14. Assessment of Blackspotted and Rougheye Rockfish stock complex in the Bering Sea/Aleutian Islands

by

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Executive Summary

Fish previously referred to as rougheye rockfish are now recognized as consisting of two species, rougheye rockfish (*Sebastes aleutianus*) and blackspotted rockfish (*Sebastes melanostictus*) (Orr and Hawkins 2008). Bering Sea/Aleutian Islands blackspotted/rougheye rockfish is assessed with an age-structured model for the Aleutian Islands portion of the stock, and a non-age-structured model for the eastern Bering Sea portion of the stock. The last full assessment for BSAI blackspotted/rougheye rockfish was presented to the Plan Team in 2022. The following changes were made to blackspotted/rougheye assessment relative to the November 2022 SAFE:

Summary of Changes in Assessment Inputs

Changes in the input data

1) Catch data was updated through 2023, and total catch for 2024 was projected.
2) The 2024 AI survey biomass estimate and length composition were included in the assessment.
3) The 2022 AI survey length composition was replaced by the 2022 AI survey age composition.
4) The 2023 fishery age compositions and 2022 fishery length compositions were included in the model.
5) The input multinomial sample sizes for the age and length composition data were reweighted using the Francis iterative reweighting procedure.

Changes in the assessment methodology

1) There were no changes in the methodology for the recommended model.

Summary of Results

The recommended model estimates a very large 2011 year class of 27.93 million with a large coefficient of variation of 0.42. This is over 8 times larger than the next-largest year class – the 2002 year class estimated at 3.27 million. Because the estimate of $B_{40\%}$ is a function of mean recruitment from the post-1977 year classes, this year class increases the estimate of $B_{40\%}$ by 47% relative to the 2022 estimate and hence changes the relative status of the stock using these proxies from the FMP.

A similar situation occurred in the 2022 assessment, although in that case it was the 2010 year class that was over 6 times the next largest estimate. In that assessment we noted that: 1) the estimates of year class strength can be uncertain and show instability; 2) because this stock has a late age of maturation and low fishery selectivity for fish even 10- 12 years old, there is relatively little effect of a large relatively recent year class on spawning stock biomass; and 3) there is a large change in the relative stock status because the large estimate of recruitment increases $B_{40\%}$ and reduces the ratio of current biomass to $B_{40\%}$ (even if the current biomass is not necessarily decreasing).

These issues still exist in the 2024 assessment. The substantial change in the 2010 year class estimate (from 21.2 M to 1.9 M between the 2022 and 2024 assessments) is an example of the uncertainty in estimating recruitment of partially observed year classes. As new length and age composition data are added to the model, the attribution of a large recent year class to a specific year has shifted. New observations on recent year classes are available from age compositions in the 2023 fishery and the 2022 AI survey. Approximately 3% of this 2011 year class was estimated to be mature in 2023 and thus contribute to spawning stock biomass (SSB), and the estimated fishery selectivity of 12 year old fish is 25%.

Despite the current estimate of SSB being larger than that from the 2023 harvest projection, the ratio of B_{2025}/ $B_{40\%}$ from the 2024 assessment would decline to 0.73 and the maximum ABC for the AI portion of the stock would decline 20% from 583 in 2024 to 468 in 2025. This decline in the recommended ABC would occur despite increasing survey abundance observed in the 2022 and 2024 AI surveys.

Methods to address the impact that uncertainty in recruitment strength and estimated numbers-at-age have on reference points and recommended ABCs and OFLs are lacking. The reduction in the max ABC of 20% is based primarily on the effect that an estimate of a large and uncertain year class has on $B_{40\%}$ and F_{abc}. However, the time series of survey biomass estimates indicates an increase since the 2020 assessment (with the assessment model estimating a large portion of the population comprised of relatively recent year classes), and we could reasonably expect that the recommended 2025 ABC would be similar to or somewhat larger than the 2024 ABC.

In the 2022 assessment, we recommended ABCs that were based on reference points calculated by setting the value of the 2010 year class to a value considered more likely, and replaced the 2010 year class with a value equal to the 2002 year class (the estimated next-largest year class). We recommend an identical procedure in this assessment, replacing the 2011 year class with the 2002 year class of 3.27 M. Note that this was done only for the calculation of average recruitment, and the estimated 2024 numbers at age used to initialize the harvest projection were not altered. It is common to not use estimates of recent year classes when computing average recruitment, and we continue to use a procedure (recommended by the Plan Team) that considers stock longevity and the age of the year class relative to the level of selection in the AI trawl survey when selecting the year classes for calculation of mean recruitment. For the 2024 blackspotted/rougheye assessment, this adjustment would result in a 2025 max ABC of 652 t, approximately 12% larger than the 2024 max ABC of 583 t for the AI portion of the stock and a 4% increase from the 2025 max ABC of 627 t obtained from the 2023 harvest projection. The following table summarizes the effect on reference points, stock status, and ABCs for both adjusted and unadjusted values for the 2010 year class (all biomass units in tons):

	2023 projection	2024 assessment	
	Adjusted 2010 YC used for $B_{40\%}$	Unadjusted 2011 YC used for $B_{40\%}$	Adjusted 2011 YC used for $B_{40\%}$
$B_{40\%}$	3,493		
$B_{40\%}$ (2024 assessment)		5,118	3,525
Percent change in $B_{40\%}$, 2022 to 2024		46.52%	0.92%
2024 SSB	3,630		
2025 SSB		3,732	3,729
2026 SSB		3,966	3,946
$B_{2024}/B_{40\%}$	1.04		
$B_{2025}/B_{40\%}$		0.73	1.06
$B_{2026}/B_{40\%}$		0.77	1.12
2024 Total Biomass	24,315		
2025 Total Biomass		28,356	28,314
2026 Total Biomass		29,004	28,814
2024 Fabc	0.034		
2025 Fabc		0.025	0.035
2026 Fabc		0.027	0.035
2024 maximum ABC	583		
2025 maximum ABC		468	652
(percent change 2024 to 2025)		-19.73%	11.84%
2026 maximum ABC		547	712
(percent change 2024 to 2025)		16.88%	9.20%

Given the options considered, we recommend using the adjusted projection to set the maximum ABC. We note that the 2011 year class is estimated to compose a large portion of the stock. Adjusting the 2011 year class stabilizes the $B_{40\%}$ reference point estimate. Using the estimate of this year class in the projections as part of the stock (as age 14 and 15 year olds in the next two years) increases the ABC considerably relative to the using an unadjusted 2011 year class to compute B40%. We accept that as the "best estimate" for maximum permissible ABC.

In the 2022 assessment, concerns about the uncertainty in the 2010 year class and the history of revising estimated year class strengths led to a recommended ABC less than the max ABC. At that time, the recommend 2023 ABC was obtained from the 2021 projection for max ABC in 2023. If we followed the same procedure for the 2024 assessment, the 2025 max ABC from the 2023 projection (627 t) is nearly the same as the 2025 max ABC from the 2024 assessment (652 t) with the adjusted 2011 year class. The mean size and age of the population is less than has been observed in the past, and a concern is that increases in fishing pressure could hinder the ability of recent strong year classes to further reverse the downward trend in the survey biomass estimates observed prior to 2018. However, a potential mitigating factor is that the fishery is actively trying to avoid catch of this bycatch species. More information is now available that suggests the stock is increasing, as the AI survey biomass estimate (for the AI management area) has increased from 15.7 kt in 2022 to 24.1 kt in 2024. Given the increases in survey biomass observed since 2018, and the continued presence of relatively large proportions of relatively young and small fish in both the survey and fishery data, we recommend the max ABC of 652 t for the AI portion of the stock, and continued evaluation regarding the strength of recent year classes and survey biomass increases.

A summary of the 2025 and 2026 recommended ABCs (from the AI model) relative to the values specified for 2024 (based on the accepted 2022 AI model) are shown below.

Quantity	As estimated or *specified* last year for:		As estimated or *recommended* this year for:	
	2024	2025	2025*	2026*
M (natural mortality rate)	0.050	0.050	0.050	0.050
Tier	3a	3a	3a	3a
Projected total (age 3+) biomass (t)	24,315	24,743	28,314	28,814
Female spawning biomass (t)				
Projected	3,630	3,821	3,729	3,946
$B_{100\%}$	8,733	8,733	8,813	8,813
$B_{40\%}$	3,493	3,493	3,525	3,525
$B_{35\%}$	3,056	3,056	3,085	3,085
F_{OFL}	0.040	0.040	0.041	0.041
$maxF_{ABC}$	0.034	0.034	0.035	0.035
F_{ABC}	0.034	0.034	0.035	0.035
OFL (t)	684	736	766	830
maxABC (t)	583	627	652	712
ABC (t)	511	549	652	712
Status	As determined *last* year for:		As determined *this* year for:	
	2022	2023	2023	2024
Overfishing	No	n/a	No	n/a
Overfished	n/a	No	n/a	No
Approaching overfished	n/a	No	n/a	No

*Projections are based on estimated catches of 571 t in 2025 and 623 in 2026. Mean recruitment and biomass reference points (i.e. $B_{xx\%}$) were based on replacing the large 2011 year class estimate of 27.93 million with 3.27 million (the estimate for the 2002 year class, the next largest).

The population size and harvest levels for the EBS portion of the population were obtained by applying Tier 5 methods to recent survey biomass estimates. A random effects model was used to fit a random walk smoother to the survey biomass data from the EBS portion of the stock. A summary of the 2025-2026 recommended ABC's for the EBS portion of the population is shown below.

Quantity	As estimated or *recommended* last year for:		As estimated or *recommended* this year for:	
	2024	2025	2025	2026
M (natural mortality rate)	0.050	0.050	0.050	0.050
Tier	5	5	5	5
Biomass (t)	1544	1544	1444	1444
F_{OFL}	0.050	0.050	0.050	0.050
$maxF_{ABC}$	0.037	0.037	0.037	0.037
F_{ABC}	0.037	0.037	0.037	0.037
OFL (t)	77	77	72	72
maxABC (t)	58	58	54	54
ABC (t)	58	58	54	54
Status	As determined *last* year for		As determined *this* year for:	
	2022	2023	2023	2024
Overfishing	No	No	No	n/a

The overall BSAI ABC and OFL are shown below.

Quantity/Status	As estimated or *specified* last year for:		As estimated or *recommended* this year for:	
	2024	2025	2025	2026
OFL (t)	761	813	838	902
ABC (t)	569	607	706	766

The BSAI blackspotted/rougheye stock complex was not subjected to overfishing in 2023. Based on the age-structured model for the AI portion of the stock, BSAI blackspotted/rougheye rockfish is not overfished nor approaching an overfished condition.

Area Apportionment

The ABC for BSAI blackspotted/rougheye is currently apportioned among two areas: the western and central Aleutian Islands, and eastern Aleutian Islands and eastern Bering Sea. A random effects model was used to smooth the time series of subarea survey biomass and obtain the proportions. The following table gives the projected OFLs and apportioned ABCs for 2025 and 2026 and the recent OFLs, ABCs, TACs, and catches.

Area/subarea	Year	Total Biomass (t)[1]	OFL	ABC	TAC	Catch[2]
BSAI	2023	25,400	703	525	525	607
	2024	25,859	761	569	569	463
	2025	29,758	838	706	n/a	n/a
	2026	30,258	902	766	n/a	n/a
Western/Central Aleutian Islands	2023			166	166	316
	2024			181	181	293
	2025			298	n/a	n/a
	2026			325	n/a	n/a
Eastern AI/Eastern Bering Sea	2023			359	359	291
	2024			388	388	170
	2025			408	n/a	n/a
	2026			441	n/a	n/a

[1] The total biomass from AI age-structured model, and survey biomass estimates from EBS.
[2] BSAI catch as of October 5, 2024.

Apportionment within the WAI/CAI area

In recent years, the WAI/CAI has been partitioned into “maximum subarea species catch” for the WAI and CAI areas. A random effects model was used to smooth the time series of subarea survey biomass and obtain proportions used for this partitioning, and the 2025 and 2026 MSSC values are shown below.

Year	WAI MSSC	CAI MSSC
2025	100	198
2026	109	216

Responses to SSC and Plan Team Comments on Assessments in General

(SSC, October 2023). *When there are time-varying biological and fishery parameters in the model, the SSC requests that a table be included in the SAFE that documents how reference points are calculated.*

Time-varying that would affect the calculation of the Amendment 56 reference points are not used in this assessment.

(SSC, December 2023).*The SSC reiterates that only fishery performance indicators that provide some inference regarding biological status of the stock should be used . . . Examples of useful indicators include CPUE, fishery spatial and temporal patterns, and catches of thin or unhealthy fish (i.e., poor condition).*

The spatial and temporal pattern of fishery CPUE is used in the risk table to draw inferences on the biological status of the stock.

(SSC, December 2023) *When risk scores are reported, the SSC requests that a brief justification for each score be provided, even when that score indicates no elevated risk.*

A brief justification is provided for each risk scores.

Responses to SSC and Plan Team Comments Specific to this Assessment

(SSC, October 2022). *The SSC acknowledged the changes in the IPHC longline survey sampling design in 2020 but noted that the survey was highly correlated with the bottom trawl survey prior to 2020. Given the retrospective bias in the current model and its difficulty in assessing the scale of the stock, the SSC recommends the author explore use of the pre-2020 data in the assessment with emphasis on sampling in untrawlable habitats.*

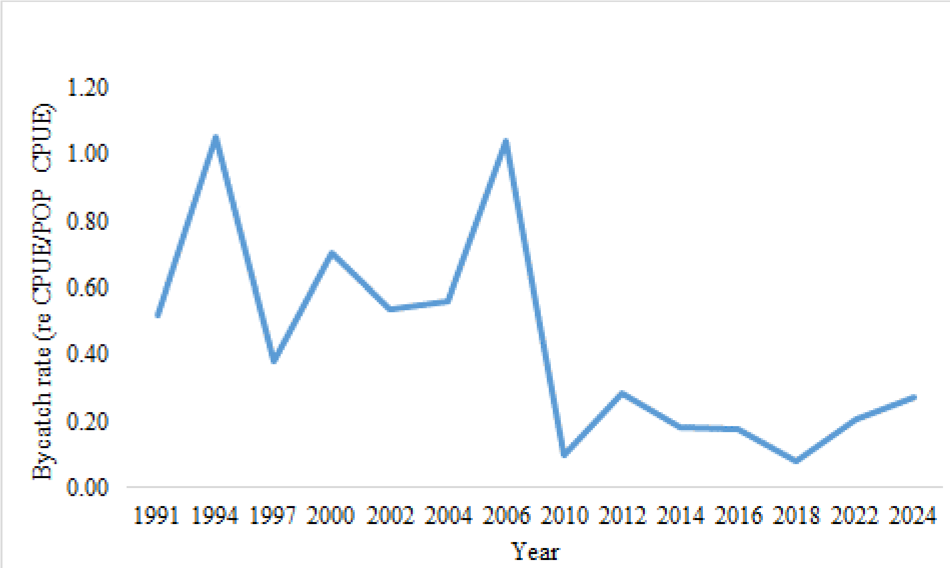
A report describing the potential inclusion of the IPHC longline survey in the assessment was presented to the BSAI Plan Team at the September, 2024 meeting and it attached as Appendix 14A. Inclusion of this survey time series is hindered by the lack of age or size composition, which prevented estimation of a survey selectivity curve.

(BSAI Plan Team, November 2022). *The Team discussed the lack of larger fish in fishery composition data and recommended examining the NMFS and IPHC longline survey data to determine if larger fish may be in the population and not showing up in the fishery. The Team also recommended looking at the rate of blackspotted/rougheye to Pacific ocean perch in the survey tows over the time series.*

A report comparing the size compositions of blackspotted/rougheye rockfish between the AFSC longline and trawl surveys and the fishery was presented to the BSAI Plan Team at the September, 2024 meeting and it attached as Appendix 14A. A variety of patterns were observed in comparing the fishery size compositions to the two surveys, but there is not an indication of larger sizes in the population than in the fishery.

(BSAI Plan Team, November 2022). *The Team also recommended looking at the rate of blackspotted/rougheye to Pacific ocean perch in the survey tows over the time series.*

A report catch rates of blackspotted/rougheye rockfish relative to Pacific ocean perch catch rates in the AI trawl survey was presented to the BSAI Plan Team at the September, 2024 meeting and it attached as Appendix 14A. The report presented in to the Plan Team defined catch rates in terms of catch weight per unit effort, and showed a decline in the ratio of blackspotted/rougheye catch rates to that of POP. This decline could be caused by some combination of changes in estimated survey abundance or fish size, and the size of blackspotted/rougheye has declined over the survey period. A plot of the ratio of numerical CPUE (i.e., number caught per square km) is shown below, and also shows a decline in CPUE similar to the ratio of weight-based CPUE, suggesting that the decline in weight-based CPUE is primarily driven by reductions in the number of blackspotted/rougheye caught relative to number of POP caught. .



(SSC, December 2022). *Recognizing that the proportion of rougheye rockfish is much smaller in the BSAI than in the GOA and that species identification remains an issue, the SSC requests the author, to the extent possible, separate survey trends by species to refine understanding of species-specific impacts.*

Blackspotted and rougheye rockfish were distinguished as two separate species beginning in the 2006 AI trawl survey. The following table show the estimated survey biomass (t) and coefficients of variation (in parentheses) by area in the AI trawl survey.

	West AI		Central AI		East AI		Southern Bering Sea		Total AI Survey	
Year	Blackspotted	Rougheye	Blackspotted	Rougheye	Blackspotted	Rougheye	Blackspotted	Rougheye	Blackspotted	Rougheye
2006	519 (0.29)	0	4,732 (0.40)	227 (0.71)	2,763 (0.33)	40 (0.58)	794 (0.47)	431 (0.36)	8,014 (0.26)	268 (0.61)
2010	1,529 (0.46)	72 (0.62)	2,215 (0.25)	24 (1.00)	4,345 (0.47)	357 (0.55)	183 (0.30)	37 (0.75)	8,089 (0.28)	452 (0.45)
2012	333 (0.38)	2 (0.99)	8,220 (0.56)	49 (0.74)	3,757 (0.37)	41 (0.64)	304 (0.35)	102 (0.35)	12,310 (0.39)	92 (0.49)
2014	572 (0.29)	17 (1.00)	2,869 (0.27)	9 (1.00)	913 (0.31)	46 (0.83)	255 (0.23)	56 (0.36)	4,353 (0.19)	72 (0.59)
2016	501 (0.34)	0	2,751 (0.36)	52 (0.92)	6,162 (0.37)	3 (1.00)	577 (0.36)	23 (0.68)	9,414 (0.26)	55 (0.87)
2018	632 (0.34)	0	2,324 (0.37)	25 (0.76)	6,441 (0.68)	93 (0.72)	313 (0.28)	15 (0.77)	9,397 (0.48)	118 (0.59)
2022	1,786 (0.20)	6 (0.61)	3,027 (0.38)	29 (0.71)	10,771 (0.71)	63 (0.92)	430 (0.45)	213 (0.53)	15,585 (0.50)	98 (0.63)
2024	3369 (30)	48 (1.00)	7945 (0.28)	27 (1.00)	12553 (0.80)	445 (0.36)	277 (0.60)	45 (0.55)	23567 (0.43)	521 (0.33)

Rougheye rockfish are rarely caught in the western and central AI, and this finding is consistent the genetic and morphological information (reviewed in the stock assessment) that did not rely solely on field identification of samples. Rougheye and blackspotted rockfish are not distinguished from each other in fishery sampling, which hinders evaluation of species-specific impacts.

Introduction

Rougheye rockfish (*Sebastes aleutianus*) have historically been managed within various stock complexes in the Bering Sea/Aleutian Islands (BSAI) region. For example, from 1991 to 2000, rougheye rockfish in the eastern Bering Sea (EBS) area were managed under the "other red rockfish" species complex, which consisted of shortraker (*Sebastes borealis*), rougheye (*S. aleutianus*), sharpchin (*S. zacentrus*), and northern rockfish (*S. polyspinis*), whereas in the Aleutian Islands (AI) area during this time rougheye rockfish were managed within the rougheye/shortraker complex. In 2001, the other red rockfish complex in the EBS was split into two groups, rougheye/shortraker and sharpchin/northern, matching the complexes used in the Aleutian Islands. Additionally, separate TACs were established for the EBS and AI management areas, but the overfishing level (OFL) pertained to the entire BSAI area. By 2004, rougheye, shortraker, and northern rockfish were managed with species-specific OFLs applied to the BSAI management area.

Species composition within the two-species complex

Fish historically referred to as "rougheye" rockfish are now recognized as consisting of two separate species (Orr and Hawkins 2008), with rougheye rockfish retaining the name *Sebastes aleutianus* and resurrection of a new species, blackspotted rockfish (*S. melanostictus*). Both species are distributed widely throughout the north Pacific. *S. aleutianus* is distributed from the eastern AI near Unalaska Island along the continental slope to southern Oregon, while *S. melanostictus* is distributed along the continental slope from Japan to California (Orr and Hawkins 2008), and *S. melanostictus* is distributed in the Western and Central Aleutian Islands, where *S. aleutianus* is not found.

Several studies (Hawkins et al. 2005; Gharrett et al. 2005; Orr and Hawkins 2008) have used genetic and morphometric analyses to document the scarcity of rougheye rockfish west of the eastern AI and the occurrence of blackspotted rockfish throughout the BSAI area, thus establishing differences in species composition between areas in the BSAI. Hawkins et al. (2005) conducted allozyme analyses on collections obtained from bottom trawl and longline survey samples from a variety of locations in the north Pacific. Two "types" of rougheye were recognized by Hawkins et al. (2005), *S. aleutianus* and *S.* sp. cf. *aleutianus*, with the Aleutian Islands composed almost entirely of *S.* sp.cf. *aleutianus*. The genetic basis for distinct species was also established by Gharrett et al. (2005), who applied mitochondrial DNA and microsatellite analyses to longline and trawl survey samples. "Type II" rougheye (corresponding to *S. aleutianus* of Hawkins et al. 2005) were absent from the western AI and western BS collections, and were rare elsewhere in the BSAI area. In contrast, "type I" rougheye (corresponding to *S.* sp.cf. *aleutianus* of Hawkins et al. 2005) extended throughout the range sampled (Figure 14.1). The distributions observed in Hawkins et al 2005 and Gharrett et al. 2005 were corroborated with microsatellite and mitochondrial analyses applied to samples obtained from the north Pacific (Gharrett et al. 2007). The description of the two rougheye species is established by application of morphometric and meristic analyses by Orr and Hawkins (2008) to catalogued samples, with genetic analysis used to verify the morphometric and meristic patterns. The range of *S. aleutianus* (corresponding to *S. aleutianus* of Hawkins et al 2005 and "type II" rougheye from Gharrett et al. 2005), was found to extend westward to the eastern Aleutian Islands near Unalaska Island, whereas the range of *S. melanostictus* (corresponding to *S.* sp.*cf. aleutianus* of Hawkins et al. 2005 and "type I" rougheye from Gharrett et al. 2005) extended throughout the BSAI area (Figure 14.2). Finally, additional genetic testing on samples collected in the 2012 AI survey corroborates these findings (Dr. Anthony Gharrett, University of Alaska, pers. comm.). Of 105 total samples, identified in the field as either rougheye or blackspotted rockfish, 4 of 80 (5%) samples in the EAI and CAI were genetically identified as rougheye rockfish, and most rougheye rockfish that were sampled were obtained from the southern Bering Sea area:

	Genetic Identification			
Area	Rougheye	Blackspotted	Hybrid	Sum
SBS	11	3	1	15
EAI	3	22		25
CAI	1	64		65
Sum	15	89	1	105

This distribution pattern has also been observed in recent AI trawl surveys, where rougheye rockfish are rarely found in the central and western AI. Identification to species within the blackspotted/rougheye complex was initiated in the 2006 AI survey and the 2008 EBS slope survey. These data show the complex is composed nearly entirely of blackspotted rockfish in the AI management area (ranging between 95% and 99% by weight in the 2006 – 2012 surveys), with a higher proportion of rougheye rockfish in the southern Bering Sea (SBS) and EBS slope. Field identification of these species can be difficult in areas where both species are abundant, such as the Gulf of Alaska, but blackspotted rockfish in the AI have been observed to have more clearly identifiable characteristics than blackspotted rockfish in other areas (Jay Orr, AFSC, pers. comm.). Errors in species identification may be particularly problematic in the Gulf of Alaska (GOA), where a field test in the 2009 GOA trawl survey reported high misidentification rates. However, the distribution pattern in the AI survey biomass estimates is consistent with information obtained from the previously cited genetic and morphometric analyses, which did not rely on field identification. Data for the two species are combined in the assessment, as species-specific catch records do not exist and identification by species has occurred in the AI trawl survey only since 2006.

Information on stock structure

A stock structure evaluation report was included in the 2010 assessment, and evaluated species distributions within the blackspotted/rougheye complex, genetic data, and size-at-age data (Appendix A in Spencer and Rooper 2010). The patterns of spatial variation in species composition noted above for this two-species complex were considered in this evaluation because differences in species composition could imply different levels of productivity across spatial areas. Tests for genetic homogeneity indicated that genetic differences occurred between samples of blackspotted rockfish grouped into four areas within the BSAI. A significant isolation by distance (IBD) pattern was also estimated in the 2010 analysis, although this was based upon a relatively small sample size. The BSAI Plan Team concluded in 2010 that spatial structure exists within the BSAI for blackspotted and rougheye rockfish, and recommended the BSAI ABC be partitioned into an ABC for the western and central Aleutian Islands, with a separate ABC for the remainder of the BSAI area.

Additional information was presented to the BSAI Plan Team in 2010, 2012, and 2013 indicating disproportionate harvesting within the three subareas within the AI and identifying several attributes regarding spatial patterns in abundance, mean size, proportion of survey tows with no blackpotted/rougheye catch, exploitation rates, and distribution of harvest.

The relatively small number of samples available for the genetic analysis conducted in 2010 motivated the collection and analysis of additional samples since 2010. The most recent genetic analysis does not indicate a statistically significant pattern of isolation by distance at the $\alpha = 0.05$ level (P=0.11). However, stock structure remains a concern. Disproportionately high harvest rates (See Appendix 14B of this assessment) and reduced abundance (prior to the 2024 AI survey estimate) have occurred in the western AI. The reduced abundance of western Aleutian Islands stock of blackspotted rockfish does not appear to have been replaced by fish from the central Aleutian Islands, consistent with a lack of movement in rockfish in general. Rockfish typically exhibit strong spatial genetic structure and further work is underway to examine the spatial stock structure of blackspotted rockfish across the Aleutian archipelago using next generation sequencing techniques.

Fishery

Historical Background

Catches of rougheye rockfish have been reported in a variety of species groups in the foreign and domestic Alaskan fisheries. Foreign catch records did not identify rougheye rockfish by species, but reported catches in categories such as "other species" (1977, 1978), "POP complex" (1979-1985, 1989), and "rockfish without POP" (1986-1988).

Rougheye rockfish have also been managed in multiple species groups since 1991 in the domestic fishery as part of the “other red rockfish” or “shortraker/rougheye” complexes. In 1991, the “other red rockfish” species group was used in both the EBS and AI, but beginning in 1992 rougheye rockfish in the AI were managed in the “rougheye/shortraker” species group. Prior to 2001, rougheye rockfish were managed with separate ABCs and TACs for the AI and EBS, and from 2001-2003, rougheye rockfish were managed as a single stock in the BSAI area with a single OFL and ABC, but separate TACs for the EBS and AI subareas. From 2005-2010, rougheye rockfish were managed with BSAI-wide OFLs, ABCs, and TACs, and beginning in 2011, the BSAI ABC and TAC has been divided between the western and central AI, and the eastern AI and the EBS area. The OFLs, ABCs, TACS, and catches by management complex from 1977-2003 are shown in Table 14.1 and those from 2004 to present are shown in Table 14.2.

Since 2003, the catch accounting system (CAS) has reported catch of rougheye by species and area. 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. This reconstruction was conducted by estimating the rougheye catch for each area (i.e., the EBS and each of the three AI areas) 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 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 rougheye since 1977 by the EBS and AI subareas are shown in Table 14.3. 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 mid-1990s, and declined in the late-1990s.

The catches by area from 1994-2024 have been relatively evenly distributed throughout the three AI subareas, with 31%, 29%, and 30% in the WAI, CAI, and EAI, respectively, and the remaining 10% in the EBS management area (Table 14.4). However, biomass estimates from the AI survey indicate that a relatively small portion of the AI stock (averaging approximately 10% from 1994-2022) occurs in WAI. Information on spatial exploitation rates is updated in Appendix 14B. The domestic fishery observer data indicates that the percentage of BSAI catch in the eastern AI averaged 71% from 1992 to 1995, with the western AI averaging 7% (Figure 14.3). The proportion of the annual harvest in the western Aleutian Islands increased to an average of 63% during 2004-2006 and has declined since 2007 to an average of 30%. Temporal variability has occurred in AI subareas in which blackspotted/rougheye rockfish are captured and in the depths of capture (Figure 14.3). The proportion captured at depths greater than 300 m has also varied, ranging between 3% to 16% in the Aleutian Islands during 1999 - 2003 to between 21% to 42% from 2009-2014, but decreasing to between 5% to 17% from 2015-2023.

Catch by species from BSAI trips targeting rockfish from 2016 to 2023 indicate that the largest non-rockfish species caught are Atka mackerel, walleye pollock (*Gadus chalcogrammus*), Pacific cod (*G. microcephalus*), arrowtooth flounder (*Atheresthes stomas*), and Kamchatka flounder (*A. evermanni*) (Table 14.5). Rougheye rockfish and blackspotted rockfish (denoted as rougheye rockfish in the catch records) are primarily caught in trips targeting rockfish, Atka mackerel, Pacific cod, and Kamchatka flounder (Table 14.6). Catch of prohibited species is low in trips targeting rockfish, with the catch of most prohibited species groups averaging less than 60 t or 4000 individuals from 2016-2024 (Table 14.7). Catch of non-FMP species by in BSAI trips targeting rockfish over this period are largest for giant grenadier (*Albatrossia pectoralis*), sculpin, squid, miscellaneous fish, and unidentified sponge (Table 14.8).

Non-commercial catches are shown in Appendix 14C.

Discards

Estimates of discarding by species complex are shown in Table 14.9. Estimates of discarding of the other red rockfish complex in the EBS were generally above 56% from 1993 to 2000, with the exception of 1993 and 1995 when discard rates were less than 21%. The variation in discard rates may reflect varying species composition of the other red rockfish catch. Discard rates of the EBS Rougheye/Shortraker complex (RE/SR) from 2001 to 2003 were at or below 52%, and discard rates of the AI RE/SR complex from 1993-2003 were below 41%. In general, the discard rates of the EBS RE/SR (2001-2003) are less than the discard rates of the EBS other red rockfish (1993-2000), likely reflecting the relatively higher value of rougheye and shortraker rockfishes over other members of the complex. From 2004 to 2024, discard rates of rougheye in the AI and EBS averaged 25% and 38%, respectively. Discarding has increased recently in the AI, with the rates for 2017 and 2019-2022 each above 29%; in contrast, the AI discarding rate was at or below 20% each year from 2005 to 2015.

Spatial Management

Examination of stock structure information in 2010 resulted in the BSAI ABC being subdivided in subarea ABCs for the WAI/CAI and EAI/EBS areas beginning in 2011. Concern over the disproportionately large harvest rates in the WAI has not led to harvest specifications specifically for this region. Instead, a “maximum subarea species catch” (MSSC) level was developed for the WAI to help guide the fishing fleet in voluntary efforts reduce harvest in this area. The MSSC is computed in an identical manner as subarea ABC; this is the only stock managed by the NPFMC in which an MSSC is used in lieu of a subarea ABC. The Plan Team and SSC have requested monitoring of WAI relative to the MSSC (Joint Plan Team, September, 2016).

The WAI MSSCs and catches are shown below (2024 catch through Oct 5):

Year	MSSC	Catch	Catch/MSSC
2015	46	70	1.51
2016	58	40	0.69
2017	29	35	1.21
2018	35	67	1.91
2019	37	104	2.81
2020	48	168	3.50
2021	31	120	3.89
2022	32	104	3.25
2023	61	181	2.97
2024	67	166	2.48

The WAI catch has exceeded the MSSC in each year except 2016, and degree of "overage" has increased in recent years such that catches are approximately 3 times larger than the MSSC from 2019-2024. Additionally, at the larger spatial scale, the WAI/CAI catches have exceeded the WAI/CAI ABC each year since 2019 and have on average been 63% larger than the WAI/CAI annual ABCs (Table 14.2).

Data

The following table summarizes the data available for the blackspotted/rougheye rockfish assessment model:

Component	Years
Fishery catch	1977-2024
Fishery age composition	2004-2005, 2007-2009, 2011, 2013, 2015, 2017, 2019-2021, 2023
Fishery size composition	1979, 1990, 1992-1993, 2003, 2010, 2012, 2014, 2016, 2018, 2022
AI Survey age composition	1991, 1994, 1997, 2000, 2002, 2004, 2006, 2010, 2012, 2014, 2016, 2018, 2022
AI Survey length composition	2024
AI Survey biomass estimates	1991, 1994, 1997, 2000, 2002, 2004, 2006, 2010, 2012, 2014, 2018, 2022, 2024

Fishery data

The catch data used in the assessment model are the estimates of single species catch described above and shown in Table 14.3.

Prior to 1999, the fishery data is characterized by inconsistent sampling of lengths (Table 14.10) and ages (Table 14.11), as many fish were measured in some years whereas other years had no data. In 1979, 1990, 1992, and 1993, over 1,000 fish were measured in the AI and the size compositions from these years are used in the assessment model. In the domestic fishery, changes in observer sampling protocol went into effect in 1999, increasing the number of fish and hauls from which rougheye rockfish age and length data are collected, increasing the utility for stock assessment modeling. The fishery length composition data used in the model is shown in Table 14.12.

The fishery age composition data indicates relatively moderate cohorts from the early 1970s to early 1980s, but some of the more recent cohorts from the mid-1990s appear inconsistently in the data (Table 14.13, Figure 14.4). For example, the 1997 cohort appears relatively strong as 12 year olds in the 2009 age composition and 14 year olds in the 2011 age composition, but was not observed in previous samples. Similarly, the 1996 cohort appears strong in the 2008 fishery age composition, is not observed in the 2009 age composition, and appears weak in the 2011 age composition. The 1998 year class appears relatively strong in both the 2009 and 2011 fishery age compositions. Beginning in 2013, the fishery began to catch increased proportion of young fish (i.e., less than 20 years). The 2015 and 2017 fishery age compositions show reduced proportions of fish at ages > 20 years. This pattern has been especially pronounced from 2019 to 2021, when fish less than 15 years comprised a relatively large portion of the catch. In 2021, a mode in the age distribution occurs for ages 9 – 11, and these cohorts (year classes 2010 – 2012) are also observed in the 2023 fishery age composition. In 2023, there also were larger proportions of fish above 20 years old than in recent years.

Survey data

Biomass estimates for other red rockfish were produced from the cooperative U.S.-Japan trawl survey from 1979-1985 on the EBS slope and from 1980-1986 in the AI. U.S trawl surveys on the EBS slope were conducted by the National Marine Fisheries Service (NMFS) in 1988, 1991, and biennially beginning in 2002. NMFS trawl surveys in the AI were conducted in 1991, 1994, 1997, and biennially beginning in 2000. The EBS slope surveys in 2006, 2014, and 2018, and the AI trawl survey in 2008 were canceled due to lack of funding or vessels. Both the AI and EBS trawl surveys were canceled in 2020 due to the COVID-19 pandemic, and the EBS slope survey is unlikely to be conducted again. Differences in vessels and gear design exist between the 1980-1986 cooperative surveys and the U.S. domestic surveys conducted since 1991. For example, the Japanese nets used in the 1980, 1983, and 1986 cooperative surveys varied between years and included large roller gear (Ronholt et al. 1994), in contrast to the poly-nor'eastern nets used in the current surveys (von Szalay et al. 2017), and similar variations in gear between surveys occurred in the cooperative EBS surveys. The cooperative surveys from the 1980s are not used in this assessment.

The AI surveys from 1991 to 2022 indicated higher abundances in the central and eastern AI than in the western AI and southern Bering Sea area (Table 14.14). However, unusually low CPUE levels occurred in the WAI during the 2012 survey, which reduced the biomass estimate for this area to 335 t from an average of 1,075 t in the 2000-2010 surveys. The 2024 survey biomass estimates in the WAI and CAI (3,417 t and 7,972 t, respectively) are approximately twice the estimates from the 2022 survey (1,793 t and 3,056 t). The 2024 biomass estimate in the EAI (12,698 t) is 17% larger than the estimate in the 2022 survey (10,834 t), and the CVs for EAI exceeded 0.7 in both the 2022 and 2024 surveys. The overall AI survey biomass estimate increased 50% from 16,325 t in the 2022 survey to 24,410 t in the 2024 survey, although CVs for the surveys since 2016 have exceeded 0.4 and are larger than in previous years. The 2018 – 2024 surveys showed similar spatial patterns of survey CPUE (Figure 14.5), with the largest percentage increases occurring in the WAI and CAI.

Length compositions from the survey indicate a reduction in the abundance of larger fish in several of the AI survey subareas until the 2022 survey (Figures 14.6 - 14.9), when increased abundances were observed. In the western AI, the decline in the biomass estimate in the 2012-2018 surveys can be attributed to a reduced number of fish across most size classes, except for fish from 30-40 cm in 2014. In the 2016 and 2018 surveys, the relative abundance of these size classes was reduced from previous years. The 2022 and 2024 surveys in the WAI showed increased abundances but relatively small fish, with 73% and 77% of the abundance ≤ 35 cm, respectively, the largest proportion in this size group within the time series. In the CAI, the abundance of fish greater than 35 cm was reduced in the 2010-2018 surveys relative to the 1991-2006 surveys, except for the 2012 survey (Figure 14.7). In the 2022 and 2024 surveys, the proportion in the CAI greater than 35 cm increased to 0.67, which is the largest value since the 2012 survey (0.90). The increase in survey biomass from 2016 to 2024 in the EAI results from a larger number of fish in the 25- 40 cm range, whereas much of the length composition in the 2006-2012 surveys was between 35 and 50 cm (Figure 14.8).

The mean size in the western AI was 32 cm in the 2022 and 2024 surveys, similar to values observed in between 2006 and 2018 (32 cm - 37 cm) (Figure 14.10). However, these recent mean sizes in the WAI are lower than those observed in earlier years, when the mean size in the 1991-2002 surveys ranged from 39 cm to 45 cm. The mean sizes in the CAI and EAI decreased sharply in the 2014 survey to 34 cm and 33 cm, respectively. The mean size in the CAI and EAI increased to 37 cm and 36 cm, respectively, in the 2024 AI survey, and there has been an overall decline in mean size in all AI survey subareas since 1991. The time series of mean age data corroborate the time series of mean size, and indicate that the mean age has declined the most in the WAI. The mean age in the WAI from the 1994 – 2002 surveys averaged 33 years, whereas the mean ages in the 2012 - 2022 surveys averaged 17 years.

The spatial pattern in the percentage of survey tows that did not catch blackspotted/rougheye rockfish was similar from 2000 – 2016 (Figure 14.11), with the WAI and EAI having the highest percentage of survey tows with no catch. In the 1991-1994 surveys, the WAI had the lowest percentage of tows without blackspotted/rougheye rockfish among the subareas, whereas from 2000 -2016 the WAI had the highest percentage (or tied for the highest percentage) of tows without blackspotted/rougheye rockfish. In the 2022 and 2024 surveys, the percentage of tows with no catch declined across all areas.

The survey biomass estimates of blackspotted and rougheye rockfish from the 2002-2012 EBS slope surveys have ranged between 556 t (2002) and 1,597 t (2012), with CVs between 0.16 and 0.51. EBS slope survey CPUE from 2016, 2012, and 2016 are shown in Figure 14.12. The 2016 slope survey estimate of 458 t is inconsistent with the increasing estimates from 2002-2012, and may be due to inadequate sampling. In the 2016 survey, equipment failure resulted in only 53 of the 75 planned stations being completed in the Bering Canyon subarea of the survey, which is the southernmost portion of the survey. Maps of survey CPUE from 2010-2016 indicate that this area typically has a large portion of the blackspotted and rougheye rockfish biomass.

A random effects smoothing model was applied to the time series of subarea biomass levels from the AI and EBS surveys (Figure 14.13). The increases in the 2022 and 2024 survey biomass estimates resulted in the smoothed biomass estimate increasing in most areas, and the smooth estimate for the WAI fits are very close to the 2022 and 2024 point estimates of survey biomass. These smoothed estimates are used for subarea partitioning of the ABC and the estimation of subarea exploitation rates shown in Appendix 14B.

Biological Data

The AI survey provides data on age and length composition of the population, growth rates, and length-weight relationships. The number of lengths measured and otoliths sampled are shown in Tables 14.15 and 14.16, along with the number of hauls producing these data. The survey data produce reasonable sample sizes of lengths and otoliths throughout the survey area. The maximum age observed in the survey samples was 134 years (observed in the 2016 survey).

