16. Assessment of the Other Rockfish stock complex in the Bering Sea/Aleutian Islands

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Executive Summary

Summary of Changes in Assessment Inputs

Changes in the input data

1) Catch and fishery lengths updated through October 13, 2016.
2) Biomass estimates, catch per unit effort (CPUE), and length frequency compositions were included from the 2016 AI trawl survey, the 2016 EBS slope survey, and the 2015 and 2016 EBS shelf surveys.

Changes in the assessment methodology

1) There were no changes in the assessment methodology.

Summary of Results

Summary for **SST portion** of the Other Rockfish complex.

Quantity	As estimated or *specified last* year for: 2016	2017	As estimated or *recommended this* year for: 2017	2018
M (natural mortality rate)	0.03	0.03	0.03	0.03
Tier	5	5	5	5
Biomass (t)	46,647	46,647	52,761	52,761
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)	1,399	1,399	1,583	1,583
maxABC (t)	1,050	1,050	1,187	1,187
ABC (t)	1,050	1,050	1,187	1,187
AI ABC (t)	374	374	398	398
EBS ABC (t)	676	676	789	789
Status	As determined *last* year for: 2014	2015	As determined *this* year for: 2015	2016
Overfishing	No	n/a	No	n/a

Summary for **non-SST portion** of the Other Rockfish complex.

Quantity	As estimated or *specified last* year for: 2016	2017	As estimated or *recommended this* year for: 2017	2018
M (natural mortality rate)*	0.09	0.09	0.09	0.09
Tier	5	5	5	5
Biomass (t)	2,983	2,983	2,592	2,592
F_{OFL}	0.09	0.09	0.09	0.09
$maxF_{ABC}$	0.0675	0.0675	0.0675	0.0675
F_{ABC}	0.0675	0.0675	0.0675	0.0675
OFL (t)	268	268	233	233
maxABC (t)	201	201	175	175
ABC (t)	201	201	175	175
AI ABC (t)	182	182	173	173
EBS ABC (t)	19	19	1	1
Status	As determined *last* year for: 2014	2015	As determined *this* year for: 2016	2017
Overfishing	No	n/a	No	n/a

*This natural mortality rate is estimated for dusky rockfish and assumed as a proxy for the non-SST portion of the Other Rockfish complex.

Summary for the **entire Other Rockfish complex** (SST and non-SST combined).

Quantity	As estimated or *specified last* year for: 2016	2017	As estimated or *recommended this* year for: 2017	2018
M (natural mortality rate)*	-	-	-	-
Tier	5	5	5	5
Biomass (t)	49,630	49,630	55,312	55,312
F_{OFL}*	-	-	-	-
$maxF_{ABC}$	-	-	-	-
F_{ABC}	-	-	-	-
OFL (t)	1,667	1,667	1,816	1,816
maxABC (t)	1,250	1,250	1,362	1,362
ABC (t)	1,250	1,250	1,362	1,362
AI ABC (t)	555	555	**572**	**572**
EBS ABC (t)	695	695	**790**	**790**
Status	As determined *last* year for: 2014	2015	As determined *this* year for: 2015	2016
Overfishing	No	n/a	No	n/a

*****Natural mortality and fishing mortality rates are specified separately for the SST and non-SST portions of the Other Rockfish complex.

The estimated biomass was based upon the random effects survey averaging model. The estimate of biomass includes model estimates for 2016 from the NMFS eastern Bering Sea shelf survey, the NMFS Bering Sea slope survey, and the NMFS Aleutian Islands (AI) survey.

Summaries for Plan Team

The following table gives the recent biomass estimates, catch, and harvest specifications, and projected biomass, OFL and ABC for 2016-2018.

Species	Year	Biomass	OFL	ABC	TAC	Catch
Other rockfish	2015	50,050	1,696	1,272	880	685
	2016	55,312	1,667	1,250	875	913*
	2017	55,312	1,816	1,362		
	2018	55,312	1,816	1,362		

* Catch as of Oct 13, 2016

Responses to SSC and Plan Team Comments on Assessments in General

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

This document has been reviewed for consistency with the 2016 SAFE guidelines for Tier 5 stocks.

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

The requested bookmarks have been added.

Responses to SSC and Plan Team Comments Specific to this Assessment

None pertaining to this assessment.

Introduction

The Bering Sea/Aleutian Islands (BSAI) Other Rockfish complex is defined by what it excludes rather than by what it includes. The Other Rockfish complex includes all species of *Sebastes* and *Sebastolobus*, other than Pacific ocean perch (POP, *Sebastes alutus*), northern rockfish (*Sebatses. polyspinis)* rougheye rockfish (*S. aleutianus*), and shortraker rockfish (*S. borealis*). Current definitions of the complex do not specifically exclude blackspotted rockfish (S. *melanostictus),* a recently recognized species (Orr and Hawkins 2008) that had historically been identified as rougheye rockfish in research surveys. However, blackspotted is currently not distinguished from rougheye rockfish in the fishery catches, and is thus currently managed under the BSAI blackspotted/rougheye complex.

The two most abundant species for Other Rockfish complex are dusky rockfish and shortspine thornyheads (SST). Shortspine thornyheads (SST) occur throughout the Aleutian Islands (AI) and eastern Bering Sea (EBS) slope but are most abundant in the western AI, where they are found between 200 m and 500 m depth (Reuter and Spencer 2001). In contrast, dusky rockfish are

typically captured between 125-200 m in the AI, and are rarely encountered on the EBS slope in either survey or fishery catches.

An analysis was conducted in the 2001 Other Rockfish SAFE report to distinguish species expected to occur in the BSAI Other Rockfish complex from rarely observed and potentially misidentified species (Reuter and Spencer 2001, http://www.afsc.noaa.gov/REFM/docs/2010/BSAIshortraker.pdf). The criteria used for the analysis was occurrence in at least one haul of the BSAI surveys and/or occurrence in at least 1% of observed fishery hauls. Using data from 1999-2001, 7 species (shortspine thornyhead; *Sebastolobus alascanus*, dusky rockfish; *Sebastes variabilis*, redbanded rockfish; *Sebastes babcocki*, redstripe rockfish; *Sebastes proriger*, yelloweye rockfish; *Sebastes ruberrimus*, harlequin rockfish; *Sebastes variegatus*, and sharpchin rockfish; *Sebastes zacentrus*) were identified as meeting these criteria. Dark rockfish also met the criteria, but have since been removed from the Other Rockfish complex and is now managed by the State of Alaska. Species composition of these seven species in survey and catch is summarized in Table 1.

Rockfish are long-lived species which do not attain reproductive maturity until 5-20 years of age. They are viviparious; they mate and fertilize the eggs internally. Embryos develop within the female, and thousands or millions of tiny larvae are released after several months. Juveniles settle in kelp, eelgrass, or rocky habitat and move to deeper water as they mature.

Fishery

The Other Rockfish category has existed in the BSAI Fishery Management Plan since 1986, and is managed through annual catch limits (Table 2). Prior to 2005, separate OFLs were established for EBS and AI management areas. In 2005, the overfishing level was was set as a combined limit for the entire BSAI. The BSAI Other Rockfish complex was also moved to a biennial assessment schedule to coincide with the frequency of trawl surveys in the AI and the EBS slope surveys. These surveys occur in even years, and for these years a full assessment of the Other Rockfish complex in the BSAI area is conducted.

Historically, foreign catch records did not identify the various Other Rockfish by species, but reported catches in categories such as "other species" (1977-1979), and "Other Rockfish" (1980-1990), with the definitions of these groups changing between years. In the domestic fishery, the NOAA Fisheries Alaska Regional Office “Blend” catch database often reported the catches of Other Rockfish species in a single “Other Rockfish” category, although species-specific catch records have been available with the Catch Accounting System (CAS) database beginning in 2003. From 1991-2002, species catches were 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. An identical procedure was used to reconstruct the estimates of catch by species 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 Other Rockfish since 1977 by area are shown in Table 3. Table 3 reports only the catches of the seven most common species identified above (dusky, yelloweye, sharpchin, redbanded, redstripe, and harlequin rockfish, and shortspine thornyhead). Some relatively high catches occurred in the late 1970s – early 1980s; total catch has only exceeded 1,000 t in 1978, 1979, 1980, 1982, and 1990.

