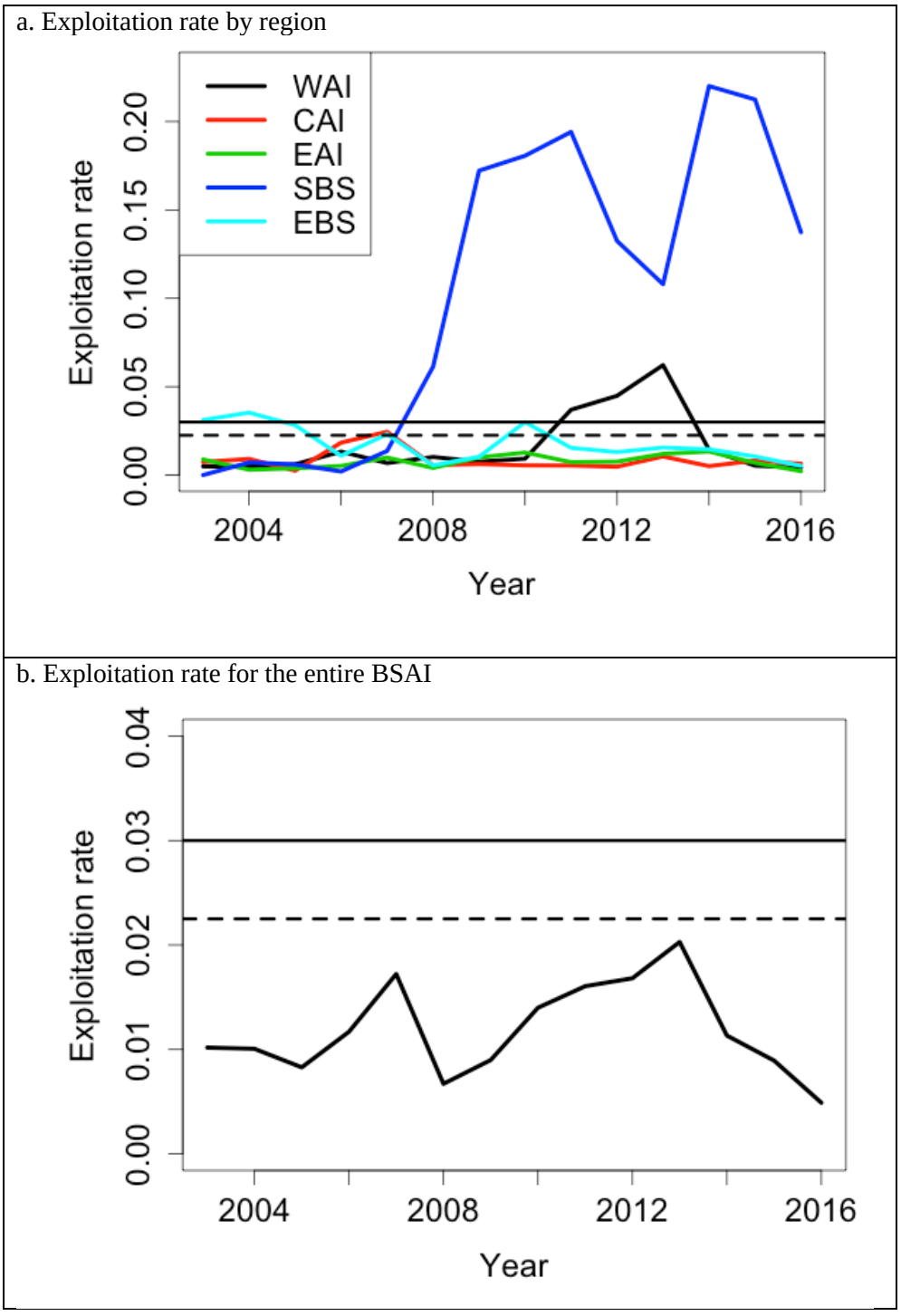

Figure 5. Area-specific exploitation rates for BSAI shortraker rockfish from 2003-2016 (panel a.), and for the entire BSAI (panel b). Abbreviations are: Western Aleutian Islands (WAI), Central Aleutian Islands (CAI), Eastern Aleutian Islands (EAI), Southern Bering Sea (SBS), Eastern Bering Sea (EBS), and Bering Sea (BS). Solid line is F_{OFL}, dotted line is F_{ABC}.