The AI survey age composition data in years prior to 2014 indicate a relatively even distribution across a broad range of ages (i.e., ages 20 to 40) (Table 14.17, Figure 14.14). Prior to 2006, fish less than 10 years old have been uncommon in the surveys; however, the 2006 and 2010 surveys indicate potentially strong 1998 and 1999 year classes. The 2014, 2016, and 2018 AI surveys show reduced proportions of fish > 20 years old, but higher proportions of fish > 20 years old were observed in the 2022 survey. The AI survey length composition for 2024 is shown in Table 14.18 and is used as input data for the assessment; AI survey length compositions for other years are used to compute age compositions.

The survey otoliths were read with the break and burn method and are considered unbiased (Chilton and Beamish 1982); however, the potential for aging error exists. The ageing error estimation methodology described by Punt et al. (2008) was applied to BSAI data (described below in the *Parameters Estimated Outside the Assessment Model* Section).

Analytic Approach

Model structure

An age-structured population model, implemented in the software program AD Model Builder, was used to obtain estimates of recruitment, numbers at age, and catch at age. The model is identical to the accepted model for the 2022 assessment. Francis weighting (Francis 2011) is used for the composition data, with the first-stage weights being the number of hauls from which fish were aged or lengthed. Prior distributions were used for survey catchability and the natural mortality rate *M*. The definitions of model parameters and quantities is shown in Table 14.20, and equations for population dynamics, estimated quantities, and likelihood components are shown in Tables 14.21-14.22.

The root mean squared error (RMSE) was used to evaluate the relative size of residuals within data types:

$$RMSE = \sqrt{\frac{\sum_{n}(\ln(y)-\ln(\hat{y}))^2}{n}}$$

where y and $\hat{y}$ are the observed and estimated values, respectively, of a series length n.

Description of Alternative Models

The model used in this assessment is the accepted model from the 2022 assessment, and alternative models are not considered.

Parameters Estimated Outside the Assessment Model

The parameters estimated independently from the assessment model include the ageing error matrix, the age-length conversion matrix, and individual weight-at-age.

The Punt et al. (2008) methodology for ageing error estimation was applied, which requires a set of fish with age readings from multiple readers for each fish, and the mean and standard deviation of the read ages for each reader was estimated based on the likelihood of observing the read age for each fish given the true age. The true ages are unobserved, and maximum likelihood estimates are obtained by integrating across all possible values for the true age. It was assumed that the readers had equal variation in the read ages and were unbiased. Additionally, the coefficient of variation of the read ages was modeled as constant with age (i.e., the standard deviation of increases linearly with age). The Punt et al. (2008) methodology was applied to 2341 double readings of blackspotted/rougheye rockfish from the BSAI sampled during 1986 – 2017. The CVs in read ages than was estimated for the 2018 model, with the CV from the Punt et al. (2008) methodology estimated at 0.121.

The AI survey otolith data were used to estimate size at age and von Bertalanffy growth parameters. Unbiased estimates of mean length-at-age were generated from multiplying the survey length composition by the age-length key to produce a matrix of estimated population numbers by age and length, from which an unbiased average length for each age could be determined. Preliminary analyses did not reveal any patterns by year and subarea within the AI survey areas, so the mean length-at-age from each survey year from 1991 to 2022 was used to fit the growth curve. The estimated von Bertalanffy parameters are as follows, and were used to create a conversion matrix and a weight-at-age vector:

L_{inf} (cm)	**K**	**t_0 (years)**
51.43	0.06	-3.30

A conversion matrix was created to convert modeled number at age into modeled number-at-length bins, and consists of the proportion of each age that is expected in each length bin. This matrix was created by fitting a polynomial model to the observed CV in length at each age, and the predicted relationship was used to produce variation around the predicted size at age from the von Bertalanffy relationship. The resulting CVs of length-at-age of the conversion matrix decrease curvilinearly from 0.19 at age 3 to 0.10 at age 45.

A length-weight relationship of the form $W = aL^b$ was fit from the survey data, and produced estimates of $a = 6.46 \times 10^{-6}$ and $b = 3.24$. This relationship was used in combination with the von Bertalanffy growth curve to obtain the estimated weight-at-age vector of the population (Table 14.19).

The estimated 2024 AI catch was obtained by summing the reported 2024 catch through September and the product of: 1) the remaining amount of catch under the 2024 BSAI ABC; 2) an estimate of the proportion of the remaining Oct-Dec ABC which has been caught in recent years; and 3) an estimate of the proportion of Oct-Dec catches obtained in the AI area.

Parameters Estimated Inside the Assessment Model

Parameters estimated inside the assessment model include the mean and annual deviations for recruitment and fishing mortality, survey catchability, natural mortality, and the parameters associated with the curves for fishery selectivity, survey selectivity, and maturity-at-age.

To facilitate parameter estimation, a lognormal prior distribution was used for the natural mortality rate *M*. The mean of the prior distribution was updated based on research by Then et al. (2015). Three natural mortality models developed by Then et al (2015) based on maximum age (t_{max}) were considered, which Then et al. (2015) recommend as the preferred methodology. The observed maximum age t_{max} for BSAI blackspotted/rougheye rockfish is 134 years, and estimates of natural mortality for each model were obtained from values of $t_{max} \pm 25$ years and ranged from 0.033 to 0.067 and averaged 0.045, which was used as the mean of the prior distribution. This value also corresponds to the center of a range considered (0.035 – 0.055) for British Columbia rougheye/blackspotted (DFO, 2020).

A lognormal prior distribution was also used for q_{AI} with a mean of 1.0 and a CV of 0.05. The standard deviation of log recruits, σ_r, was fixed at 0.75.

The proportion mature-at-age was estimated within the assessment model based on 237 aged blackspotted rockfish collected in the Gulf of Alaska from 2009-2012 by Christina Conrath (NOAA-Fisheries, AFSC, pers. comm.). Parameters of the logistic equation were estimated by maximizing the bionomial likelihood within the assessment model. The number of fish sampled and number of mature fish by age for each collection were the input data, thus weighting each age by the sample size. Due to the low number of young fish, high weights were applied to age 3 and 4 fish to preclude the logistic equation from predicting a high proportion of mature fish at age 0.

The estimated number of parameters is shown below:

Parameter type	***Number***
1) fishing mortality mean	1
2) fishing mortality deviations	48
3) recruitment mean	1
4) recruitment deviations	45
5) historic recruitment	1
6) first year recruitment deviations	42
7) biomass survey catchability	1
8) natural mortality rate	1
9) survey selectivity parameters	2
10) fishery selectivity parameters	2
11) maturity parameters	2
Total number of parameters	146

Results

Model Evaluation

Alterative models were not considered in this assessment. The updated data weights are shown in Figure 14.15, and were similar to those estimated in the 2022 assessment.

The plot of retrospective estimates of spawning stock biomass (SSB) indicates that the 2024 model run has a larger estimated biomass that the 2023 retrospective peel, and lower biomass than most of the other retrospective peels (Figure 14.16). The relatively small changes between the 2022 – 2023 retrospective peels and the 2024 model run suggests that the increase in the 2024 AI survey biomass estimate is relatively consistent with the recent age and length composition data observed prior to 2024.

Mohn’s rho can be used to evaluate the severity of any retrospective pattern, and compares an estimated quantity (in this case, SSB) in the terminal year of each retrospective model run with the estimated quantity in the same year of the model using the full data set. The Mohn’s rho for the 2024 assessment was 0.11, in contrast with 0.28 in the 2022 assessment.

The retrospective estimates of recruitment strength indicate that the estimates for some year classes may be substantially revised as additional data becomes available (Figure 14.17). For example, the estimate of the 2002 year class was 6.4 million in the 2018 peel and was lowered to 3.3 million in the 2024 peel. More dramatically, the 2010 year class estimate peaked at 22.8 million in the 2022 peel, but was reduced to 1.9 million in the 2024 peel. The recent age and length composition data suggest relatively strong recent recruitment, but this is attributed to the 2011 year class in the 2024 assessment, rather than the 2010 year class.

Convergence was determined by successful inversion of the Hessian matrix and a maximum gradient component of 9.1e-6. A jitter analysis revealed that the model is insensitive to perturbations of parameter start values on the order of 15%. All parameters were estimated within their pre-specified bounds. Estimated values of model parameters and their standard deviations are shown in Table 14.23 and the likelihoods by data components are shown in Table 14.24.

A longstanding issue in the BSAI blackspotted/rougheye assessment has been the poor fit to the AI survey biomass time series, with AI survey estimates from 1994 – 2012 being underestimated. It is useful to exclude age and length composition data sets to explore their influence in the fit to the AI survey biomass estimates. A series of sensitivity model runs were conducted in which either all or all but one of the age/length composition data sets were excluded from the model. Excluding all the composition data (i.e., only fitting to the catch and survey biomass data) produces reasonably satisfactory fit to the AI survey biomass time series (Figure 14.18), although the 2000, 2002, and 2012 survey estimates are still being underestimated to a large degree. Adding either the AI survey age composition or the fishery age compositions produces similar fits, and provides a worse fit to the 2000, 2002, and 2012 survey estimates but a better fit to the 2022 and 2024 survey estimates. The fishery length composition data appears to be the most influential, as including only this composition data set resulted the largest change relative to the model with no composition data.

A profile on the natural mortality parameter estimate (M) indicates that the fishery age composition data and the survey biomass estimates are slightly informative, with the lowest negative log-likelihood occurring at values of M at 0.07 and 0.09, respectively (Figure 14.19). However, these values are larger than those obtained for many model-independent procedures for estimating M. The profile of negative log-likelihoods for fishery length compositions, AI survey age compositions, and AI survey length compositions were the lowest at the lowest values of M considered. The profile for AI survey catchability (q) also indicates that most data components are uninformative for this parameter, with the negative log-likelihoods occurring at or close to the maximum value of q considered of 1.8 (Figure 14.20).

Time series results

In this assessment, SSB is defined as the biomass estimate of mature females age 3 and older. Total biomass is defined as the biomass estimate of all blackspotted/rougheye rockfish age 3 and older. Recruitment is defined as the number of age 3 blackspotted/rougheye rockfish.

Biomass Trends

The estimated AI survey biomass decreased during the 1990s and early 2000s to 7,450 t in 2007, and has increased to 15,202 t in 2024 (Figure 14.21). The total biomass and SSB also show a decline in the late 1970s, increases throughout the 1980s, and a decline during most of the 1990s. Since 2005, SSB has increased from 2,704 t to 3,354 t in 2024, and the total biomass has increased from 10,533 t to 27,665 t over this period (Figure 14.22). The more rapid recent increase of total biomass relative to SSB reveals that much of this increase can be attributed to relatively recent year classes that have not fully matured. The time series of estimated total biomass, spawner biomass, and recruitment, and their estimated CVs (from the Hessian approximation) are shown in Table 14.25, and the estimated numbers-at-age are shown in Table 14.26.

Age/size compositions

The fits to the fishery age composition are shown in Figures 14.23, and the aggregate fits over all years and the Pearson residuals are shown in Figure 12.24. The aggregate fits show underfitting of ages less than 15 years old, and overfitting of ages 17-25 and the 45+ group. The recent young year classes observed in the 2019 to 2023 fishery age compositions are not well fit by the model. The fishery age compositions are strongly downweighted by the Francis data weighting procedure.

The fits to the fishery length compositions are shown in Figures 14.25, and the aggregate fits over all years and the Pearson residuals are shown in Figure 14.26. The 2010 and 2012 fishery length composition data indicate that higher proportions of relatively small rougheye (i.e., 33-36 cm in 2010, 35-40 cm in 2012) are caught by the fishery. These lengths correspond approximately to 13-16 year old fish in 2010, 15-22 year old fish in 2012, and the 1990-1997 year classes. Because these year classes are not consistently observed in other age and length compositions, the model does not produce a strong fit to these fishery length composition data. The fishery length composition data since 2012 showed a broader range of sizes (although generally smaller fish than observed in the 1990s) and had better model fits. The aggregate fits show overfitting of lengths between 25-30 cm and the 50+ cm group, and underfitting of lengths between 35-45 cm. The degree of lack of fit in the aggregated fits does not appear to be as strong as observed for the fishery age compositions, and the fishery length compositions are more strongly weighted in the model.

The fits to the AI survey age compositions are shown in Figures 14.27, and the aggregate fits over all years and the Pearson residuals are shown in Figure 12.28. The 2010, 2014, and 2018 AI survey age composition data also indicates relatively strong 1998 and 1999 year classes, but either or both of these year classes appeared less strong in the 2012 and 2016 AI survey age composition data (Figure 14.27). The 2014-2018 survey age composition also showed relatively high proportions for ages < 17, although this is influenced by the absence of older fish. The aggregate fits show substantial overfitting of the 45+ group, and underfitting of most ages between 25-38 years. In general, the model does not track cohort strengths between years with a high degree of precision in this data set, in part because the data show some inconsistencies and the Francis weights deemphasizes the composition data.

The fit to the 2024 AI survey length composition is shown in Figure 14.29; the models underestimates the amount of fish between about 35 and 42 cm, and overestimates the amount of fish in the 50+ cm group.

Catchability, natural mortality, and selectivity

The CVs of 5% for the priors on survey catchability and natural mortality constrained these parameters to values of 1.04 and 0.050, slight increases from the prior distribution means of 1.0 and 0.045.

The estimated age at 50% selection for the AI trawl survey was 15.7, very similar to the value of 16.2 in the 2022 assessment (Figure 14.30). The fishery selectivity reached 50% at age 13.7, also similar to the value of 13.5 in the 2022 assessment.

Maturity

The estimated proportion mature based on Gulf of Alaska sampling by Dr. Christina Conrath (Figure 14.31, Table 14.19) has an estimated age at 50% of 24.5. The samples from Dr. Conrath show several ages of older fish (≥ 30) with unusually low observed proportions of mature fish (i.e., < 50%). For most of these ages the sample sizes are small, and these outliers were not used to fit the maturity ogive.

Fishing Mortality and Stock Status

The estimates of instantaneous fishing mortality rate are shown in Figure 14.32. Very high rates of fishing mortality are required in 1978 and 1979 to account for the high catches during these years, followed by rapid decreases in the early 1980s. Fishing mortality rates began to increase during the late 1980s and were high for several years between the late 1980s and mid-1990s. With the exception of 2001, fishing mortality rates began to decline from late 1990s to the mid-2000s. Recently, fishing mortality rates have increased from 0.017 in 2016 to 0.038 in 2020, and declined to 0.030 in 2023.

The stock status, relative to $B_{40\%}$, depends on a set of year classes used to compute average recruitment. The recommendation from the Plan Team work group on recruitment is to identify a critical age as the sum of $0.05/M$ (rounded to the nearest integer) and the age at which fish are 10% selected in the AI survey, and estimated mean recruitment would be based on cohorts which exceeded this age in the final model year. For AI blackspotted/rougheye rockfish, this procedure results in a critical age of 11 and would use recruitments from year classes 1977 – 2013.

As mentioned in the Executive Summary, the large 2011 year class of 27.93 million was replaced by a value equal to the 2002 year class (the next largest) for the purpose of computing reference points and determining stock status. The $B_{40\%}$ resulting from the mean recruitment (with the adjustment for the 2011 year class) is 3,525 t, and the ratio of SSB in 2024 to $B_{40\%}$ is 1.01 (Table 14.27). A plot of fishing mortality rates and SSB in reference to the ABC and OFL harvest control rules (Figure 14.33) shows stock status relative to $B_{35\%}$.

Recruitment

Recruitment strengths by year class, with credibility bounds from the MCMC integration, are shown in Figure 14.34. Other than the unusually large 2011 year class, the use of Francis weights generally results in reduced interannual variability in estimated recruitment, although the 1999 and 2002 year classes are estimated as relatively strong.

The plot of recruitment against SSB is shown in Figure 14.35.

Harvest Recommendations

Amendment 56 reference points for AI blackspotted/rougheye rockfish

The reference fishing mortality rate for blackspotted/rougheye rockfish is determined by the amount of reliable population information available (Amendment 56 of the Fishery Management Plan for the groundfish fishery of the Bering Sea/Aleutian Islands). Estimates of $F_{0.40}$, $F_{0.35}$, and $SPR_{0.40}$ were obtained from a spawner-per-recruit analysis. Based on the information presented above, estimated recruitment from the 1977-2013 year classes were used to estimate equilibrium recruitment for the future. The average recruitment from these year classes estimated in this assessment is assumed to represent a reliable estimate of equilibrium recruitment (after replacing the estimated recruitment for the 2011 year class with that of the 2002 year class). An estimate of $B_{0.40}$ is calculated as the product of $SPR_{0.40}$ * equilibrium recruits, and this quantity is 3,525 t. The year 2025 SSB is estimated as 3,729 t. Time-varying parameters that would affect these reference points are not used in the assessment.

Amendment 56 reference points for EBS blackspotted/rougheye rockfish

The age-structured model pertains to the AI management area, and management reference points for the EBS management area were obtained from applying Tier 5 methods to the survey data in the EBS management area. Tier 5 reference points specify $F_{abc} = 0.75*M$ and $F_{ofl} = M$. Current estimates of M for blackspotted/rougheye rockfish obtained from the AI age structured model (0.050) were used, resulting in F_{abc} and F_{ofl} levels of 0.037 and 0.050 respectively. The ABC and OFL levels for the EBS blackspotted/rougheye rockfish were obtained by multiplying the F_{abc} and F_{ofl} values by estimated biomass. The random effects model was used to smooth the survey biomass time series and obtain estimates of current biomass.

Application of the random effects model results in a biomass estimate of 1,444 t for the EBS subarea, and was obtained by summing the estimates of biomass obtained from the EBS slope and the southern Bering Sea (SBS) area sampled by the AI trawl survey. Application of the F_{abc} and F_{ofl} values above to this biomass estimate yields the EBS OFL and ABC values to 72 t and 54 t, respectively. Summing the EBS ABC and OFL values with those obtained from the age-structured model for the AI portion of the population results in an overall BSAI maximum ABC and OFL of 706 t and 838 t, respectively.

Specification of OFL and maximum permissible ABC for AI blackspotted/rougheye rockfish

Since reliable estimates of the 2025 SSB (B), $B_{0.40}$, $F_{0.40}$, and $F_{0.35}$ exist and B>$B_{0.40}$ (3,729 t < 3,525 t), blackspotted/rougheye rockfish reference fishing mortality is defined in Tier 3a. For this tier, the maximum permissible F_{ABC} and F_{OFL} are $F_{0.40}$ and $F_{0.35}$, respectively. The 2025 values of F_{abc} and F_{OFL} are 0.035 and 0.040, respectively. The 2025 maximum ABC and OFL for the AI blackspotted/rougheye resulting from these rates are 652 t and 766 t, respectively. A summary of these values is below.

2025 SSB estimate (B)	=	3,729 t
$B_{0.40}$	=	3,525 t
$F_{0.40}$	=	0.035
F_{ABC}	=	0.035
$F_{0.35}$	=	0.040
F_{OFL}	=	0.040

Projections

Age-structured population projections are not possible for the EBS portion of the blackspotted/rougheye rockfish, and were conducted only for the AI blackspotted/rougheye rockfish. For each scenario, the projections begin with the vector of 2024 numbers-at-age estimated in the assessment. This vector is then projected forward to the beginning of 2025 using the schedules of natural mortality and selectivity described in the assessment and the best available estimate of total (year-end) catch for 2024. In each subsequent year, the fishing mortality rate is prescribed on the basis of the SSB in that year and the respective harvest scenario. In each year, recruitment is drawn from an inverse Gaussian distribution whose parameters consist of maximum likelihood estimates determined from recruitments estimated in the assessment. SSB is computed in each year based on the time of peak spawning and the maturity and weight schedules described in the assessment. Total catch is assumed to equal the catch associated with the respective harvest scenario in all years. This projection scheme is run 1000 times to obtain distributions of possible future stock sizes, fishing mortality rates, and catches.

The first five scenarios are designed to provide a range of harvest alternatives that are likely to bracket the final TAC for 2025, are as follow ("*max* F_{ABC}" refers to the maximum permissible value of F_{ABC} under Amendment 56):

> *Scenario 1*: In all future years, *F* is set equal to *max* F_{ABC}. (Rationale: Historically, TAC has been constrained by ABC, so this scenario provides a likely upper limit on future TACs.)

> *Scenario 2*: In all future years, *F* is set equal to a constant fraction of *max* F_{ABC}, where this fraction is equal to the ratio of the F_{ABC} value for 2025 recommended in the assessment to the *max* F_{ABC} for 2025. (Rationale: When F_{ABC} is set at a value below *max* F_{ABC}, it is often set at the value recommended in the stock assessment.)

> *Scenario 3*: In all future years, *F* is set equal to the 2019-2023 average *F*. (Rationale: For some stocks, TAC can be well below ABC, and recent average *F* may provide a better indicator of F_{TAC} than F_{ABC}.)

> *Scenario 4*: In all future years, *F* is set equal to $F_{75\%}$. (Rationale: This scenario provides a likely lower bound on F_{ABC} that still allows future harvest rates to be adjusted downward when stocks fall below reference levels.)

> *Scenario 5*: In all future years, *F* is set equal to zero. (Rationale: In extreme cases, TAC may be set at a level close to zero.)

Two other scenarios are needed to satisfy the MSFCMA's requirement to determine whether a stock is currently in an overfished condition or is approaching an overfished condition. These two scenarios are as follows (for Tier 3 stocks, the MSY level is defined as $B_{35\%}$):

> *Scenario 6*: In all future years, *F* is set equal to F_{OFL}. (Rationale: This scenario determines whether a stock is overfished. If the stock is expected to be; 1) above its MSY level in 2024 or; 2) above ½ of its MSY level in 2024 and above its MSY level in 2034 under this scenario, then the stock is not overfished.)

> *Scenario 7*: In 2025 and 2026, *F* is set equal to *max* F_{ABC}, and in all subsequent years *F* is set equal to F_{OFL}. (Rationale: This scenario determines whether a stock is approaching an overfished condition. If the stock is 1) above its MSY level in 2026 or 2) above 1/2 of its MSY level in assessment 2026 and expected to be above its MSY level in assessment 2036 under this scenario, then the stock is not approaching an overfished condition).

The recommended F_{ABC} and the maximum F_{ABC} are equivalent in this assessment, and projections of the mean harvest and SSB for the remaining six scenarios are shown in Table 14.28.

Risk Table and ABC recommendation

The risk table and definitions of the risk level (i.e., normal, increased concern, and extreme concern) by risk category is in the Introduction to the BSAI SAFE document. Application of the risk table is described below for each risk category.

Assessment considerations

The AI assessment model shows a relatively poor fit to the AI survey biomass estimates, with the large estimates in years 2000, 2002, and 2012, and the low estimate in 2014, not well fit by the model. The AI survey biomass estimates have increased sharply since the 2018 survey. The AI survey biomass from the assessment model, while increasing, has not been able to match the rate of increase in the survey biomass estimates.

For this assessment, the model is not able explain the decline in abundance of older fish (i.e., ages ≥ 20) that were observed in the fishery age compositions (years 2019 – 2021) and the survey age compositions (years 2014 – 2018). Some key parameters and population process are tightly constrained in the model (i.e., natural mortality and survey catchability), which limit the capacity of the model to explain the recent decline in older fish, and the likelihood profiles for the natural mortality and recruitment profiles indicate the data are generally uninformative for these parameters. The use of strong priors for key parameters such as natural mortality and survey catchability understates the level of uncertainty in the assessment. The population process that has the most flexibility in the model to explain the decline in older fish is recruitment, even if the actual mechanisms are something other than recruitment. This potential aliasing also contributes to the assessment uncertainty. The unusually large size and uncertainty in the 2011 year class is further evidence of problematic assessment performance.

The aggregated (across years) fits to the age and length compositions indicate generally poor fits to these data. This may be because of the strong variability in the composition data, both within and between data sets, that impedes clear signals of year-class strength that are easily tracked through time.

A moderate retrospective bias exists, with a Mohn's rho for the recommended model of 0.11, and the positive retrospective bias indicates the potential for overharvesting and may indicate model misspecification by Hurtado-Ferro at al. (2015). The retrospective pattern is improved from the 2022 assessment (Mohn's rho = 0.28), and is attributable to a greater consistency between the survey biomass estimates and the age/length composition data in the 2024 assessment relative to previous assessments.

Given these considerations, we rank the assessment considerations for the recommended Model 20 (2024) as a 2 *(Increased concern; Substantially increased assessment uncertainty/ unresolved issues, such as residual patterns and substantial retrospective patterns, especially positive ones*).

Population dynamics considerations

In addition to the decline of older fish mentioned above, the number of younger fish observed in the AI survey has increased. These two factors combine to result in a population comprised primarily of young fish, with the 70% of estimated 2024 abundance from the recommended model 20 (2024) comprised of ages with less than 27% survey selectivity. The estimated age at 50% maturity is 24 years, indicating that a young population of blackspotted rockfish would have limited reproductive capacity. The recruitment estimates from recommended model 20 (2024) indicates an usual pattern of large recruitment in recent years, with the estimate of 27.9 million for the 2011 year class exceeding the next highest recruitment value (the 2002 year class) by a factor of 8.5.

Rockfish generally show relatively strong spatial structure with limited movement as adults. BSAI blackspotted/rougheye rockfish were one of the first stocks to be analyzed for stock structure, and are the only Alaska stock which has a ranking of "strong concern" regarding stock structure. This designation was applied due, in part, to high catch levels in the 1990s in the WAI followed by sharp declines in WAI beginning in 2000, and disproportionately large catches in the WAI (the area with the lowest survey biomass). Current harvest specifications apply an ABC to the combined WAI/CAI spatial area, which has not been effective in limiting catch in the WAI and reducing disproportionate harvesting. The catches in the WAI have exceeded reference MSSC catch levels in every year except one, and overages have increased over time such the current WAI catch is ~ 3 times the MSSC values. Additionally, the WAI/CAI ABC has been exceeded each year from 2019 – 2024. The existing spatial management measures are also generally inconsistent with the smaller spatial structure of Pacific rockfish. The catch is occurring as bycatch from other target fisheries, and the large catches in the WAI and CAI in recent years appear to be comprised of relatively young fish. If recent recruitment has actually increased, the large harvest of young fish may limit their potential to further rebuild the stock in this area. Overall, we rank the population dynamic considerations as a 2 (*Increased concern; Stock population dynamics (e.g., recruitment, growth, natural mortality) are unusual; trends increasing or decreasing faster than has been seen recently, or patterns are atypical.*)

Environmental/ecosystem considerations

The average bottom temperature from the Aleutian Islands bottom trawl survey (165°W – 172°E, 30-500 m) was close to the 20-year mean (1991–2012) for all subareas but still above the long term mean. This is in contrast with the four survey years prior, which were generally warmer than average for bottom temperatures. The bottom temperature means are similar across all four regions (Howard and Laman, 2024) and values close to the long term mean are considered a positive indicator. Satellite surface temperatures show a step increase in 2014 with higher temperatures both in summer and winter (Xiao and Ren 2023). Sea surface temperatures were above the mean through winter across all subregions. Over the eastern Aleutian Islands, there were few days of MHW status relative to the mean over the last decade, which was also the case in 2021 and 2022. While there were also warm anomalies and MHWs over 25% of the central and eastern Aleutians in summer, these were not sufficient to register in the spatial mean (Lemagie and Callahan, 2024).

Rougheye and blackspotted rockfish are typically found in the Aleutians at temperatures between 2.9–5.1°C in the eastern Bering Sea, while only between 3.9–4.2 in the Aleutian Islands. Their corresponding depth range is from 120–150m in the EBS and 200–450 m in the Aleutian Islands. Although there appears to be an expansion in the rougheye-blackspotted rockfish complex distributions into shallower habitats in the Aleutian Islands over time, this may due to the increase of younger fish which are distributed at shallower depths and a decrease of older fish, which are distributed in deeper water (Conrath and Dowlin 2024). Temperatures in 2024 offered a respite from the warming trend in bottom water temperature and the potential risk of thermal stress. Cooler temperatures close to the 1991-2012 mean may be considered a positive indicator for rougheye and blackspotted rockfish. Despite the past several years of warmer temperatures, biomass of rougheye and blackspotted rockfish appears to have increased based on estimates from the 2024 Aleutian Islands bottom trawl survey.

Based on stomachs of rougheye rockfish sampled during the AI bottom trawl survey, rougheye rockfish feed on a variety of fish including myctophids and other deepfish and roundfish, shrimps and squids; no consistent prey item dominates their diet. Smaller rougheye seem to feed more on shrimps and increase the amount of fish as they grow. Although shrimp appears to have decreased in the Aleutians, as a generalist, rougheye can offset decreases in available prey by switching to other prey.

Rougheye rockfish share prey items with shortraker rockfish and shortspine thornyheads which also consume general fish, myctophids and shrimp (shortraker rockfish) as well as squid and shrimps (shortspine thornyheads). Biomass estimates based on the bottom trawl survey data show that shrimp decreased across the Aleutian chain. The indicator most relevant to reflecting habitat disturbance is the estimated area disturbed by trawls from the fishing effects model (Olson, 2021). Trends in potential habitat disturbance are relevant for adult rougheye as they can be found on soft substrates, where shrimp is abundant, and in areas with frequent boulders and steep slopes, which are generally not targeted by bottom trawlers. The fishing effects model has not indicated large changes in habitat disturbance trends, and has remained below 3% for the Aleutian Islands (EAI, CAI and WAI) since 2009. Some habitat-forming species might be more impacted (Conrath et al 2024), and the bycatch of structural epifauna in the fishery shows a slight increase (Whitehouse, 2024). Rooper et al (2019) concluded the removal of deep coral and sponges is likely to reduce the overall density of rockfishes.

Overall, we rank the environmental/ecosystem considerations as a 1 (*Normal; No apparent ecosystem concerns related to biological status (e.g., environment, prey, competition, predation), or minor concerns with uncertain impacts on the stock*).

Fishery performance

Catches of blackspotted/rougheye are currently obtained as bycatch in other fisheries. The spatial pattern of catch per unit effort (CPUE) differs from the spatial pattern in the survey biomass estimates (Figure 14.36). CPUE was computed from hauls sampled for species composition in the Groundfish observer program, and a target fishery was assigned based on the dominant species (in weight) in the haul catch. Target hauls for POP were defined as those in which rockfish, as a group, were the dominant species group and also POP was the dominant rockfish species. CPUE was defined as the average tons of blackspotted rockfish caught per hour fished in tows targeting POP, and shown in Figure 14.36 for the WAI, CAI, and EAI areas. If CPUE is interpreted as a rough index of biomass, particularly in cases where the fish are not targeted and caught relatively randomly, then the rank order of CPUE among spatial areas should roughly correspond to the rank of biomass. From 2006 to 2011, CPUE was similar among the three areas despite lower survey biomass in the WAI. Similarly, since 2014 the CPUE has been higher in the WAI than the EAI, whereas the survey biomass shows higher biomass in the EAI. Since 2017, the CPUE in both the CAI and WAI has increased. An example of a concern listed above for this category is fishery CPUE showing a contrasting pattern from the stock biomass, and this is exhibited spatially for this stock.

For these reasons, we rank the fishery performance as a 2 (*Increased concern; fishery CPUE is showing a contrasting pattern from the stock biomass trend*).

Summary and ABC recommendation

Assessment-related considerations	*Population dynamics considerations*	*Environmental/ecosystem considerations*	*Fishery Performance considerations*
Level 2: Increased concern	Level 2: Increased concern	Level 1: Normal	Level 2: Increased concern

The level 2 rankings above are consistent with previous years, after accounting for the change in the risk table scoring categories, and may be expected to produce a reduction in the recommended ABC. In the 2022 assessment, concerns about a large recent year class, and whether the survey biomass estimates showed strong evidence of a population increase, led to author-recommended reduction of ABC from the max ABC. While there are still concerns about the assessment estimate of a large recent year class (the 2011 year class in the 2024 assessment), more information is now available that suggests the stock is increasing, as the AI survey biomass estimate (for the AI management area) has increased from 15.7 kt in 2022 to 24.1 kt in 2024. Additionally, this increase in survey biomass is consistent with recent age and length composition data from both the fishery and AI survey in recent years. Given the increases in survey biomass observed since 2018, we recommend the max ABC of 652 t for the AI portion of the stock, and continued evaluation regarding the strength of recent year classes and survey biomass increases.

Area Allocation of ABC

The BSAI blackspotted/rougheye ABC is currently allocated with a subarea ABC for the WAI-CAI area, and a separate subarea ABC for the EAI-EBS area. In recent years the subarea ABC for the western and central Aleutians Islands has partitioned into “maximum subarea species catch” in order to guide voluntary efforts from the fishing fleet to reduce harvest in the WAI.

A random effects model is used to smooth subarea survey biomass estimates to obtain the proportions of biomass across the spatial areas, which is used to allocate the ABC across areas.

			Area		
	WAI	CAI	EAI	SBS	EBS slope
Smoothed biomass	2,913	5,788	10,366	433	1,011
percentage (within AI subarea)	15.3%	30.4%	54.4%		

The apportioned ABCs and MSSCs for 2025 and 2026 are:

			Area		
	WAI	CAI	WAI/CAI	EAI/EBS	Total
Year	MSSC	MSSC	ABC	ABC	ABC
2025	100	198	298	408	706
2026	109	216	325	441	766

Status Determination

In addition to the seven standard harvest scenarios, Amendments 48/48 to the BSAI and GOA Groundfish Fishery Management Plans require projections of the likely OFL two years into the future. While Scenario 6 gives the best estimate of OFL for 2025, it does not provide the best estimate of OFL for 2026 because the mean 2026 catch under Scenario 6 is predicated on the 2025 catch being equal to the 2025 OFL, whereas the actual 2025 catch will likely be less than the 2025 OFL. The executive summary contains the appropriate one- and two-year ahead projections for both ABC and OFL. Catches for 2025 and 2026 were obtained by fishing at $F = 0.030$ (the 5-year average F).

Under the MSFCMA, the Secretary of Commerce is required to report on the status of each U.S. fishery with respect to overfishing. This report involves the answers to three questions: 1) Is the stock being subjected to overfishing? 2) Is the stock currently overfished? 3) Is the stock approaching an overfished condition?

Is the stock being subjected to overfishing? The official BSAI catch estimate for the most recent complete year (2023) is 607 t. This is less than the 2023 BSAI OFL of 703 t. Therefore, the stock is not being subjected to overfishing.

Harvest Scenarios #6 and #7 are intended to permit determination of the status of a stock with respect to its minimum stock size threshold (MSST). Any stock that is below its MSST is defined to be *overfished*. Any stock that is expected to fall below its MSST in the next two years is defined to be *approaching* an overfished condition. In this assessment, determination of whether the stock is overfished is complicated in that the age-structured model is applied only to the AI portion of the population; an estimate of MSST is only available for this portion of the population. Because current management regulations use a single OFL for the BSAI area, a meaningful measure of MSST and overfished status would need to reflect the entire BSAI population. However, the AI portion of the population composes the majority of the BSAI blackspotted/rougheye rockfish, and evaluation of its population size relative the MSST computed for the AI provides a useful index of stock condition. Harvest Scenarios #6 and #7 are used in these determinations as follows:

Is the AI portion of the stock currently overfished? This depends on the estimated SSB in 2024:

a. If SSB for 2024 is estimated to be below ½ $B_{35\%}$, the stock is below its MSST.

b. If SSB for 2024 is estimated to be above $B_{35\%}$ the stock is above its MSST.

c. If SSB for 2024 is estimated to be above ½ $B_{35\%}$ but below $B_{35\%}$, the stock's status relative to MSST is determined by referring to harvest Scenario #6 (Table 14.28). If the mean SSB for 2034 is below $B_{35\%}$, the stock is below its MSST. Otherwise, the stock is above its MSST.

Is the AI portion of the stock approaching an overfished condition? This is determined by referring to harvest Scenario #7:

a. If the mean SSB for 2026 is below 1/2 $B_{35\%}$, the stock is approaching an overfished condition.

b. If the mean SSB for 2026 is above $B_{35\%}$, the stock is not approaching an overfished condition.

c. If the mean SSB for 2026 is above 1/2 $B_{35\%}$ but below $B_{35\%}$, the determination depends on the mean SSB for 2036. If the mean SSB for 2036 is below $B_{35\%}$, the stock is approaching an overfished condition. Otherwise, the stock is not approaching an overfished condition.

The results of these two scenarios indicate that the AI portion of the stock blackspotted/rougheye rockfish stock is neither overfished nor approaching an overfished condition. With regard whether the stock is currently below overfished, the estimated stock size in 2024 is 3,552 t and exceeds the $B_{35\%}$ value of 3,085 t. With regard to whether the stock is likely to be overfished in the future, the expected stock size in 2026 of 3,927 t exceeds the $B_{35\%}$ value.

Based on the recommended model for the AI portion of the stock, the F that would have produced an AI catch for 2023 equal to the AI portion of the 2023 OFL is 0.046.

Ecosystem Considerations

Ecosystem Effects on the stock

1) Prey availability/abundance trends

The largest components of the blackspotted/rougheye rockfish diet is pandalid and hippolytid shrimp (Yang 1993, 1996, Yang and Nelson 2000). Analysis of specimens in the Aleutian Islands surveys in 1991 and 1994 indicated that the diet of large blackspotted/rougheye rockfish had proportionally more fish (e.g., myctophids) than small blackspotted/rougheye, whereas smaller blackspotted/rougheye consumed proportionally more shrimp. The availability and abundance trends of these prey species are unknown.

2) Predator population trends

Blackspotted/rougheye rockfish are not commonly observed in field samples of stomach contents. Pacific ocean perch, a rockfish with some similar life-history characteristics as blackspotted and rougheye rockfish, has been found in the stomachs of Pacific halibut and sablefish (Major and Shippen 1970), and it is possible that these also prey upon blackspotted and rougheye rockfish as well.

3) Changes in habitat quality

Adults are demersal and generally occur at depths between 300 m and 500 m. Submersible work in southeast Alaska indicates that blackspotted/rougheye rockfish were associated with habitats containing frequent boulders, steep slopes (more than 20°), and sand-mud substrates (Krieger and Ito 1999). Krieger and Wing (2002) found that large rockfish had a strong association with *Primnoa* spp. coral growing on boulders and it is likely than many of these large rockfish were blackspotted/rougheye rockfish.

There has been little information identifying how rockfish habitat quality has changed over time, but recent EFH reviews have not indicated effects greater than "minimal and temporary".

Fishery Effects on the ecosystem

Blackspotted/rougheye rockfish are not subject to a target fishery in the BSAI management area. As previously discussed, much of the blackspotted/rougheye catch occurs in the POP fishery in the western and central Aleutians Islands, and in the POP, arrowtooth flounder, pollock, and Pacific cod fisheries in the eastern Aleutian Islands and eastern Bering Sea area. The ecosystem effects of the fisheries for these stocks can be found in their chapters in in this SAFE document.

Harvesting of blackspotted/rougheye rockfish is not likely to diminish the amount of blackspotted/rougheye rockfish available as prey, due to the low fishery selectivity for fish less than 20 cm. Although the recent fishing mortality rates have been relatively light, relatively high exploitation rates have occurred in the 1990s and it is not known how harvesting affects maturity-at-age.

Data Gaps and Research Priorities

Little information is known regarding most aspects of the biology of blackspotted and rougheye rockfish, particularly in the AI. Distinguishing blackspotted rockfish from rougheye rockfish in the field is a pressing issue, particularly along the EBS slope where both species are found. Further studies to examine the distribution and movement of early life-history stages are needed. Given the results of recent genetic work, further information on the population structure associated with distinctive oceanographic features such as AI passes is needed. Finally, 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.

The relatively poor fits to both the survey biomass indices and the age and length composition data are concerning. Research models that explore various options for the data processing of these data (i.e.. procedures for converting raw data to aggregate data representing the entire survey or fishery) are worth re-evaluating, as well as further investigations on data-weighting. Simulation exercises that explore how variability in observed data, perhaps resulting from sampling patchily-distributed populations, can affect assessment uncertainty may be useful.

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Tables

Table 14.1. Total allowable catch (TAC), acceptable biological catch (ABC), and catch of the species groups used to manage blackspotted and rougheye rockfish in the Aleutian Islands and eastern Bering Sea from 1977 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.