Reported ABCs, TACs, and catches of Other Rockfish from 2004-2016 are shown in Table 2. The catch of other rockfish in the Bering Sea has remained stable, but catch in the AI increased substantially in 2011-2016.

There is no directed fishing for any of the Other Rockfish species; however, incidental catch occurs in multiple fisheries and gear types. Between 2004 and 2016, approximately 16% of the "Other Rockfish" was caught in the directed rockfish fishery. The highest proportion (36%) has been caught in the Atka mackerel fishery, followed by the flatfish fishery (19%), the sablefish fishery (12%), and Pacific cod fisheries (11%). Other less significant fisheries include Pacific halibut (3%) and walleye pollock (3%). Since 2004 they have been primarily caught by bottom trawl (68%) and hook and line (31%).

The catches of Other Rockfish are composed primarily of dusky rockfish and shortspine thornyhead; from 2004 -2016, these two species composed 90% of the catch identified to species in the AI and 98% in the EBS (Tables 4 and 5). In the AI, the catches of dusky rockfish and SST average 252 t and 147 t, respectively, from 2004-2016. The proportion of SST in the EBS Other Rockfish catch was higher, as the catches of dusky rockfish and SST averaged 33 t and 174 t, respectively from 2004-2016. Discrepancy between total catch and individual catch (e.g. Tables 2 and 4) is due to the catch weight of less common species and to catch assigned to the "Other Rockfish" group without being identified to species.

The catch of dusky rockfish and SST in various target fisheries and gear types from 2004-2016 are shown in Tables 6-9. In the EBS, dusky rockfish are primarily caught in the Pacific cod longline fishery (43%), followed by trawl fisheries for pollock (27%), rockfish (12%), Pacific cod (8%), Atka mackerel (3%), and various flatfish (5%) (Table 6). Most of the shortspine thornyhead catches in the EBS occur in the bottom trawl fisheries for flatfish (arrowtooth flounder, Kamchatka flounder, Greenland turbot, flathead sole, rock sole, and yellowfin sole) (43%), followed by flatfish longline fisheries (20%), and the rockfish trawl fishery (14%) (Table 7). Dusky rockfish in the AI are caught in the Atka mackerel trawl fishery (84%) followed by the rockfish trawl fishery (12%) and Pacific cod longline gear (3%) (Table 8). Shortspine thornyhead in the AI are caught primarily in the sablefish longline fishery (47%) followed by the rockfish trawl fishery (29%), and the flatfish longline fishery (7%) (Table 9). In the EBS, both species are caught primarily along the continental slope in NMFS reporting areas 517, 519, and 521 (Tables 6 and 7). In the AI, the catch of dusky rockfish is almost entirely in the eastern Aleutians (area 541), but shortspine thornyhead catch is highest in the western Aleutians (area 543) (Tables 8 and 9).

A summary of the Other Rockfish catch retained and discarded from 2004-2016 are shown in Table 10. The percent of Other Rockfish retained has ranged from 51% to over 90%, and has generally increased over time. Low discard rates are primarily from fixed-gear, which yields a higher quality product than trawl gear (Hiatt *et al*. 2002).

Data

Fishery:

Fishery length samples have been collected by observers for both SST and dusky rockfish since 2002. Generally, between 500 and 1,500 length samples are taken each year. The fishery length

frequencies for each species since 2002 show little change, with the bulk of the dusky rockfish lengths between approximately 36 and 50 cm (Figure 1), and the bulk of the SST lengths between 30 and 60 cm (Figure 2).

Catches of the Other Rockfish complex from non-commercial sources (i.e. those not included in the Alaska Regional Office's Catch Accounting System) are shown in Appendix Table 1. Non-commercial removals ranged from 1-23 metric tons (t) between 2004 and 2016.

Survey:

Several bottom trawl surveys provide biomass estimates for the EBS and AI regions. The 1979-85 cooperative U.S.-Japan trawl surveys in the EBS were conducted both on the continental shelf and slope, and cooperative surveys were also conducted in the AI from 1980-1986. 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, and 2016 in the AI (Tables 11, 12, and 13). The 2002 EBS slope survey represents the initiation of a new survey time series distinct from the previous surveys in 1988 and 1991. The EBS slope survey samples depths from 200 to ~1200 m, whereas the AI survey samples depths to 500 m. Thus, survey biomass estimates of deep-water species such as shortspine thornyhead are likely underestimated in the AI survey. The cooperative U.S. – Japan AI trawl survey were conducted with different vessels, survey gear, and sampling design relative to the U.S. domestic trawls surveys that began in 1991. The NMFS EBS shelf survey has been conducted every year since 1982, but few rockfish are found there, primarily dusky and harlequin rockfish.

From 1979-2016, the biomass estimates for Other Rockfish in the AI trawl survey have gradually increased, with lower values reported for 1979-1997 but higher values since 2002 (Table 11). Biomass estimates for the Aleutian Islands portion of the AI survey have been high since 2006, but were not particularly large in 2016; Bering Sea shelf estimates remain small (Table 11).

Between 1997 and 2016, the dusky rockfish biomass estimate in the AI area has fluctuated between 236 t (2012) and 6,260 t (2014), although the larger estimates are driven by a small number of very large tows, leading to large coefficients of variation (CV) (Table 12). Such large fluctuations would not be expected in such a long-lived species, and are likely due to high uncertainty in the biomass estimates. The biomass estimate of SST in the AI area increased from 6,153 t in 1991 to 16-18,000 from 2004-2016 (Table 13).

Biomass estimates of Other Rockfish from the Bering Sea slope have increased dramatically from historical levels. The 2016 slope survey estimate was the highest ever observed at 35,978 t, nearly all of which was SST. The overwhelming majority of EBS slope survey biomass from 2002-2016 have been SST, but has also included broadfin thornyhead, longspine thornyhead, dusky, silvergray, yellowmouth, and redbanded rockfish, although the estimated biomass for redbanded rockfish did not exceed 7 t for any year. Dusky rockfish are fairly rare in the EBS slope survey, and were not seen at all in the 2016 survey (Table 12).

The lengths of dusky rockfish obtained in the 1997-2016 AI surveys (dusky was not identified by species prior to 1997) were generally between 35 and 45 cm, corresponding closely to the length distribution in the BSAI fishery (Figure 3). Shortspine thornyhead lengths from the survey are smaller than those for the fishery, falling primarily between 20 and 44 cm (Figure 4). Assuming

that larger SST in the AI inhabit deeper water, this difference is likely related to the 500 m depth limit of the AI survey. Length frequencies were generally consistent between years.

The spatial distribution of dusky rockfish and SST biomass was investigated in the 2014 stock assessment (Spies *et al*. 2014). For dusky rockfish, AI surveys showed concentrations near the Delarof and Krenitzin Islands in the eastern AI, with some biomass throughout the eastern and central AI. The spatial distribution of SST shows high densities along the Bering Sea slope and primarily at the far western end of the AI, with most biomass west of Petrel Bank.

Very little age information exists for species in the Other Rockfish complex. The only available age data for dusky rockfish are from the 2002 AI survey (n = 108). Growth analysis of these data using a von Bertalanffy growth equation result in an L_{inf} of 41.6 cm, k=0.32 and a t_o=2.5 (Reuter and Spencer 2001). These results show that dusky rockfish in the AI grow to a smaller maximum length than dusky rockfish in the GOA (Clausen and Heifetz 2001). No age data exists for SST because an ageing technique has yet to be satisfactorily determined. Research studies on aging and maturity of SST are currently being conducted.