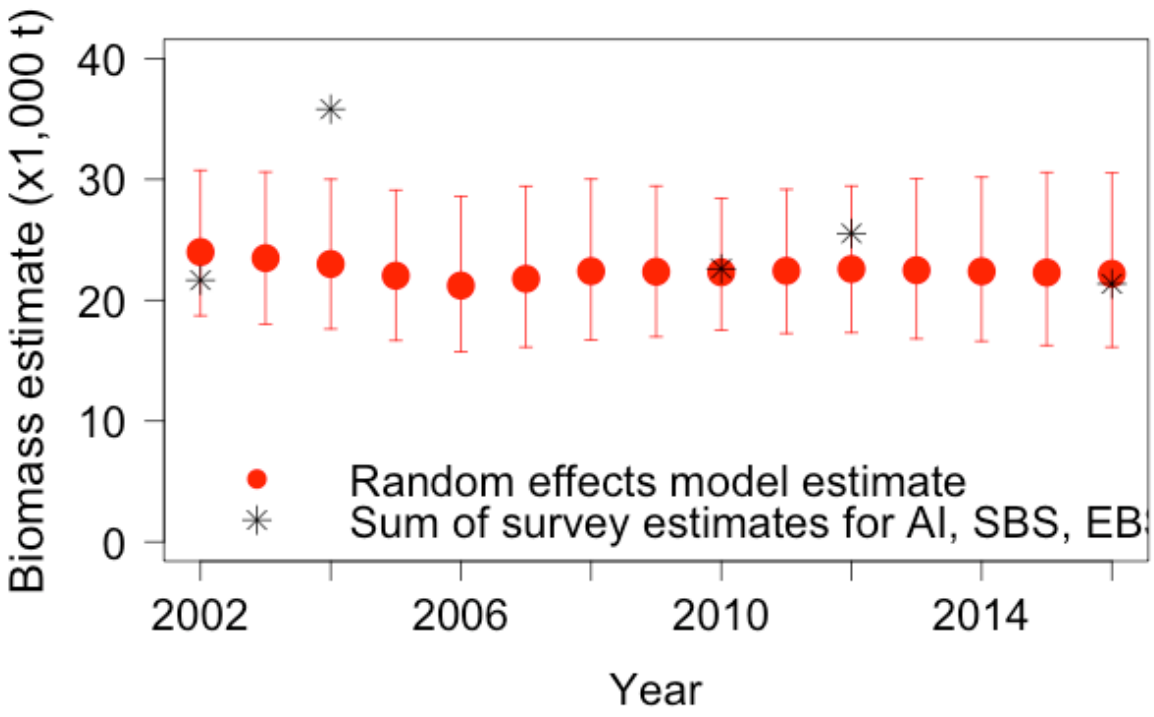

Figure 6. Estimated Bering Sea/Aleutian Islands (BSAI) shortraker biomass (1,000 t), from 2002-2016, based on the random effects model, with 95% confidence intervals, shown in red. Survey estimates for the most recent six years that the EBS slope and the AI survey were run in the same year are shown as black asterisks.

Appendix 1. Supplemental Catch Data

In order to comply with the Annual Catch Limit (ACL) requirements, two new datasets have been generated to help estimate total catch and removals from NMFS stocks in Alaska. The first dataset, non-commercial removals, estimates total removals that do not occur during directed groundfish fishing activities (Appendix 1 Table 1). 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 7 t and 3 t in 2010 and 2011, respectively, which represent less than 2% 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 2 and 6 t.

The second dataset, Halibut Fishery Incidental Catch Estimation (HFICE), is an estimate of the incidental catch of groundfish in the halibut IFQ fishery in Alaska. To estimate removals in the halibut fishery, methods were developed by the HFICE working group and approved by the Gulf of Alaska (GOA) and BSAI Plan Teams and the Scientific and Statistical Committee of the North Pacific Fishery Management Council. A detailed description of the methods is available in Tribuzio et al. (2011).