	BSAI					AI					EBS				
Year	Management Group	OFL	ABC (t)	TAC (t)	Catch (t)	Management Group	OFL (t)	ABC	TAC	Catch	Management Group	OFL	ABC	TAC	Catch
1977						Other species				155	Other species				2
1978						Other species				2423	Other species				99
1979						Other species				3077	Other species				477
1980						Other species				660	Other species				160
1981						Other species				595	Other species				283
1982						POP complex				189	POP complex				124
1983						POP complex				58	POP complex				53
1984						POP complex				35	POP complex				79
1985						POP complex				10	POP complex				18
1986						Other rockfish			5800	21	Other rockfish			825	52
1987						Other rockfish			1430	79	Other rockfish			450	99
1988						Other rockfish		1100	1100	75	Other rockfish		400	400	111
1989						POP Complex		16600	6000	381	POP Complex		6000	5000	204
1990						POP Complex		16600	6000	1619	POP Complex		6300	6300	369
1991						Other red rockfish		4685	4685	137	Other red rockfish		1670	1670	106
1992						RE/SR	1220	1220	1220	1181	Other red rockfish	1400	1400	1400	77
1993						RE/SR	1220	1220	1100	924	Other red rockfish	1400	1400	1200	146
1994						RE/SR	1220	1220	1220	749	Other red rockfish	1400	1400	1400	22
1995						RE/SR	1220	1220	1098	395	Other red rockfish	1400	1400	1260	28
1996						RE/SR	1250	1250	1125	816	Other red rockfish	1400	1400	1260	34
1997						RE/SR	1250	938	938	954	Other red rockfish	1400	1050	1050	15
1998						RE/SR	1290	965	965	526	Other red rockfish	356	267	267	16
1999						RE/SR	1290	965	965	385	Other red rockfish	356	267	267	9
2000						RE/SR	1180	885	885	280	Other red rockfish	259	194	194	26
2001	RE/SR	1369	1028	1028	565	RE/SR			912	550	RE/SR			116	15
2002	RE/SR	1369	1028	1028	284	RE/SR			912	273	RE/SR			116	12
2003	RE/SR	1289	967	967	191	RE/SR			830	174	RE/SR			137	17

Table 14.2. Total allowable catch (TAC), acceptable biological catch (ABC), and catch of the species groups used to manage blackspotted and rougheye rockfish in the Aleutian Islands and eastern Bering Sea from 2004 to 2024. Catch data is through a week-end-date of October 5, 2024, from NMFS Alaska Regional Office. The "rougheye" management group includes both blackspotted rockfish and rougheye rockfish.

	BSAI					WAI/CAI					EAI/EBS				
Year	Management Group	OFL	ABC (t)	TAC (t)	Catch (t)	Management Group	OFL	ABC	TAC	Catch	Management Group	OFL	ABC	TAC	Catch
2004	Rougheye	259	195	195	208										
2005	Rougheye	298	223	223	90										
2006	Rougheye	299	224	224	203										
2007	Rougheye	269	202	202	168										
2008	Rougheye	269	202	202	193										
2009	Rougheye	660	539	539	197										
2010	Rougheye	669	547	547	228										
2011	Rougheye	549	454	454	170	Rougheye		220	220	77	Rougheye		234	234	92
2012	Rougheye	576	475	475	201	Rougheye		244	244	130	Rougheye		231	231	71
2013	Rougheye	462	378	378	337	Rougheye		209	209	152	Rougheye		169	169	185
2014	Rougheye	505	416	416	208	Rougheye		239	239	101	Rougheye		177	177	108
2015	Rougheye	560	453	349	196	Rougheye		304	200	125	Rougheye		149	149	71
2016	Rougheye	693	561	300	164	Rougheye		382	200	89	Rougheye		179	100	75
2017	Rougheye	612	501	225	234	Rougheye		195	125	153	Rougheye		306	100	81
2018	Rougheye	749	613	225	250	Rougheye		239	150	180	Rougheye		374	75	70
2019	Rougheye	676	555	279	405	Rougheye		204	204	311	Rougheye		351	75	94
2020	Rougheye	861	708	349	531	Rougheye		264	264	380	Rougheye		444	85	151
2021	Rougheye	576	482	482	515	Rougheye		169	169	319	Rougheye		313	313	196
2022	Rougheye	598	503	503	455	Rougheye		177	177	250	Rougheye		326	326	204
2023	Rougheye	703	525	525	607	Rougheye		166	166	316	Rougheye		359	359	291
2024*	Rougheye	761	569	569	463	Rougheye		181	181	293	Rougheye		388	388	170

Table 14.3. Catch of blackspotted and rougheye rockfish (t) in the BSAI area.

	Eastern Bering Sea			Aleutian Islands			BSAI
Year	Foreign	JV	Domestic	Foreign	JV	Domestic	Total
1977	2	0		155	0		157
1978	99	0		2,423	0		2,522
1979	477	0		3,077	0		3,553
1980	160	0		660	0		820
1981	283	0		595	0		878
1982	124	0		189	0		312
1983	53	0		56	2		111
1984	79	0		31	4		114
1985	18	0		1	9		27
1986	3	1	48	0	2	19	74
1987	1	2	96	0	3	76	179
1988	0	1	110	0	5	70	185
1989	0	2	202	0	0	381	585
1990			369			1,619	1,988
1991			106			137	243
1992			77			1,181	1,258
1993			146			924	1,070
1994			22			749	770
1995			28			395	423
1996			34			816	850
1997			15			954	969
1998			16			526	542
1999			9			385	394
2000			26			280	307
2001			15			550	565
2002			12			273	284
2003			17			174	191
2004			23			185	208
2005			12			78	90
2006			7			197	203
2007			10			157	168
2008			22			171	193
2009			13			184	197
2010			27			201	228
2011			38			131	170
2012			19			182	201
2013			34			303	337
2014			29			179	208
2015			37			159	196
2016			43			121	164
2017			43			191	234
2018			19			232	250
2019			60			345	405
2020			54			477	531
2021			103			412	515
2022			114			341	455
2023			138			469	607
2024*			38			425	463

*Catch data through October 5, 2024, from NMFS Alaska Regional Office.

Table 14.4. Area-specific catches (t) of blackspotted and rougheye rockfish (t) in the BSAI area, obtained from the North Pacific Groundfish Observer Program, NMFS Alaska Regional Office. BSAI subareas are the western Aleutians Islands (WAI), central Aleutian Islands (CAI), and eastern Aleutian Islands (EAI), and eastern Bering Sea (EBS).

Year	WAI	CAI	EAI	EBS	Total
1994	49	197	503	22	770
1995	43	100	252	28	423
1996	446	184	186	34	850
1997	513	138	303	15	969
1998	109	232	185	16	542
1999	88	161	136	9	394
2000	103	139	39	26	307
2001	128	133	289	15	565
2002	96	63	114	12	284
2003	66	58	51	17	191
2004	112	64	10	23	208
2005	43	24	11	12	90
2006	109	45	43	7	203
2007	43	42	72	10	168
2008	58	67	47	22	193
2009	67	81	37	13	197
2010	85	42	74	27	228
2011	46	31	54	38	170
2012	65	65	52	19	201
2013	84	68	151	34	337
2014	57	44	79	29	208
2015	70	56	34	37	196
2016	40	50	32	43	164
2017	35	118	38	43	234
2018	67	113	52	19	250
2019	104	208	34	60	405
2020	168	212	97	54	531
2021	120	198	93	103	515
2022	104	146	91	114	455
2023	181	135	153	138	607
2024*	166	127	132	38	463

* Estimated removals through October 5, 2024.

Table 14.5. Catch (t) of FMP groundfish species caught in BSAI trips targeting rockfish. The rougheye rockfish species group name also includes blackspotted rockfish. “Conf” indicates confidential records with less than three vessels or processors. Source: Alaska Regional Office, via AKFIN 09/30/2024.

Species Group Name	2016	2017	2018	2019	2020	2021	2022	2023	2024	Average
Pacific Ocean Perch	19589	20422	21091	27651	25802	23637	23415	25374	15198	22464
Atka Mackerel	5255	5365	5513	8734	8527	6846	6173	8895	5954	6807
Northern Rockfish	1338	1476	1768	4527	3512	2193	3133	5217	3348	2946
Pollock	875	1424	1524	2254	1995	2248	2779	3626	2664	2154
Pacific Cod	625	813	637	1217	975	899	721	810	633	814
Arrowtooth Flounder	363	359	257	465	579	672	708	738	759	544
BSAI Kamchatka Flounder	463	427	322	518	714	549	305	554	743	511
Sablefish	14	143	147	286	370	475	707	681	667	388
Other Rockfish	129	163	198	342	405	284	355	424	311	290
BSAI Skate and GOA Skate, Other	139	144	165	294	282	216	174	183	181	198
Rougheye Rockfish	70	65	116	246	288	248	219	332	191	197
Sculpin	88	135	106	199	188					143
BSAI Other Flatfish	16	52	88	157	141	161	248	244	174	142
Flathead Sole	41	53	67	119	89	125	172	245	239	128
BSAI Shortraker Rockfish	38	36	116	121	146	224	152	152	50	115
Greenland Turbot	28	37	53	119	165	115	91	169	168	105
Rock Sole	15	32	36	67	61	49	59	50	57	47
Squid	26	31	50							35
Shark	2	Conf	2	2	4	2	6	3	10	4
Octopus	1	3	3	4	2	2	3	3	3	3
Yellowfin Sole	1	0	4	1	1	5	0	0		1
BSAI Alaska Plaice	Conf		1		0	Conf	Conf			0

Table 14.6. Catch (t) of BSAI rougheye rockfish and blackspotted rockfish by trip target fishery. "Conf" indicates confidential records with less than three vessels or processors. Source: Alaska Regional Office, via AKFIN 09/30/2024.

Fishery	2016	2017	2018	2019	2020	2021	2022	2023	2024	Average
Rockfish	70	65	116	246	288	248	219	332	191	197
Atka Mackerel	35	38	79	76	98	144	133	167	191	107
Pacific Cod	13	78	35	30	69	43	39	4	20	37
Kamchatka Flounder - BSAI	25	9	6	5	35	42	40	80	16	29
Arrowtooth Flounder	9	1	2	1	11	17	4	4	26	8
Halibut	6	26	7	9	8	4	4	3	6	8
Flathead Sole	Conf	Conf		9	Conf	7	6	3		6
Sablefish	0	Conf	1	Conf	3	2	3	8	12	4
Greenland Turbot - BSAI	Conf	1	2	8	5	2	2	Conf		3
Pollock - midwater	2	7	2	8	4	0	0	1	1	3
Other Flatfish - BSAI	1	2	Conf	3	Conf	5	1	4	Conf	3
Pollock - bottom	1	3	1	4	2	Conf	3	Conf	Conf	2

Table 14.7. Bycatch (t) of PSC species by BSAI trip targeting rockfish, in tons for halibut and herring and 1000s of individuals for crab and salmon. Source: Alaska Regional Office, via AKFIN 09/30/2024.

Species	2024	2023	2022	2021	2020	2019	2018	2017	2016	Average
Bairdi Tanner Crab	8.01	4.64	0.70	7.66	0.25	0.62	0.84	0.10	0.07	2.54
Blue King Crab	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Chinook Salmon	0.08	0.11	0.21	0.39	0.17	1.04	0.27	0.58	0.21	0.34
Golden (Brown) King Crab	2.01	3.11	3.32	3.30	3.66	6.30	4.95	3.02	5.29	3.88
Halibut	36.29	72.32	73.87	81.93	59.64	86.00	44.16	51.18	24.98	58.93
Herring	0.44	2.08	2.12	0.01	0.00	1.34	0.04	0.01	0.00	0.67
Non-Chinook Salmon	0.74	1.09	0.95	0.77	0.41	1.28	0.76	0.12	0.19	0.70
Opilio Tanner (Snow) Crab	1.34	0.58	0.14	2.31	0.10	0.71	14.54	0.07	0.02	2.20
Red King Crab	0.00	0.18	0.00	0.21	0.06	0.33	0.48	0.63	0.06	0.22

Table 14.8. Bycatch (t) of non-FMP species by BSAI trip targeting rockfish. "Conf" indicates confidential records with less than three vessels or processors. Source: Alaska Regional Office, via AKFIN 9/30/2024.

Species Group Name	2024	2023	2022	2021	2020	2019	2018	2017	2016
Benthic urochordata	0.18	2.70	0.40	0.46	6.08	12.16	2.88	0.32	0.18
Birds - Auklets							Conf		
Birds - Black-footed Albatross			Conf				Conf		
Birds - Laysan Albatross							Conf		
Birds - Northern Fulmar	Conf	Conf	Conf				Conf		
Birds - Shearwaters	Conf			Conf			Conf	Conf	
Birds - Storm Petrels		Conf		Conf			Conf		
Bivalves	0.20	0.23	0.07	0.17	0.03	0.15	0.05	0.02	0.05
Brittle star unidentified	0.72	3.63	1.13	3.27	6.08	3.21	5.02	0.14	0.12
Corals Bryozoans - Corals Bryozoans Uniden	3.61	10.48	9.45	5.23	9.25	23.56	5.89	26.61	11.15
Eelpouts	40.24	20.72	19.26	3.17	3.57	2.46	1.75	4.56	1.33
Giant Grenadier	233.51	284.93	240.85	321.44	181.68	95.36	121.74	29.33	108.63
Greenlings	1.07	2.38	2.43	0.46	0.79	0.67	Conf	Conf	
Grenadier - Rattail Grenadier Unidentified	Conf	3.84	3.25	Conf		23.44	Conf		
Hermit crab unidentified	0.11	0.14	0.15	0.08	0.04	0.10	0.04	0.01	0.02
Invertebrate unidentified	0.14	0.47	0.32	8.62	1.69	4.86	0.16	0.13	1.86
Lanternfishes (myctophidae)	0.03	0.04	0.08	0.14	Conf	0.11	0.03	Conf	Conf
Misc crabs	2.31	2.68	5.11	0.35	0.30	1.00	0.28	0.24	0.40
Misc crustaceans	0.01	0.18	0.23	0.15	0.18	0.18	0.22	0.38	0.11
Misc deep fish	Conf	Conf	Conf	0.01	Conf	Conf	Conf		Conf
Misc fish	36.91	65.24	51.04	55.68	78.92	104.32	74.95	107.35	58.93
Misc inverts (worms etc)	0.14	0.01	0.01	0.01	0.03	0.00	Conf		0.00
Other osmerids	Conf			0.01	0.04	Conf	Conf		
Pacific Hake			Conf						
Pacific Sand lance		Conf			Conf				
Pandalid shrimp	0.27	0.36	0.53	0.38	0.16	0.14	0.32	0.10	0.15
Polychaete unidentified	0.01	0.43	0.01	0.00	Conf	0.03	0.02		Conf
Saffron Cod							Conf		
Sculpin	120.60	184.75	145.76	96.57					
Scypho jellies	1.05	5.53	2.49	15.23	3.43	11.50	1.23	0.39	0.52
Sea anemone unidentified	9.07	13.10	2.51	4.41	0.36	1.22	0.49	0.25	0.19
Sea pens whips	0.09	0.14	0.04	0.15	0.20	0.14	0.46	Conf	0.06
Sea star	18.33	20.56	12.78	12.45	16.01	32.69	45.25	4.27	3.29
Smelt (Family Osmeridae)			Conf						
Snails	0.95	1.50	0.80	0.76	0.79	0.80	0.81	0.31	0.13
Sponge unidentified	34.56	81.58	53.41	72.86	92.48	96.75	77.81	71.48	48.31
Squid	126.93	122.51	79.23	75.80	56.42	23.41			
State-managed Rockfish	1.17	2.75	0.58	0.46	1.13	0.34	0.36	Conf	0.62
Stichaeidae	Conf	Conf			Conf		Conf		Conf
urchins dollars cucumbers	6.26	6.27	3.94	1.05	0.69	2.64	2.10	1.14	0.37

Table 14.9. Estimated retained (t), discarded (t), and percent discarded of other red rockfish (ORR), shortraker/rougheye (SR/RE), and blackspotted/rougheye rockfish from the eastern Bering Sea (EBS) and Aleutian Islands (AI) regions.

	AI					EBS				
Year	Species Group	Retained	Discarded	Total	Percent Discarded	Species Group	Retained	Discarded	Total	Percent Discarded
1993	RE/SR	737	403	1139	35%	Other red rockfish	367	97	464	21%
1994	RE/SR	701	224	925	24%	Other red rockfish	29	100	129	78%
1995	RE/SR	456	103	558	18%	Other red rockfish	274	70	344	20%
1996	RE/SR	751	208	959	22%	Other red rockfish	58	149	207	72%
1997	RE/SR	733	310	1043	30%	Other red rockfish	44	174	218	80%
1998	RE/SR	447	238	685	35%	Other red rockfish	38	59	97	61%
1999	RE/SR	319	195	514	38%	Other red rockfish	75	163	238	68%
2000	RE/SR	285	196	480	41%	Other red rockfish	111	141	253	56%
2001	RE/SR	476	246	722	34%	RE/SR	27	16	43	38%
2002	RE/SR	333	146	478	30%	RE/SR	50	54	105	52%
2003	RE/SR	197	84	281	30%	RE/SR	62	54	116	47%
2004	Rougheye	83	102	185	55%	Rougheye	15	8	23	36%
2005	Rougheye	72	6	78	8%	Rougheye	3	8	12	70%
2006	Rougheye	167	30	197	15%	Rougheye	5	2	7	30%
2007	Rougheye	127	30	157	19%	Rougheye	7	3	10	29%
2008	Rougheye	137	35	171	20%	Rougheye	12	10	22	46%
2009	Rougheye	155	30	184	16%	Rougheye	10	3	13	23%
2010	Rougheye	174	27	201	13%	Rougheye	18	9	27	34%
2011	Rougheye	115	16	131	12%	Rougheye	30	8	38	22%
2012	Rougheye	158	24	182	13%	Rougheye	14	5	19	25%
2013	Rougheye	243	60	303	20%	Rougheye	21	13	34	39%
2014	Rougheye	158	21	179	12%	Rougheye	17	12	29	40%
2015	Rougheye	135	24	159	15%	Rougheye	23	15	37	39%
2016	Rougheye	106	15	121	13%	Rougheye	34	9	43	21%
2017	Rougheye	109	82	191	43%	Rougheye	23	20	43	46%
2018	Rougheye	193	39	232	17%	Rougheye	10	9	19	47%
2019	Rougheye	244	101	345	29%	Rougheye	32	28	60	47%
2020	Rougheye	319	158	477	33%	Rougheye	42	12	54	23%
2021	Rougheye	250	161	412	39%	Rougheye	59	44	103	42%
2022	Rougheye	197	144	341	42%	Rougheye	60	54	114	47%
2023	Rougheye	270	199	469	42%	Rougheye	58	81	138	58%
2024*	Rougheye	240	185	425	44%	Rougheye	24	14	38	37%

* Estimated removals through October 5, 2024.

Table 14.10. Samples sizes of blackspotted/rougheye lengths from fishery sampling in the eastern Bering Sea (EBS), Aleutian Islands (AI), and the eastern Bering Sea and Aleutian Islands combined (BSAI), with the number of hauls from which these data were collected, from 1977-2024.

	EBS		AI		BSAI	
Year	Lengths	Hauls	Lengths	Hauls	Lengths	Hauls
1977						
1978			54	6	54	6
1979	2340	132	4406	93	6746	225
1980						
1981						
1982						
1983			33	1	33	1
1984						
1985						
1986						
1987						
1988						
1989						
1990	800	29	1161	20	1961	49
1991	95	16	49	1	144	17
1992	61	1	1182	67	1243	68
1993	2	2	1046	39	1048	41
1994			27	1	27	1
1995	42	3			42	3
1996	14	3			14	3
1997						
1998						
1999	4	2	53	4	57	6
2000	4	1	160	21	164	22
2001	10	1	277	42	287	43
2002			336	49	336	49
2003	76	18	832	100	908	118
2004	215	41	1265	242	1480	283
2005	71	39	314	94	385	133
2006	61	16	266	56	327	72
2007	104	40	716	160	820	200
2008	38	20	371	105	409	125
2009	16	10	1002	211	1018	221
2010	103	46	1904	375	2007	421
2011	157	81	692	170	849	251
2012	81	48	923	164	1004	212
2013	209	81	1504	276	1713	357
2014	153	93	748	213	901	306
2015	312	151	1546	287	1858	438
2016	115	57	488	130	603	187
2017	74	32	2007	426	2081	458
2018	159	34	1308	331	1467	365
2019	519	260	1352	267	1871	527
2020	354	205	2089	610	2443	815
2021	457	203	3008	765	3465	968
2022	648	259	2167	621	2815	880
2023	843	327	2360	719	3203	1046
2024	203	122	1147	346	1350	468

Table 14.11. Samples sizes of blackspotted/rougheye otoliths from fishery sampling in the eastern Bering Sea (EBS), Aleutian Islands (AI), and the eastern Bering Sea and Aleutian Islands combined (BSAI), with the number of hauls from which these data were collected, from 1977-2024.

	Otoliths Sampled			Otoliths Read			Hauls (Otoliths Read)		
Year	EBS	AI	BSAI	EBS	AI	BSAI	EBS	AI	BSAI
1977									
1978									
1979	440	383	823	14	38	52	6	4	10
1980									
1981									
1982									
1983									
1984									
1985									
1986									
1987									
1988									
1989									
1990	54	0	54						
1991									
1992	0	50	50						
1993									
1994									
1995									
1996									
1997									
1998									
1999	4	4	8						
2000	2	24	26						
2001	2	76	78						
2002		67	67						
2003	19	120	139						
2004	14	147	161	14	146	160	11	90	101
2005	37	100	137	35	97	132	23	65	88
2006	5	83	88		82	82		47	47
2007	14	138	152	14	134	148	10	83	93
2008	17	125	142	17	121	138	13	74	87
2009	13	138	151	6	138	144	6	90	96
2010	24	172	196						
2011	22	153	175	19	152	171	12	85	97
2012	26	109	135						
2013	44	254	298	41	252	293	33	160	193
2014	51	242	293						
2015	70	206	276	69	206	275	47	126	173
2016	17	118	135						
2017	18	260	278	18	258	276	12	156	168
2018	38	332	370						
2019	346	342	688	332	341	673	184	201	385
2020	245	805	1050	82	264	346	67	224	291
2021	257	997	1254	122	489	611	98	397	495
2022	355	777	1132						
2023	412	1038	1450	207	517	724	155	422	577
2024	109	397	506						

Table 14.12. Fishery length compositions used in the model, from the NORPAC foreign and domestic Observer databases.

	Year										
Length (cm)	1979	1990	1992	1993	2003	2010	2012	2014	2016	2018	2022
12	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
13	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.000
14	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.006	0.000	0.000
15	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.000	0.000	0.003	0.000
16	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.003	0.004	0.001
17	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.000	0.006	0.001	0.002
18	0.003	0.000	0.000	0.000	0.000	0.000	0.000	0.003	0.009	0.004	0.002
19	0.002	0.000	0.000	0.000	0.000	0.000	0.004	0.001	0.006	0.005	0.003
20	0.003	0.000	0.000	0.000	0.000	0.000	0.000	0.005	0.003	0.004	0.006
21	0.002	0.000	0.000	0.000	0.000	0.001	0.001	0.002	0.009	0.011	0.011
22	0.004	0.000	0.000	0.000	0.000	0.000	0.002	0.008	0.012	0.011	0.020
23	0.004	0.000	0.000	0.001	0.000	0.002	0.006	0.016	0.006	0.013	0.016
24	0.007	0.002	0.000	0.001	0.000	0.001	0.015	0.012	0.010	0.015	0.016
25	0.011	0.000	0.000	0.002	0.000	0.003	0.002	0.016	0.021	0.011	0.023
26	0.010	0.000	0.000	0.001	0.000	0.004	0.014	0.020	0.006	0.018	0.029
27	0.014	0.000	0.000	0.009	0.000	0.010	0.028	0.014	0.011	0.020	0.031
28	0.018	0.001	0.004	0.007	0.000	0.015	0.018	0.023	0.019	0.016	0.032
29	0.020	0.002	0.002	0.002	0.002	0.026	0.012	0.032	0.028	0.015	0.034
30	0.026	0.002	0.004	0.009	0.001	0.033	0.024	0.027	0.019	0.018	0.042
31	0.033	0.010	0.002	0.016	0.000	0.044	0.026	0.043	0.038	0.021	0.041
32	0.037	0.023	0.007	0.012	0.004	0.056	0.033	0.033	0.030	0.030	0.044
33	0.045	0.014	0.011	0.018	0.008	0.068	0.049	0.035	0.046	0.029	0.038
34	0.048	0.016	0.021	0.013	0.014	0.069	0.047	0.044	0.031	0.040	0.040
35	0.055	0.007	0.019	0.023	0.015	0.078	0.074	0.041	0.069	0.053	0.039
36	0.055	0.048	0.028	0.016	0.022	0.065	0.076	0.047	0.065	0.042	0.041
37	0.059	0.029	0.020	0.027	0.029	0.054	0.065	0.063	0.046	0.055	0.038
38	0.053	0.027	0.022	0.040	0.059	0.032	0.059	0.047	0.062	0.050	0.041
39	0.056	0.044	0.057	0.034	0.060	0.042	0.051	0.053	0.061	0.053	0.052
40	0.055	0.043	0.066	0.037	0.052	0.031	0.056	0.049	0.044	0.066	0.045
41	0.050	0.059	0.093	0.042	0.083	0.032	0.031	0.045	0.068	0.064	0.042
42	0.046	0.079	0.107	0.064	0.059	0.022	0.030	0.027	0.046	0.049	0.049
43	0.053	0.051	0.108	0.059	0.095	0.031	0.031	0.041	0.051	0.061	0.034
44	0.046	0.090	0.104	0.093	0.083	0.028	0.021	0.036	0.024	0.042	0.035
45	0.037	0.067	0.060	0.107	0.072	0.025	0.033	0.035	0.017	0.037	0.032
46	0.029	0.099	0.085	0.094	0.064	0.021	0.024	0.031	0.027	0.041	0.024
47	0.028	0.073	0.058	0.092	0.052	0.026	0.017	0.023	0.014	0.020	0.023
48	0.020	0.090	0.034	0.071	0.036	0.026	0.015	0.024	0.006	0.020	0.018
49	0.014	0.049	0.016	0.029	0.036	0.023	0.017	0.020	0.003	0.009	0.011
50+	0.057	0.076	0.071	0.082	0.155	0.130	0.115	0.085	0.075	0.048	0.046

Table 14.13. Fishery age compositions used in the model, from the NORPAC domestic Observer database.

	Year												
Age	2004	2005	2007	2008	2009	2011	2013	2015	2017	2019	2020	2021	2023
3	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.000	0.000	0.000
4	0.000	0.000	0.003	0.000	0.000	0.000	0.000	0.000	0.005	0.004	0.004	0.000	0.003
5	0.000	0.000	0.000	0.000	0.000	0.000	0.002	0.000	0.000	0.006	0.025	0.033	0.003
6	0.000	0.000	0.000	0.007	0.000	0.005	0.003	0.000	0.000	0.010	0.027	0.033	0.041
7	0.000	0.000	0.004	0.000	0.000	0.005	0.001	0.000	0.006	0.025	0.030	0.034	0.037
8	0.000	0.000	0.000	0.004	0.019	0.016	0.004	0.000	0.006	0.031	0.056	0.048	0.048
9	0.003	0.000	0.013	0.052	0.056	0.021	0.000	0.010	0.012	0.068	0.109	0.074	0.042
10	0.000	0.000	0.003	0.014	0.179	0.015	0.030	0.008	0.006	0.028	0.036	0.085	0.064
11	0.001	0.000	0.000	0.008	0.174	0.031	0.041	0.008	0.018	0.046	0.027	0.066	0.104
12	0.000	0.005	0.011	0.140	0.055	0.028	0.062	0.058	0.013	0.068	0.053	0.042	0.090
13	0.000	0.000	0.007	0.021	0.010	0.076	0.101	0.083	0.018	0.043	0.068	0.050	0.057
14	0.000	0.000	0.000	0.027	0.000	0.031	0.191	0.127	0.072	0.073	0.076	0.054	0.040
15	0.000	0.009	0.000	0.022	0.022	0.009	0.092	0.063	0.155	0.076	0.072	0.072	0.035
16	0.012	0.003	0.000	0.000	0.000	0.007	0.069	0.140	0.110	0.089	0.049	0.074	0.019
17	0.000	0.007	0.010	0.004	0.005	0.000	0.030	0.125	0.109	0.100	0.058	0.063	0.044
18	0.013	0.006	0.000	0.007	0.004	0.000	0.005	0.088	0.124	0.106	0.049	0.038	0.033
19	0.011	0.018	0.006	0.000	0.018	0.027	0.015	0.044	0.113	0.058	0.059	0.034	0.047
20	0.021	0.048	0.008	0.006	0.010	0.023	0.004	0.028	0.071	0.046	0.044	0.050	0.050
21	0.038	0.025	0.012	0.032	0.010	0.000	0.035	0.018	0.037	0.019	0.020	0.028	0.034
22	0.034	0.051	0.000	0.026	0.017	0.000	0.023	0.009	0.029	0.009	0.035	0.016	0.049
23	0.072	0.051	0.039	0.056	0.029	0.039	0.026	0.000	0.021	0.007	0.007	0.020	0.033
24	0.065	0.029	0.027	0.000	0.024	0.038	0.018	0.014	0.007	0.005	0.008	0.012	0.032
25	0.044	0.159	0.102	0.019	0.042	0.038	0.035	0.007	0.004	0.000	0.018	0.006	0.021
26	0.052	0.056	0.025	0.060	0.020	0.027	0.032	0.008	0.006	0.007	0.008	0.011	0.007
27	0.050	0.070	0.063	0.022	0.055	0.037	0.011	0.013	0.000	0.000	0.008	0.005	0.006
28	0.062	0.028	0.079	0.021	0.029	0.047	0.030	0.020	0.000	0.007	0.006	0.006	0.005
29	0.055	0.016	0.054	0.040	0.031	0.035	0.009	0.013	0.005	0.003	0.004	0.003	0.007
30	0.069	0.052	0.046	0.027	0.034	0.028	0.009	0.007	0.006	0.004	0.003	0.006	0.007
31	0.012	0.014	0.054	0.028	0.039	0.039	0.007	0.015	0.000	0.007	0.003	0.008	0.002
32	0.027	0.012	0.033	0.042	0.033	0.014	0.014	0.003	0.006	0.001	0.004	0.002	0.000
33	0.022	0.027	0.010	0.081	0.005	0.018	0.011	0.007	0.006	0.000	0.004	0.001	0.002
34	0.017	0.023	0.034	0.021	0.013	0.057	0.018	0.011	0.000	0.010	0.000	0.002	0.001
35	0.050	0.000	0.056	0.016	0.007	0.022	0.010	0.000	0.002	0.000	0.009	0.001	0.002
36	0.010	0.000	0.008	0.000	0.006	0.012	0.003	0.000	0.006	0.005	0.001	0.003	0.004
37	0.037	0.022	0.007	0.009	0.000	0.029	0.001	0.000	0.006	0.004	0.000	0.001	0.003
38	0.004	0.016	0.032	0.028	0.009	0.031	0.007	0.005	0.001	0.000	0.001	0.003	0.003
39	0.000	0.016	0.016	0.017	0.006	0.005	0.000	0.008	0.000	0.002	0.003	0.000	0.001
40	0.006	0.009	0.007	0.019	0.005	0.033	0.007	0.000	0.000	0.002	0.001	0.003	0.001
41	0.024	0.018	0.008	0.012	0.003	0.032	0.005	0.000	0.000	0.000	0.000	0.000	0.001
42	0.050	0.055	0.017	0.020	0.000	0.017	0.002	0.011	0.000	0.003	0.001	0.001	0.001
43	0.016	0.000	0.018	0.023	0.000	0.013	0.005	0.000	0.000	0.002	0.000	0.001	0.002
44	0.020	0.005	0.015	0.000	0.000	0.007	0.000	0.002	0.003	0.001	0.001	0.000	0.000
45+	0.104	0.153	0.173	0.071	0.033	0.087	0.032	0.048	0.015	0.023	0.014	0.009	0.019

Table 14.14. Estimated biomass (t) of blackspotted/rougheye rockfish from the EBS slope survey and AI trawl survey (by management area), with the coefficient of variation (CV) shown in parentheses.

	Aleutian Islands Survey					
Year	Western	Central	Eastern	southern BS	Total AI survey	EBS slope survey
1980						
1983						
1986						
1991	3,037 (0.42)	2,380 (0.41)	5,221 (0.90)	676 (0.12)	11,314 (0.44)	
1994	2,908 (0.43)	3,470 (0.21)	7,037 (0.49)	1,208 (0.49)	14,623 (0.26)	
1997	3,373 (0.50)	4,607 (0.22)	2,925 (0.50)	561 (0.66)	11,466 (0.21)	
2000	661 (0.29)	9,333 (0.33)	4,224 (0.24)	1,054 (0.26)	15,271 (0.21)	
2002	1,390 (0.69)	3,934 (0.26)	3,099 (0.36)	1,251 (0.48)	9,674 (0.20)	556 (0.20)
2004	1,185 (0.54)	7,681 (0.37)	5,520 (0.44)	654 (0.31)	15,039 (0.25)	646 (0.16)
2006	519 (0.29)	4,959 (0.38)	2,803 (0.32)	1,224 (0.33)	9,506 (0.23)	
2008						833 (0.24)
2010	1,601 (0.44)	2,238 (0.24)	4,702 (0.44)	221 (0.28)	8,762 (0.26)	999 (0.25)
2012	335 (0.38)	8,268 (0.55)	3,798 (0.36)	405 (0.27)	12,807 (0.37)	1,597 (0.51)
2014	589 (0.28)	2,878 (0.27)	958 (0.30)	311 (0.20)	4,736 (0.18)	
2016	501 (0.34)	2,803 (0.35)	6,165 (0.37)	600 (0.35)	10,069 (0.25)	458 (0.27)
2018	632 (0.34)	2,438 (0.36)	6,535 (0.68)	328 (0.27)	9,843 (0.46)	
2022	1,793 (0.19)	3,056 (0.37)	10,834 (0.71)	643 (0.35)	16,325 (0.48)	
2024	3,417 (0.30)	7,972 (0.28)	12,698 (0.77)	323 (0.52)	24,410 (0.41)	

Table 14.15. Samples sizes of blackspotted/rougheye lengths from the Aleutian Island trawl survey, with the number of hauls from which these data were collected, from 1991-2024.

	Aleutian Islands		Eastern Bering Sea	
Year	Lengths	Hauls	Lengths	Hauls
1991	1060	35		
1994	2375	104		
1997	1817	121		
2000	1673	119		
2002	1288	98	119	30
2004	1522	117	225	49
2006	1260	109		
2008			213	43
2010	986	78	267	43
2012	1356	105	230	37
2014	1035	99		
2016	1574	105	162	21
2018	1209	104		
2022	2159	136		
2024	2280	112		

Table 14.16. Number of sample and read otoliths of blackspotted/rougheye otoliths from the Aleutian Island and EBS slope trawl surveys, with the number of hauls from which these data were collected, from 1991-2024.

	Aleutian Islands survey			Eastern Bering Sea slope		
Year	Sampled	Read	Hauls	Sampled	Read	Hauls
1991	480	476	29			
1994	729	486	68			
1997	866	578	92			
2000	492	490	87			
2002	473	451	81	104	104	27
2004	475	472	97	217	216	48
2006	459	459	89			
2008				206	206	40
2010	491	482	76	262	130	36
2012	560	557	99	162	161	36
2014	441	441	82			
2016	329	323	97	150	150	21
2018	314	314	96			
2022	652	647	133			
2024	548					

Table 14.17. AI survey age compositions used in the model.

	Year												
Age	1991	1994	1997	2000	2002	2004	2006	2010	2012	2014	2016	2018	2022
3	0.000	0.000	0.000	0.000	0.005	0.002	0.002	0.002	0.000	0.007	0.003	0.003	0.000
4	0.001	0.000	0.000	0.000	0.011	0.011	0.004	0.009	0.000	0.012	0.007	0.003	0.000
5	0.001	0.000	0.000	0.000	0.001	0.008	0.008	0.005	0.005	0.022	0.015	0.002	0.000
6	0.001	0.000	0.000	0.000	0.001	0.013	0.012	0.004	0.013	0.023	0.025	0.017	0.002
7	0.003	0.000	0.000	0.000	0.000	0.007	0.021	0.018	0.009	0.027	0.009	0.029	0.005
8	0.010	0.000	0.002	0.001	0.002	0.003	0.026	0.039	0.013	0.027	0.038	0.072	0.006
9	0.010	0.001	0.004	0.001	0.000	0.001	0.008	0.028	0.021	0.024	0.027	0.035	0.025
10	0.019	0.001	0.006	0.000	0.000	0.001	0.002	0.032	0.028	0.020	0.011	0.018	0.040
11	0.019	0.006	0.008	0.001	0.000	0.005	0.005	0.058	0.022	0.073	0.065	0.031	0.044
12	0.010	0.010	0.001	0.001	0.001	0.001	0.000	0.051	0.031	0.076	0.045	0.046	0.073
13	0.002	0.015	0.007	0.008	0.000	0.003	0.000	0.025	0.048	0.096	0.131	0.036	0.073
14	0.034	0.014	0.027	0.009	0.002	0.005	0.000	0.015	0.031	0.050	0.077	0.071	0.048
15	0.014	0.034	0.018	0.008	0.017	0.000	0.000	0.010	0.018	0.077	0.081	0.113	0.051
16	0.014	0.022	0.021	0.017	0.010	0.006	0.004	0.011	0.007	0.086	0.109	0.091	0.041
17	0.005	0.039	0.020	0.016	0.009	0.019	0.008	0.005	0.027	0.050	0.092	0.074	0.050
18	0.009	0.029	0.020	0.013	0.021	0.009	0.007	0.001	0.017	0.015	0.039	0.094	0.059
19	0.016	0.025	0.029	0.024	0.027	0.017	0.007	0.018	0.002	0.023	0.007	0.058	0.049
20	0.041	0.032	0.048	0.030	0.038	0.027	0.018	0.002	0.020	0.005	0.032	0.068	0.074
21	0.021	0.048	0.053	0.028	0.036	0.027	0.045	0.010	0.021	0.004	0.012	0.031	0.060
22	0.031	0.010	0.029	0.013	0.051	0.056	0.029	0.023	0.020	0.007	0.011	0.017	0.059
23	0.039	0.023	0.012	0.039	0.041	0.025	0.047	0.032	0.018	0.005	0.002	0.009	0.038
24	0.037	0.032	0.027	0.057	0.048	0.059	0.038	0.011	0.043	0.006	0.003	0.006	0.060
25	0.032	0.026	0.035	0.049	0.025	0.045	0.048	0.028	0.030	0.009	0.018	0.002	0.044
26	0.053	0.042	0.047	0.038	0.039	0.047	0.041	0.059	0.017	0.016	0.011	0.000	0.032
27	0.062	0.018	0.051	0.048	0.032	0.048	0.036	0.040	0.034	0.008	0.013	0.000	0.015
28	0.054	0.021	0.047	0.028	0.030	0.056	0.021	0.071	0.038	0.019	0.014	0.010	0.010
29	0.085	0.021	0.032	0.033	0.028	0.048	0.033	0.040	0.046	0.007	0.007	0.000	0.004
30	0.070	0.039	0.039	0.069	0.041	0.036	0.036	0.042	0.087	0.018	0.007	0.000	0.003
31	0.045	0.059	0.037	0.044	0.038	0.036	0.037	0.012	0.056	0.013	0.001	0.005	0.002
32	0.050	0.073	0.035	0.055	0.059	0.035	0.028	0.026	0.041	0.015	0.005	0.000	0.005
33	0.047	0.034	0.058	0.042	0.031	0.031	0.035	0.031	0.034	0.014	0.015	0.011	0.006
34	0.037	0.054	0.038	0.016	0.051	0.048	0.032	0.020	0.008	0.018	0.006	0.001	0.001
35	0.038	0.033	0.040	0.039	0.030	0.039	0.030	0.020	0.008	0.013	0.011	0.002	0.000
36	0.033	0.062	0.045	0.021	0.024	0.016	0.026	0.028	0.035	0.009	0.000	0.001	0.000
37	0.011	0.035	0.024	0.026	0.023	0.030	0.066	0.010	0.016	0.005	0.000	0.007	0.003
38	0.017	0.025	0.018	0.020	0.030	0.022	0.022	0.001	0.019	0.011	0.006	0.004	0.002
39	0.007	0.030	0.032	0.032	0.018	0.011	0.024	0.012	0.013	0.006	0.012	0.008	0.001
40	0.004	0.012	0.013	0.038	0.015	0.011	0.020	0.014	0.005	0.009	0.006	0.000	0.000
41	0.002	0.021	0.010	0.016	0.036	0.018	0.025	0.020	0.010	0.010	0.000	0.002	0.003
42	0.006	0.008	0.023	0.022	0.028	0.018	0.034	0.007	0.017	0.010	0.003	0.001	0.002
43	0.003	0.024	0.008	0.013	0.018	0.005	0.013	0.011	0.006	0.006	0.001	0.002	0.000
44	0.000	0.007	0.010	0.018	0.015	0.009	0.020	0.006	0.005	0.005	0.000	0.002	0.001
45+	0.005	0.015	0.027	0.065	0.066	0.085	0.080	0.093	0.061	0.046	0.024	0.019	0.010

Table 14.18. AI survey length compositions used in the model.

	Year
Length (cm)	2024
12	0.000
13	0.000
14	0.000
15	0.001
16	0.000
17	0.000
18	0.002
19	0.005
20	0.005
21	0.003
22	0.006
23	0.008
24	0.018
25	0.014
26	0.023
27	0.030
28	0.033
29	0.029
30	0.036
31	0.029
32	0.036
33	0.040
34	0.042
35	0.064
36	0.074
37	0.082
38	0.055
39	0.068
40	0.088
41	0.066
42	0.048
43	0.027
44	0.026
45	0.010
46	0.008
47	0.007
48	0.005
49	0.003
50+	0.008

Table 14.19. Predicted weight and proportion mature at age for BSAI rougheye rockfish.