Analytic Approach

Model Structure

Other Rockfish are currently assessed with the Tier 5 methodology, which requires estimates of natural mortality (M) and population size. For Tier 5 stocks, F_{OFL} and F_{ABC} are defined as M and 0.75M, respectively. The acceptable biological catch (ABC) is obtained by multiplying F_{ABC} by the estimated biomass, and the overfishing level (OFL) is obtained by multiplying F_{OFL} by the estimated biomass. The estimated natural mortality differs between shortspine thornyhead (SST) and the remaining stocks in the Other Rockfish complex; therefore, ABC and OFL (and F_{OFL} and F_{ABC}) are calculated separately for SST and non-SST Other Rockfish. Apportionments between the AI and the EBS are based on survey estimates in those regions.

Biomass estimates for Other Rockfish in 2010-2014 were obtained by taking a weighted (4-6-9) biomass estimate of the most recent three surveys by area, with higher weights applied to more recent surveys (Bering Sea slope, Bering Sea shelf, and Aleutian Islands surveys). The EBS estimated biomass was obtained from summing the weighted average from the EBS slope survey with the weighted average from the SBS portion of the AI survey, and the AI biomass estimate was obtained using the AI portions of the AI surveys.

In 2015 and 2016, biomass is estimated using the Random Effects model (Figure 5), and the most recent biomass estimate from this model is used to set OFL and ABC. 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). This method has been selected by the SSC as the preferred approach for Tier 5 assessments.

Fishery exploitation rates (Figure 6) are estimated as the observed catch divided by the RE model biomass. The exploitation rate for SST in recent years has remained less than 1.5%. Catches of

dusky and harlequin rockfish in the AI have increased in recent years, leading to an increases in exploitation rate from 1% to 3%. Total other rockfish catches in the AI region exceeded ABC in all but one of the last six years (Table 2), and overall BSAI catch exceeded TAC in 2014 and 2016. The overall BSAI OFL, however, remains well above the recent catch rates.

Parameter Estimates

Estimates of natural mortality of SST have been variable due to the difficulty of ageing this species. In the GOA shortspine thornyhead assessment, Gaichas and Ianelli (2003) presented natural mortality estimates from several studies. Studies have calculated natural mortality differently due to the age of their oldest sample. Miller (1985) estimated natural mortality to be 0.07 from a sample of SST in Southeast Alaska whose oldest age was 62 years old. A study using west coast SST estimated a natural mortality between 0.05-0.07 with the oldest age in the sample being 80 (Kline 1996). Pearson and Gunderson (2003) suggest that SST from Alaska have an M = 0.013, based on a study using the gonadosomatic index to estimate natural mortality. A natural mortality rate that low suggests that these fish reach maximum ages from 250-350 years, which would be very old even among rockfish species. One source of variability in these estimates is the variation in otolith age reading techniques. Miller (1985) used surface ageing and the break and burn technique, and found that precision and comparability was low. Kline (1996) used a thin section technique that had better inter-reader ageing agreement, and radiometric verification supported this technique. Subsequent radiometric work by Kastelle *et al*. (2000) corroborated Kline's results. Thus, Kline's methodology and results are presumed to be the most accurate given the uncertainty of ageing SST. Work is currently being done at the Alaska Fisheries Science Center to determine the best ageing technique to use for SST (personal communication Todd Tenbrink, AFSC).

Historically, the value of M of 0.07 has been used to assess the Other Rockfish stock, which represents an approximation based on knowledge of rockfish life histories from other areas. This value is based on the estimate for SST from Ianelli and Ito (1994), as this species comprises well over 90% of the Other Rockfish biomass (as calculated by survey data). In the 2003 GOA SST assessment a value of M of 0.038 was used, which was obtained as an alternate value given in Pearson and Gunderson (2003). Because this value has been accepted by the Plan Team and SSC, we use a value of 0.03 for the SST portion of the BSAI Other Rockfish biomass in order to maintain consistency with GOA SST. The majority of the non-SST Other Rockfish biomass is composed of dusky rockfish. The parameter estimate for natural mortality for dusky rockfish in the GOA is 0.09, and thus is currently the best estimate of M (Clausen and Heifetz 2001). For the 2016 assessment, we use an M of 0.09 for the remaining group of Other Rockfish.

Results

Harvest Recommendations

The 2016 biomass estimate of all species in the Other Rockfish complex from RE model results is 55,312 t; 52,761 t for the SST component, and 2,592 t for the non-SST component. The 95% confidence intervals are wider for the non-SST component of the stock complex, reflecting

uncertainty in those estimates. Survey biomass estimates were used as inputs to the RE models for each survey and subgroup.

In recent years, BSAI Other Rockfish have been managed with a BSAI-wide OFL level and separate ABCs for the AI and EBS subareas. For the 2017 fishery, we recommend the maximum allowable ABC of 790 t for the Other Rockfish complex in the EBS and 572 t in the AI. We also recommend an OFL of 1,816 t for the entire complex. Further breakdowns of reference values for SST and the remaining stocks in the Other Rockfish complex are summarized in the following table.

2016:	SST	NonSST	TotalORF
M	0.03	0.09	
Biomass	52,761	2,592	55,312
LCI	(41,677)	(1,578)	(43,254)
UCI	(66,898)	(4,282)	(71,181)
Fofl	0.03	0.09	-
maxFabc	0.02	0.07	-
Fabc	0.02	0.07	-
OFL	1,583	233	1,816
max ABC	1,187	175	1,362
ABC	1,187	175	1,362
AI ABC	398	173	**572**
EBS ABC	789	1	**790**

Ecosystem Considerations

Ecosystem Effects on Stock

Little to no information is available to determine the diet of Other Rockfish species, important predators, or their trends over time.

Fishery Effects on the Ecosystem

The Other Rockfish complex is not a targeted fishery, therefore reference on the effects of the fishery on the ecosystem will be described in the SAFE chapters of the fisheries in which Other Rockfish is taken as bycatch.

Data gaps and research priorities

Validating aging techniques of shortspine thornyhead, and obtaining ages from archived samples, remain research priorities and are required for age-structured population modeling of this species. Little is known regarding most aspects of the biology of the species in the Other Rockfish complex, 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. Research studies on aging techniques and maturity of SST in the Aleutians are currently underway.

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Tables

Table 1. The percentage catch of "Other Rockfish" in AFSC research bottom trawl surveys and in observed fisheries hauls from a) 1991-2001 and b) 2004-2016.

a) Period: 1991-2001

		EBS		AI	
Common name	Scientific name	**Survey**	**Fishery**	**Survey**	**Fishery**
Redbanded rockfish	*Sebastes babcocki*	~	~	1%	<1%
Dusky rockfish	*Sebastes variabilis*	18%	39%	22%	45%
Redstripe rockfish	*Sebastes proriger*	~	1%	~	1%
Yelloweye rockfish	*Sebastes ruberrimus*	~	1%	<1%	1%
Harlequin rockfish	*Sebastes variegatus*	~	1%	9%	5%
Sharpchin rockfish	*Sebastes zacentrus*	~	<1%	<1%	<1%
Shortspine thornyhead	*Sebastolobus alascanus*	62%	43%	61%	34%

b) Period: 2004-2016

		EBS		AI	
Common name	Scientific name	**Survey**	**Fishery**	**Survey**	**Fishery**
Redbanded rockfish	*Sebastes babcocki*	~	<1%	~	<1%
Dusky rockfish	*Sebastes variabilis*	<1%	15%	15%	53%
Redstripe rockfish	*Sebastes proriger*	~	<1%	~	<1%
Yelloweye rockfish	*Sebastes ruberrimus*	~	<1%	~	<1%
Harlequin rockfish	*Sebastes variegatus*	~	<1%	<1%	7%
Sharpchin rockfish	*Sebastes zacentrus*	~	<1%	~	<1%
Shortspine thornyhead	*Sebastolobus alascanus*	99%	80%	85%	31%

Table 2. Regulatory catch limits (OFL, ABC, and TAC) and total catch of Other Rockfish in the BSAI, 1995-2016. Catch data for 2004-2016 data is from the NMFS Alaska Regional Office Catch Accounting System, accessed October 13, 2016. Catch data previous to 2004 was obtained using several different sources that are described in the text. Light shading indicates catch that exceeded TAC, but not ABC. Shading with bold print indicates catch that exceeded both TAC and ABC, but not OFL.