These estimates are for total catch of groundfish species in the halibut IFQ fishery and do not distinguish between "retained" or "discarded" catch. These estimates should be considered a separate time series from the current CAS estimates of total catch. Because of potential overlaps HFICE removals should not be added to the CAS produced catch estimates. The overlap will apply when groundfish are retained or discarded during an IFQ halibut trip. IFQ halibut landings that also include landed groundfish are recorded as retained in eLandings and a discard amount for all groundfish is estimated for such landings in CAS. Discard amounts for groundfish are not currently estimated for IFQ halibut landings that do not also include landed groundfish. For example, catch information for a trip that includes both landed IFQ halibut and sablefish would contain the total amount of sablefish landed (reported in eLandings) and an estimate of discard based on at-sea observer information. Further, because a groundfish species was landed during the trip, catch accounting would also estimate discard for all groundfish species based on available observer information and following methods described in Cahalan et al. (2010). The HFICE method estimates all groundfish caught during a halibut IFQ trip and thus is an estimate of groundfish caught whether landed or discarded. This prevents simply adding the CAS total with the HFICE estimate because it would be analogous to counting both retained and discarded groundfish species twice. Further, there are situations where the HFICE estimate includes groundfish caught in State waters and this would need to be considered with respect to ACLs (e.g. Chatham Strait sablefish fisheries). Therefore, the HFICE estimates should be considered preliminary estimates for what is caught in the IFQ halibut fishery. Improved estimates of groundfish catch in the halibut fishery will become available following restructuring of the Observer Program in 2013, when all vessels >25 ft will be monitored for groundfish catch.

The HFICE estimates of BSAI shortraker rockfish catches are variable, ranging between 2 and 18 t from 2001 -2014. Years with relatively high catches are caused by increased catches in the eastern and central AI.

Appendix 1 Table 1. Removals (t) of BSAI shortraker rockfish from activities other than groundfish fishing. Trawl and longline include research survey and occasional short-term projects. "Other" is recreational, personal use, and subsistence harvest. Data obtained October 20, 2016, and is only available through 2015. Source: AKR.V_NONCOMMERCIAL_FISHERY_CATCH table.

		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						
1991		3.437				
1992	NMFS-AFSC survey databases					
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
2005		0.011	1.299			0.347
2006		2.176	1.186			3.367
2007			1.307			0.429
2008		2.321	0.650			1.544
2009			1.706			0.571
2010	NMFS-Alaska Regional Office	2.764	2.556		0.018	1.546
2011		1.424	2.544			0.411
2012		3.874				
2013		1.205				
2014			2.054			
2015			0.672			

Appendix 1 Table 2. Estimates of the BSAI shortraker rockfish catch (t) from the Halibut Fishery Incidental Catch Estimation (HFICE) working group.

Year	Eastern AI	Central AI	Western AI	Central/Western AI	Total
2001	0.85	2.68	2.88	0.00	6.40
2002	1.65	1.50	0.17	0.00	3.32
2003	0.00	4.52	0.00	0.00	4.52
2004	1.31	0.00	1.09	0.00	2.40
2005	14.05	1.27	0.15	0.00	15.47
2006	10.69	4.95	0.00	0.00	15.65
2007	1.98	4.10	0.44	0.00	6.52
2008	1.95	2.65	0.00	0.00	4.60
2009	3.36			0.11	3.47
2010	7.52	8.74	1.32	0.00	17.58
2011					1.12
2012					0.56
2013					0.51
Average	4.33	3.38	0.67	0.01	7.99

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Tribuzio, C.A., S. Gaichas, J. Gasper, H. Gilroy, T. Kong, O. Ormseth, J. Cahalan, J. DiCosimo, M. Furuness, H. Shen, K. Green. 2011. Methods for the estimation of non-target species catch in the unobserved halibut IFQ fleet. August Plan Team document. Presented to the Joint Plan Teams of the North Pacific Fishery Management Council.

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