Age	Predicted weight (g)	Proportion mature
3	61	0.003
4	90	0.004
5	124	0.006
6	163	0.007
7	208	0.010
8	256	0.013
9	309	0.016
10	364	0.021
11	423	0.027
12	483	0.035
13	544	0.046
14	607	0.059
15	671	0.075
16	734	0.095
17	797	0.121
18	860	0.152
19	922	0.189
20	983	0.232
21	1,043	0.283
22	1,102	0.339
23	1,159	0.400
24	1,214	0.465
25	1,268	0.531
26	1,319	0.596
27	1,369	0.657
28	1,418	0.714
29	1,464	0.765
30	1,508	0.809
31	1,551	0.846
32	1,591	0.878
33	1,630	0.903
34	1,667	0.924
35	1,702	0.940
36	1,736	0.954
37	1,768	0.964
38	1,799	0.972
39	1,828	0.978
40	1,855	0.983
41	1,881	0.987
42	1,906	0.990
43	1,929	0.992
44	1,951	0.994
45+	2,061	0.998

Table 14.20. Parameters and quantities for the BSAI blackspotted/rougheye rockfish model, with values where fixed or specified.

Parameter	Description	Value(s)
Y	Year	1977, . . . , 2024
N	Population abundance	
a	Age classes	
a_r	Age of recruitment	3
A	Plus-group age	45
l	Length classes	12, . . ., 50+
$w_{y,a}^{p}$	Vector of population weight-at-age by year (kg)	
$w_{y,a}^{f}$	Vector of fishery weight-at-age by year (kg)	
m_a	Vector of maturity-at-age	
μ_r	Average annual recruitment, log-scale	
μ_{init}	Average annual recruitment, log-scale, cohorts in initial year	
μ_f	Average fishing mortality	
ε_y	Annual fishing mortality deviation, log-scale	
τ_y	Annual recruitment deviation	
γ_y	Annual recruitment deviation, cohorts in first year	
σ_R	Recruitment variability	0.75
s_a^f	Vector of selectivity-at-age for fishery	
s_a^f	Vector of selectivity-at-age for survey	
M	Natural mortality	
$F_{y,a}$	Fishing mortality for year y and age class a	
$Z_{y,a}$	Total mortality for year y and age class a	
SB_frac	Spawning month as fraction of year	0.17

Table 14.20 (continued). Parameters and quantities for the BSAI blackspotted/rougheye rockfish model, with values where fixed or specified.

Parameter	Description	Value(s)
$T_{a \to a'}$	Aging error matrix	
$T_{a \to l}$	Age to length conversion matrix	
q	Trawl survey catchability	
SB_y	Spawning biomass in year y ($=m_a\, w_a\, N_{y,a}$)	
M_{prior}	Prior mean for natural mortality	0.045
q_{prior}	Prior mean for trawl survey catchability	1.0
σ_M	Prior log-scale standard deviation for natural mortality	0.05
σ_q	Prior log-scale standard deviation for trawl survey catchability	0.05
$n_y^{f,a}, n_y^{f,l}, n_y^{t,a}$	First-stage input sample sizes for fishery length and age compositions, and survey age compositions (number of hauls)	
$\lambda_{\hat{p}_a^f}, \lambda_{\hat{p}_l^f}, \lambda_{\hat{p}_a^t}$	Second-stage weights for fishery length and age compositions, and survey age compositions (from McAllister-Ianelli weighting)	
$\lambda_{\hat{C}},$	Weight for catch likelihood	50
$\lambda_{\hat{I}}$	Weight for survey index	1
λ_f	Weight for F fishing mortality deviations	0.1

Table 14.21. Equations for modeling the population dynamics and observed data for BSAI blackspotted/rougheye rockfish model, see Table 14.20 for definitions.

Equations describing population dynamics	
$N_{y,3}=\begin{cases} e^{\mu_r+\tau_y} & 1977 \le y \le 2021 \\ e^{\mu_r+\sigma_r^2/2} & 2022 \le y \le 2024 \end{cases}$	Number at age of recruitment
$N_{styr,a}=\begin{cases} e^{\mu_{init}-M(a-a_r)+\gamma_{a-a_r+1}}, & a_r < a < A \\ \dfrac{e^{\mu_{init}-M(A-a_r)+\gamma_{A-a_r+1}}}{(1-e^{-M})} & a = A \end{cases}$	Numbers at age, start year
$N_{y,a}=\begin{cases} N_{y-1,a-1}e^{-Z_{y-1,a-1}} & a_r < a < A \\ N_{y-1,a-1}e^{-Z_{y-1,a-1}}+N_{y-1,a}e^{-Z_{y-1,a}} & a = A \end{cases}$	Numbers at age, subsequent years
$s_a^f=\left(1+e^{-\delta^f(a-a_{50\%}^f)}\right)^{-1}$	Fishery selectivity
$F_{y,a}=s_a^f e^{\mu_f+\epsilon_y}$	Fishing mortality
$Z_{y,a}=F_{y,a}+M$	Total mortality
$SSB_{y,a}=0.5N_{y,a}m_a w_{y,a}^p e^{-SB_{frac}*Z_{y,a}}$	Spawning biomass

Equations describing the observed data	
$\bar{N}_{y,a}=N_{y,a}(1-e^{-Z_{y,a}})/Z_{y,a}$	Mean numbers at age
$\hat{C}_{y,a}=F_{y,a}\bar{N}_{y,a}$	Estimated catch numbers at age
$\hat{Y}_t=\sum_{a=a_r}^{A} w_a\hat{C}_{y,a}$	Estimated catch biomass
$s_a^t=\left(1+e^{-\delta^t(a-a_{50\%}^t)}\right)^{-1}$	AI trawl survey selectivity
$\hat{I}_{t,y}=q\sum_{a=a_r}^{A} w_a s_a^t\bar{N}_{y,a}$	Estimated trawl survey biomass
$\hat{p}_{y,a}^t=T_{a\to a'}\dfrac{s_a^t\bar{N}_{y,a}}{\sum_{a=a_r}^{A}s_a^t\bar{N}_{y,a}}$	Estimated trawl survey age compositon
$\hat{p}_{y,l}^f=T_{a\to l}\dfrac{\hat{C}_{y,a}}{\sum_{a=a_r}^{A}\hat{C}_{y,a}}$	Estimated fishery length compositon
$\hat{p}_{y,a}^f=T_{a\to a'}\dfrac{\hat{C}_{y,a}}{\sum_{a=a_r}^{A}\hat{C}_{y,a}}$	Estimated fishery age compositon
$\widehat{m}_a=\left(1+e^{-\delta^m(a-a_{50\%}^m)}\right)^{-1}$	Estimated maturity at age

Table 14.22. Equations for likelihood components for the BSAI blackspotted/rouheye rockfish model, see Tables 14.20 – 14.21 for definitions.

Negative log likelihood, data components	
$L_{\hat{C}} = \lambda_{\hat{C}} \sum_{Y} ln\left(\frac{Y_y + 0.001}{\hat{Y}_y + 0.001}\right)^2$	Catch likelihood
$L_{\hat{I}} = \lambda_{\hat{I}} \sum_{Y} \frac{1}{2(\sigma_{I,y}/I_y)} ln\left(\frac{I_y}{\hat{I}_y}\right)^2$	Trawl survey biomass likelihood
$L_{\hat{p}^f_a} = \lambda_{\hat{p}^f_a}\left(\sum_{Y} -n_y^{f,a} \sum_{a=a_r}^{A} (p^f_{y,a} + 0.00001)\, ln(\hat{p}^f_{y,a} + 0.00001)\right)$	Fishery age compostion likelihood
$L_{\hat{p}^f_l} = \lambda_{\hat{p}^f_l}\left(\sum_{Y} -n_y^{f,l} \sum_{L} (p^f_{y,l} + 0.00001)\, ln(\hat{p}^f_{y,l} + 0.00001)\right)$	Fishery length compostion likelihood
$L_{\hat{p}^t_a} = \lambda_{\hat{p}^t_a}\left(\sum_{Y} -n_y^{t,a} \sum_{a=a_r}^{A} (p^t_{y,a} + 0.00001)\, ln(\hat{p}^t_{y,a} + 0.00001)\right)$	Trawl survey age compostion likelihood
$L_m = \sum_{D} \sum_{a=a_r}^{A} -\lambda_{D,a} \ln\left(Binom(n_{a,D}, \widehat{m}_a)\right)$	Maturity likelihood
Negative log likelihoods, prior distributions and penalties	
$L_r = \frac{1}{2\sigma_r^2} \sum_{Y} \left(\tau_y + \sigma_r^2/2\right)^2 + Y \ln \sigma_r$	Recruitment deviations
$L_r = \frac{1}{2\sigma_r^2} \sum_{A} \left(\gamma_y\right)^2 + A \ln \sigma_r$	Recruitment deviations for cohorts in first ye
$L_M = \frac{1}{2\sigma_M^2}\left(\ln\theta - \ln M_{prior} + \sigma_M^2/2\right)^2$	Prior distribution for natural mortality
$L_q = \frac{1}{2\sigma_q^2}\left(\ln\theta - \ln q_{prior} + \sigma_q^2/2\right)^2$	Prior distribution for survey catchability
$L_f = \lambda_f \sum_{Y} \epsilon_y^2$	F deviation penalty

Table 14.23. Estimated parameter values and standard deviations from the age-structure model applied to AI blackspotted/rougheye rockfish.

Parameter	Estimate	Standard Deviation	Parameter	Estimate	Standard Deviation	Parameter	Estimate	Standard Deviation
sel_aslope_fish	0.63	0.07	fmort_dev	0.44	0.14	rec_dev	0.01	0.74
sel_a50_fish	13.71	0.55	fmort_dev	0.25	0.15	mean_log_	0.32	0.15
sel_aslope_ai_srv	0.36	0.05	fmort_dev	-0.01	0.15	log_rinit	0.28	0.12
sel_a50_ai_srv	15.67	1.05	fmort_dev	0.22	0.16	fydev	-0.03	0.71
M	0.05	0.00	fmort_dev	0.09	0.17	fydev	0.04	0.73
log_avg_fmort	-3.72	0.09	rec_dev	-0.09	0.68	fydev	0.11	0.76
fmort_dev	-0.93	0.13	rec_dev	-0.14	0.67	fydev	0.19	0.79
fmort_dev	1.87	0.13	rec_dev	-0.18	0.66	fydev	0.25	0.82
fmort_dev	2.25	0.13	rec_dev	-0.21	0.65	fydev	0.30	0.85
fmort_dev	0.80	0.13	rec_dev	-0.23	0.64	fydev	0.35	0.89
fmort_dev	0.71	0.13	rec_dev	-0.22	0.64	fydev	0.41	0.93
fmort_dev	-0.45	0.13	rec_dev	-0.20	0.64	fydev	0.49	0.98
fmort_dev	-1.65	0.13	rec_dev	-0.19	0.64	fydev	0.51	1.01
fmort_dev	-2.19	0.12	rec_dev	-0.26	0.63	fydev	0.54	1.03
fmort_dev	-3.47	0.12	rec_dev	-0.38	0.60	fydev	0.51	1.01
fmort_dev	-2.75	0.12	rec_dev	-0.54	0.58	fydev	0.43	0.95
fmort_dev	-1.45	0.12	rec_dev	-0.69	0.56	fydev	0.34	0.89
fmort_dev	-1.52	0.12	rec_dev	-0.81	0.54	fydev	0.26	0.85
fmort_dev	0.09	0.12	rec_dev	-0.92	0.53	fydev	0.18	0.81
fmort_dev	1.59	0.11	rec_dev	-1.01	0.52	fydev	0.11	0.78
fmort_dev	-0.83	0.11	rec_dev	-1.05	0.51	fydev	0.06	0.76
fmort_dev	1.35	0.11	rec_dev	-1.05	0.51	fydev	0.00	0.74
fmort_dev	1.17	0.11	rec_dev	-1.00	0.52	fydev	-0.05	0.72
fmort_dev	1.01	0.11	rec_dev	-0.91	0.53	fydev	-0.08	0.71
fmort_dev	0.41	0.11	rec_dev	-0.79	0.54	fydev	-0.12	0.70
fmort_dev	1.17	0.11	rec_dev	-0.65	0.56	fydev	-0.14	0.69
fmort_dev	1.40	0.10	rec_dev	-0.48	0.58	fydev	-0.16	0.69
fmort_dev	0.86	0.10	rec_dev	-0.30	0.61	fydev	-0.18	0.68
fmort_dev	0.59	0.10	rec_dev	-0.02	0.68	fydev	-0.19	0.68
fmort_dev	0.29	0.10	rec_dev	0.46	0.76	fydev	-0.20	0.68
fmort_dev	1.02	0.10	rec_dev	0.56	0.85	fydev	-0.20	0.67
fmort_dev	0.35	0.10	rec_dev	0.50	0.88	fydev	-0.20	0.67
fmort_dev	-0.08	0.10	rec_dev	0.59	0.99	fydev	-0.20	0.67
fmort_dev	0.00	0.11	rec_dev	0.86	0.97	fydev	-0.20	0.67
fmort_dev	-0.86	0.11	rec_dev	0.46	0.91	fydev	-0.20	0.67
fmort_dev	0.08	0.11	rec_dev	0.29	0.80	fydev	-0.20	0.68
fmort_dev	-0.14	0.11	rec_dev	0.34	0.81	fydev	-0.20	0.68
fmort_dev	-0.05	0.11	rec_dev	0.51	0.86	fydev	-0.20	0.68
fmort_dev	0.01	0.11	rec_dev	0.57	0.92	fydev	-0.20	0.68
fmort_dev	0.09	0.11	rec_dev	0.63	0.96	fydev	-0.19	0.68
fmort_dev	-0.37	0.11	rec_dev	0.49	0.94	fydev	-0.19	0.68
fmort_dev	-0.08	0.11	rec_dev	0.33	0.90	fydev	-0.18	0.68
fmort_dev	0.39	0.11	rec_dev	3.01	0.39	fydev	-0.18	0.68
fmort_dev	-0.20	0.12	rec_dev	0.23	0.84	fydev	-0.17	0.68
fmort_dev	-0.38	0.12	rec_dev	0.42	0.90	fydev	-1.25	0.49
fmort_dev	-0.72	0.12	rec_dev	0.65	1.03	q_ai_srv	1.04	0.05
fmort_dev	-0.32	0.12	rec_dev	0.77	1.05	mat_beta1	-6.47	5.49
fmort_dev	-0.18	0.13	rec_dev	0.49	0.91	mat_beta2	0.26	0.23
fmort_dev	0.16	0.13	rec_dev	0.16	0.78			

Table 14.24. Negative log likelihoods, effective sample sizes, and root mean squared errors, for the evaluated models for BSAI blackspotted/rougheye rockfish.

	20 (2024)
Negative log-likelihood	
Data components	
AI survey biomass	13.29
Catch biomass	0.00
Fishery ages	36.05
Fishery lengths	95.79
AI survey ages	51.92
AI survey lengths	4.34
Maturity	1.39
Priors and penalties	
Recruitment	-0.53
Prior on survey q	0.40
Prior on M	2.31
Total negative log-likelihood	210.80
Parameters	146
Effective sample size	
Fishery ages	49
Fishery lengths	203
AI survey ages	79
AI survey lengths	76
Root mean square error	
AI survey biomass	0.345
Recruitment	0.792
Fishery ages	0.021
Fishery lengths	0.016
AI survey ages	0.016
AI survey lengths	0.016

Table 14.25. Estimated time series of AI blackspotted/rougheye total biomass (t), spawner biomass (t), and recruitment (thousands), and their CVs (from the Hessian approximation).

	Total Biomass (ages 3+)				Spawner Biomass (ages 3+)				Recruitment (age 3)			
	Assessment Year				Assessment Year				Assessment Year			
	2024		2022		2024		2022		2024		2022	
Year or Year Class	Est	CV	Est	CV	Est	CV	Est	CV	Est	CV	Est	CV
1977	20,945	0.070	20,807	0.068	4,965	0.326	4,974	0.334	1,118	0.655	1,158	0.656
1978	21,202	0.067	21,060	0.065	4,936	0.326	4,968	0.334	1,100	0.649	1,144	0.651
1979	19,118	0.071	18,971	0.070	4,303	0.334	4,360	0.339	1,112	0.647	1,164	0.650
1980	16,361	0.080	16,206	0.078	3,645	0.346	3,716	0.347	1,136	0.645	1,210	0.652
1981	16,070	0.079	15,902	0.077	3,573	0.351	3,653	0.350	1,137	0.639	1,227	0.649
1982	15,833	0.078	15,652	0.077	3,540	0.357	3,626	0.352	1,069	0.625	1,178	0.637
1983	15,996	0.075	15,805	0.074	3,616	0.360	3,708	0.353	941	0.605	1,040	0.617
1984	16,278	0.072	16,079	0.072	3,732	0.363	3,827	0.354	805	0.584	896	0.596
1985	16,563	0.069	16,359	0.069	3,861	0.365	3,958	0.353	696	0.564	773	0.575
1986	16,846	0.067	16,642	0.066	4,002	0.365	4,099	0.352	612	0.548	677	0.557
1987	17,093	0.064	16,890	0.064	4,146	0.364	4,240	0.349	548	0.536	604	0.545
1988	17,248	0.062	17,051	0.062	4,278	0.362	4,368	0.346	503	0.529	554	0.538
1989	17,375	0.060	17,185	0.060	4,398	0.358	4,482	0.342	481	0.526	533	0.536
1990	17,159	0.060	16,979	0.060	4,370	0.354	4,444	0.337	485	0.528	539	0.539
1991	15,665	0.063	15,495	0.064	4,094	0.349	4,154	0.333	510	0.534	576	0.547
1992	15,654	0.062	15,497	0.063	4,129	0.342	4,181	0.327	558	0.543	645	0.561
1993	14,563	0.066	14,419	0.067	3,893	0.336	3,932	0.321	626	0.556	749	0.580
1994	13,720	0.069	13,592	0.070	3,718	0.329	3,748	0.315	720	0.572	902	0.604
1995	13,046	0.071	12,935	0.073	3,595	0.322	3,618	0.308	851	0.593	1,124	0.636
1996	12,726	0.073	12,634	0.075	3,534	0.314	3,551	0.302	1,018	0.626	1,369	0.679
1997	11,975	0.076	11,907	0.079	3,340	0.307	3,351	0.296	1,348	0.690	1,739	0.757
1998	11,092	0.082	11,054	0.085	3,121	0.302	3,128	0.292	2,177	0.769	2,571	0.814
1999	10,663	0.086	10,663	0.089	3,019	0.296	3,024	0.288	2,425	0.860	2,362	0.879
2000	10,409	0.089	10,452	0.093	2,955	0.291	2,959	0.284	2,268	0.891	2,335	0.882
2001	10,330	0.091	10,419	0.096	2,899	0.287	2,903	0.281	2,487	1.003	2,385	0.961
2002	10,029	0.096	10,141	0.102	2,777	0.284	2,782	0.279	3,273	0.975	3,435	0.974
2003	10,057	0.100	10,194	0.106	2,736	0.281	2,742	0.277	2,198	0.926	2,360	0.951
2004	10,250	0.102	10,397	0.109	2,720	0.278	2,728	0.276	1,840	0.823	1,937	0.839
2005	10,533	0.105	10,692	0.113	2,704	0.275	2,715	0.274	1,948	0.830	2,047	0.847
2006	10,935	0.107	11,105	0.115	2,711	0.272	2,726	0.272	2,297	0.874	2,432	0.883
2007	11,239	0.111	11,417	0.120	2,683	0.270	2,703	0.271	2,435	0.935	2,330	0.898
2008	11,629	0.115	11,809	0.124	2,666	0.268	2,692	0.271	2,584	0.978	2,040	0.888
2009	12,060	0.119	12,239	0.128	2,645	0.267	2,677	0.272	2,257	0.962	1,773	0.863
2010	12,524	0.123	12,686	0.133	2,621	0.269	2,662	0.275	1,924	0.929	21,247	0.584
2011	13,017	0.127	13,127	0.137	2,601	0.274	2,650	0.282	27,926	0.424	1,994	0.930
2012	13,600	0.131	13,645	0.141	2,603	0.283	2,661	0.292	1,730	0.869	2,277	0.944
2013	14,135	0.135	15,189	0.156	2,595	0.298	2,665	0.307	2,093	0.922	2,244	0.915
2014	16,143	0.153	15,982	0.166	2,577	0.320	2,656	0.328	2,655	1.049	2,199	0.899
2015	17,330	0.161	16,968	0.175	2,603	0.345	2,692	0.352	2,981	1.073	1,992	0.862
2016	18,611	0.169	17,998	0.183	2,652	0.374	2,751	0.379	2,266	0.934	1,725	0.813
2017	20,009	0.176	19,112	0.190	2,726	0.405	2,834	0.407	1,625	0.813		
2018	21,416	0.184	20,132	0.198	2,806	0.438	2,922	0.435	1,397	0.772		
2019	22,733	0.190	21,089	0.206	2,896	0.470	3,019	0.461				
2020	23,909	0.198	21,908	0.214	2,984	0.501	3,111	0.486				
2021	24,868	0.205	22,547	0.222	3,075	0.529	3,203	0.509				
2022	25,881	0.211	23,221	0.229	3,208	0.553	3,335	0.527				
2023	26,881	0.216	23,883		3,378	0.572	3,472					
2024	27,665	0.221			3,554	0.588						
2025	28,314				3,729							
Mean recruitment of post-1976 year classes									2,147		2,037	

Table 14.26. Estimated numbers at age for BSAI blackspotted/rougheye rockfish (millions).

	Age																			
Year	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
1977	1.26	1.22	1.24	1.28	1.30	1.33	1.32	1.32	1.34	1.37	1.34	1.30	1.20	1.07	0.92	0.81	0.71	0.63	0.57	0.51
1978	1.20	1.20	1.16	1.18	1.21	1.24	1.26	1.25	1.26	1.27	1.30	1.27	1.23	1.14	1.01	0.87	0.77	0.67	0.60	0.53
1979	1.16	1.14	1.14	1.10	1.12	1.15	1.17	1.19	1.18	1.17	1.16	1.16	1.11	1.05	0.95	0.83	0.72	0.63	0.55	0.49
1980	1.12	1.10	1.09	1.08	1.05	1.07	1.09	1.10	1.11	1.08	1.05	1.01	0.98	0.90	0.83	0.74	0.64	0.55	0.48	0.42
1981	1.10	1.06	1.05	1.03	1.03	1.00	1.01	1.03	1.05	1.05	1.01	0.98	0.93	0.89	0.82	0.75	0.67	0.58	0.49	0.43
1982	1.11	1.05	1.01	0.99	0.98	0.98	0.95	0.96	0.98	0.99	0.98	0.95	0.90	0.86	0.82	0.74	0.68	0.61	0.52	0.45
1983	1.14	1.06	1.00	0.96	0.95	0.93	0.93	0.90	0.91	0.93	0.94	0.93	0.89	0.85	0.81	0.77	0.70	0.64	0.57	0.49
1984	1.14	1.08	1.01	0.95	0.91	0.90	0.89	0.89	0.86	0.87	0.88	0.89	0.88	0.85	0.81	0.76	0.73	0.66	0.61	0.54
1985	1.07	1.08	1.03	0.96	0.90	0.87	0.86	0.85	0.84	0.81	0.82	0.84	0.84	0.84	0.80	0.77	0.73	0.69	0.63	0.58
1986	0.94	1.02	1.03	0.98	0.91	0.86	0.83	0.81	0.80	0.80	0.77	0.78	0.80	0.80	0.80	0.76	0.73	0.69	0.65	0.60
1987	0.81	0.89	0.97	0.98	0.93	0.87	0.81	0.79	0.77	0.76	0.76	0.74	0.75	0.76	0.76	0.76	0.72	0.69	0.66	0.62
1988	0.70	0.77	0.85	0.92	0.93	0.88	0.82	0.77	0.75	0.74	0.73	0.72	0.70	0.71	0.72	0.72	0.72	0.69	0.65	0.62
1989	0.61	0.66	0.73	0.81	0.88	0.89	0.84	0.78	0.74	0.71	0.70	0.69	0.69	0.66	0.67	0.68	0.68	0.68	0.65	0.62
1990	0.55	0.58	0.63	0.69	0.77	0.83	0.84	0.80	0.74	0.70	0.67	0.66	0.65	0.64	0.62	0.62	0.63	0.63	0.63	0.60
1991	0.50	0.52	0.55	0.60	0.66	0.73	0.79	0.80	0.75	0.69	0.64	0.61	0.59	0.57	0.55	0.53	0.53	0.53	0.54	0.53
1992	0.48	0.48	0.50	0.53	0.57	0.63	0.70	0.75	0.76	0.71	0.66	0.61	0.58	0.55	0.53	0.52	0.50	0.50	0.50	0.50
1993	0.49	0.46	0.46	0.47	0.50	0.54	0.59	0.66	0.71	0.71	0.66	0.60	0.55	0.51	0.49	0.47	0.45	0.43	0.43	0.44
1994	0.51	0.46	0.44	0.43	0.45	0.48	0.51	0.56	0.62	0.67	0.66	0.61	0.55	0.50	0.46	0.43	0.41	0.40	0.38	0.38
1995	0.56	0.48	0.44	0.41	0.41	0.43	0.45	0.49	0.53	0.59	0.62	0.61	0.56	0.50	0.45	0.41	0.39	0.37	0.36	0.34
1996	0.63	0.53	0.46	0.42	0.39	0.39	0.40	0.43	0.46	0.50	0.55	0.58	0.57	0.52	0.46	0.41	0.38	0.36	0.34	0.33
1997	0.72	0.59	0.50	0.44	0.40	0.37	0.37	0.38	0.41	0.43	0.47	0.51	0.53	0.51	0.46	0.41	0.36	0.33	0.31	0.30
1998	0.85	0.69	0.57	0.48	0.42	0.38	0.35	0.35	0.36	0.38	0.40	0.43	0.46	0.47	0.45	0.41	0.36	0.32	0.29	0.27
1999	1.02	0.81	0.65	0.54	0.46	0.40	0.36	0.34	0.33	0.34	0.36	0.37	0.40	0.42	0.43	0.41	0.37	0.32	0.28	0.26
2000	1.35	0.97	0.77	0.62	0.51	0.43	0.38	0.34	0.32	0.31	0.32	0.33	0.35	0.37	0.39	0.39	0.37	0.33	0.29	0.26
2001	2.18	1.28	0.92	0.73	0.59	0.49	0.41	0.36	0.32	0.30	0.30	0.30	0.31	0.32	0.34	0.36	0.36	0.34	0.31	0.27
2002	2.43	2.07	1.22	0.88	0.70	0.56	0.46	0.39	0.34	0.30	0.28	0.27	0.28	0.28	0.29	0.30	0.32	0.32	0.31	0.27
2003	2.27	2.31	1.97	1.16	0.83	0.66	0.53	0.44	0.37	0.32	0.29	0.26	0.26	0.26	0.26	0.27	0.28	0.29	0.30	0.28
2004	2.49	2.16	2.19	1.87	1.10	0.79	0.63	0.51	0.42	0.35	0.30	0.27	0.25	0.24	0.24	0.24	0.25	0.26	0.27	0.28
2005	3.27	2.37	2.05	2.09	1.78	1.05	0.75	0.60	0.48	0.39	0.33	0.28	0.25	0.23	0.22	0.22	0.23	0.23	0.24	0.25
2006	2.20	3.11	2.25	1.95	1.98	1.69	1.00	0.72	0.57	0.46	0.37	0.31	0.27	0.24	0.22	0.21	0.21	0.21	0.22	0.23
2007	1.84	2.09	2.96	2.14	1.86	1.89	1.61	0.95	0.68	0.54	0.43	0.35	0.29	0.25	0.22	0.20	0.20	0.19	0.20	0.20
2008	1.95	1.75	1.99	2.82	2.04	1.76	1.79	1.53	0.90	0.64	0.51	0.41	0.33	0.28	0.24	0.21	0.19	0.18	0.18	0.18
2009	2.30	1.85	1.66	1.89	2.68	1.94	1.68	1.70	1.45	0.85	0.61	0.48	0.38	0.31	0.26	0.22	0.19	0.18	0.17	0.17
2010	2.43	2.19	1.76	1.58	1.80	2.55	1.84	1.59	1.62	1.38	0.81	0.57	0.45	0.36	0.29	0.24	0.20	0.18	0.16	0.16
2011	2.58	2.32	2.08	1.68	1.51	1.71	2.42	1.75	1.51	1.53	1.30	0.76	0.54	0.42	0.33	0.27	0.22	0.19	0.17	0.15
2012	2.26	2.46	2.20	1.98	1.59	1.43	1.63	2.30	1.66	1.43	1.45	1.23	0.71	0.51	0.39	0.31	0.25	0.21	0.18	0.16
2013	1.92	2.15	2.34	2.09	1.88	1.52	1.36	1.54	2.18	1.57	1.36	1.37	1.15	0.67	0.47	0.37	0.29	0.23	0.19	0.16
2014	27.93	1.83	2.04	2.22	1.99	1.79	1.44	1.29	1.46	2.07	1.48	1.27	1.28	1.07	0.62	0.44	0.34	0.27	0.22	0.18
2015	1.73	26.56	1.74	1.94	2.11	1.89	1.70	1.37	1.23	1.39	1.96	1.40	1.20	1.20	1.00	0.58	0.41	0.32	0.25	0.20
2016	2.09	1.65	25.26	1.66	1.85	2.01	1.80	1.61	1.30	1.16	1.32	1.85	1.32	1.13	1.12	0.94	0.54	0.38	0.30	0.23
2017	2.66	1.99	1.57	24.03	1.57	1.76	1.91	1.71	1.53	1.23	1.10	1.25	1.75	1.24	1.06	1.06	0.88	0.51	0.36	0.28
2018	2.98	2.53	1.89	1.49	22.85	1.50	1.67	1.82	1.63	1.46	1.17	1.04	1.17	1.64	1.17	0.99	0.99	0.83	0.48	0.33
2019	2.27	2.83	2.40	1.80	1.42	21.73	1.42	1.59	1.73	1.54	1.38	1.10	0.98	1.10	1.54	1.09	0.93	0.92	0.77	0.44
2020	1.62	2.15	2.70	2.28	1.71	1.35	20.66	1.35	1.51	1.63	1.46	1.30	1.03	0.91	1.02	1.42	1.01	0.86	0.85	0.71
2021	1.40	1.55	2.05	2.56	2.17	1.63	1.28	19.61	1.28	1.42	1.54	1.36	1.21	0.96	0.84	0.94	1.31	0.93	0.79	0.78
2022	1.83	1.33	1.47	1.95	2.44	2.07	1.55	1.21	18.60	1.21	1.34	1.45	1.28	1.12	0.89	0.78	0.87	1.21	0.85	0.73
2023	1.83	1.74	1.26	1.40	1.85	2.32	1.96	1.47	1.15	17.63	1.15	1.27	1.36	1.19	1.05	0.83	0.73	0.81	1.12	0.79
2024	1.83	1.74	1.66	1.20	1.33	1.76	2.20	1.86	1.39	1.09	16.64	1.08	1.18	1.26	1.11	0.97	0.76	0.67	0.75	1.03

Table 14.26 (continued). Estimated numbers at age for BSAI blackspotted/rougheye rockfish (millions).

	Age																						
Year	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45+
1977	0.46	0.43	0.39	0.36	0.34	0.32	0.30	0.28	0.27	0.25	0.24	0.23	0.22	0.21	0.20	0.19	0.18	0.17	0.16	0.16	0.15	0.14	0.95
1978	0.48	0.44	0.40	0.37	0.34	0.32	0.30	0.28	0.27	0.25	0.24	0.23	0.22	0.21	0.20	0.19	0.18	0.17	0.16	0.15	0.15	0.14	1.03
1979	0.44	0.39	0.36	0.33	0.30	0.28	0.26	0.24	0.23	0.22	0.20	0.19	0.18	0.18	0.17	0.16	0.15	0.14	0.14	0.13	0.13	0.12	0.95
1980	0.37	0.33	0.30	0.27	0.25	0.23	0.21	0.20	0.18	0.17	0.16	0.15	0.15	0.14	0.13	0.13	0.12	0.11	0.11	0.10	0.10	0.09	0.81
1981	0.37	0.33	0.30	0.27	0.24	0.22	0.20	0.19	0.18	0.17	0.16	0.15	0.14	0.13	0.13	0.12	0.11	0.11	0.10	0.10	0.09	0.09	0.82
1982	0.39	0.34	0.30	0.27	0.24	0.22	0.20	0.19	0.17	0.16	0.15	0.14	0.13	0.13	0.12	0.11	0.11	0.10	0.10	0.09	0.09	0.08	0.82
1983	0.42	0.36	0.32	0.28	0.25	0.23	0.21	0.19	0.17	0.16	0.15	0.14	0.13	0.12	0.12	0.11	0.11	0.10	0.10	0.09	0.09	0.08	0.85
1984	0.46	0.40	0.34	0.30	0.27	0.24	0.21	0.19	0.18	0.16	0.15	0.14	0.13	0.12	0.12	0.11	0.11	0.10	0.10	0.09	0.09	0.08	0.88
1985	0.51	0.44	0.37	0.33	0.29	0.25	0.23	0.20	0.18	0.17	0.16	0.14	0.13	0.13	0.12	0.11	0.11	0.10	0.10	0.09	0.09	0.08	0.91
1986	0.55	0.48	0.42	0.36	0.31	0.27	0.24	0.21	0.19	0.18	0.16	0.15	0.14	0.13	0.12	0.11	0.11	0.10	0.10	0.09	0.09	0.08	0.95
1987	0.57	0.52	0.46	0.40	0.34	0.29	0.26	0.23	0.20	0.18	0.17	0.15	0.14	0.13	0.12	0.11	0.11	0.10	0.10	0.09	0.09	0.08	0.98
1988	0.59	0.54	0.49	0.43	0.38	0.32	0.28	0.24	0.22	0.19	0.17	0.16	0.14	0.13	0.12	0.12	0.11	0.10	0.10	0.09	0.09	0.08	1.00
1989	0.59	0.56	0.51	0.46	0.41	0.35	0.30	0.26	0.23	0.20	0.18	0.16	0.15	0.14	0.13	0.12	0.11	0.10	0.10	0.09	0.09	0.08	1.03
1990	0.57	0.54	0.52	0.47	0.43	0.38	0.33	0.28	0.24	0.21	0.19	0.17	0.15	0.14	0.13	0.12	0.11	0.10	0.09	0.09	0.08	0.08	1.03
1991	0.51	0.48	0.46	0.44	0.40	0.36	0.32	0.28	0.24	0.21	0.18	0.16	0.14	0.13	0.12	0.11	0.10	0.09	0.09	0.08	0.07	0.07	0.93
1992	0.50	0.48	0.46	0.43	0.41	0.37	0.34	0.30	0.26	0.22	0.19	0.17	0.15	0.13	0.12	0.11	0.10	0.09	0.09	0.08	0.08	0.07	0.94
1993	0.44	0.43	0.41	0.39	0.37	0.35	0.32	0.30	0.26	0.23	0.19	0.17	0.15	0.13	0.12	0.10	0.10	0.09	0.08	0.07	0.07	0.06	0.88
1994	0.38	0.38	0.38	0.36	0.35	0.33	0.31	0.28	0.26	0.23	0.20	0.17	0.15	0.13	0.11	0.10	0.09	0.08	0.08	0.07	0.07	0.06	0.83
1995	0.34	0.34	0.34	0.34	0.32	0.31	0.29	0.28	0.25	0.23	0.21	0.18	0.15	0.13	0.12	0.10	0.09	0.08	0.07	0.07	0.06	0.06	0.79
1996	0.31	0.31	0.31	0.31	0.31	0.30	0.28	0.27	0.25	0.23	0.21	0.19	0.16	0.14	0.12	0.11	0.09	0.08	0.08	0.07	0.06	0.06	0.78
1997	0.29	0.27	0.27	0.28	0.28	0.27	0.26	0.25	0.24	0.22	0.20	0.19	0.17	0.14	0.12	0.11	0.09	0.08	0.07	0.07	0.06	0.06	0.74
1998	0.26	0.25	0.24	0.24	0.24	0.24	0.24	0.23	0.21	0.20	0.19	0.18	0.16	0.14	0.12	0.11	0.09	0.08	0.07	0.06	0.06	0.05	0.68
1999	0.24	0.23	0.22	0.21	0.21	0.21	0.21	0.21	0.20	0.19	0.18	0.17	0.16	0.14	0.13	0.11	0.09	0.08	0.07	0.06	0.06	0.05	0.66
2000	0.24	0.22	0.21	0.20	0.19	0.19	0.19	0.19	0.19	0.18	0.18	0.17	0.16	0.14	0.13	0.12	0.10	0.09	0.07	0.07	0.06	0.05	0.65
2001	0.24	0.22	0.20	0.19	0.19	0.18	0.18	0.18	0.18	0.18	0.17	0.16	0.15	0.15	0.13	0.12	0.11	0.09	0.08	0.07	0.06	0.05	0.64
2002	0.24	0.21	0.19	0.18	0.17	0.17	0.16	0.16	0.16	0.16	0.16	0.15	0.14	0.14	0.13	0.12	0.11	0.10	0.08	0.07	0.06	0.05	0.62
2003	0.25	0.22	0.19	0.18	0.17	0.16	0.15	0.14	0.14	0.15	0.15	0.14	0.14	0.13	0.13	0.12	0.11	0.10	0.09	0.08	0.06	0.06	0.62
2004	0.26	0.23	0.20	0.18	0.17	0.15	0.15	0.14	0.13	0.13	0.14	0.14	0.13	0.13	0.12	0.12	0.11	0.10	0.09	0.08	0.07	0.06	0.63
2005	0.26	0.24	0.22	0.19	0.17	0.15	0.14	0.14	0.13	0.13	0.13	0.13	0.13	0.13	0.12	0.11	0.11	0.10	0.09	0.09	0.08	0.07	0.64
2006	0.24	0.24	0.23	0.20	0.18	0.16	0.14	0.14	0.13	0.12	0.12	0.12	0.12	0.12	0.12	0.11	0.11	0.10	0.10	0.09	0.08	0.07	0.66
2007	0.21	0.22	0.22	0.21	0.19	0.17	0.15	0.13	0.13	0.12	0.12	0.11	0.11	0.11	0.11	0.11	0.10	0.10	0.09	0.09	0.08	0.07	0.68
2008	0.19	0.20	0.21	0.21	0.20	0.18	0.15	0.14	0.12	0.12	0.11	0.11	0.10	0.10	0.10	0.10	0.10	0.10	0.09	0.09	0.08	0.08	0.70
2009	0.17	0.18	0.18	0.19	0.19	0.18	0.16	0.14	0.13	0.12	0.11	0.10	0.10	0.09	0.09	0.10	0.10	0.09	0.09	0.09	0.08	0.08	0.72
2010	0.16	0.16	0.16	0.17	0.18	0.18	0.17	0.15	0.13	0.12	0.11	0.10	0.10	0.09	0.09	0.09	0.09	0.09	0.09	0.08	0.08	0.08	0.74
2011	0.15	0.14	0.15	0.15	0.16	0.16	0.17	0.16	0.14	0.12	0.11	0.10	0.09	0.09	0.09	0.08	0.08	0.08	0.08	0.08	0.08	0.07	0.76
2012	0.14	0.14	0.14	0.14	0.14	0.15	0.15	0.16	0.15	0.13	0.12	0.10	0.09	0.09	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.07	0.78
2013	0.14	0.13	0.13	0.13	0.13	0.13	0.14	0.14	0.14	0.14	0.12	0.11	0.09	0.09	0.08	0.08	0.07	0.07	0.07	0.07	0.07	0.07	0.79
2014	0.15	0.13	0.12	0.12	0.12	0.12	0.12	0.13	0.13	0.13	0.13	0.11	0.10	0.09	0.08	0.07	0.07	0.07	0.06	0.06	0.07	0.07	0.79
2015	0.17	0.14	0.12	0.11	0.11	0.11	0.11	0.11	0.12	0.12	0.12	0.12	0.10	0.09	0.08	0.07	0.07	0.07	0.06	0.06	0.06	0.06	0.80
2016	0.19	0.16	0.13	0.12	0.11	0.10	0.10	0.10	0.11	0.11	0.11	0.12	0.11	0.10	0.09	0.08	0.07	0.06	0.06	0.06	0.06	0.06	0.81
2017	0.22	0.18	0.15	0.12	0.11	0.10	0.10	0.09	0.10	0.10	0.10	0.11	0.11	0.10	0.09	0.08	0.07	0.07	0.06	0.06	0.06	0.05	0.81
2018	0.26	0.20	0.16	0.14	0.12	0.10	0.09	0.09	0.09	0.09	0.09	0.10	0.10	0.10	0.10	0.09	0.08	0.07	0.06	0.06	0.05	0.05	0.81
2019	0.31	0.24	0.19	0.15	0.13	0.11	0.09	0.09	0.08	0.08	0.08	0.09	0.09	0.09	0.09	0.09	0.08	0.07	0.06	0.06	0.05	0.05	0.80
2020	0.41	0.29	0.22	0.18	0.14	0.12	0.10	0.09	0.08	0.08	0.08	0.08	0.08	0.08	0.09	0.09	0.08	0.07	0.06	0.06	0.05	0.05	0.79
2021	0.65	0.38	0.26	0.21	0.16	0.13	0.11	0.09	0.08	0.07	0.07	0.07	0.07	0.07	0.08	0.08	0.08	0.08	0.07	0.06	0.05	0.05	0.77
2022	0.72	0.60	0.35	0.24	0.19	0.15	0.12	0.10	0.08	0.07	0.07	0.07	0.06	0.07	0.07	0.07	0.07	0.07	0.07	0.06	0.05	0.05	0.75
2023	0.67	0.67	0.56	0.32	0.23	0.18	0.14	0.11	0.09	0.08	0.07	0.06	0.06	0.06	0.06	0.06	0.06	0.07	0.07	0.07	0.06	0.05	0.74
2024	0.73	0.62	0.62	0.52	0.30	0.21	0.16	0.13	0.10	0.09	0.07	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.05	0.73

Table 14.27. Key parameter estimates and management quantities for the evaluated models for the AI portion of BSAI blackspotted/rougheye.