	BSAI				AI				BS			
Year	OFL	ABC	TAC	Catch	OFL	ABC	TAC	Catch	OFL	ABC	TAC	Catch
1995		1135	1022	480	770	770	693	223	365	365	329	257
1996		1449	1354	436	952	952	857	272	497	497	447	164
1997		1087	1087	388	952	714	714	274	497	373	373	114
1998		1054	1054	482	913	685	685	327	492	369	369	155
1999		1054	1054	517	913	685	685	372	492	369	369	145
2000		1054	1054	797	916	685	685	558	492	369	369	239
2001		1037	1037	819	901	676	676	524	482	361	361	295
2002		1037	1037	872	901	676	676	502	482	361	361	**370**
2003		1594	1594	724	846	634	634	408	1280	960	960	316
2004		1594	1094	513	846	634	634	266	1280	960	460	247
2005	1870	1400	1050	372		590	590	242		810	460	130
2006	1870	1400	1050	451		590	590	324		810	460	127
2007	1330	999	999	602		585	585	397		414	414	205
2008	1330	999	999	524		585	585	330		414	414	194
2009	1380	1040	1040	487		555	555	303		485	485	184
2010	1380	1040	1040	760		555	555	494		485	485	266
2011	1700	1280	1000	943		570	500	**616**		710	500	327
2012	1700	1280	1070	921		570	570	**712**		710	500	209
2013	1540	1159	873	814		473	473	**623**		686	400	191
2014	1550	1163	773	898		473	473	**575**		690	300	323
2015	1667	1250	880	685		555	555	501		695	325	184
2016	1667	1250	875	913		555	550	**656**		695	325	257

Table 3. Historical catch (t) of Other Rockfish species from 1977 to 2003 in foreign, joint venture (JV), and domestic fisheries. Data were obtained using several different sources that are described in the text. Data prior to 1990 are on file at the Alaska Fisheries Science Center, 7600 Sand Point Way N.E., Seattle, WA 98115.

	Eastern Bering Sea				Aleutian Islands				BSAI
Year	Foreign	JV	Domestic	Total	Foreign	JV	Domestic	Total	Total
1977	52	0		52	537	0		537	589
1978	304	0		304	795	0		795	1,099
1979	281	0		281	2,053	0		2,053	2,334
1980	566	1		567	484	0		484	1,051
1981	337	0		337	236	0		236	574
1982	365	0		365	2,057	0		2,057	2,422
1983	208	1		210	717	4		721	931
1984	112	7		119	57	25		81	200
1985	35	1		36	1	14		15	51
1986	4	14	81	99	0	10	147	157	256
1987	3	4	535	542	0	5	138	143	684
1988	0	3	252	254	0	68	168	237	491
1989	0	9	171	180	0	0	352	352	533
1990			395	395			822	822	1,217
1991			239	239			313	313	552
1992			201	201			470	470	671
1993			142	142			443	443	584
1994			123	123			272	272	395
1995			257	257			223	223	479
1996			164	164			272	272	437
1997			114	114			274	274	388
1998			155	155			327	327	482
1999			145	145			372	372	517
2000			239	239			558	558	797
2001			295	295			524	524	819
2002			370	370			502	502	872
2003			316	316			408	408	724

Table 4. Catch (t) of Other Rockfish species in the Aleutian Islands from 2004-2016. Source: NMFS AKRO Catch Accounting System, AKFIN database, accessed October 13, 2016.

Year	dusky rockfish	SST	harlequin rockfish	sharpchin rockfish	yelloweye rockfish
2004	129.5	97.4	36.87	14.05	0.90
2005	134.2	113.2	14.35	0.01	5.57
2006	161.4	158.4	25.22	2.00	0.38
2007	231.7	131.3	39.93		0.57
2008	179.8	115.2	34.33	0.01	4.48
2009	142.0	142.7	22.76		0.22
2010	224.7	162.7	42.60	0.08	0.54
2011	380.5	157.6	59.25		0.26
2012	435.0	170.9	51.94		0.15
2013	331.4	238.8	25.93		0.53
2014	346.9	169.1	19.99		
2015	294.2	142.3	32.65		0.04
2016	281.1	113.4	32.54	0.06	1.14
Average	251.7	147.2	33.72	2.70	1.23

Year	red-banded rockfish	redstripe rockfish	black rockfish	silver-gray rockfish	dark-blotched rockfish	Total (t)
2004	0.17	3.15	1.35		0.21	337.4
2005	0.17	0.00				286.5
2006	0.13	1.72	0.15		0.75	426.4
2007	1.42	0.53	0.09	3.01		435.8
2008	1.03	0.65	3.18	0.02	0.06	390.0
2009	0.39	0.05	1.24		0.01	403.3
2010	3.61	0.93	0.36			493.9
2011	0.40		0.12			616.1
2012	3.70	0.04	0.18			711.6
2013	0.96		0.01		0.03	623.4
2014	0.42	0.26	0.22			574.7
2015	4.25		0.07	0.05	0.45	501.4
2016	0.43	0.25	0.07			432.5
Average	1.31	0.76	0.59	1.03	0.25	479.4

Table 5. Catch (t) of Other Rockfish species in the eastern Bering Sea from 2004-2016. Species with catches less than 1 ton of catch from 2004-2014 are not shown. Source: NMFS AKRO Catch Accounting System, AKFIN database, accessed October 13, 2016.

Year	dusky rockfish	SST	harlequin rockfish	yelloweye rockfish
2004	31.86	241.9	0.37	1.42
2005	36.22	118.8	0.19	0.74
2006	46.60	93.2	0.04	1.41
2007	44.95	168.2	0.03	1.72
2008	15.39	186.4	0.03	1.04
2009	10.25	178.7	0.07	1.07
2010	32.33	201.2	0.35	1.39
2011	43.76	255.6	4.57	1.38
2012	27.08	143.6	0.05	0.47
2013	27.85	138.5	0.62	0.20
2014	40.28	238.0	1.53	0.92
2015	38.80	99.3	1.82	1.11
2016	29.18	201.0	2.52	0.76
Average	32.66	174.2	0.94	1.05

Year	redbanded rockfish	redstripe rockfish	black rockfish	Total (t)
2004	10.44	0.02	0.86	247.0
2005	0.31		7.20	130.0
2006	0.40	0.06	0.18	127.0
2007	0.05	0.04	0.29	205.0
2008	0.04	0.06	2.23	194.0
2009	0.22	0.05	0.18	184.0
2010	0.48		0.03	266.0
2011	0.42	0.03	2.17	327.0
2012	2.59	0.08	1.20	209.0
2013	0.10	0.04	0.17	191.0
2014	0.02	4.61	0.36	323.0
2015	0.15		1.28	184.0
2016	0.08	0.04	1.10	257.0
Average	1.18	0.50	1.33	218.8

Table 6. Total catch (t) of EBS dusky rockfish from 2004-2016 by target fishery and gear type. Areas 508-524 refer to NMFS areas within the BSAI. Source: NMFS AKRO Catch Accounting System, accessed October 13, 2016.

Gear	Target	508	509	513	514	516	517	518	519	521	523	524	Percent of Total
Bottom Trawl	Rockfish	0.16					40.10	2.54	6.64	0.76	0.71		0.12
Bottom Trawl	Pacific Cod		4.10				4.94		17.11	8.67	0.12	0.07	0.08
Bottom Trawl	Flatfish		2.19	1.47		0.03	3.56	0.15	3.84	9.33		0.28	0.05
Bottom Trawl	Pollock		1.77	0.08		0.01	3.44		3.20	11.23	0.11	0.02	0.05
Bottom Trawl	Atka Mackerel						0.01		13.15				0.03
Bottom Trawl	Sablefish								0.08				0.00
Bottom Trawl	Other Species						0.04						0.00
Jig	Rockfish				0.58			0.06	0.09				0.00
Jig	Pacific Cod							0.08	0.04				0.00
Longline	Pacific Cod		0.19	3.52			16.62	0.02	4.34	158.3	0.38	0.01	0.43
Longline	Flatfish									2.16	0.05		0.01
Longline	Halibut							0.11				0.04	0.00
Longline	Sablefish							0.04					0.00
Longline	Rockfish									0.00			0.00
Pelagic Trawl	Pollock		5.48	0.66	0.06	0.03	58.38		14.35	13.29	0.92	0.25	0.22
Pot	Pacific Cod		1.11	0.03			0.53	0.06	2.86	0.00			0.01

Table 7. Total catch (t) of EBS shortspine thornyhead from 2004-2016 by target fishery and gear type. Areas 508-524 refer to NMFS areas within the BSAI. Source: NMFS AKRO Catch Accounting System, AKFIN database, accessed on Oct 13, 2016.

Gear	Target	508	509	513	514	517	518	519	521	523	524	530	Total	Percent of Total
Bottom Trawl	Flatfish		0.04	3.47	0.06	688.51	12.36	225.28	37.92	0.77	1.53		969.9	0.43
Bottom Trawl	Rockfish					136.2	0.87	131.3	38.26	5.03			311.7	0.14
Bottom Trawl	Pacific Cod					43.81		18.93	0.01				62.7	0.03
Bottom Trawl	Atka Mackerel					3.69		27.2					30.9	0.01
Bottom Trawl	Pollock		0.05			14.4	0.2	6.26	0.63	0			21.5	0.01
Bottom Trawl	Sablefish					2.61	0.03	6.16					8.8	0
Bottom Trawl	Other Species					0.57							0.6	0
Longline	Flatfish					23.05	4.89	1.13	306.85	103.35	4.65		443.8	0.20
Longline	Sablefish	0.08			0.2	35.46	62.97	21.14	4.34	4.42		0.15	128.8	0.06
Longline	Halibut			0.26		8.85	45.58	5.44	8.22	5.68	0.05		74.1	0.03
Longline	Pacific Cod					7.71	0.44	1.51	33.85	5.57	0.21		49.3	0.02
Longline	Rockfish					0.68	1.5	1.61	0.48	1.58			5.8	0
Longline	Other Species								0.54	0.12			0.7	0
Pelagic Trawl	Pollock		0.47	0.32		93.7		56.91	0.26	0.02	0.01		151.7	0.07
Pot	Sablefish					0.15	2.31	1.08					3.5	0

Table 8. Total catch (t) of AI dusky rockfish from 2004-2016 by target fishery and gear type. Areas 541, 542, and 543 refer to NMFS areas within the AI. Source: NMFS AKRO Catch Accounting System, AKFIN database, accessed October 13, 2016.

Gear	Target	541	542	543	Total	Percent of Total
Bottom Trawl	Atka Mackerel	2,175	435	75	2,685	0.82
Bottom Trawl	Rockfish	233.1	91.4	51.2	375.7	0.12
Bottom Trawl	Pacific Cod	36.9	5.6	3.2	45.7	0.01
Bottom Trawl	Flatfish	30.8			30.8	0.01
Longline	Pacific Cod	48.2	41.0	19.3	108.5	0.03
Longline	Flatfish		0.5		0.5	0.00
Longline	Halibut	0.0	0.3	0.0	0.3	0.00
Longline	Other Species		0.0	0.2	0.2	0.00
Longline	Sablefish	0.1	0.1		0.1	0.00
Pelagic Trawl	Pollock	0.1			0.1	0.00
Pot	Pacific Cod	0.0	0.4		0.4	0.00

Table 9. Total catches (t) of Aleutian Island (AI) shortspine thornyhead from 2004-2016 by target fishery and gear type. Areas 541, 542, and 543 refer to NMFS areas within the AI. Source: NMFS AKRO Catch Accounting System, AKFIN database, as of 10/13/16.

Gear	Target	541	542	543	All AI	Percentage of Total
Bottom Trawl	Rockfish	18.34	126.79	398.86	543.98	0.29
Bottom Trawl	Atka Mackerel	5.94	45.75	52.14	103.83	0.05
Bottom Trawl	Flatfish	13.15			13.15	0
Bottom Trawl	Pacific Cod	0.2		0.52	0.72	0
Bottom Trawl	Pollock	0.07			0.07	0
Jig	Pacific Cod	0.02			0.02	0
Longline	Sablefish	402.24	308.39	183.68	894.31	0.47
Longline	Flatfish	11.7			142.08	0.07
Longline	Halibut	41.55	63.28	22.16	126.99	0.07
Longline	Pacific Cod	30.18	12.78	16.68	59.64	0.03
Longline	Rockfish	0.75	6.25	11.68	18.68	0.01
Longline	Other Species	0.37	1.96		2.33	0
Pot	Sablefish	2.26	0.1		2.36	0
Pot	Rockfish	0.02			0.02	0
Pot	Pacific Cod		0.01		0.01	0

Table 10. Retained and discarded catch of Other Rockfish species from 2004 to 2016 in the Aleutian Islands and Eastern Bering Sea. Accessed October 5, 2016 from the NMFS AKRO Catch Accounting System, AKFIN database.

Area	Year	Retained (t)	Discarded (t)	Total catch (t)	Percent Discarded
Aleutian	2004	162	120	282	42.55%
Islands	2005	185	82	267	30.71%
	2006	228	121	349	34.67%
	2007	208	197	405	48.64%
	2008	266	70	336	20.83%
	2009	253	55	308	17.86%
	2010	379	63	442	14.25%
	2011	472	126	598	21.07%
	2012	574	80	654	12.23%
	2013	461	137	598	22.91%
	2014	461	57	518	11.00%
	2015	192	54	245	21.85%
	2016	149	14	163	8.30%
Eastern	2004	221	65	286	22.73%
Bering	2005	137	19	156	12.18%
Sea	2006	119	23	142	16.20%
	2007	143	72	215	33.49%
	2008	140	63	203	31.03%
	2009	169	21	190	11.05%
	2010	199	37	236	15.68%
	2011	267	39	306	12.75%
	2012	146	28	174	16.09%
	2013	143	24	167	14.37%
	2014	237	41	278	14.75%
	2015	99	62	160	38.40%
	2016	138	72	210	34.18%

Table 11. Survey biomass estimates (t) and CVs (in parentheses) for Other Rockfish (including shortspine thornyhead) from 1979 - 2016. Southern Bering Sea refers to NMFS reporting area 799.