	20 (2024)
Key parameters and management quantities	
AI Survey catchability	1.04
CV	0.05
Natural mortality	0.05
CV	0.05
2024 total biomass (t)	27,665
CV	0.22
2024 Spawning stock biomass (t)	3,554
CV	0.59
2011 year class (millions)	27.93
CV	0.42

Table 14.28. Projections of blackspotted/rougheye rockfish SSB (t), catch (t), and fishing mortality rate for each of the several scenarios. The values of $B_{40\%}$ and $B_{35\%}$ are 3,525 t and 3,085 t, respectively.

Catch	*Scenario 1*	*Scenario 2*	*Scenario 3*	*Scenario 4*	*Scenario 5*	*Scenario 6*	*Scenario 7*
2024	453	453	453	453	453	453	453
2025	652	652	571	181	0	766	652
2026	709	709	623	201	0	830	709
2027	756	756	666	219	0	879	888
2028	789	789	698	233	0	913	921
2029	809	809	719	244	0	932	940
2030	819	819	730	253	0	939	947
2031	822	822	735	259	0	937	945
2032	819	819	736	263	0	929	937
2033	812	812	732	267	0	917	924
2034	803	803	726	269	0	902	909
2035	791	791	718	270	0	884	891
2036	778	778	708	271	0	865	871
2037	763	763	696	271	0	845	851
Sp. Biomass	*Scenario 1*	*Scenario 2*	*Scenario 3*	*Scenario 4*	*Scenario 5*	*Scenario 6*	*Scenario 7*
2024	3,523	3,523	3,523	3,523	3,523	3,523	3,523
2025	3,727	3,727	3,729	3,742	3,747	3,723	3,727
2026	3,927	3,927	3,946	4,037	4,079	3,901	3,927
2027	4,144	4,144	4,180	4,360	4,445	4,092	4,140
2028	4,376	4,376	4,433	4,713	4,847	4,297	4,346
2029	4,624	4,624	4,702	5,096	5,288	4,515	4,565
2030	4,884	4,884	4,987	5,509	5,766	4,743	4,794
2031	5,156	5,156	5,285	5,949	6,282	4,978	5,031
2032	5,433	5,433	5,592	6,414	6,832	5,217	5,271
2033	5,711	5,711	5,901	6,896	7,409	5,454	5,509
2034	5,980	5,980	6,203	7,385	8,002	5,680	5,735
2035	6,231	6,231	6,488	7,867	8,598	5,885	5,942
2036	6,454	6,454	6,746	8,332	9,183	6,064	6,120
2037	6,639	6,639	6,966	8,760	9,737	6,205	6,261
F	*Scenario 1*	*Scenario 2*	*Scenario 3*	*Scenario 4*	*Scenario 5*	*Scenario 6*	*Scenario 7*
2024	0.027	0.027	0.027	0.027	0.027	0.027	0.027
2025	0.035	0.035	0.030	0.010	0	0.041	0.035
2026	0.035	0.035	0.030	0.010	0	0.041	0.035
2027	0.035	0.035	0.030	0.010	0	0.041	0.041
2028	0.035	0.035	0.030	0.010	0	0.041	0.041
2029	0.035	0.035	0.030	0.010	0	0.041	0.041
2030	0.035	0.035	0.030	0.010	0	0.041	0.041
2031	0.035	0.035	0.030	0.010	0	0.041	0.041
2032	0.035	0.035	0.030	0.010	0	0.041	0.041
2033	0.035	0.035	0.030	0.010	0	0.041	0.041
2034	0.035	0.035	0.030	0.010	0	0.041	0.041
2035	0.035	0.035	0.030	0.010	0	0.041	0.041
2036	0.035	0.035	0.030	0.010	0	0.041	0.041
2037	0.035	0.035	0.030	0.010	0	0.041	0.041

Figures

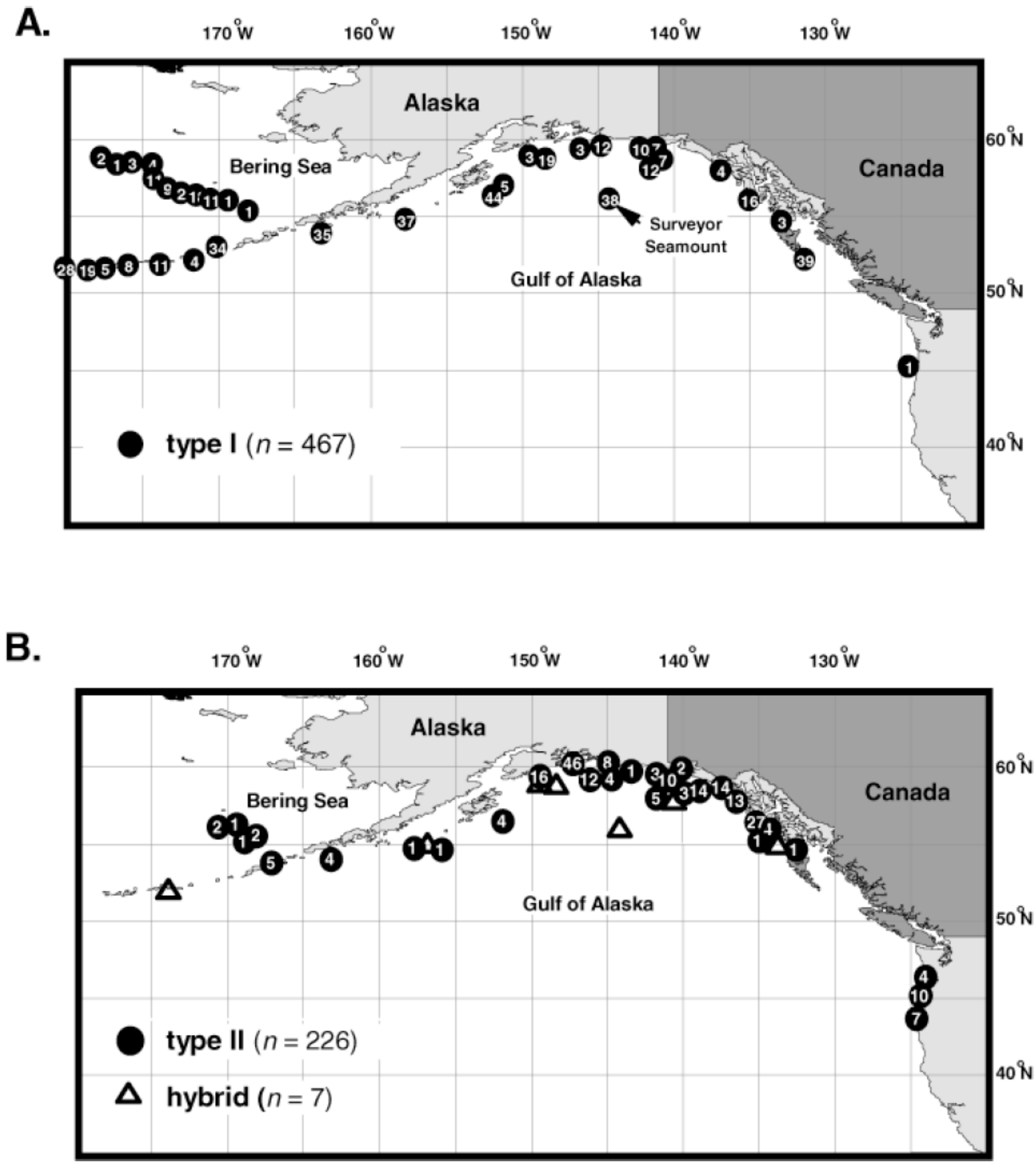

Figure 14.1. Distribution type I (i.e., blackspotted rockfish, *S. melanostictus*) and type II (i.e., rougheye rockfish, *S. aleutianus*) fish previously thought to be a single species of rougheye rockfish, based mtDNA and microsatellite genetic analyses. From Gharrett et al. (2005).

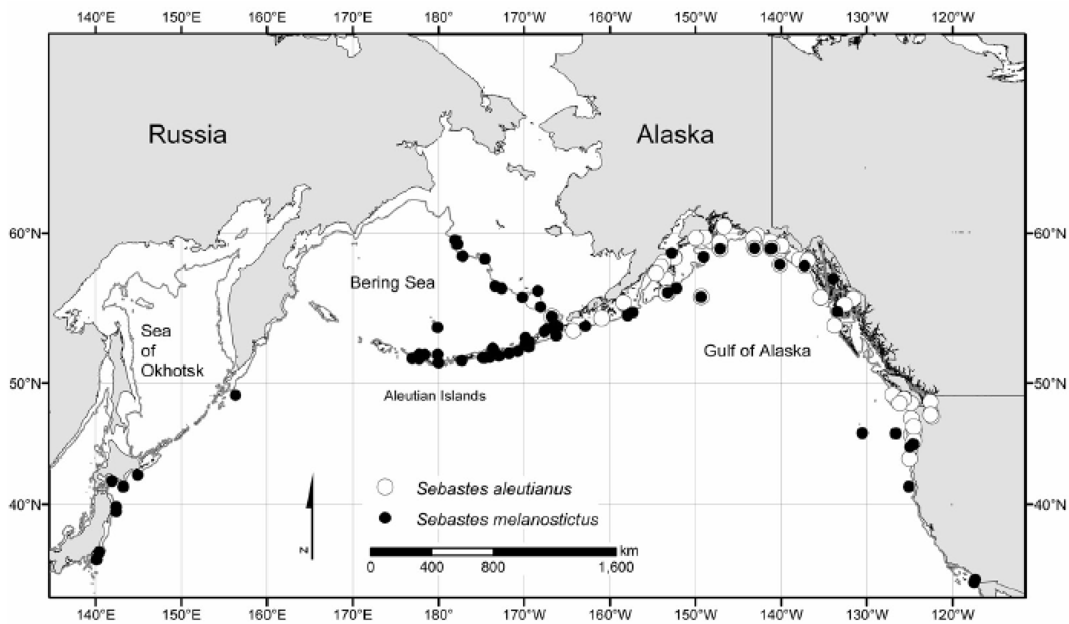

Figure 14.2. Distribution blackspotted rockfish (*S. melanostictus*) and rougheye rockfish (*S. aleutianus*) based upon genetic, morphometric, and meristic analyses. From Orr and Hawkins (2008).

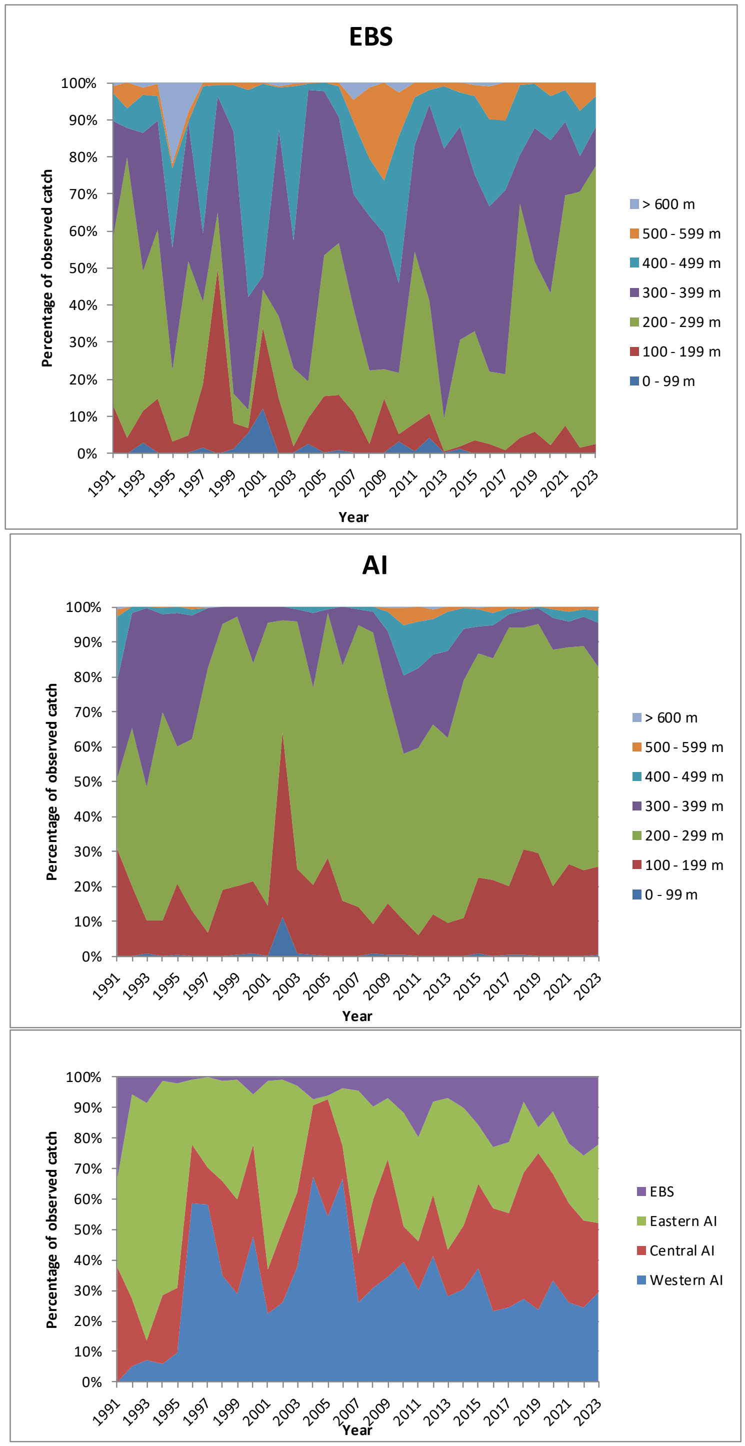

Figure 14.3. Distribution of observed BSAI blackspotted/rougheye rockfish catch (from North Pacific Groundfish Observer Program) by depth zone for the AI (top panel) and EBS (middle panel), and by BSAI subarea (bottom panel) from 1991 to 2023.

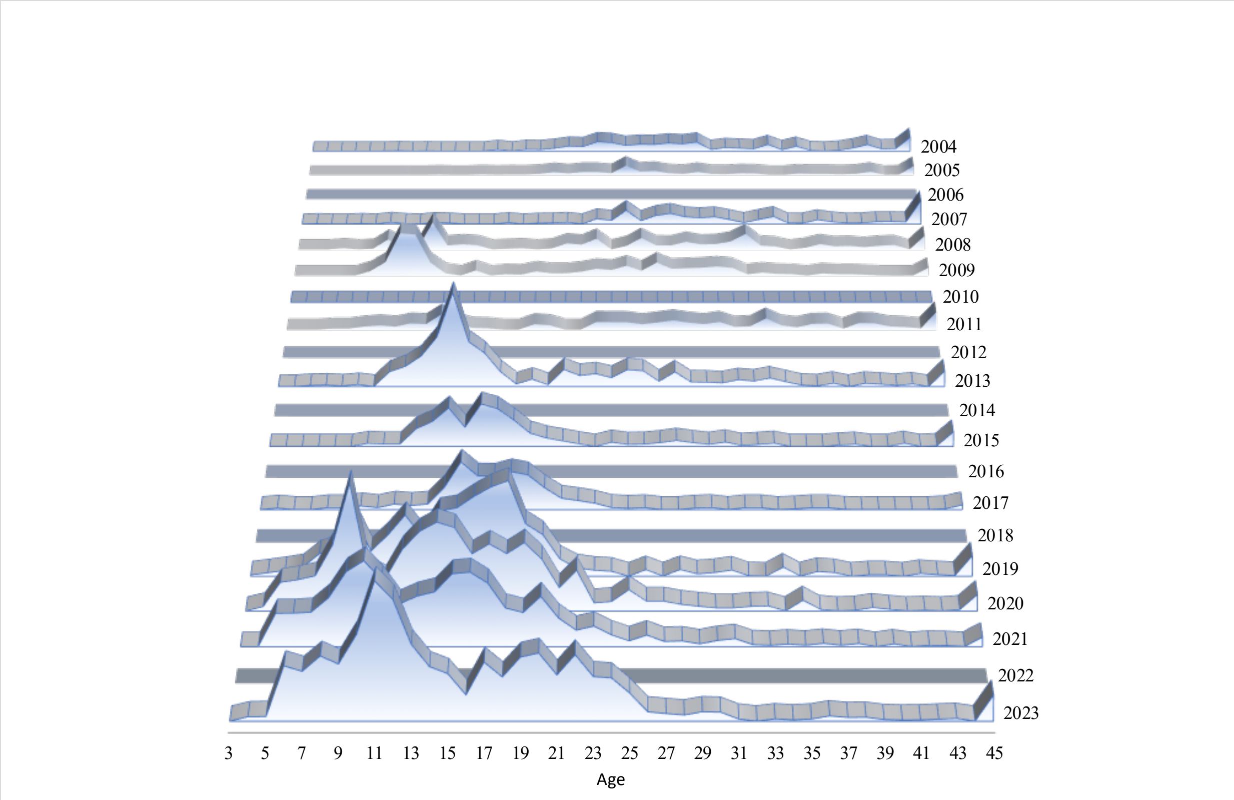

Figure 14.4. Fishery age composition data for the BSAI, scaled to the extrapolated number of fish caught from Observer sampling.

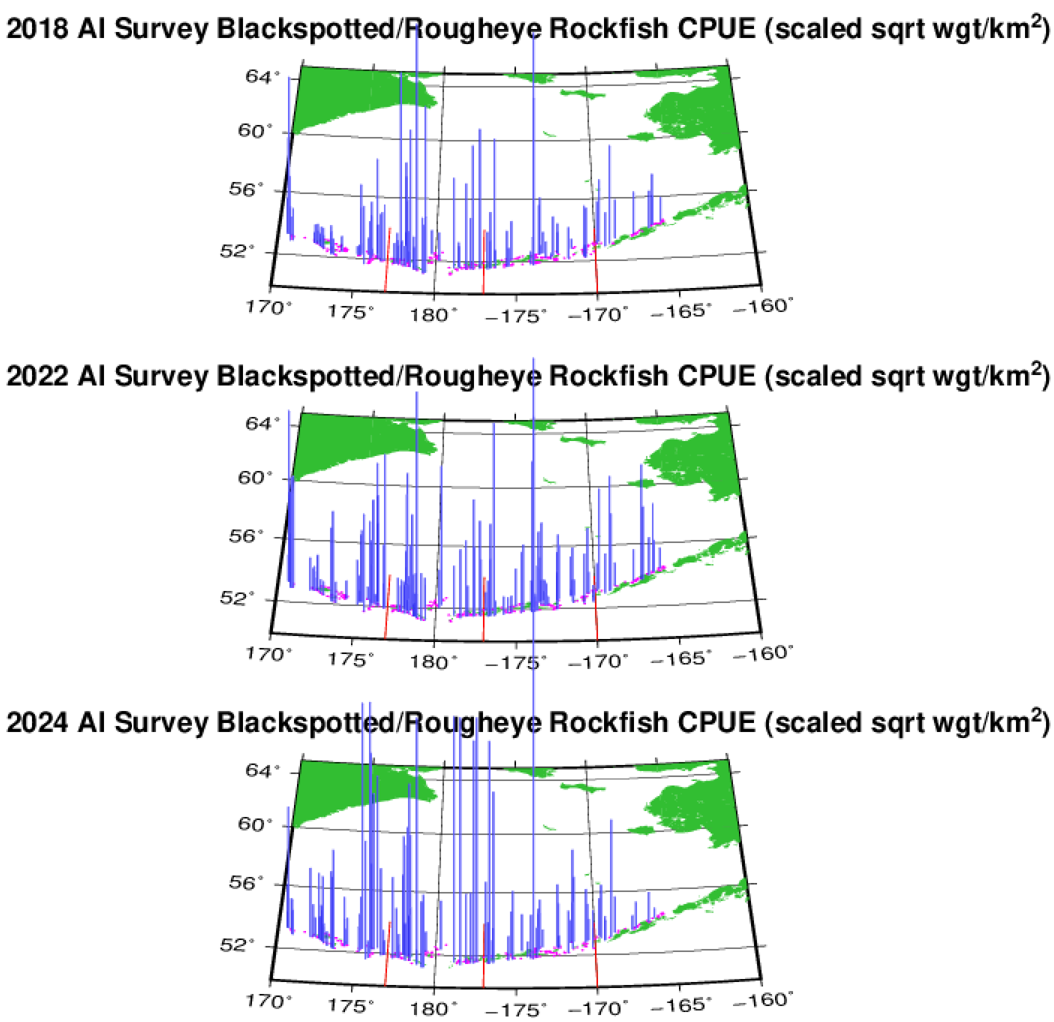

Figure 14.5. Scaled Aleutian Islands (AI) survey combined blackspotted and rougheye rockfish CPUE (kg/km^2) from 2016-2024; the symbol × denotes tows with no catch. The red lines indicate boundaries between the western Aleutian Islands (WAI), central Aleutian Islands (CAI), eastern Aleutian Islands (EAI), and eastern Bering Sea (EBS) areas.

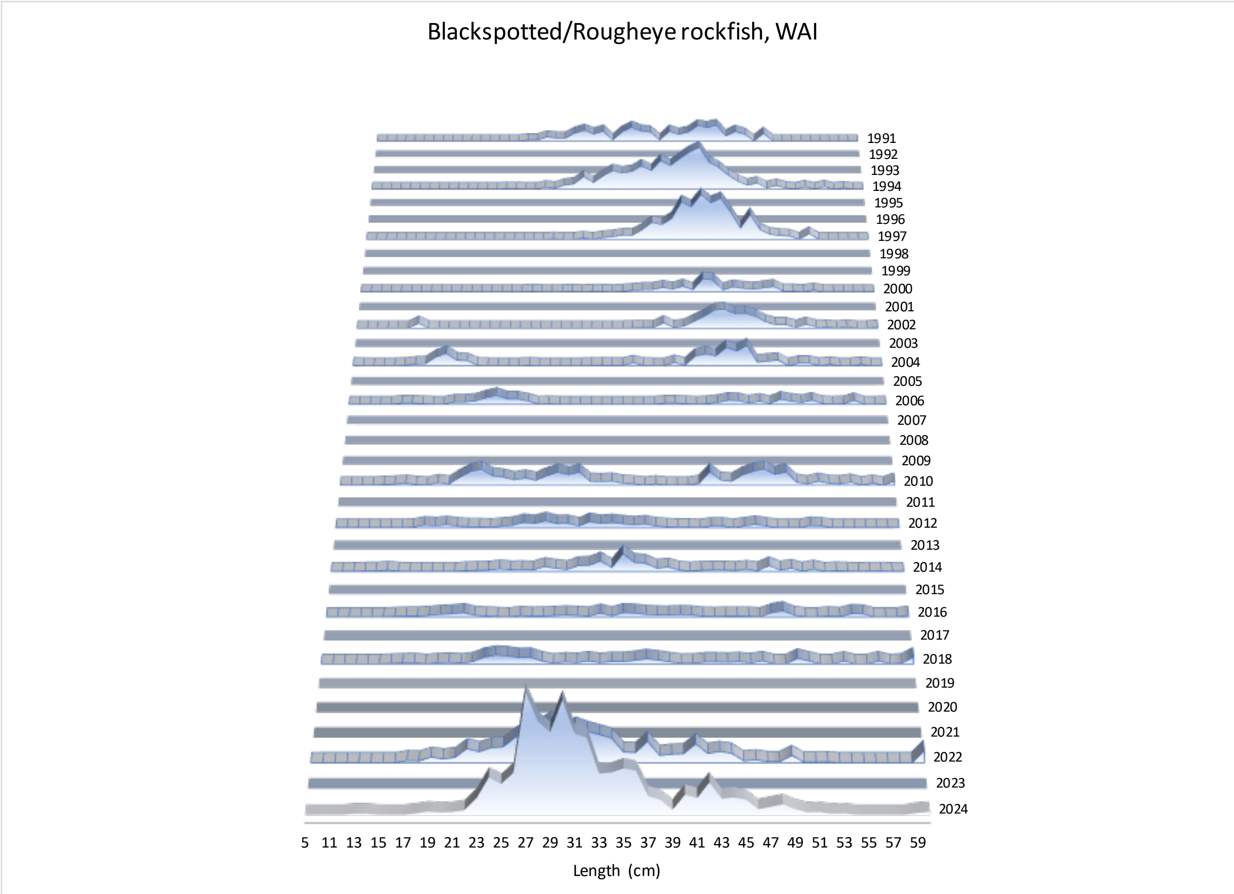

Figure 14.6. Estimated abundance by length for blackspotted/rougheye rockfish in the western Aleutian Islands subarea, from the 1991-2024 AI surveys.

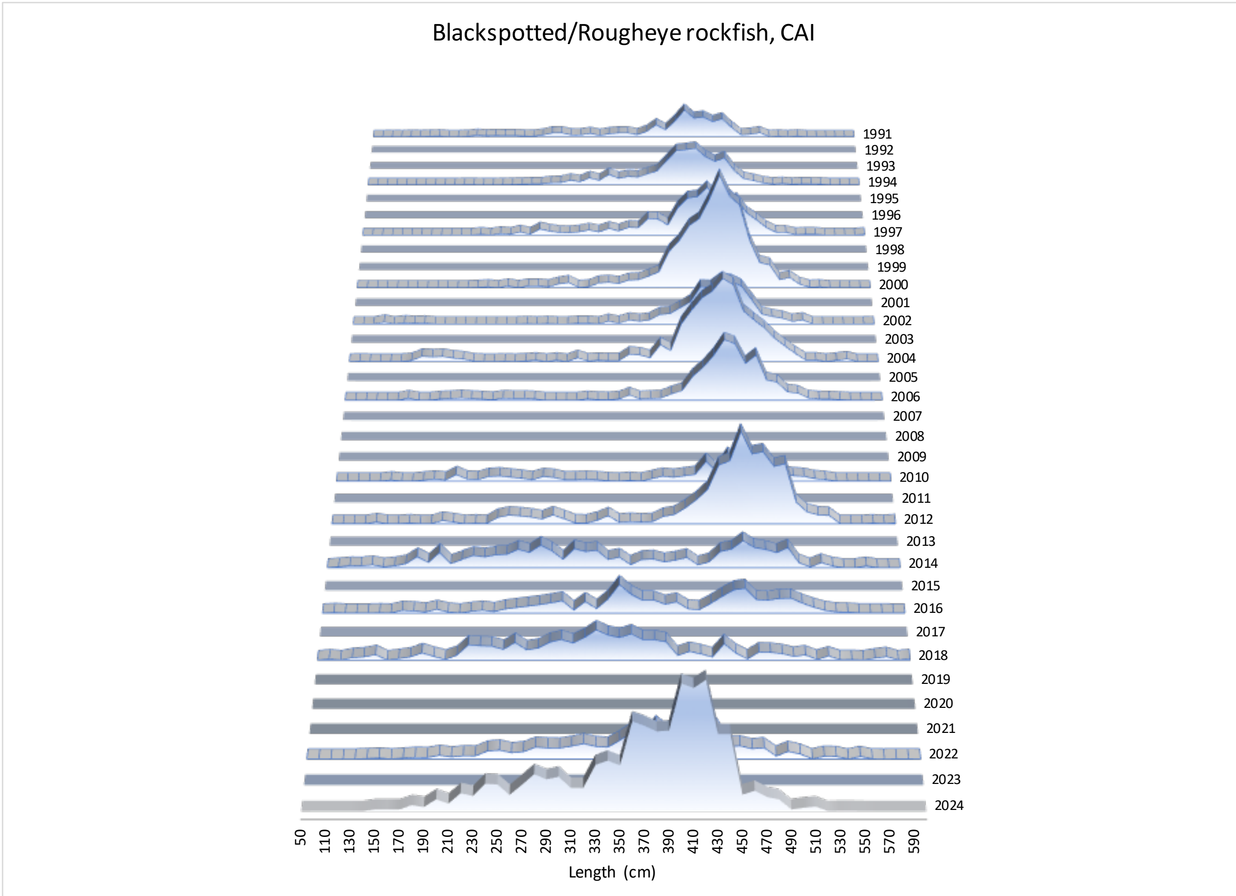

Figure 14.7. Estimated abundance by length for blackspotted/rougheye rockfish in the central Aleutian Islands subarea, from the 1991-2024 AI surveys

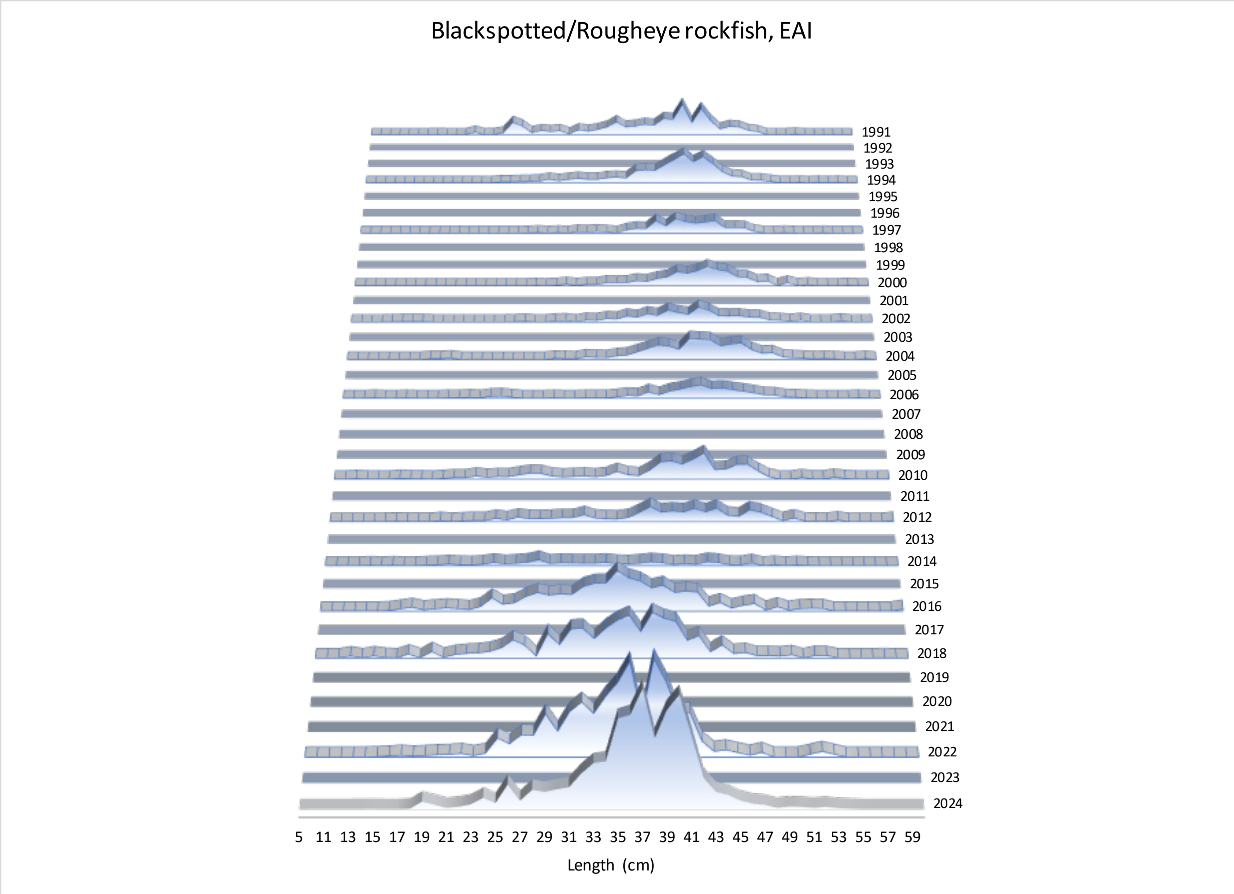

Figure 14.8. Estimated abundance by length for blackspotted/rougheye rockfish in the eastern Aleutian Islands subarea, from the 1991-2024 AI surveys.

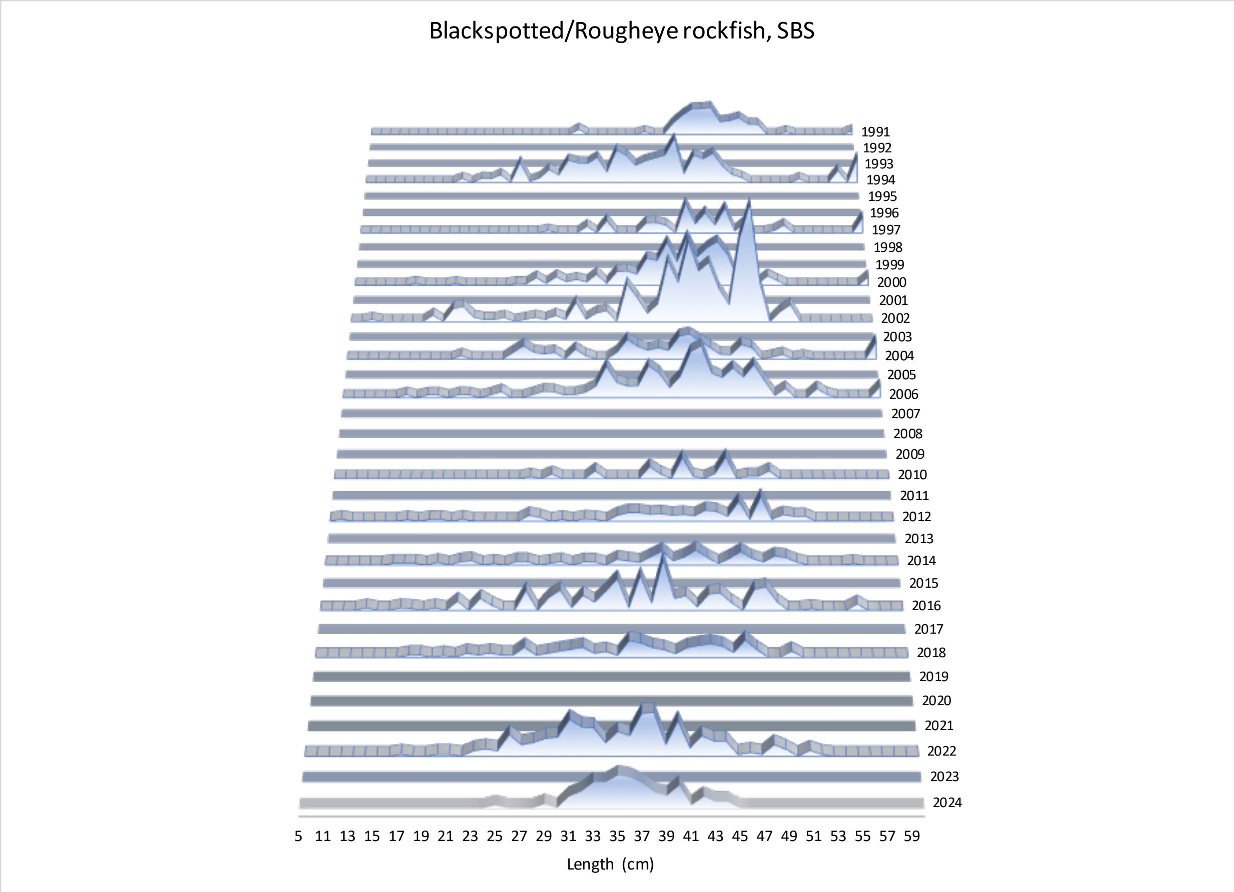

Figure 14.9. Estimated abundance by length for blackspotted/rougheye rockfish in the southern Bering Sea, from the 1991-2024 AI surveys.

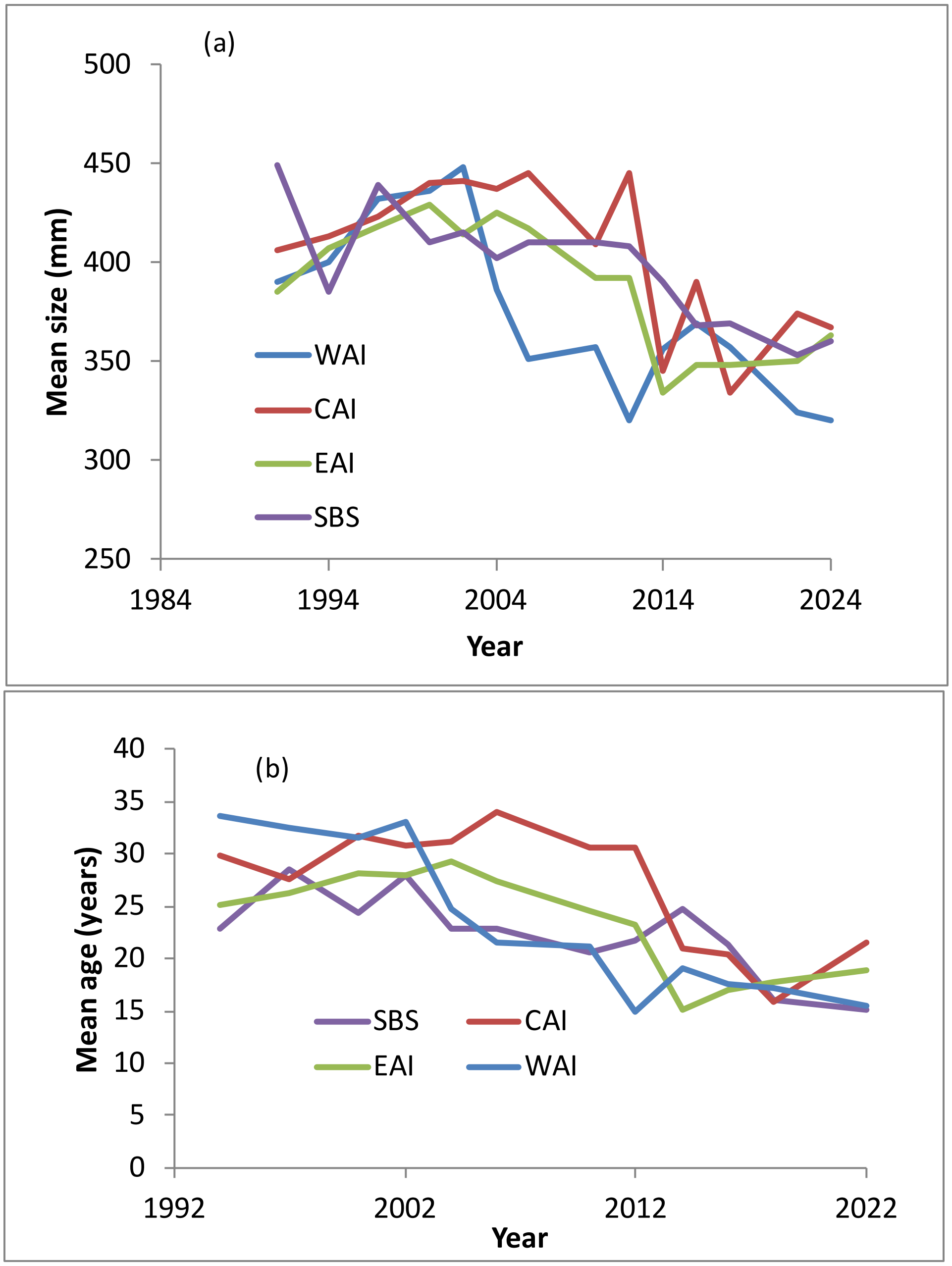

Figure 14.10. Mean size (a) and age (b) of blackspotted/rougheye rockfish from the 1991-2024 AI trawl surveys by subarea.