	AI survey			EBS Shelf survey	EBS Slope survey
Year	AI	S. Bering Sea	Total		
1979					3,251
1980	930 (0.18)	36 (0.73)	966 (0.18)		
1981					4,975
1982					4,381
1983	3,971 (0.17)	802 (0.23)	4,774 (0.15)		
1984				18 (1.0)	
1985				0	5,127
1986	6,550 (0.19)	3,253 (0.86)	9,803 (0.31)	0	
1987				0	
1988				0	8,759
1989				0	
1990				0	
1991	6,643 (0.22)	248 (0.48)	6,891 (0.22)	0	4,529
1992				0	
1993				0	
1994	6,452 (0.16)	1,172 (0.48)	7,624 (0.15)	0	
1995				0	
1996				36 (1.0)	
1997	9,539 (0.17)	1,683 (0.63)	11,223 (0.18)	0	
1998				538 (0.68)	
1999				398 (0.75)	
2000	11,924 (0.17)	1,107 (0.45)	13,031 (0.16)	0	
2001				0	
2002	14,781 (0.20)	1,111 (37)	15,892 (0.18)	0	16,975 (0.12)
2003				55 (0.70)	
2004	18,566 (0.18)	6,473 (67)	25,039 (0.22)	0	18,807 (0.09)
2005				36 (1.0)	
2006	23,879 (0.24)	1,706 (0.52)	25,585 (0.23)	357 (0.85)	
2007				0	
2008				0	26,082 (0.12)
2009				122 (0.58)	
2010	18,663 (0.15)	1,172 (0.66)	19,835 (0.15)	57 (0.92)	29,482 (0.12)
2011				56 (1.0)	
2012	14,694 (0.15)	586 (0.61)	15,280 (0.15)	37 (1.0)	29,617 (0.12)
2013				40 (1.0)	
2014	23,972 (0.26)	2,801 (0.61)	26,773 (0.24)	28 (1.0)	
2015				143 (1.0)	
2016	18,789 (0.15)	1,830 (0.47)	20,619 (0.14)	20 (1.0)	35,978 (0.11)

Table 12. Survey biomass estimates (t) and CVs (in parentheses) for Dusky rockfish from 1997 - 2016. Southern Bering Sea refers to NMFS reporting area 799.

	AI survey			EBS Slope survey
Year	AI	S. Bering Sea	Total	
1997	574 (0.76)	138 (0.46)	712 (0.62)	
1998				
1999				
2000	1,250 (0.34)	55 (0.36)	1,306 (0.33)	
2001				
2002	515 (0.32)	97 (0.36)	612 (0.27)	25 (0.57)
2003				
2004	730 (0.44)	1,359 (0.91)	2,089 (0.61)	13(0.57)
2005				
2006	5,956 (0.89)	731 (0.96)	6,687 (0.80)	
2007				
2008				10 (1.00)
2009				
2010	560 (0.34)	120 (0.44)	680 (0.29)	117 (0.87)
2011				
2012	236 (0.32)	135 (0.57)	371 (0.29)	40 (0.61)
2013				
2014	6,260 (0.74)	233 (0.50)	6,493 (0.71)	
2015				
2016	2,148 (0.30)	222 (0.53)	2,370 (0.27)	0

Table 13. Survey biomass estimates (t) and CVs (in parentheses) for shortspine thornyhead from 1991- 2016. Southern Bering Sea refers to NMFS reporting area 799.

	AI survey			EBS Slope survey
Year	AI	S. Bering Sea	Total	
1991	6,153 (0.24)	187 (0.58)	6,341 (0.23)	
1992				
1993				
1994	6,240 (0.16)	1,071 (0.52)	7,311 (0.16)	
1995				
1996				
1997	8,896 (0.18)	1,545 (0.69)	10,441 (0.18)	
1998				
1999				
2000	10,649 (0.19)	1,051 (0.48)	11,700 (0.17)	
2001				
2002	14,243 (0.20)	1,012 (0.41)	15,255 (0.19)	16,950 (0.12)
2003				
2004	17,335 (0.19)	945 (0.56)	18,280 (0.18)	18,793 (0.09)
2005				
2006	17,876 (0.12)	968 (0.55)	18,844 (0.12)	
2007				
2008				26,055 (0.12)
2009				
2010	18,075 (0.16)	1,052 (0.73)	19,127 (0.16)	29,334 (0.12)
2011				
2012	14,443 (0.15)	452 (0.77)	14,895 (0.15)	29,564 (0.11)
2013				
2014	17,611 (0.24)	2,567 (0.67)	20,178 (0.23)	
2015				
2016	16,541 (0.16)	1,607 (0.53)	18,148 (0.16)	35,947 (0.11)

Figures

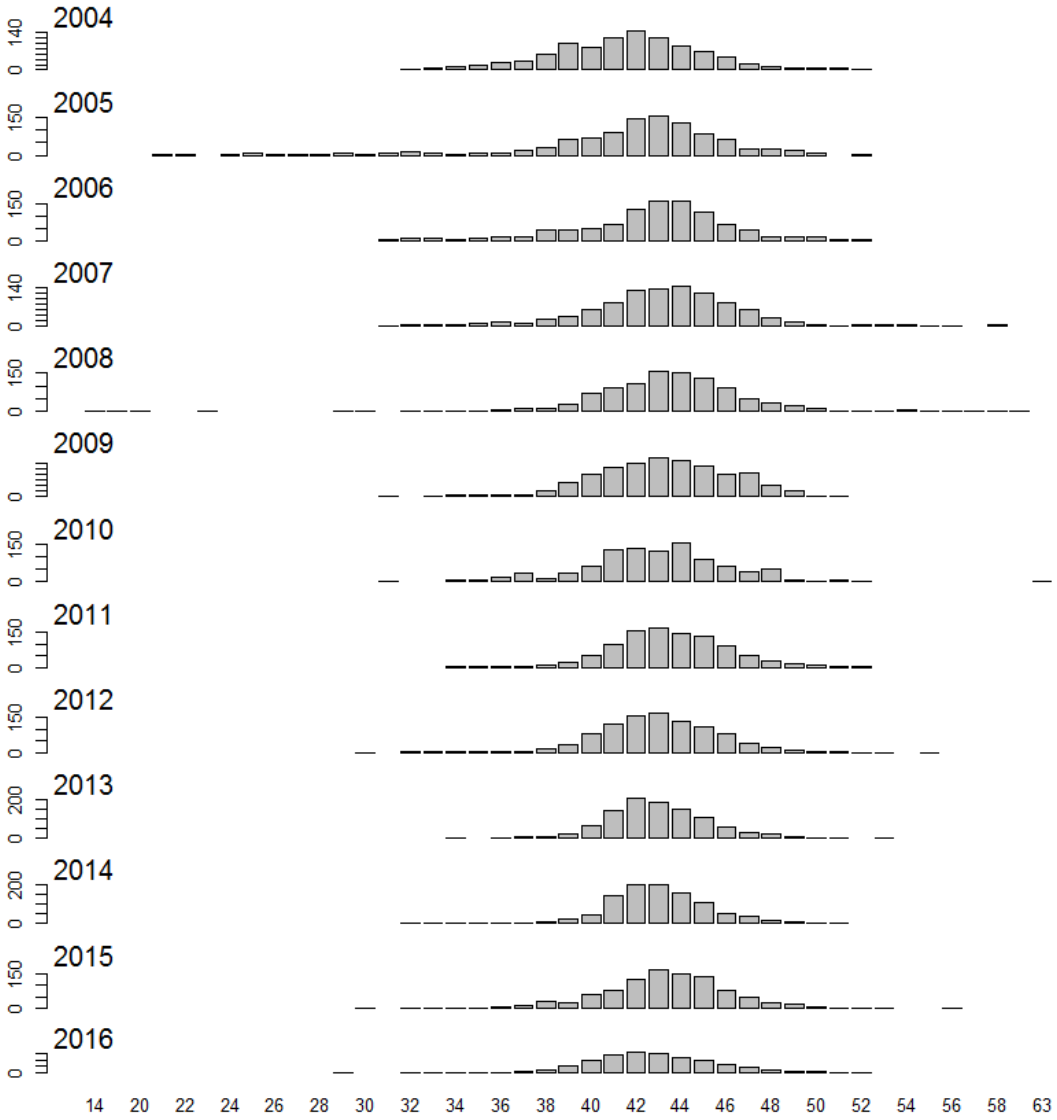


Figure 1. Dusky rockfish length frequency data from fishery observers in the BSAI, 2004-2016. Source: NMFS AFSC FMA Observer Debriefed Haul and Length tables.