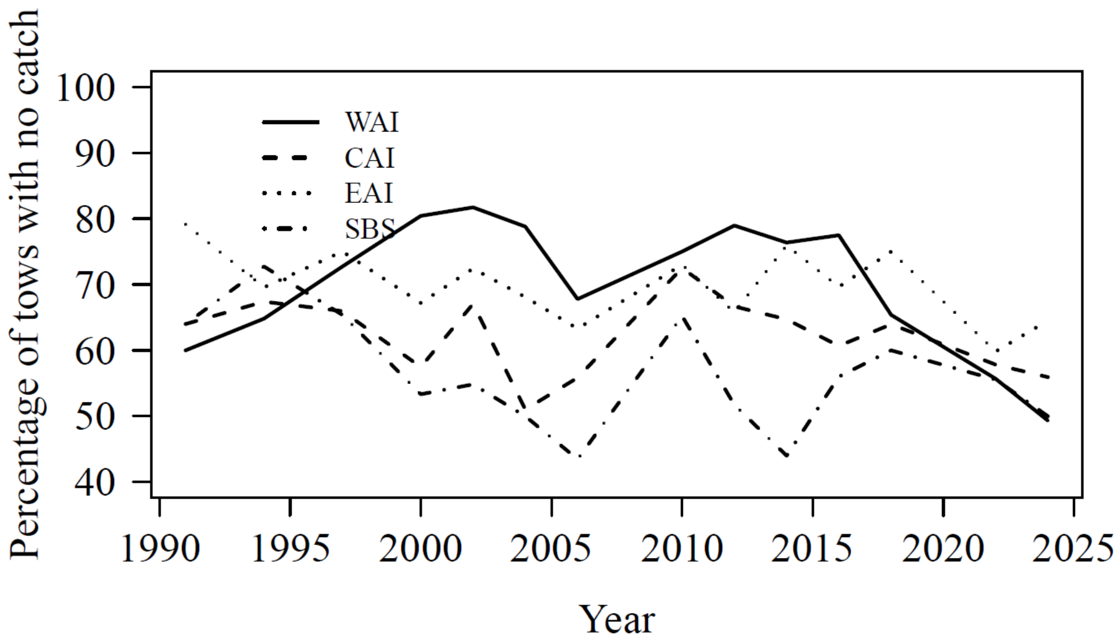

Figure 14.11. Percentage of survey tows with no catch of blackspotted/rougheye rockfish from the 1991-2024 AI trawl surveys by subarea.

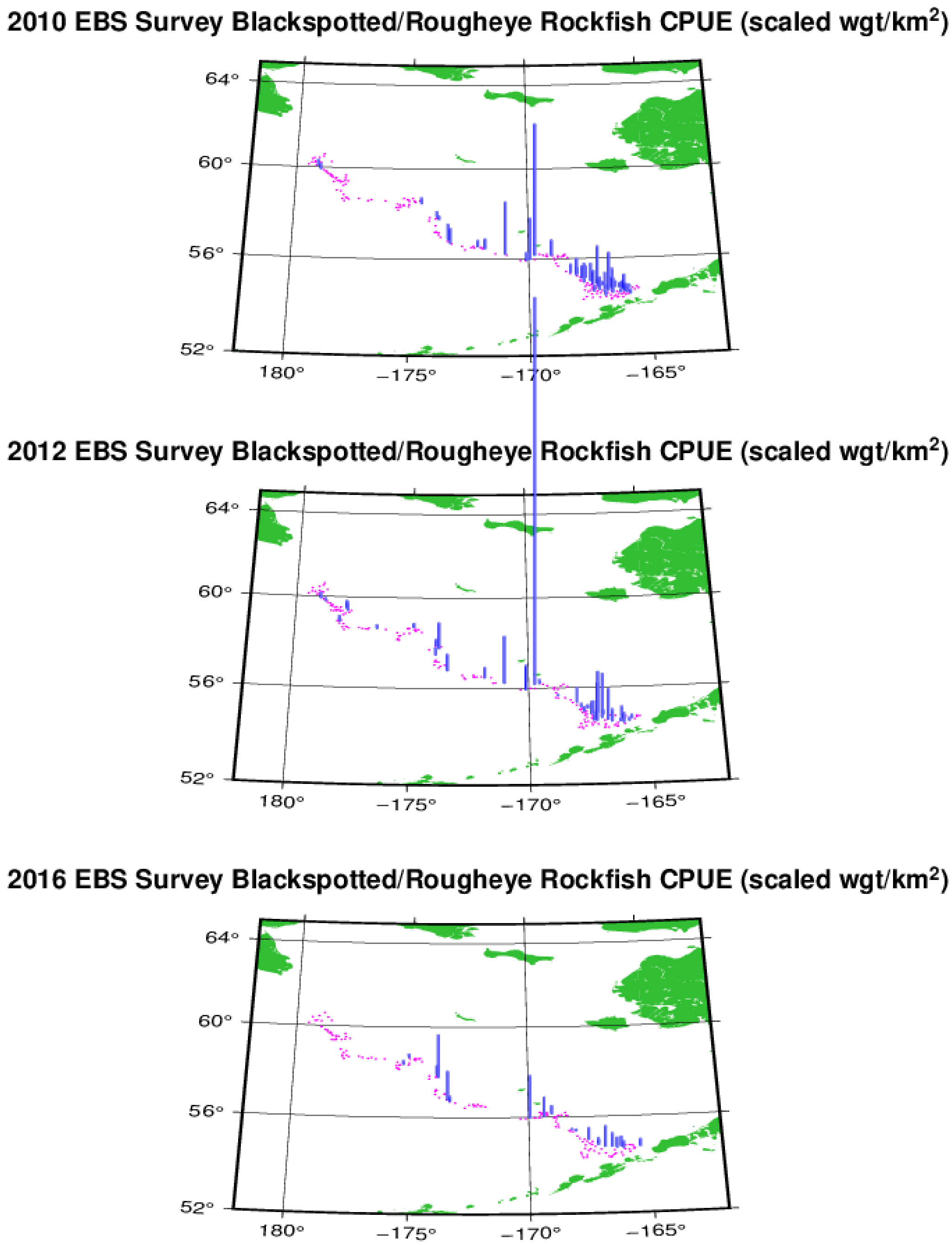

Figure 14.12. Scaled EBS survey combined blackspotted and rougheye rockfish CPUE (kg/km^2) from 2010-2016; the symbol × denotes tows with no catch.

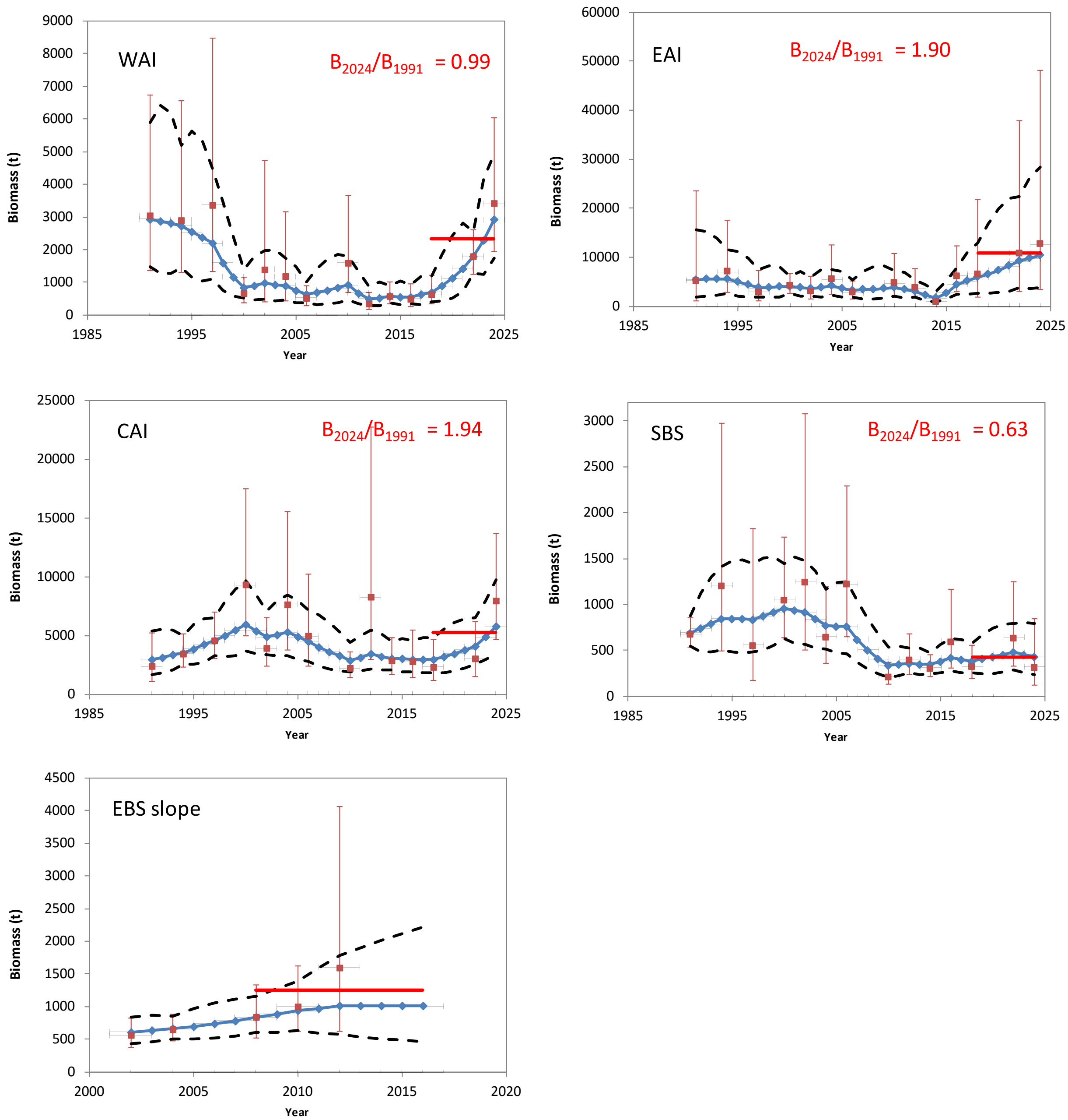

Figure 14.13. Time series of AI and EBS slope trawl survey biomass by subarea, with the fits from a random effects model to smooth the time series. The ratio of the biomass estimate in 2024 to that in 1991 indicates relative change over this time period. The horizontal red lines show the estimate from a weighted average of the three most recent surveys.

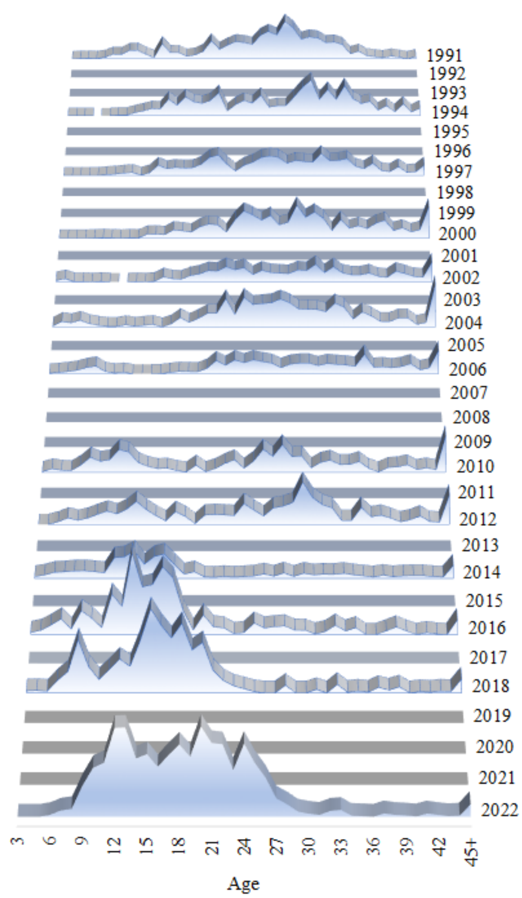

Figure 14.14. Estimated abundance by age from the Aleutian Islands trawl survey, 1991-2022.

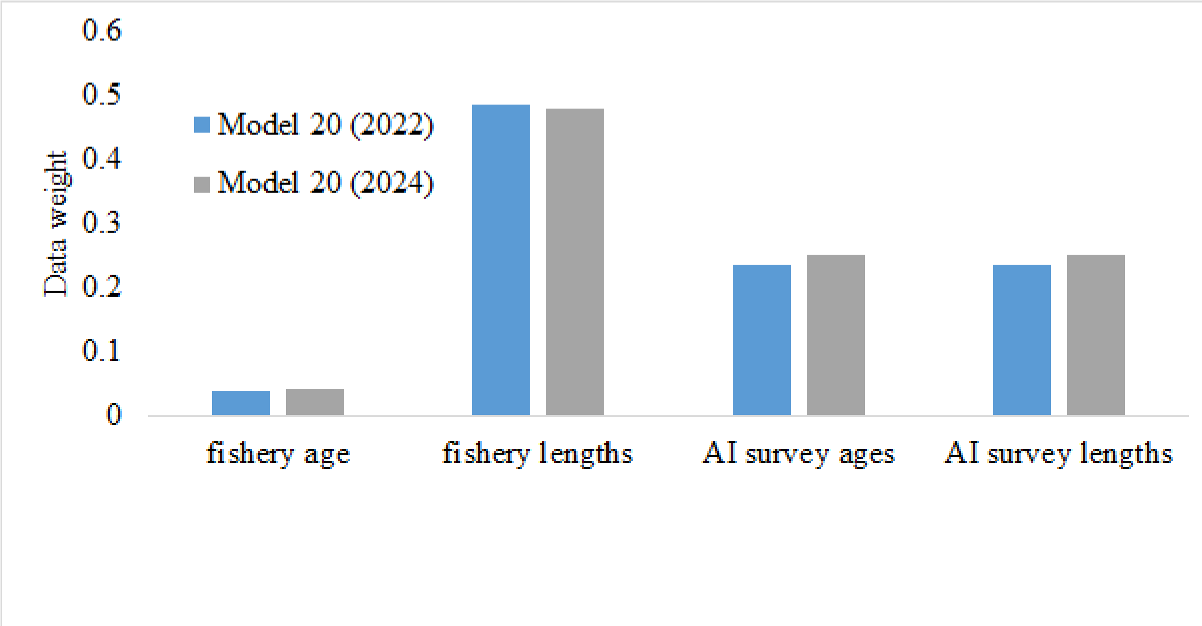

Figure 14.15. Estimated stage 2 composition data weights for 2022 and 2024 assessment models.

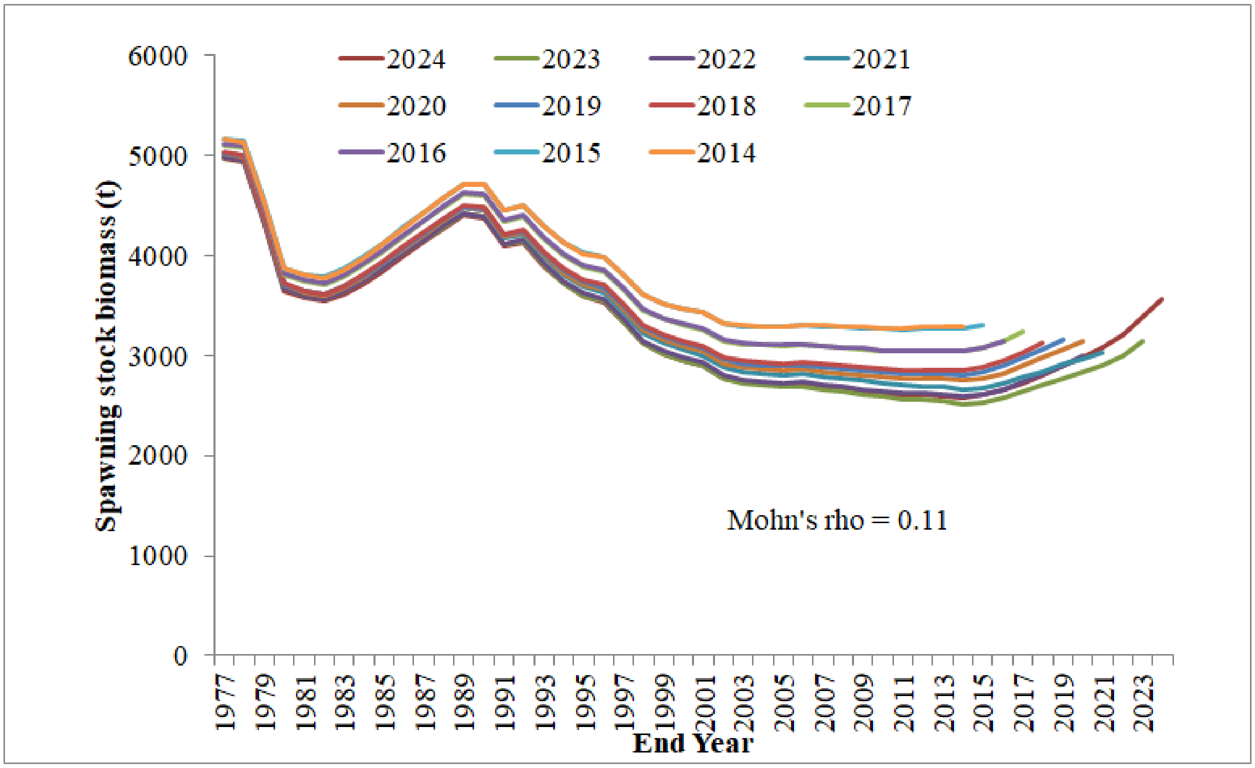

Figure 14.16. Retrospective estimate of SSB from model 20 (2024).

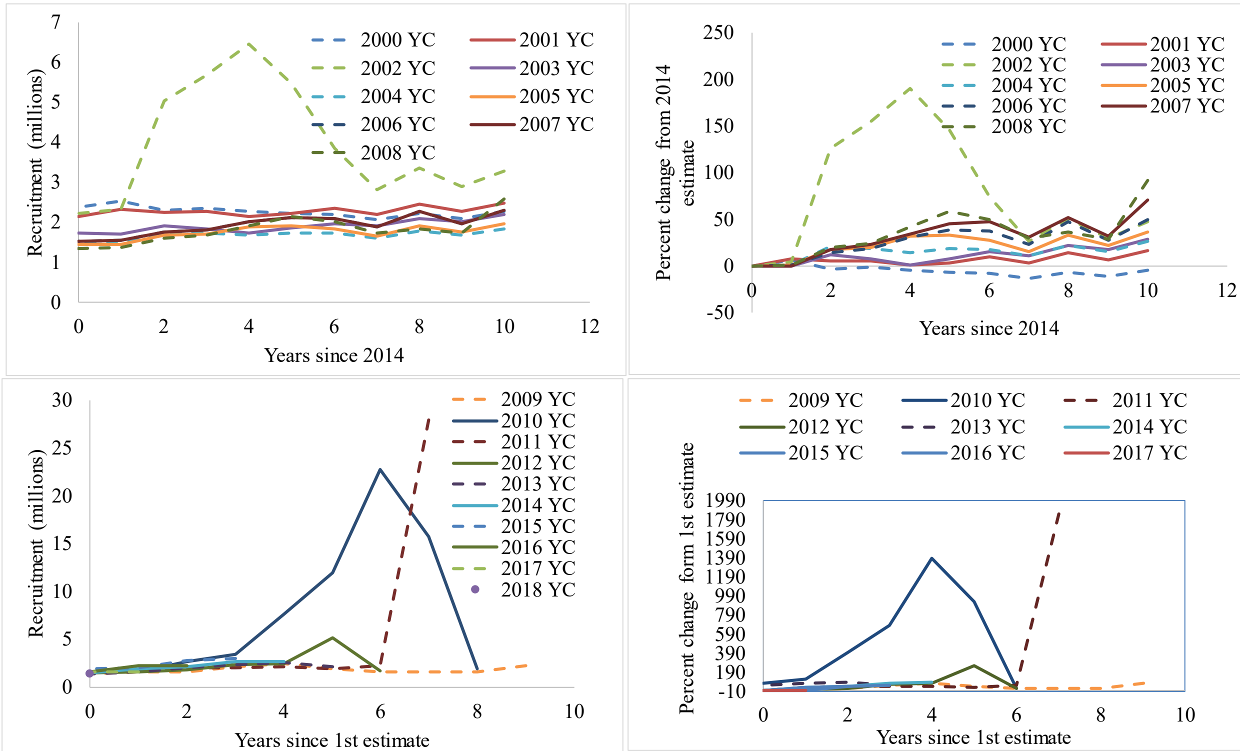

Figure 14.17. Retrospective estimates of recruitment for the 2000 – 2018 year classes, as a function of the years since either the first estimate or 2014 (whichever is later), for model 20 (2024).

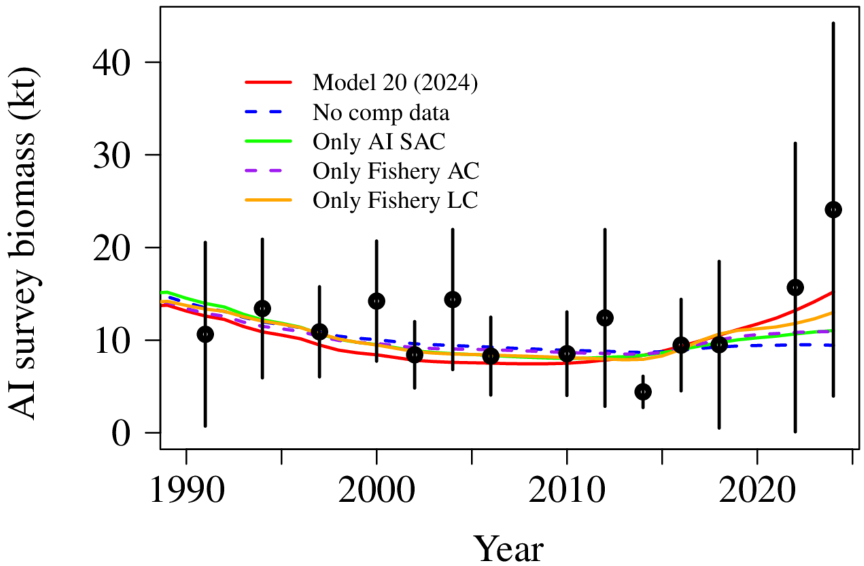

Figure 14.18. Fit to the AI survey biomass time series from model 20 (2024), and from sensitivity runs in which either all or all but one composition data is removed.

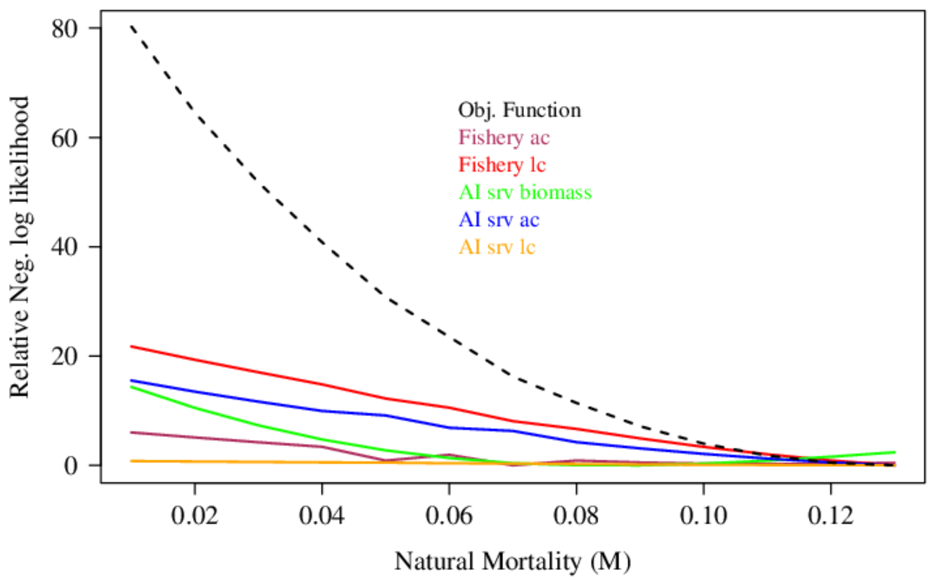

Figure 14.19. Likelihood profile for the estimated natural mortality parameter (*M*).

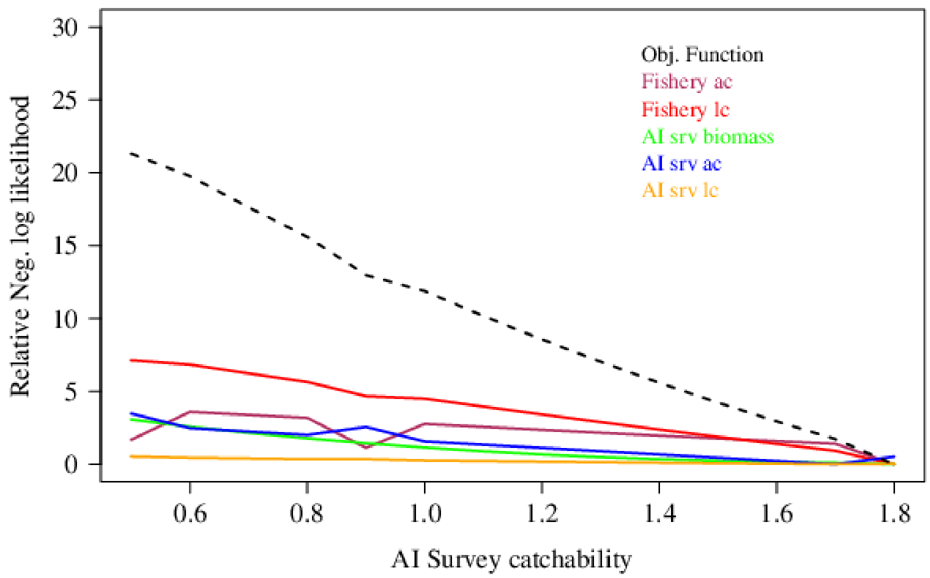

Figure 14.20. Likelihood profile for the estimated catchability of the AI trawl survey.

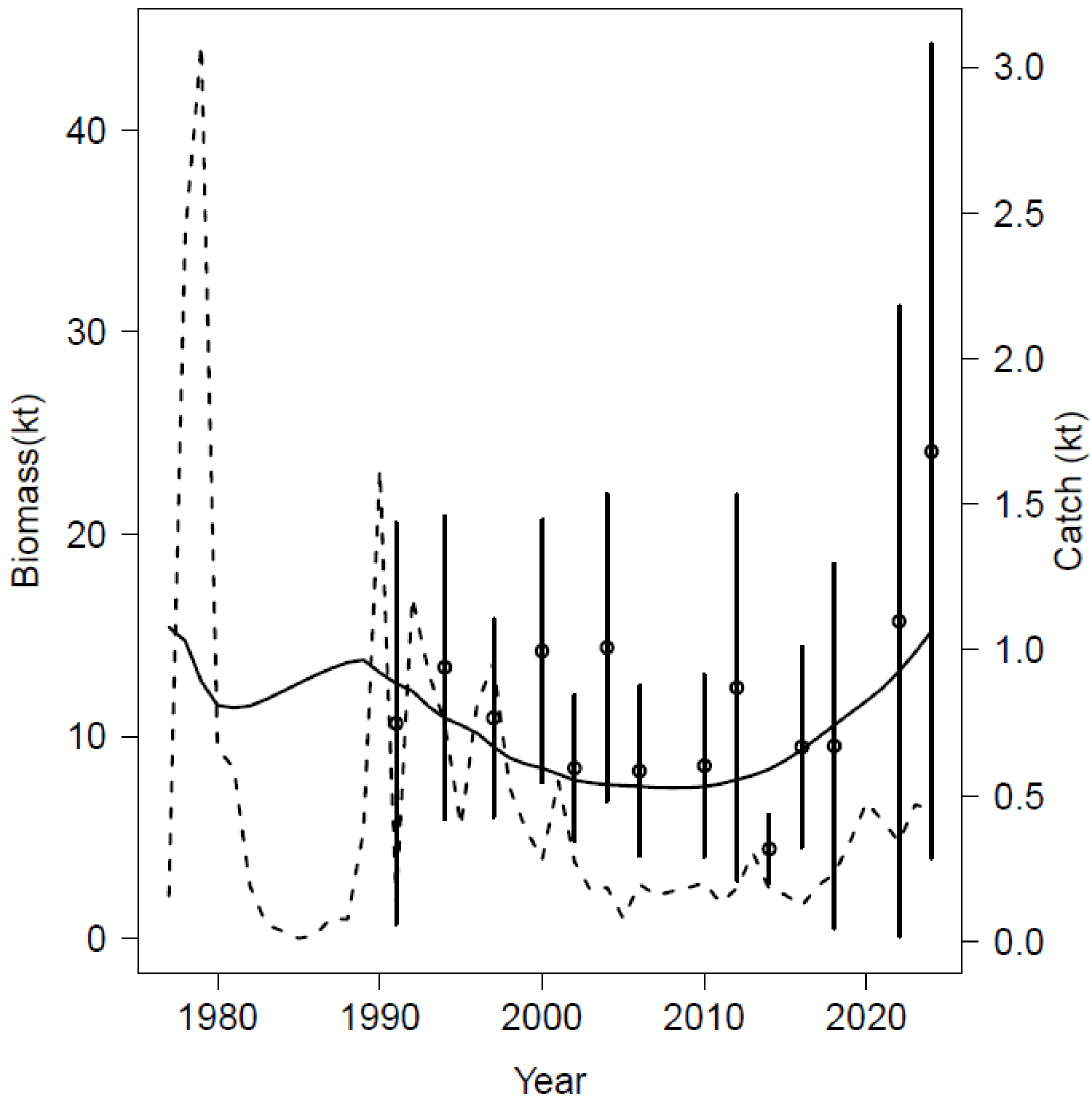

Figure 14.21. Observed Aleutian Islands (AI) survey biomass for blackspotted/rougheye rockfish (data points, +/- 2 standard deviations), predicted survey biomass (solid line), and harvest (dashed line).

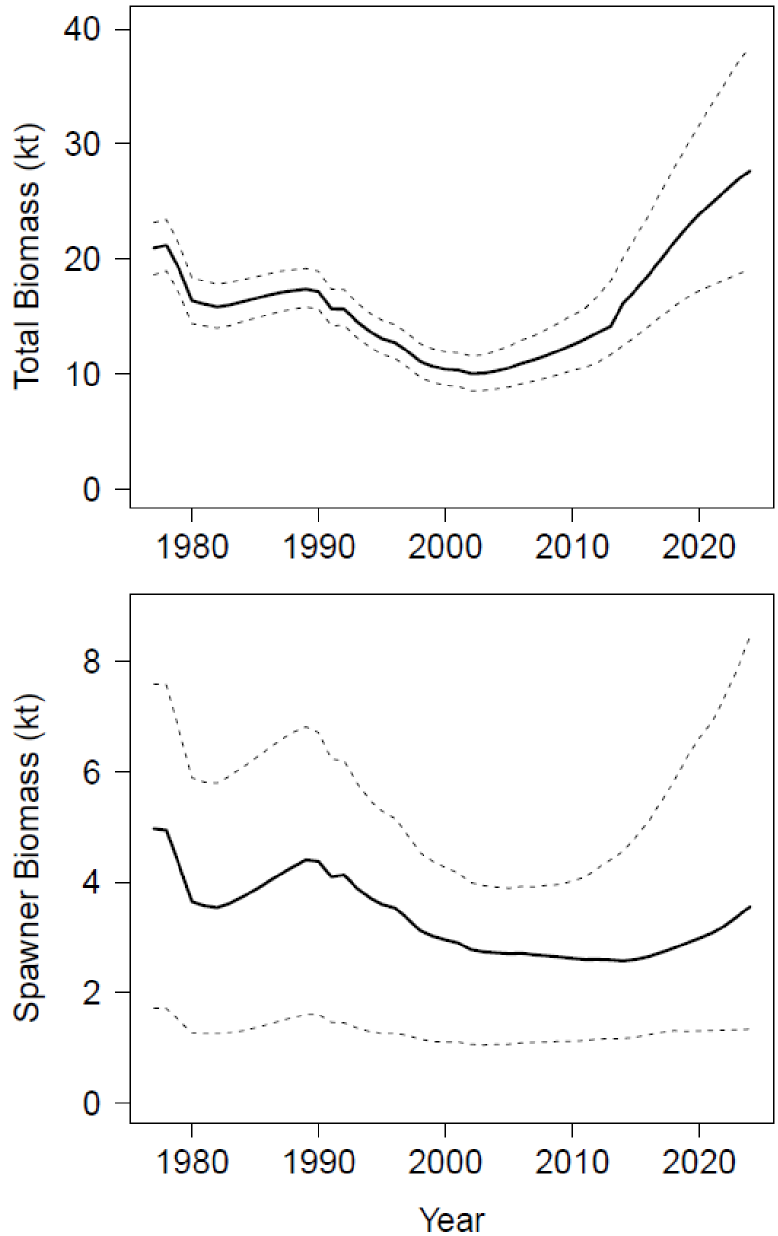

Figure 14.22. Total (top panel) and spawner (bottom panel) biomass for BSAI blackspotted/rougheye rockfish, with 95% confidence intervals from MCMC integration.

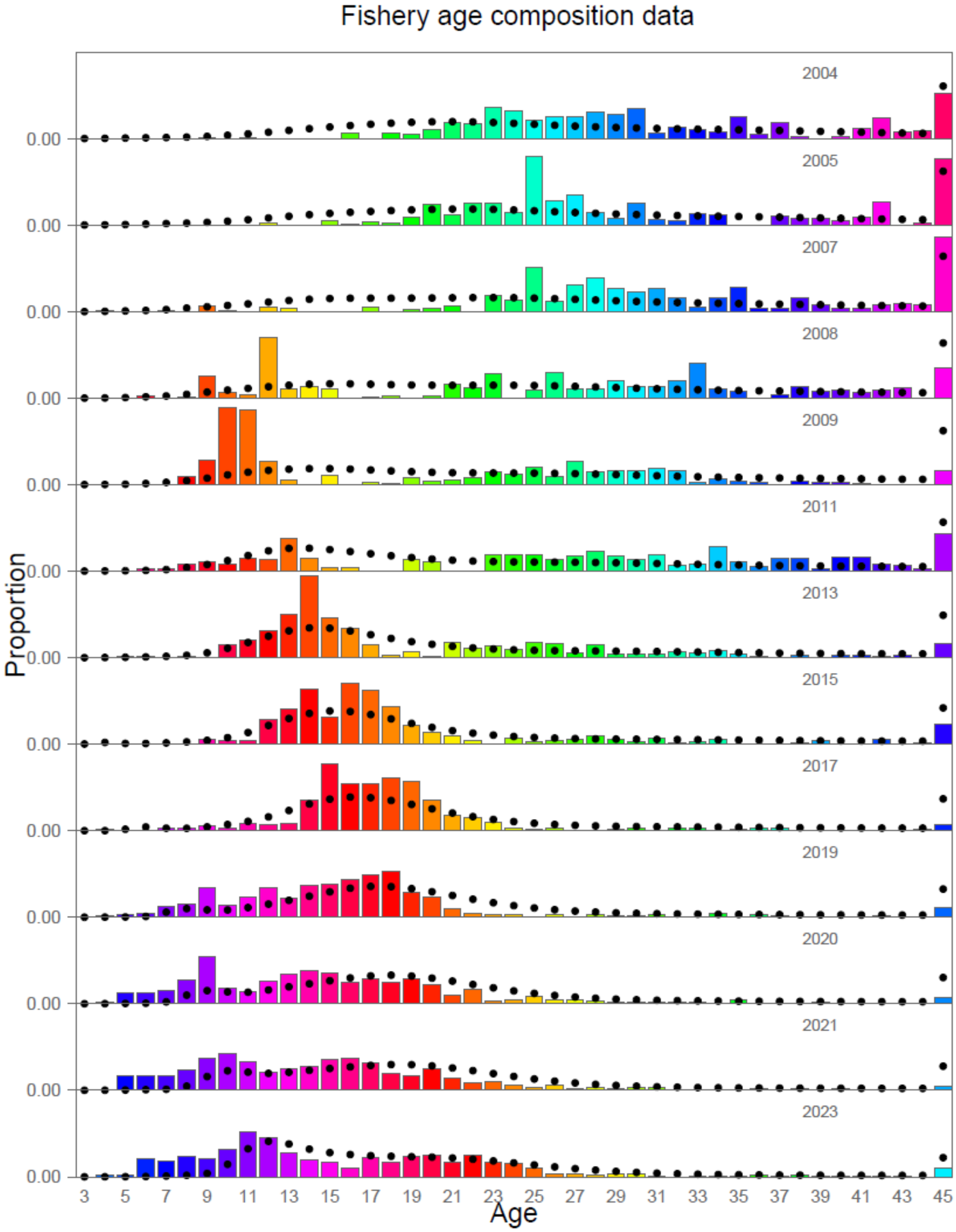

Figure 14.23. Model fits (dots) to fishery age composition data (columns) for BSAI blackspotted/rougheye, 2004-2023. Colors correspond to cohorts (except for the 45+ group).

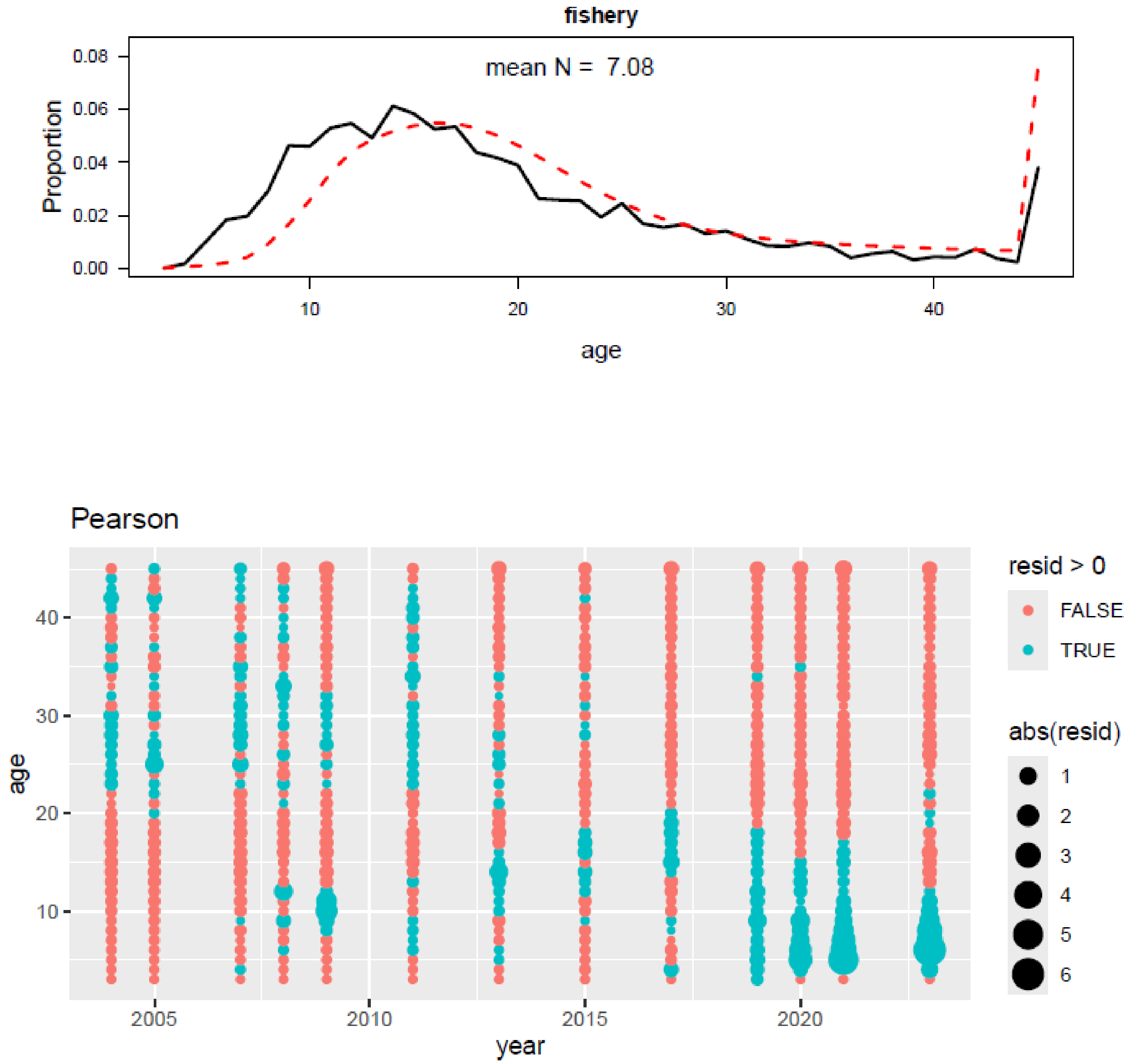

Figure 14.24. Aggregated observed (black) and estimated (red) fishery age compositions (top panel) and Pearson residuals (bottom panel).