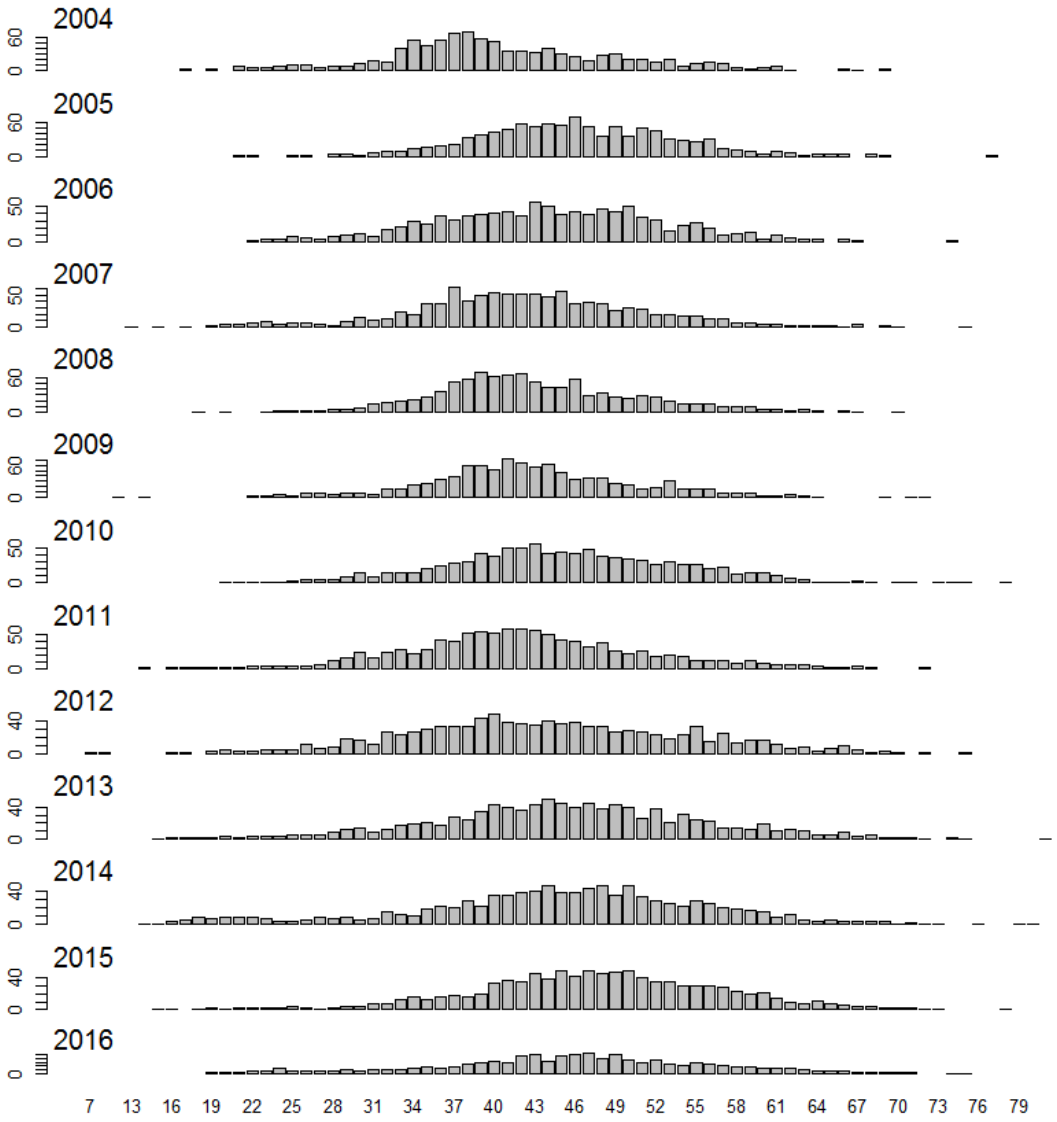


Figure 2. Shortspine thornyhead length frequency data from fisheries observers in the BSAI, 2004-2016. Source: NMFS AFSC FMA Observer Debriefed Haul and Length tables.

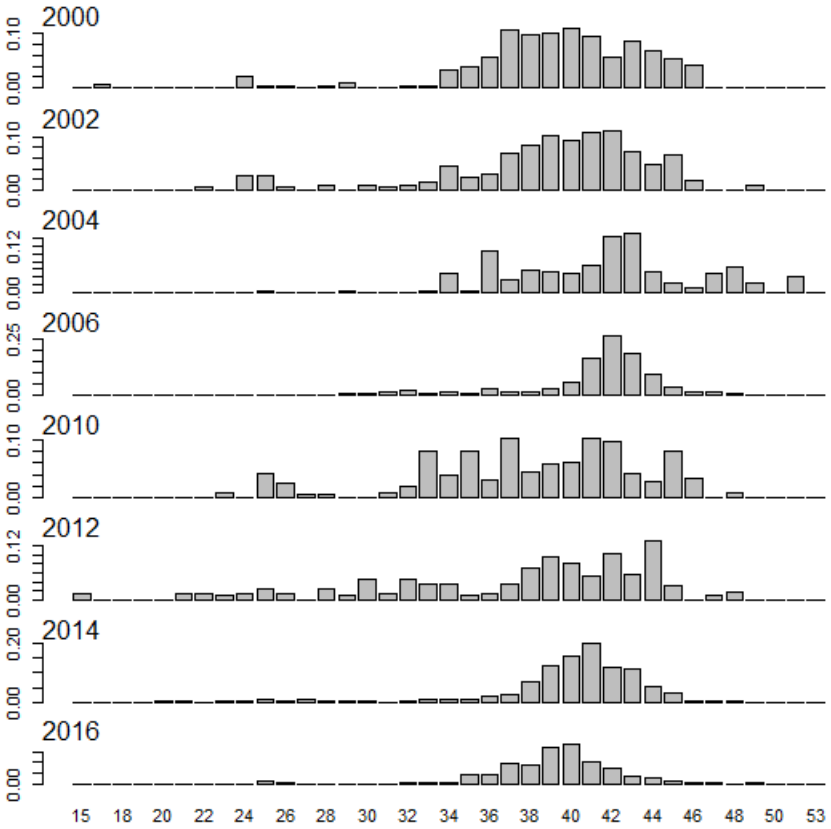


Figure 3. Dusky rockfish lengths (cm) from Aleutian Islands survey data 2000-2016.