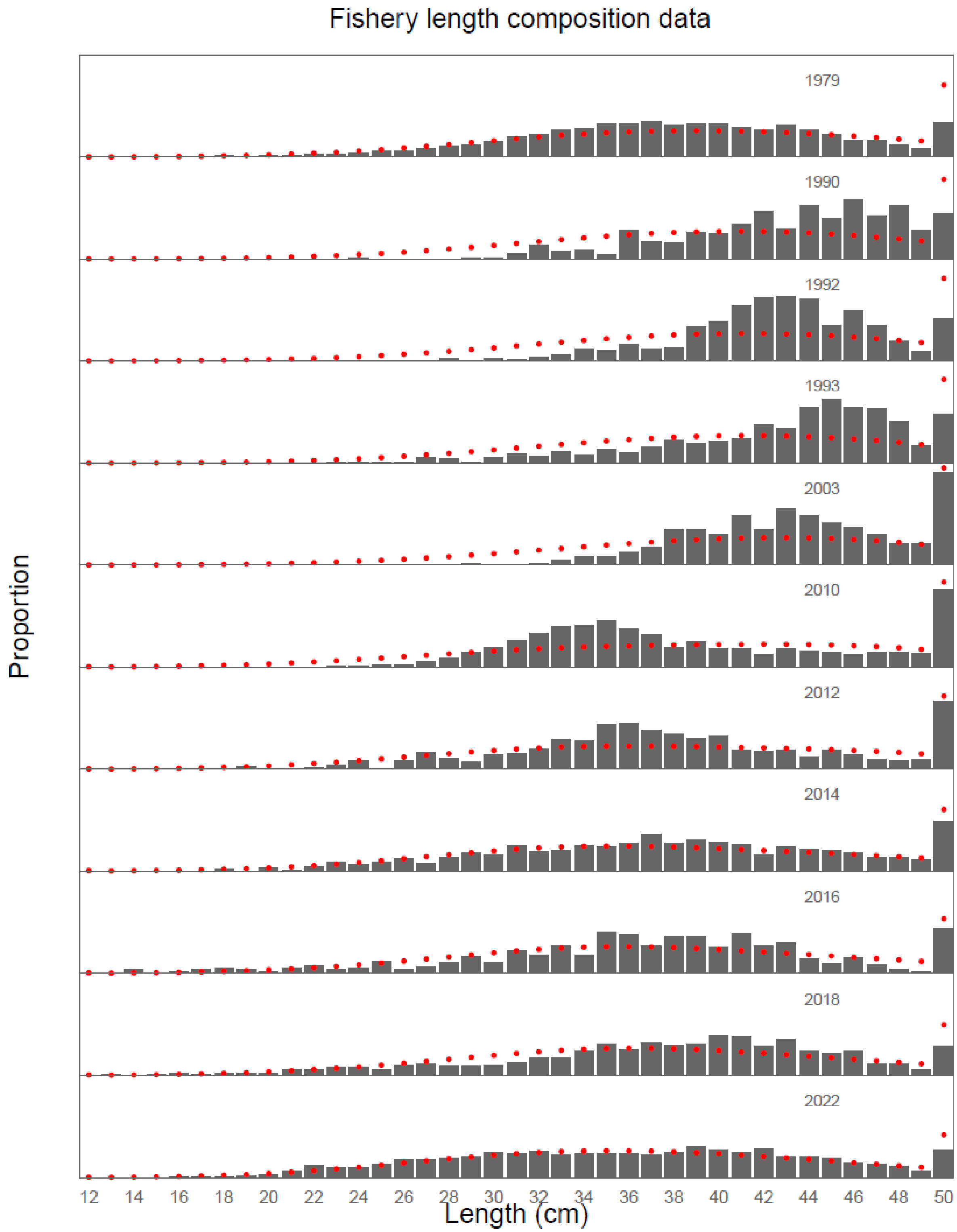

Figure 14.25. Model fits (dots) to the fishery length composition data (columns) for AI blackspotted/rougheye rockfish, 1979-2022.

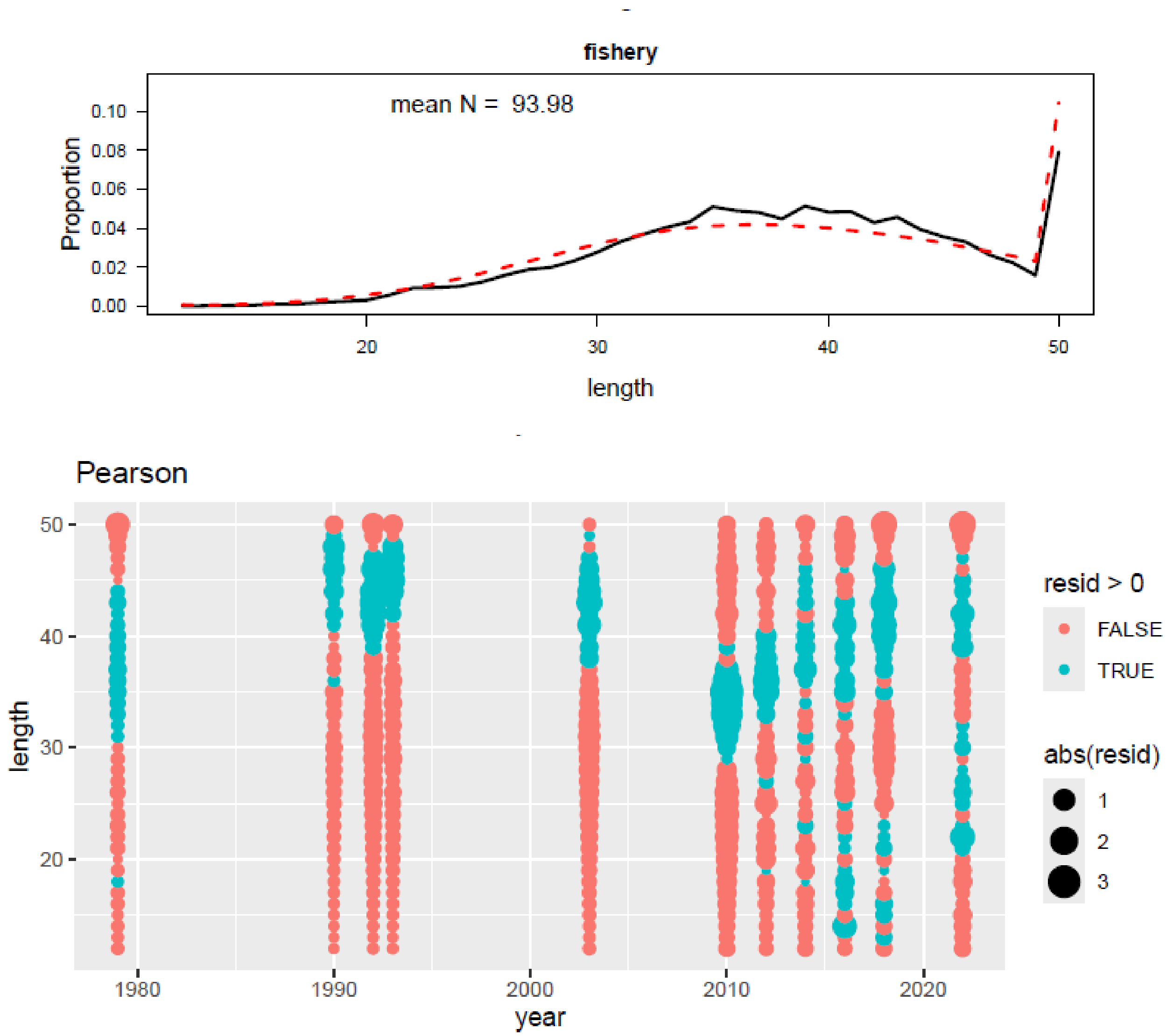

Figure 14.26. Aggregated observed (black) and estimated (red) fishery length compositions (top panel) and Pearson residuals (bottom panel).

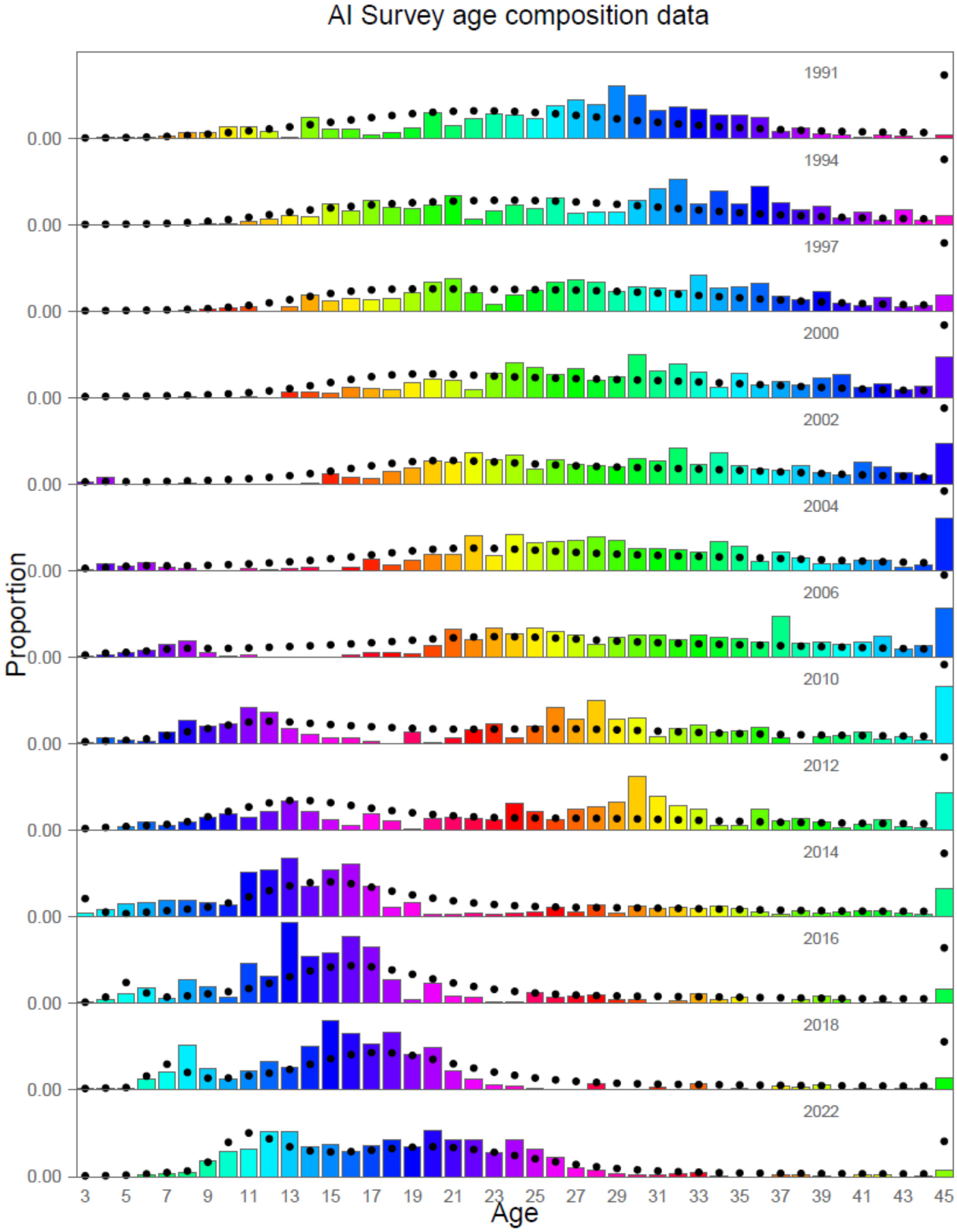

Figure 14.27. Model fits (dots) to AI survey age composition data (columns) for blackspotted/rougheye, 1991-2022. Colors correspond to cohorts (except for the 45+ group).

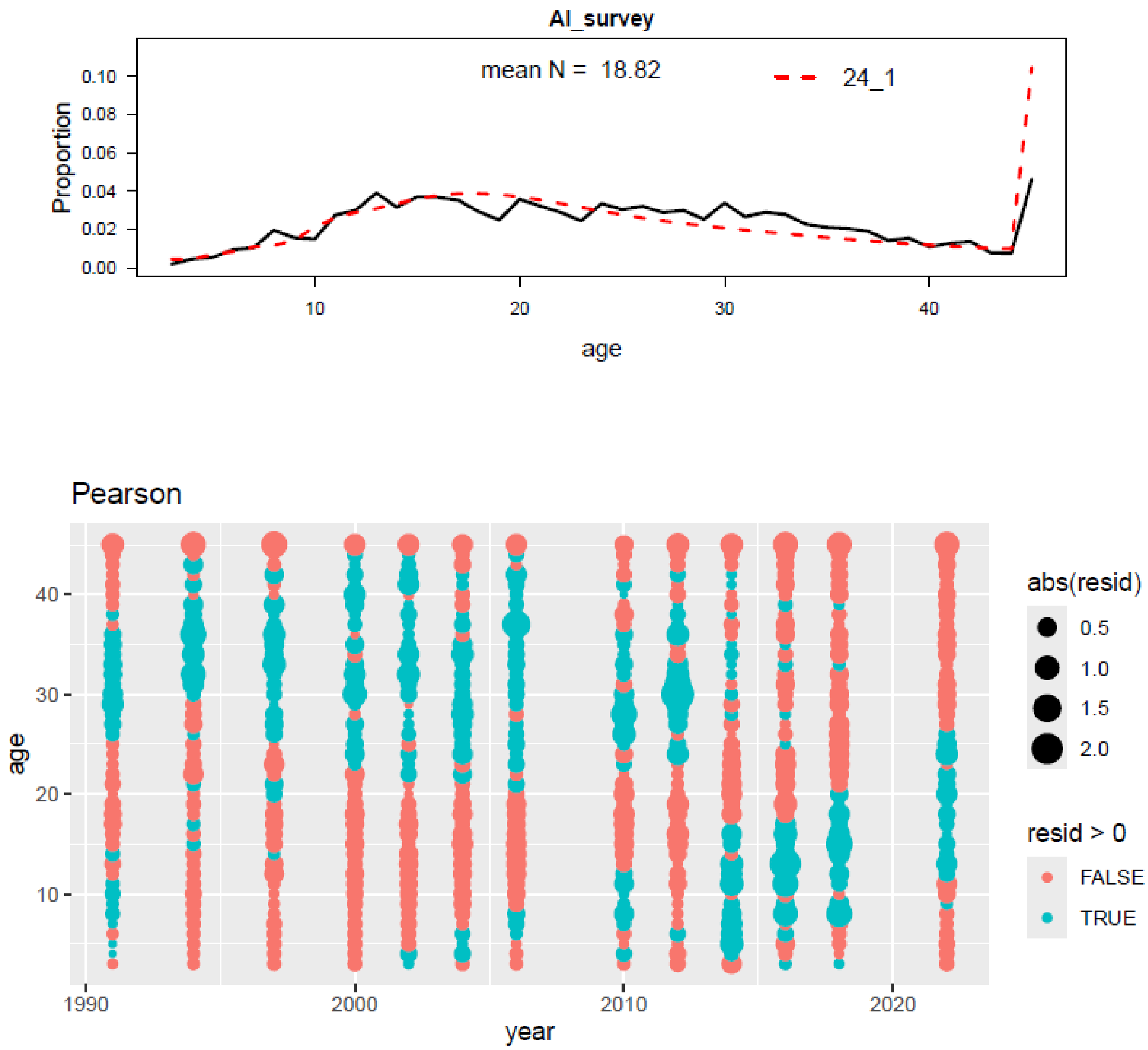

Figure 14.28. Aggregated observed (black) and estimated (red) AI survey age compositions (top panel) and Pearson residuals (bottom panel).

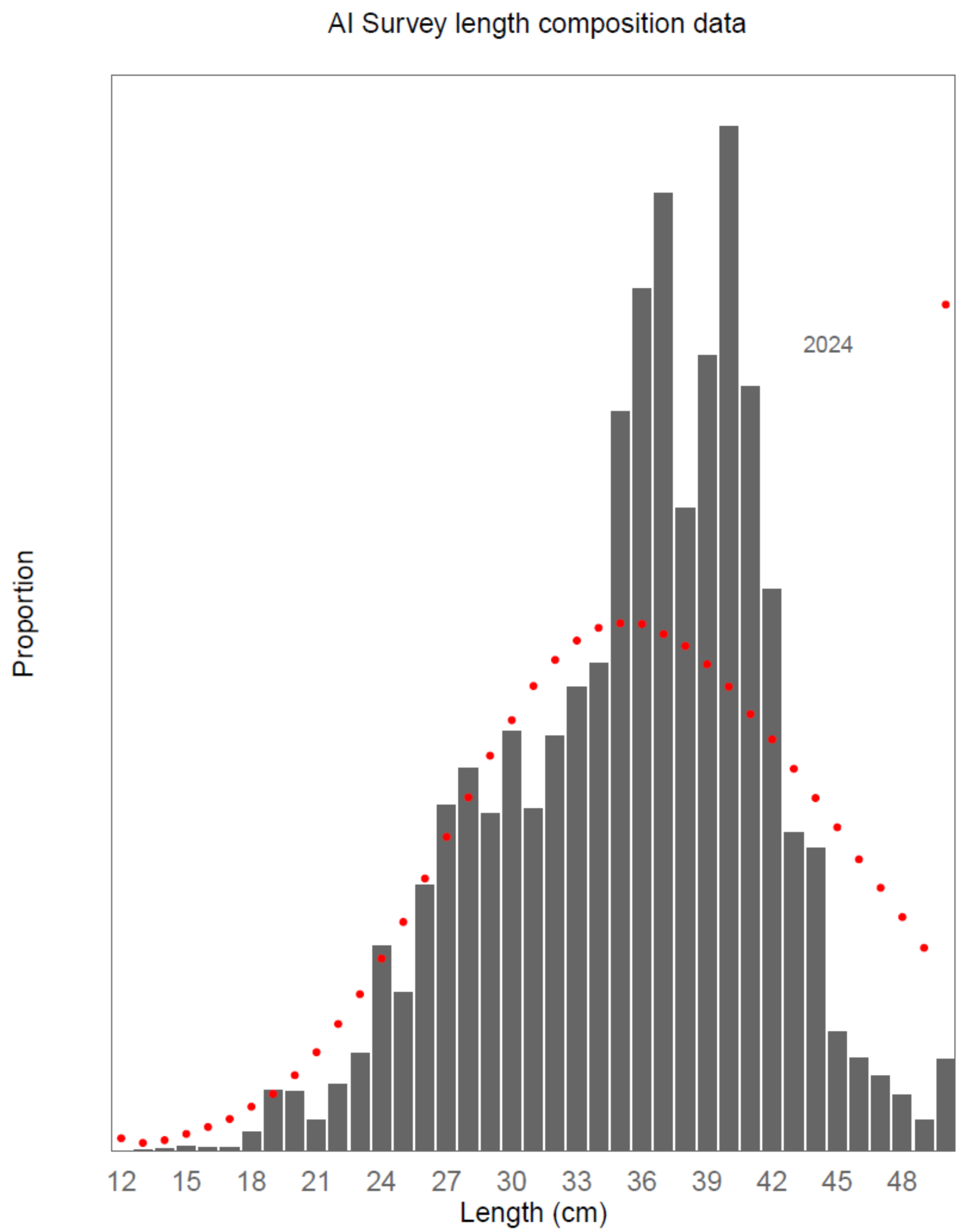

Figure 14.29. Model fits (dots) to 2024 AI survey length composition data (columns) for blackspotted/rougheye rockfish.

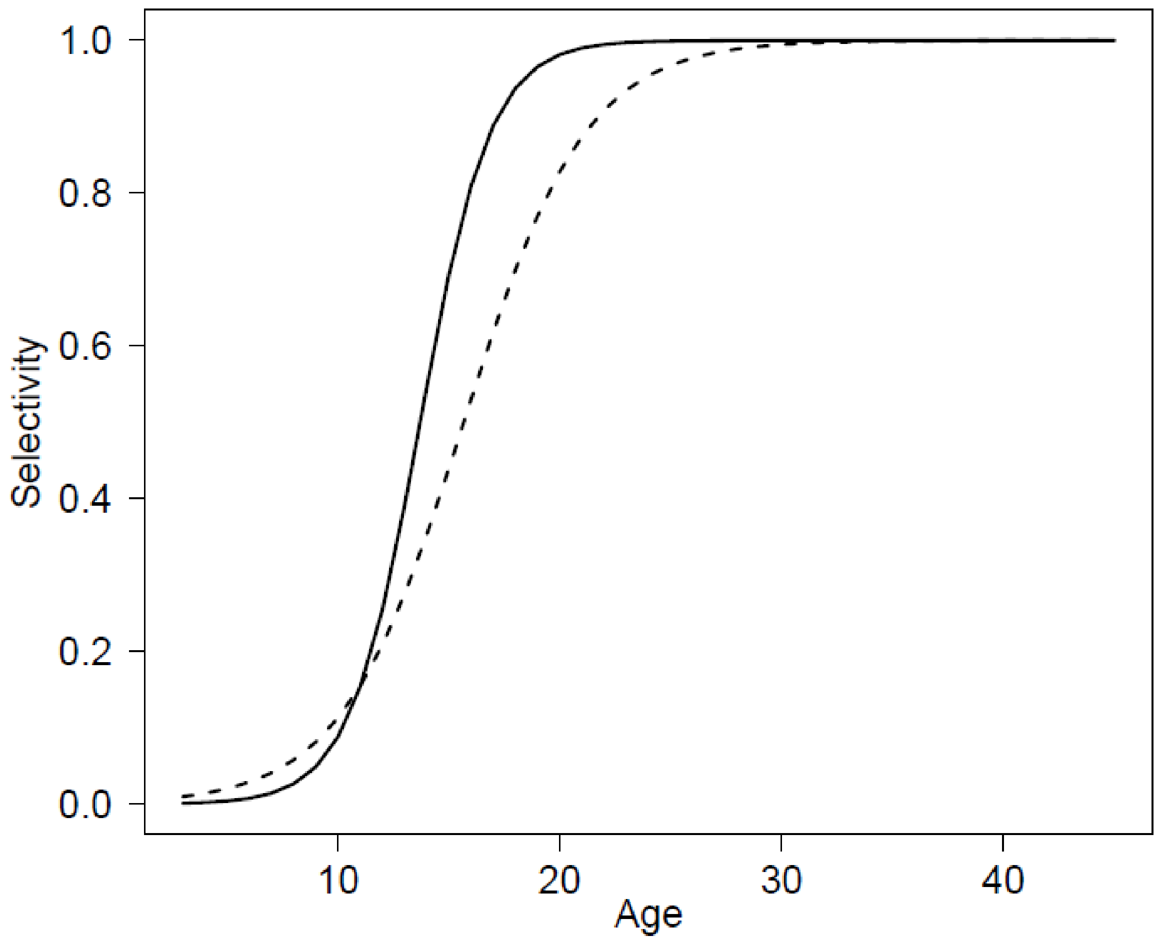

Figure 14.30. Estimated fishery (solid line) and AI survey (black dashed line) selectivity curves by age for blackspotted/rougheye rockfish.

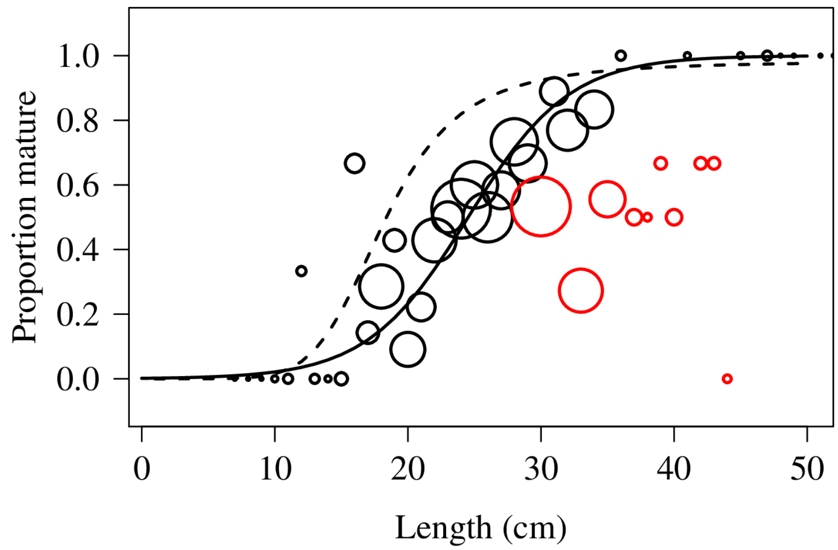

Figure 14.31. Observed and estimated proportion mature at age from data collected in the GAO from Dr. Christina Conrath (black circles and solid line, respectively). Symbol size is scaled by the number of observations. Red data point represent outliers which had unusually low proportion mature for old fish, and were not used for model estimation. For reference, the maturity ogive used in the 2018 assessment is shown as the dashed line.

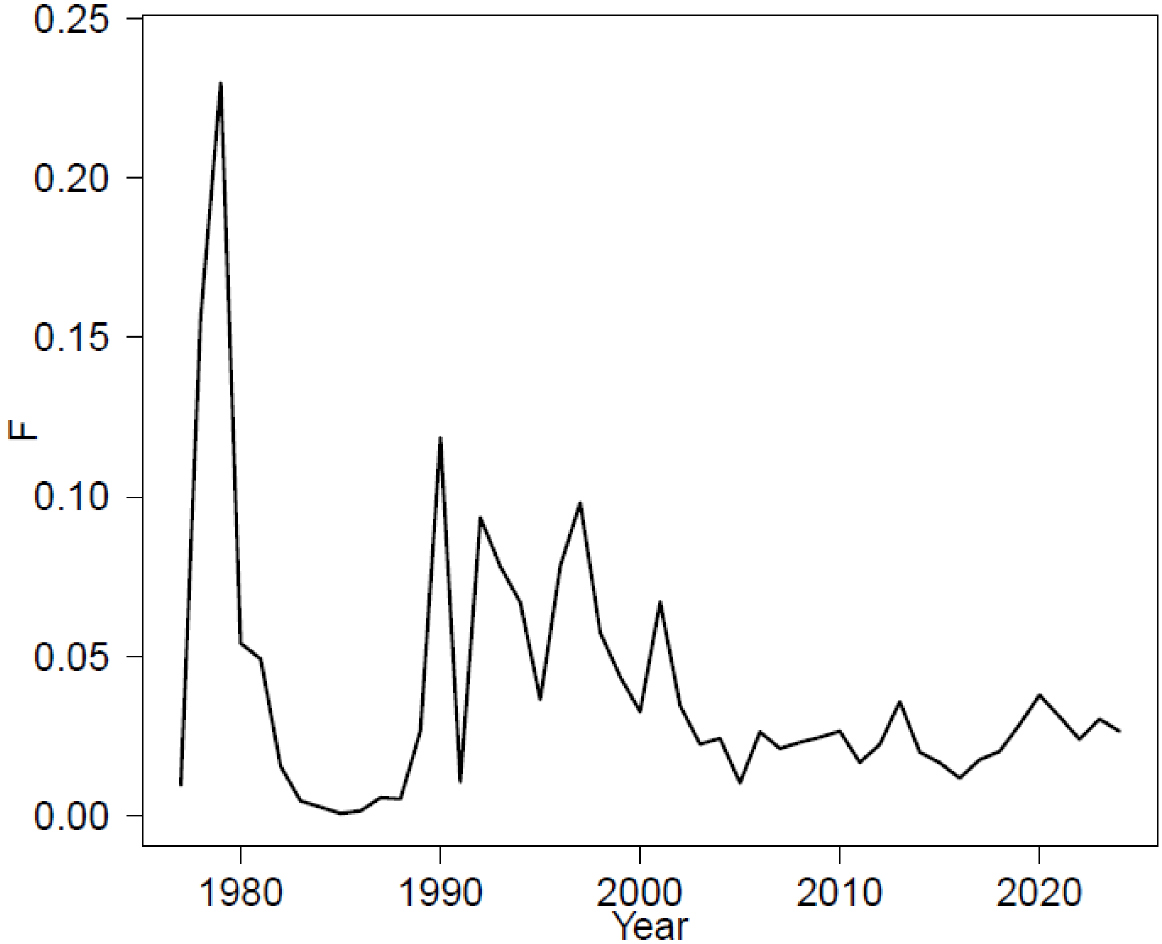

Figure 14.32. Estimated fully selected fishing mortality for blackspotted/rougheye rockfish.

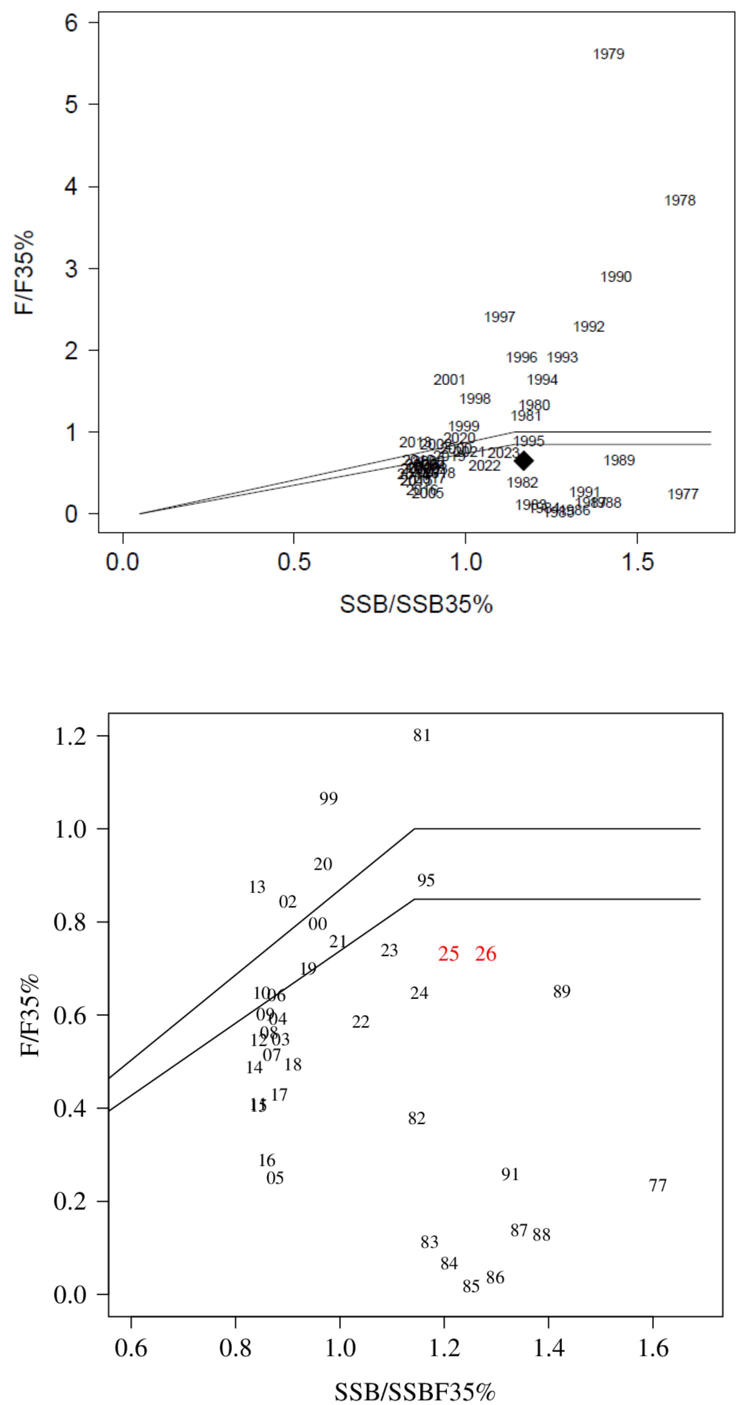

Figure 14.33. (Top panel) Estimated fishing mortality and SSB in reference to OFL (upper line) and ABC (lower line) harvest control rules, with 2024 shown as the diamond symbol. The bottom panel shows the projected stock status and *F* for 2025 and 2026.

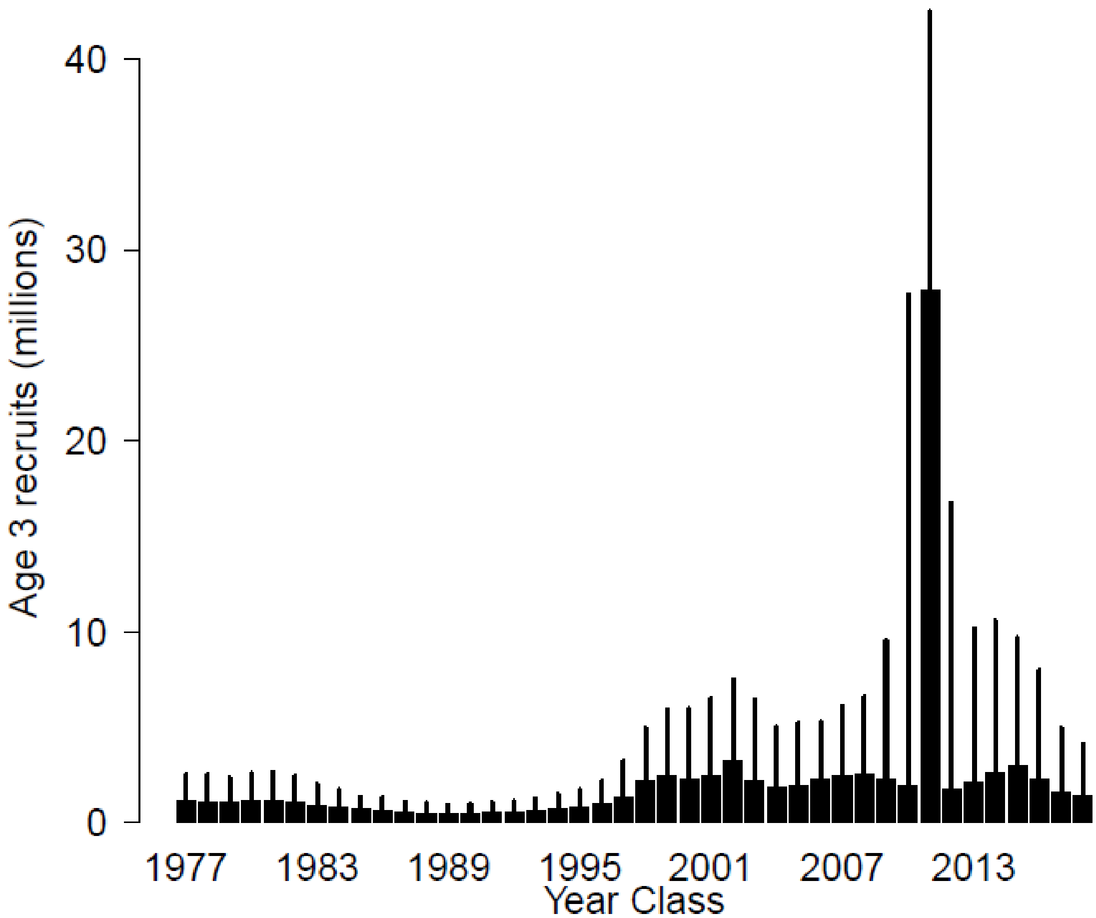

Figure 14.34. Estimated recruitment (age 3) of blackspotted/rougheye rockfish, with 95% CI. limits obtained from MCMC integration.

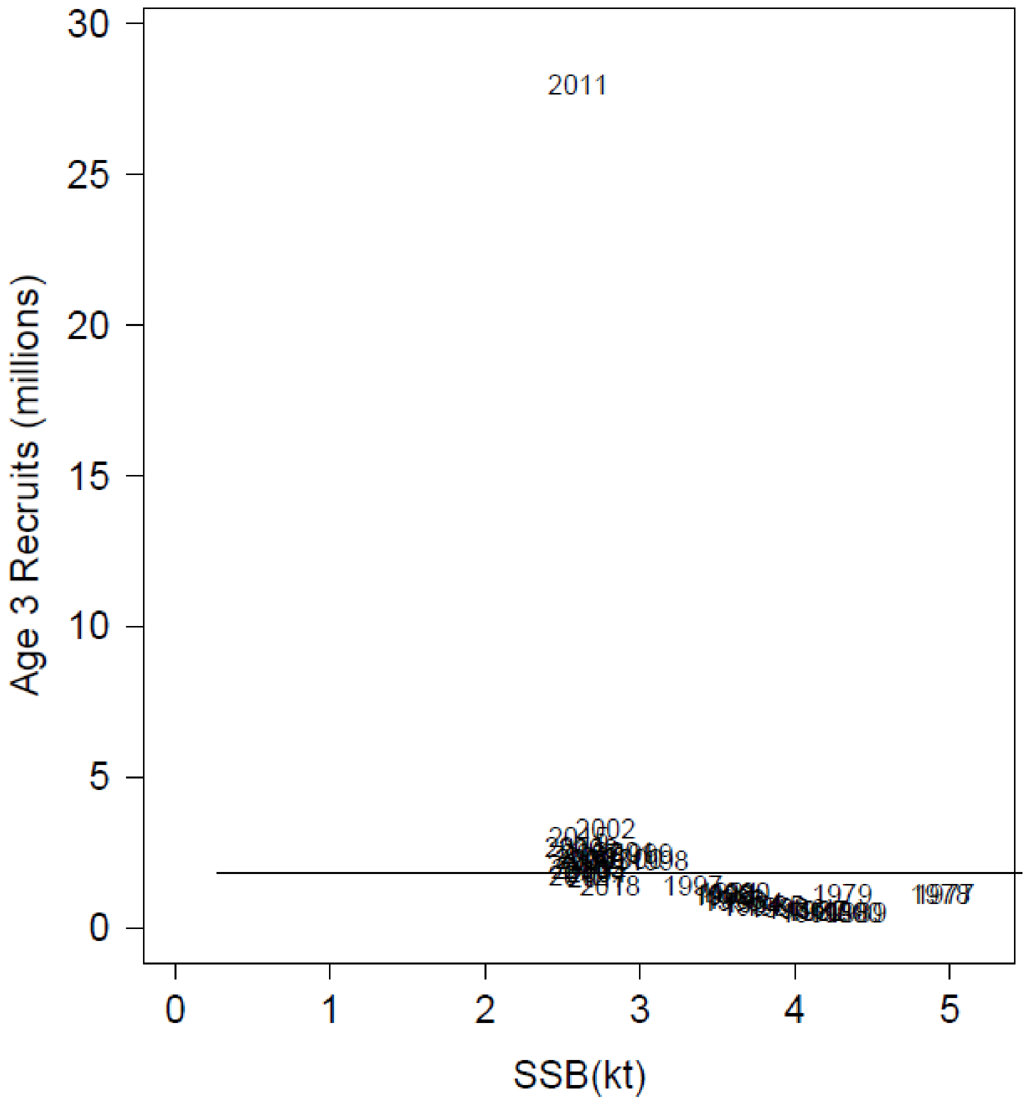

Figure 14.35. Scatterplot of blackspotted/rougheye rockfish spawner-recruit data; label is year class. Horizontal line is median recruitment.

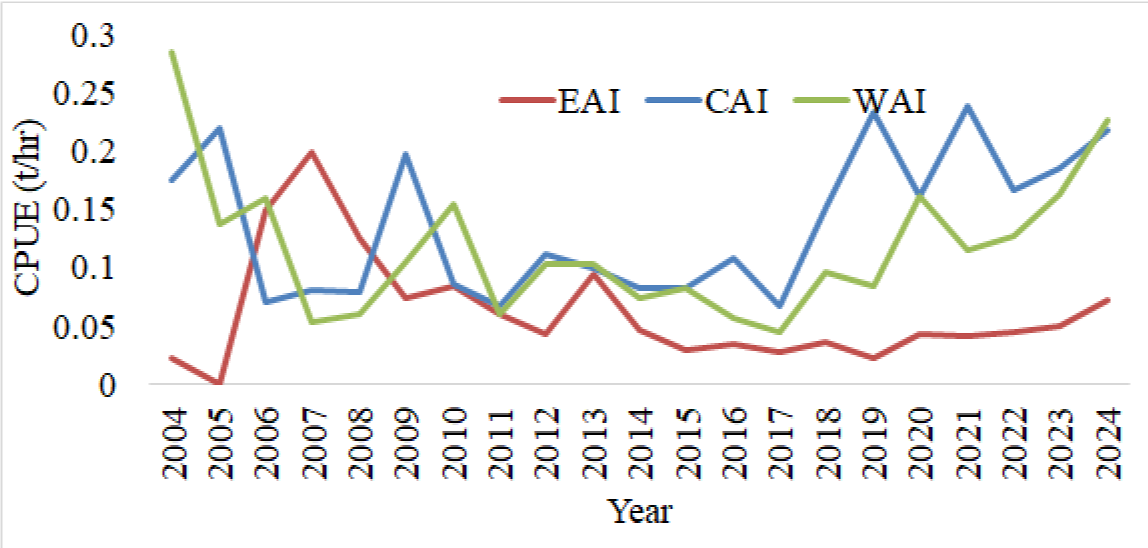

Figure 14.36. Bycatch of blackspotted/rougheye rockfish (t/hr) in tows targeting POP by AI subarea, from tows sampled for species composition in the North Pacific Groundfish Observer Program.

Appendix 14A. Update on Plan Team and SSC requests for the BSAI Blackspotted/rougheye stock assessment, with preliminary model runs

Introduction

In 2022, the Bering Sea/Aleutian Islands Plan Team and the Statistical and Scientific Committee of the North Pacific Fisheries Management Council made several recommendations regarding the BSAI blackspotted/rougheye rockfish (BSRE) assessment model:

(SSC, October 2022). *The SSC acknowledged the changes in the IPHC longline survey sampling design in 2020 but noted that the survey was highly correlated with the bottom trawl survey prior to 2020. Given the retrospective bias in the current model and its difficulty in assessing the scale of the stock, the SSC recommends the author explore use of the pre-2020 data in the assessment with emphasis on sampling in untrawlable habitats.*

(BSAI Plan Team, November 2022). *The Team discussed the lack of larger fish in fishery composition data and recommended examining the NMFS and IPHC longline survey data to determine if larger fish may be in the population and not showing up in the fishery. The Team also recommended looking at the rate of blackspotted/rougheye to Pacific ocean perch in the survey tows over the time series.*

(SSC, December 2022). *Recognizing that the proportion of rougheye rockfish is much smaller in the BSAI than in the GOA and that species identification remains an issue, the SSC requests the author, to the extent possible, separate survey trends by species to refine understanding of species-specific impacts.*

The purpose of this report is to address the items above that concern the BSAI blackspotted/rougheye stock assessment and its input data, and present potential options for the 2024 assessment.