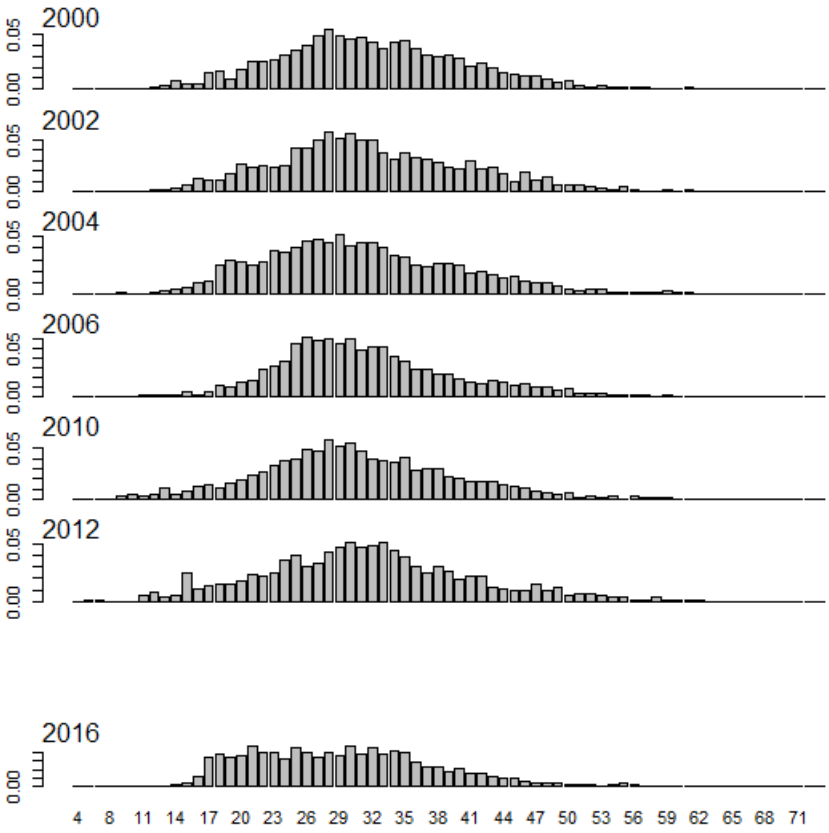
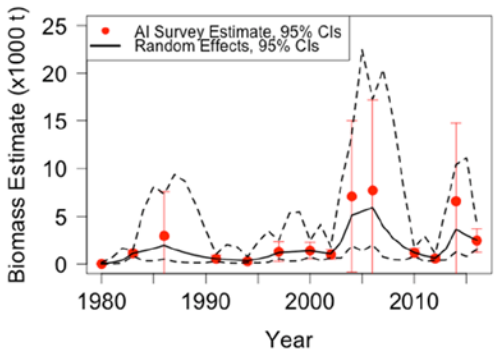
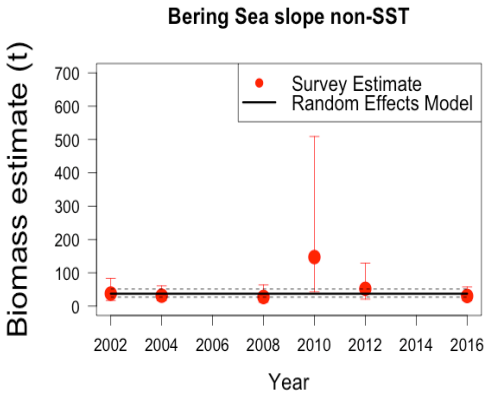


Figure 4. Shortspine thornyhead rockfish length frequencies from Aleutian Islands survey data, 2000-2016.

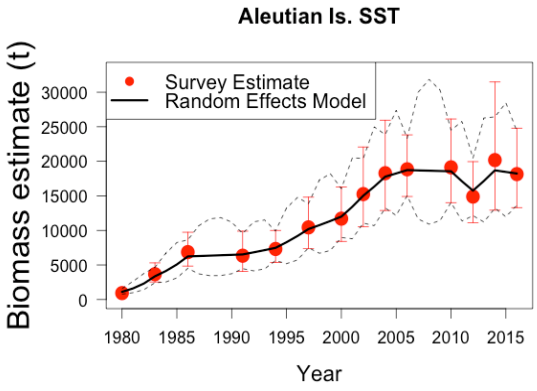
Aleutian Islands non-SST Other Rockfish



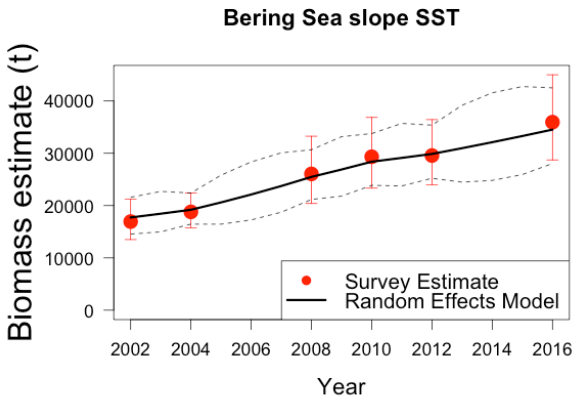
Bering Sea slope non-SST Other Rockfish



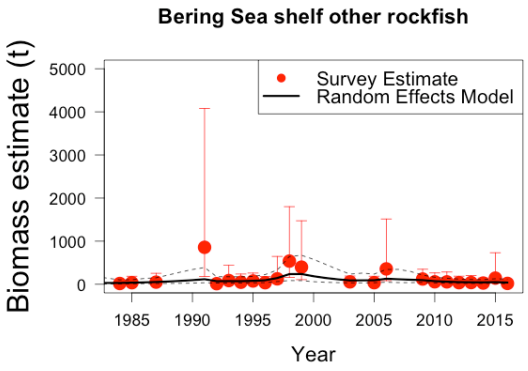
Aleutian Islands SST



Bering Sea slope SST



Bering Sea shelf all Other Rockfish



Combined Random effect estimates of all Other Rockfish biomass (BSAI)

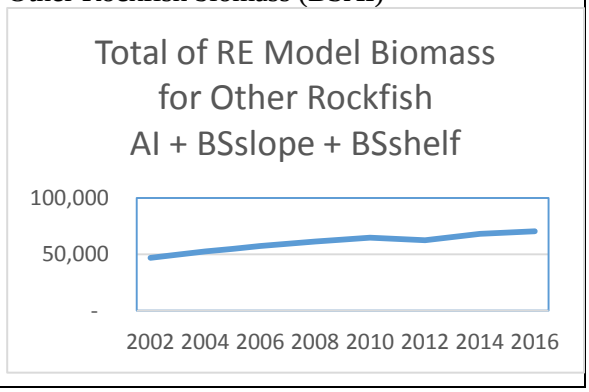


Figure 5. Random effect model biomass estimates of Other Rockfish in the Aleutian Islands, Southern Bering Sea, Bering Sea shelf and slope.

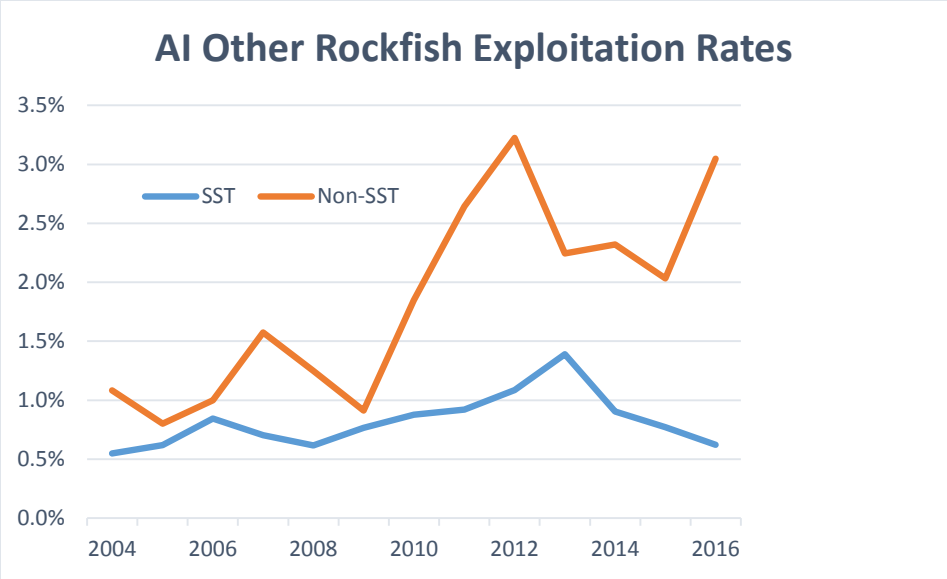


Figure 6. Exploitation rates 2004-2016 for other rockfish in the Aleutian Islands region, based on fishery catch and annual biomass predicted by the Random Effects model. Shortspine thornyhead (SST) is separated from other rockfish species (primarily dusky and harlequin rockfish).

Appendix Table 1. Removals from sources other than those included in the Alaska Region's official estimate of catch (e.g., removals due to scientific surveys, subsistence fishing, recreational fishing, fisheries managed under other FMPs). Source: AKRO. Data for the current year are not yet available.

Year	Catch (t)
1996	3.18
1997	2.48
1998	3.32
1999	0.62
2000	1.59
2001	1.02
2002	1.55
2003	1.36
2004	1.46
2005	1.36
2006	1.68
2007	1.78
2008	1.49
2009	2.00
2010	13.54
2011	23.39
2012	10.22
2013	3.86
2014	5.70
2015	3.89