1) Inclusion of the IPHC longline survey in the model

Estimates of the Relative Population Number (RPN) are available from the IPHC longline survey beginning in 1998. The sampling design for this survey was substantially changed beginning in 2021, with no sampling in the WAI.

In a 2022 document presented to the BSAI Plan Team, it was noted that the IPHC RPN values are generally consistent with the AFSC trawl survey (r^2 = 0.71). However, this correlation only used the years in common for both time series and does not reflect the period in the late 1990s when the AI longline survey was relatively stable but the IPHC survey declined sharply (Figure 14A.1).

A model that includes the IPHC was run (model 24.1), and was compared to the 2022 assessment model (model 20) with respect to several quantities. The fit to the IPHC longline survey generally shows a poor residual pattern with the early 1990s years with high IPHC RPNs being underfit and most years between 2005 and 2015 being overfit (Figure 14A.2).

The fit to the AI trawl survey was similar between the two models, with the exception of the years since 2015 in which the model 24.1 shows a relative stable biomass trend, in contrast with model 20 which showed a more pronounced biomass increase (Figure 14A.3). This pattern also holds for the AI total biomass (Figure 14A.4).

Inclusion of the IPHC longline survey had very little effect on the fits to the age and length composition data. In Figures 14A.5 and 14A.6, the observed and predicted age and length compositions, respectively, are shown for the two models, aggregated across years and weighted by the year-specific data weightings within each data type used in the 2022 assessment. The predicted age compositions for the AI trawl survey are nearly identical to each other (Figure 14A.5, upper panel), and the predicted fishery age compositions are differ only slightly from each other (Figure 14A.5, lower panel). The fit to the fishery length composition data are also very similar between the models (Figure 14A.6).

The IPHC longline survey does not have any size or age composition data available for blackspotted-rougheye rockfish, as length and otoliths are only routinely sampled for halibut. Thus, there is no information by which to estimate a survey selectivity curve for the IPHC survey, and the estimated IPHC selectivity in model 24.1 is 1 for all ages (Figure 14A.7). The assumption that young fish are fully selected in this survey is in contrast with the AI trawl survey, and accounts for the differences in the biomass trends between the two models. In the 2022 assessment, the cause of the rapid increase in biomass in recent years was the observation of young fish for which AI trawl survey selectivity is typically small, which leads to an inference of large recent recruitment. If all ages are equally selected in the IPHC longline survey, then large recent year classes are not necessary to fit the scale of the IPHC index, and the lower level of recruitments results in a flatter trend of total biomass in recent years.

2) Comparison of size compositions between survey and fishery data

Comparisons between fishery and survey size compositions can help assess whether a portion of the size groups exist in the survey data but not the fishery data. As mentioned above, size composition data for blackspotted/rougheye rockfish are not available in the IPHC longline survey. The available data sets with size composition data are the AI trawl survey, the AFSC longline survey, and the fishery data separated by the trawl and longline gear types. The length compositions for the AFSC longline survey were restricted to the AI area covered by this survey, which is the EAI and a portion of the CAI. The length compositions for the fishery and the AFSC trawl survey were restricted to the EAI and CAI and shown separately for each of these areas. Comparisons between the fishery and survey size compositions are shown in Figure 14A.8 by area for different time periods. Each of the time periods shows the combined size composition for 3 years of fishery catch that bracket a year in which both the AI trawl survey and the AI portion of the AFSC longline survey were conducted.

For most of the early comparisons in the EAI, the cumulative size distributions for the AI trawl survey and the AFSC longline survey are very similar to each other, particularly for sizes above 40 cm, although in the 2009-2011 and 2001 – 2013 time periods the trawl survey has a larger proportion of smaller fish (i.e., ~ 30 cm). In the CAI, the size distributions between the two surveys are also similar to each other, but the longline survey shows slightly larger fish in the 1999-2001, 2001-2003, and 2003-2005 periods. In the most recent periods (i.e., 2013-2023), the trawl survey typically shows larger proportions of smaller fish than the longline survey.

The size compositions from the fishery trawl and longline gear show a variety of patterns relative to the survey data, either larger sizes (EAI, 1999-2001, 2001-2003), smaller sizes (CAI, 2011-2013), bracketing the survey compositions (EAI, 2011-2013), or sizes similar to the survey data (CAI, 1999-2001, 2001-2003, 2003-2005 and EAI 2015-2017).

In most of the time periods, the cumulative proportions are very similar at the upper end of the distributions (i.e., about the 90% percentile), indicating that the largest fish seen is similar between the fishery and surveys. In the EAI since 2015, the longline survey has observed larger fish than the trawl survey. However, the sizes observed at the 90% percentiles in both the trawl and longline fishery data are either similar to or larger than those in the longline survey.

In summary, there are a variety of patterns observed in comparing the fishery size compositions to the two surveys, but there is not an indication of larger sizes in the population than in the fishery.

3) Rate of blackspotted/rougheye catch to Pacific ocean perch catch in the AI survey tows.

Catches from the survey are expressed as catch per unit effort (CPUE; kg/km^2), and the rate catches are defined as (rougheye-blackspotted CPUE)/(POP CPUE). This rate is defined only for those hauls with a positive catch of POP. The proportion of AI survey tows with positive POP catches has increased from approximately 50% in the early 1990s to greater than 70% since 2014 (Figure 14A.9a). For the tows with positive POP catch, the proportion that also had positive rougheye catch has been relatively consistent prior to the 2022 survey and averaged 34%; however, the value for the 2022 survey increased to 44%. The mean bycatch rate ranged between 0.84 and 2.37 between the 1991 and 2006 survey with an average of 1.45. However, in the 2010 – 2022 surveys the bycatch rates ranged between 0.16 and 0.59 with an average of 0.31. These data suggest that the decline in the bycatch rate is not due to increasing number of POP tows with no blackspotted/rougheye catch, but rather smaller sizes of blackspotted/rougheye being caught in the survey. This conclusion is also supported by the smaller sizes observed in the survey length composition data.

Summary, and recommendations for November 2024 assessment

Inclusion of the IPHC RPN values for blacksptted/rougheye in the assessment is not recommended. The lack of blackspotted/rougheye size and age composition data for this survey precludes the estimation of a survey selectivity curve, without which the scaling of the survey index to population abundance cannot be reliably estimated.

A variety of patterns were observed in comparing the fishery size compositions to the two surveys, but there is not an indication of larger sizes in the population than in the fishery. Additionally, examination of bycatch rates, and the percent occurrence of blackspotted rougheye in tows with positive POP catch, indicate that the decline in the bycatch rate is not due to increasing number of POP tows with no blackspotted/rougheye catch, but rather smaller sizes of blackspotted/rougheye being caught in the survey. Finally, the length compositions and the bycatch rates are consistent with previous data presented to the Plan Team, which noted that the declines in size were observed in both the fishery and AI trawl survey.

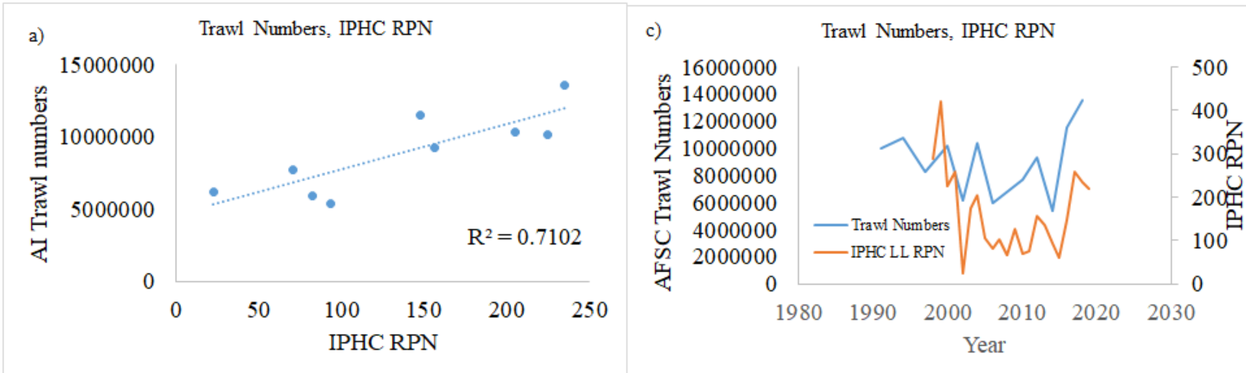

Figure 14A.1. Correlation between IPHC longline survey RPN estimates and AFSC trawl survey abundance estimates from the Aleutian Islands (areas WAI, CAI, and EAI).

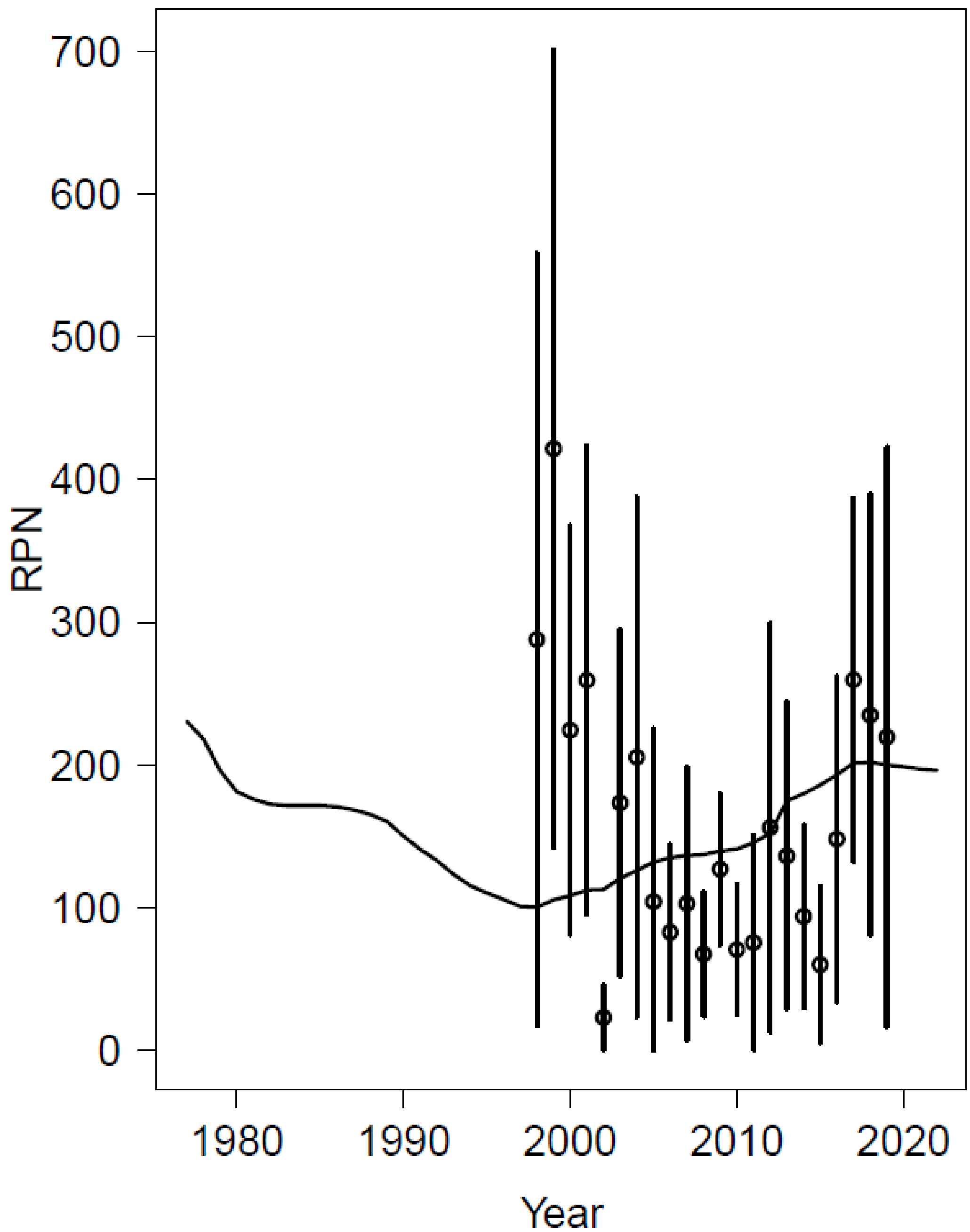

Figure 14A.2. Fit to the IPHC RPN time series for model 24.1.

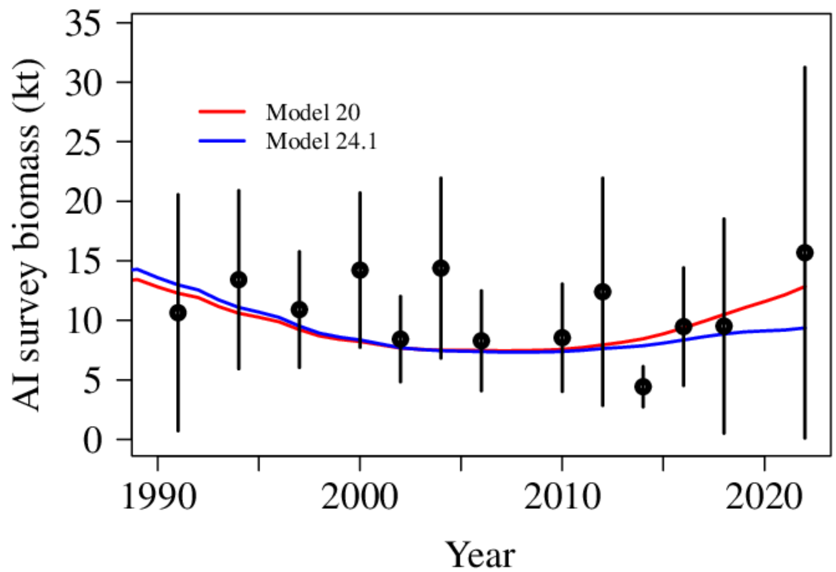

Figure 14A.3 Fit to the AI survey biomass time series for models either with (model 24.1) and without (model 20) inclusion of the IPHC RPN values for blackspotted/rougheye.

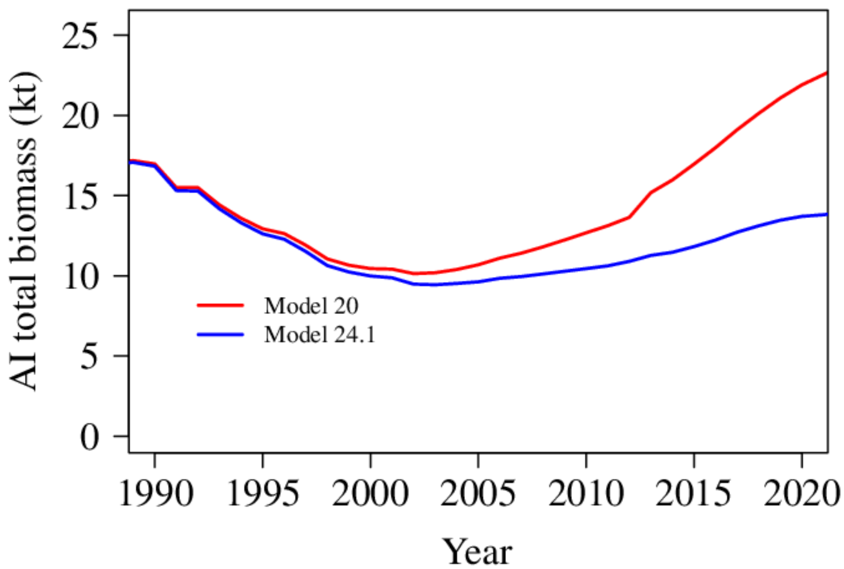

Figure 14A.4. Estimated total biomass for models either with (Model 24.1) and without (Model 20) inclusion of the IPHC RPN values for blackspotted/rougheye rockfish.

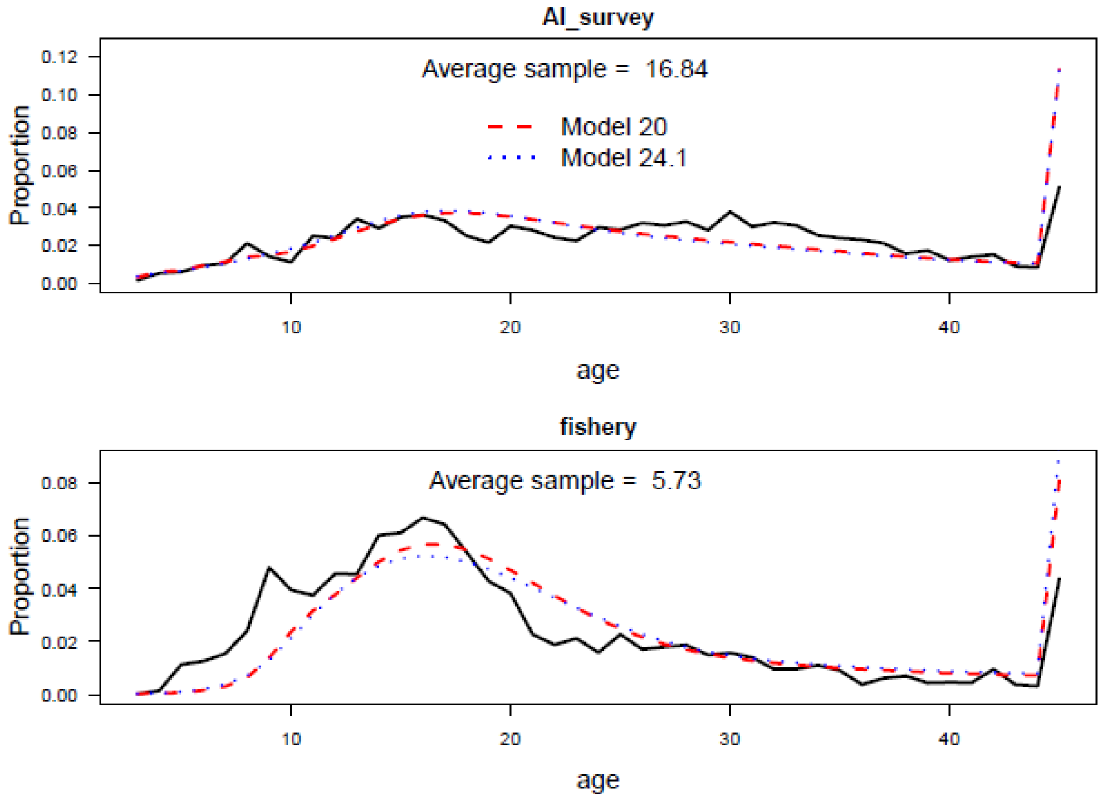

Figure 14A.5. Aggregated age composition data and fits from models either with (model 24.1) and without (model 20) for the AI survey and fishery. Years within a data type were weighted by the year-specific sample size.

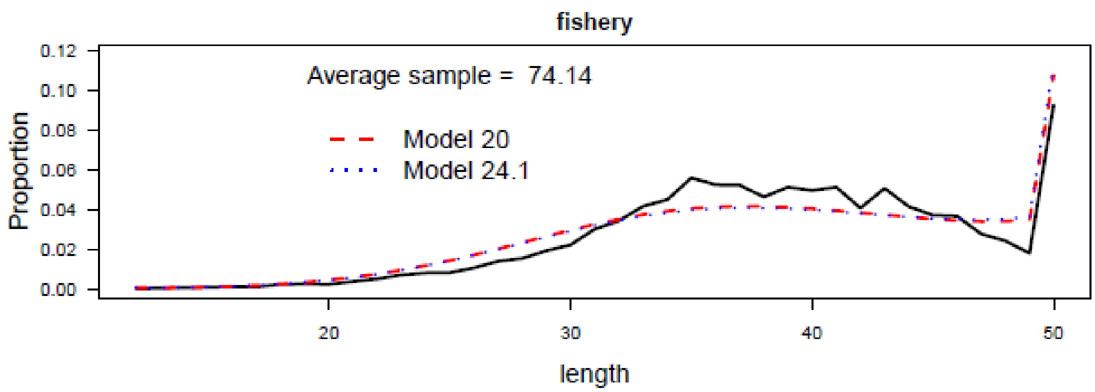

Figure 14A.6. Aggregated length composition data and fits from models either with (model 24.1) and without (model 20) for the AI fishery. Years within a data type were weighted by the year-specific sample size.

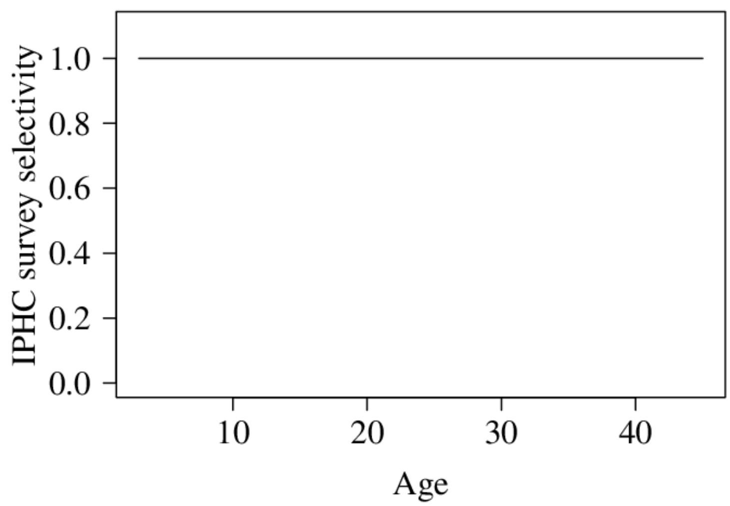

Figure 14A.7. Estimated survey selectivity for the IPHC RPN survey index in model 24.1.

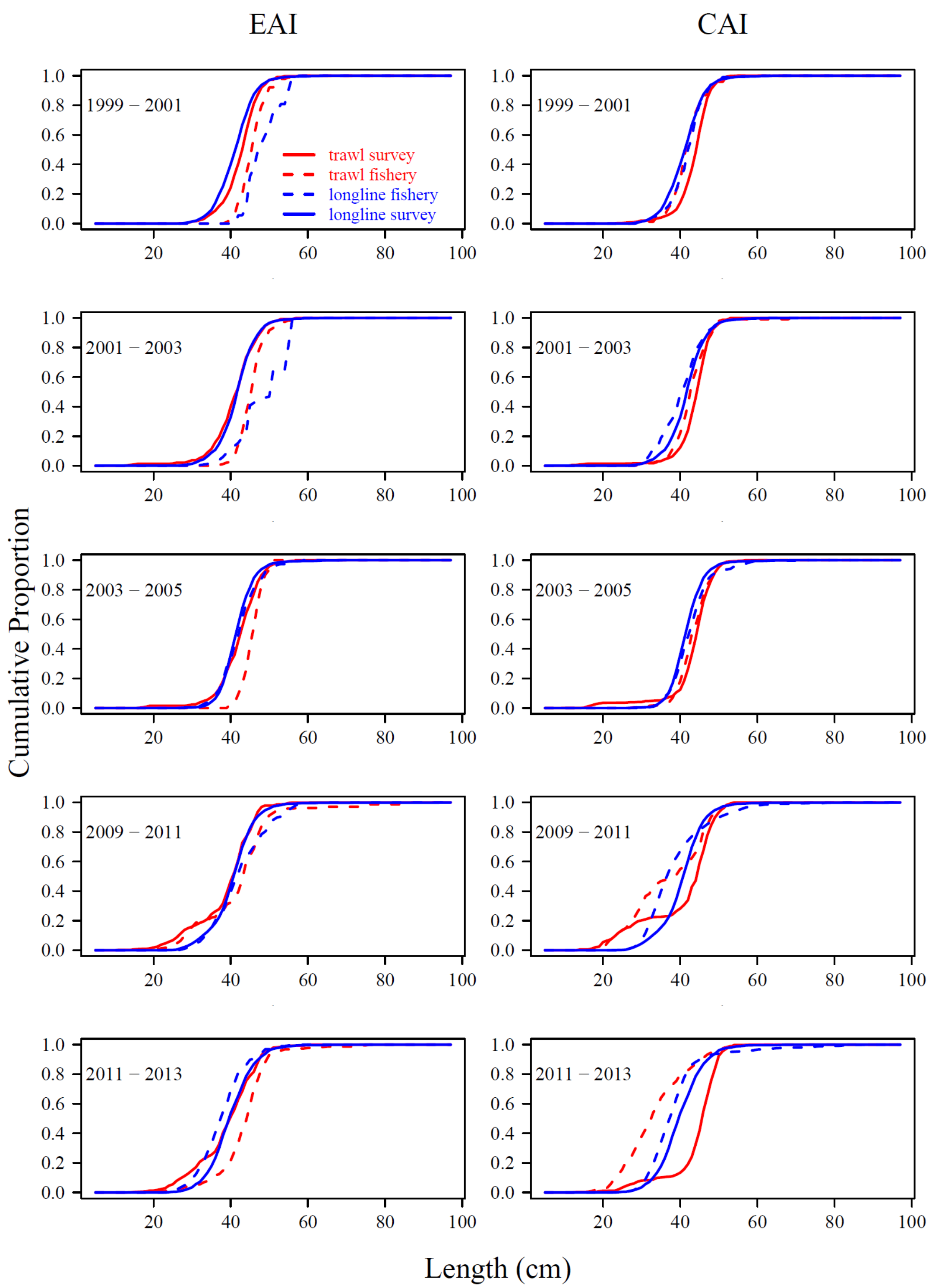

Figure 14A.8. Cumulative distributions of fish size in the AI trawl survey, AFSC longline survey (AI area), and the AI fishery (separated by trawl and longline gear), by area and time periods.

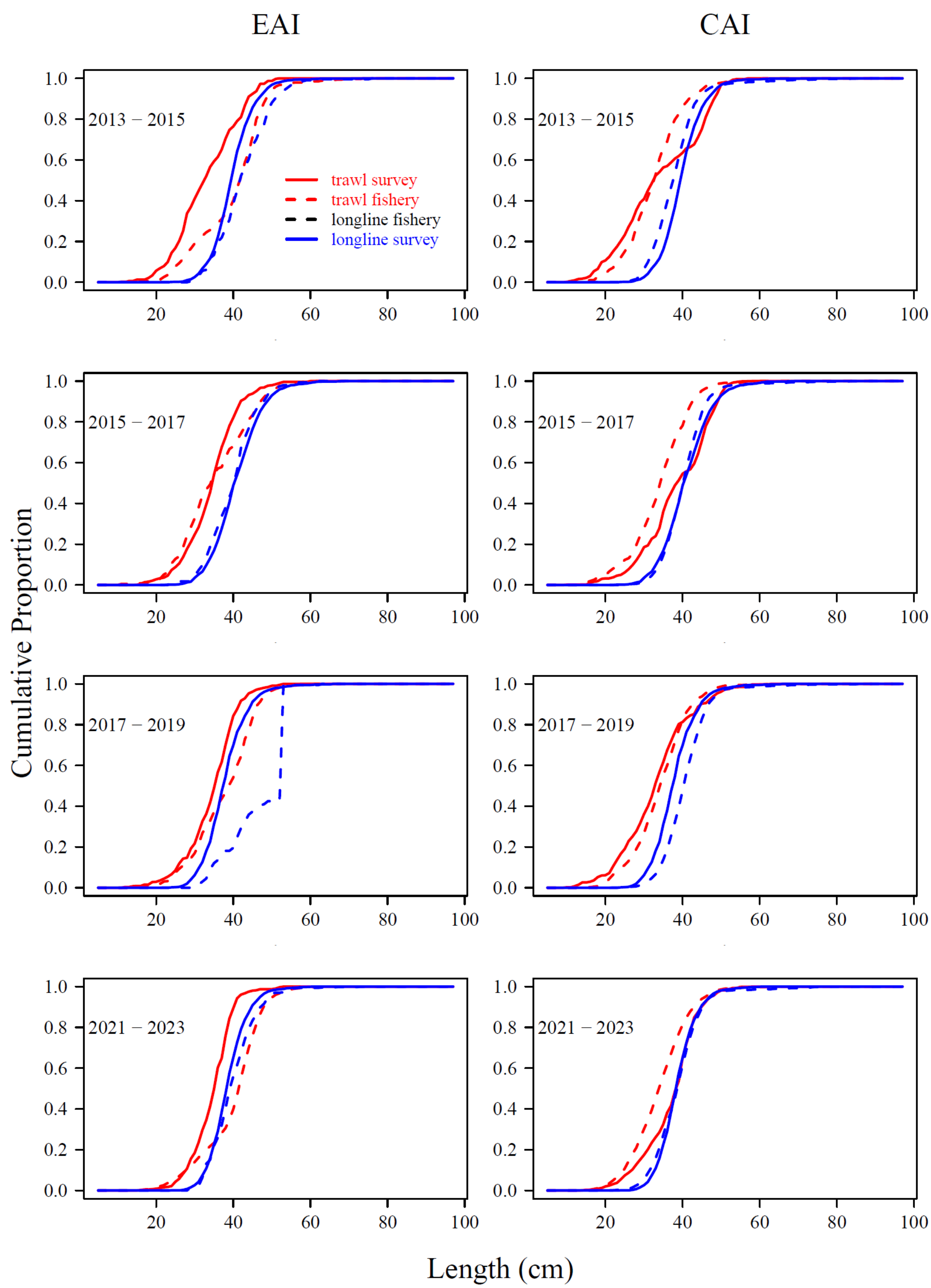

Figure 14A.8, continued).

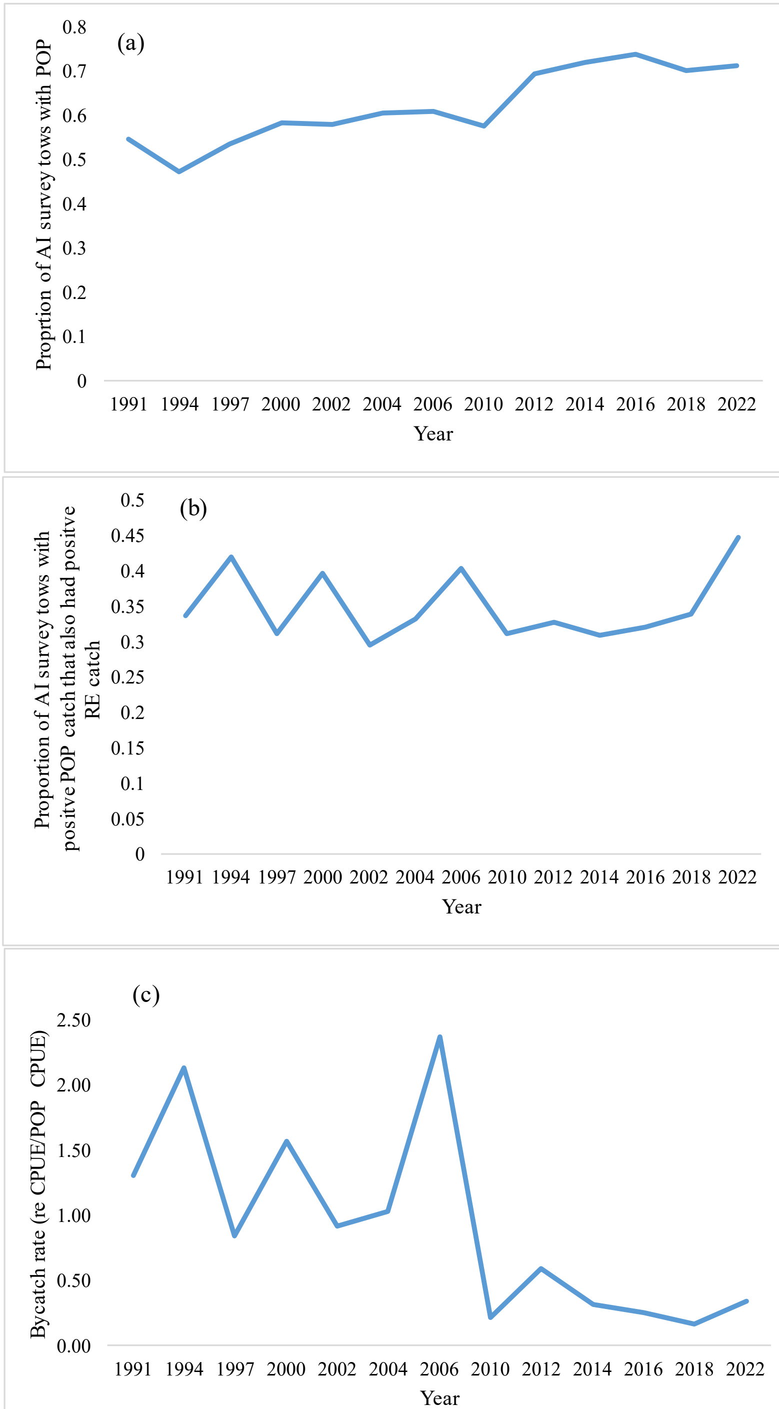

Figure A.9. Proportion of AI survey tows with POP (a), occurrence of blackspotted/rougheye rockfish in AI survey tows with POP (b), and bycatch rates of rougheye to POP in the AI survey (c).

Appendix 14B. Area-specific exploitation rates

Area-specific exploitation rates are defined here as the yearly catch within a subarea divided by an estimate of the subarea biomass at the beginning of the year. Area-specific exploitation rates are generated to assess whether subarea harvest is disproportionate to biomass, which could result in reductions of subarea biomass for stocks with spatial structure.

For each year from 2004 through 2024, the biomass for the subareas was obtained by partitioning the estimated total AI biomass (ages 3+) at the beginning of the year (obtained from 2024 AI blackspotted/rougheye age-structured model). The biomass estimates from the 2024 AI age-structured model are assumed to be the best available information on the time series of total biomass for the AI area, and this method can be considered a "retrospective" look at past exploitation rates. The distribution of biomass across the AI subareas was obtained by fitting a random walk smoother (with changes in biomass modeled as random effects) to the time series of biomass within each subarea, and computing the relative spatial distribution of the smoothed results. The smoothed biomass estimates for the SBS area and the EBS slope survey were used as the best available biomass estimates for the EBS area. Catches through October 5, 2024, were obtained from the Catch Accounting System database.

To evaluate the potential impact upon the population, exploitation rates were compared to two reference levels: 1) 0.75 times the estimated rate of natural mortality (M), which is the fishing mortality F_{abc} that produces the allowable biological catch for Tier 5 stocks; and 2) the exploitation rate for each year that would result from applying a fishing rate of $F_{40\%}$ to the estimated beginning-year numbers, and this rate is defined as $U_{F40\%}$. The $U_{F40\%}$ rate takes into account maturity, fishing selectivity, size-at-age, and time-varying number at age, and thus may be seen as more appropriate for Tier 3 stocks because harvest recommendations are based upon this age-structured information. Blackspotted/rougheye rockfish were assessed as a Tier 5 stock prior to 2009, and as a Tier 3 stock since 2009.

The exploitation rate in the WAI has been above $U_{F40\%}$ for each year since 2004. Exploitation rates in the WAI from 2014 to 2017 have declined from generally higher levels from 2004-2013 (Figure 14B.1). However, the WAI exploitation rate in 2020 increased to 0.09, the largest observed since 2006 and approximately 4.4 times $U_{F40\%}$ reference value of 0.019, before declining from 2021 to 2023. The exploitation rates for the CAI have also been increasing and were above $U_{F40\%}$ from 2019 - 2021. The exploitation rates in the EBS have increased rapidly from 2018 – 2023, and averaged 4.2 times $U_{F40\%}$ from 2021 – 2023 before decreasing to 1.2 times $U_{F40\%}$ in 2024 (based on the partial year 2024 catches). It is important to note that in recent years, blackspotted/rougheye rockfish have been managed as Tier 3b stock and the F values used for management were lower than $F_{40\%}$.

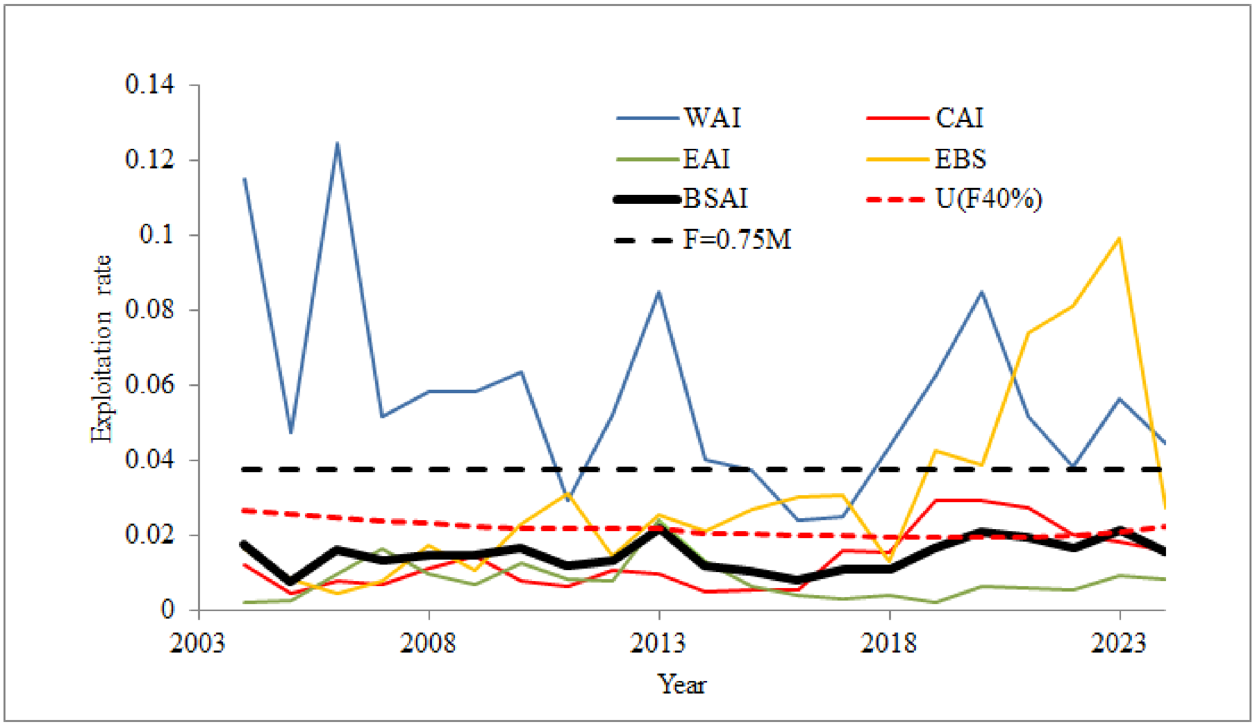

Figure 14B.1. Exploitation rates within BSAI subareas for blackspotted/rougheye rockfish, with reference exploitation rates of 0.75*M and $U_{F40\%}$.

Appendix 14C. Supplemental Catch Data.

In order to comply with the Annual Catch Limit (ACL) requirements, non-commercial removals that do not occur during directed groundfish fishing activities are reported (Table 14C.1). In these datasets, blackspotted /rougheye rockfish are often reported as rougheye rockfish. 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 BSAI blackspotted/rougheye rockfish, these estimates can be compared to the trawl research removals reported in previous assessments. BSAI blackspotted/rougheye 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 blackspotted/rougheye rockfish. The annual amount of blackspotted/rougheye rockfish captured in research longline gear did not exceed 1.1 t. Total removals ranged between 2010 and 2023 ranged between 0.005 t and 1.08 t.

Appendix Table 14C.1. Removals of BSAI blackspotted/rougheye rockfish (t) 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.

Year	Source	Trawl	Longline	Other
1977	NMFS-AFSC survey databases	0.000		
1978		0.002		
1979		0.468		
1980		6.844		
1981		1.086		
1982		0.963		
1983		9.780		
1984		0.000		
1985		3.719		
1986		24.241		
1987		0.006		
1988		0.200		
1989		0.001		
1990		0.018		
1991		1.994		
1992		0.014		
1993		0.000		
1994		2.769		
1995		0.003		
1996		0.001		
1997		2.596		
1998		0.000		
1999		0.010		
2000		3.343		
2001		0.001		
2002		2.276		
2003		0.011		
2004		3.499		
2005		0.001		
2006		1.976		
2007		0.001		
2008		0.205		
2009		0.006		
2010	AKFIN database	0.133	0.424	
2011		0.005	0.154	
2012		0.132	0.300	
2013		0.000	0.299	
2014		0.032	0.508	
2015		0.000	0.216	
2016		0.048	0.334	
2017		0.000	1.080	
2018		0.018	0.623	
2019		0.000	1.009	
2020		0.000	0.149	
2021		0.000	0.175	
2022		0.067	0.340	
2023		0.005	0.000	