14. Assessment of the Blackspotted and Rougheye Rockfish Stock Complex in the Bering Sea and Aleutian Islands

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Executive Summary

In 2022 a full assessment was conducted for the BSAI blackspotted and rougheye rockfish complex (https://apps-afsc.fisheries.noaa.gov/Plan_Team/2022/BSAIrougheye.pdf). A harvest projection assessment is conducted this year by revising the recent catch data and re-running the projection model using the results from the previous full assessment as a starting point for the Aleutian Islands portion of the stock, with the eastern Bering Sea portion assessed with Tier 5 methods applied to survey biomass estimates. Therefore, this update does not incorporate any changes to the 2022 assessment methodology, but does update the catch estimates for 2022 and provides an estimated catch for 2023. This assessment also includes estimates of catch/biomass (i.e., exploitation rates), using estimated total biomass from the 2022 assessment and updated projection model.

Summary of Changes in Assessment Inputs

Changes in input data: The updated information for this harvest projection assessment is replacing the estimated 2022 catch with the final catch value, and revising the 2023 and 2024 catch estimates. The 2022 AI catch was 341 t, 12% larger than the estimate of 305 t that was used in the 2022 projection. The estimated 2023 AI catch of 454 t was obtained by summing the reported 2023 catch through September (439 t) and the product of the remaining amount of catch under the ABC (33 t), an estimate of the proportion of the remaining Oct-Dec ABC which has been caught in recent years (105%, based on 2021 and 2022 data), and an estimate of the proportion of Oct-Dec catches obtained in the AI area (43%, based on 2021 and 2022 data). The estimated 2023 AI catch is 4.9% larger than the value of 433 estimated in the 2022 AI projection model. The estimated 2024 and 2025 catches are assumed to result from fishing at an average of the 2022 and 2023 F rates, resulting in 448 t and 482 t, respectively.

There were no changes to the input data for the Tier 5 calculation for the EBS portion of the stock.

Changes in assessment methodology: There were no changes in assessment methodology since this was a harvest projection assessment year.

Summary of Results

For the 2022 fishery, the maximum AI ABC and OFL are 453 t and 531 t, respectively, based on the updated projection model. The maximum ABC for 2022 ABC is 5% greater than the 2021 ABC of 432 and 0.7% larger than the projected 2022 ABC of 450 from the 2020 projection model.

The 2022 assessment estimated the 2010 year class to be greater than 6 times the next largest year class, with a large CV of 0.58. Because a small proportion of this year class is estimated to have reached maturity, this year class had little effect on spawning stock biomass. However, the estimated mean recruitment and $B_{40\%}$ were increased substantially, which lowered the ratio of $B/B_{40\%}$ and the recommended F_{abc} and ABC. In 2022, the value of this uncertain year class was set to that of the next largest year class for the purpose of stabilizing the estimate of the maximum ABC. Additionally, in 2022 we recommended a 2023 ABC less than the maximum ABC so as to avoid substantially increasing the ABC until more information can be obtained. The recommended 2023 ABC for the AI portion of the stock was 467 t, which was the projected 2023 value from the 2021 projection model. This ABC was 87.6% of the maximum 2023 ABC of 533 t, and this ratio between recommended ABC and max ABC is also applied for this harvest projection. A summary of the updated projection model results for the AI portion of the stock is shown below.

Quantity	As estimated or specified last year for:		As estimated or recommended this year for:	
	2023	2024	2024[*]	2025[*]
M (natural mortality rate)	0.050	0.050	0.050	0.050
Tier	3b	3a	3a	3a
Projected total (age 3+) biomass	23,856	24,374	24,315	24,743
Female spawning biomass (t)				
Projected	3,471	3,642	3,630	3,821
$B_{100\%}$	8,733	8,733	8,733	8,733
$B_{40\%}$	3,493	3,493	3,493	3,493
$B_{35\%}$	3,056	3,056	3,056	3,056
F_{OFL}	0.040	0.040	0.040	0.040
$maxF_{ABC}$	0.034	0.034	0.034	0.034
F_{ABC}	0.030	0.030	0.034	0.034
OFL (t)	626	686	684	736
maxABC (t)	533	584	583	627
ABC (t)	467	512	511	549
Status	As determined last year		As determined this year	
	2021	2022	2022	2023
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 448 t in 2024, and 482 t used in place of maximum permissible ABC for 2025. Mean recruitment and biomass reference points (i.e. $B_{xx\%}$) were based on replacing the large 2010 year class estimate of 21.25 million with 3.44 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 2023-2024 recommended ABCs for the EBS portion of the population is shown below, and is unchanged from the 2022 assessment.

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

BSAI blackspotted/rougheye rockfish was not subjected to overfishing in 2022. 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.

BSAI blackspotted/rougheye rockfish exploitation rates have averaged 0.015 from 2004-2023 (Figure 1), which is below the exploitation rate associated with fishing at $F_{40\%}$ (defined as $U_{F40\%}$). However, exploitation rates in the western AI (WAI) have been much higher than other areas, and averaged 0.057 from 2004-2023. The WAI exploitation rates have increased since 2017; the large WAI exploitation rate in 2020 results from the catch of 168 t exceeding the 2020 WAI "maximum subarea species catch" (MSSC) of 48 t. Exploitation rates are computed as the ratio of catch within a year to the beginning year biomass (ages 3+). The estimate of biomass for 2023 was updated from re-running the projection model with updated catch data, where the biomass estimates for other years were obtained from the 2022 stock assessment. Exploitation rates for BSAI subareas were obtained by using smoothed estimates of survey biomass from the random effects models to spatially partition the estimated total biomass. In 2022, the exploitation rates for all subareas except the eastern Aleutian Islands were above $U_{F40\%}$. Catches and exploitation rates in 2023, relative to the 2022 estimates, have declined have increased in the WAI but decreased in the EBS; however, the 2023 catch is through Sept 16 and thus preliminary.

Area Allocation of Harvests

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 2022 and 2023 and the recent OFLs, ABCs, TACs, and catches.

Area/subarea	Year	Total Biomass (t)[1]	OFL	ABC	TAC	Catch[2]
BSAI	2022	19,145	598	503	503	454
	2023	25,400	703	525	525	492
	2024	25,859	761	569	n/a	n/a
	2025	26,287	813	607	n/a	n/a
Western/Central Aleutian Islands	2022			177	177	250
	2023			166	166	302
	2024			181	n/a	n/a
	2025			195	n/a	n/a
Eastern AI/Eastern Bering Sea	2022			326	326	204
	2023			359	359	190
	2024			388	n/a	n/a
	2025			412	n/a	n/a

[1]The total biomass is from an AI age-structured model and survey biomass estimates from EBS.
[2]BSAI catch as of September 16, 2023.

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 2024 and 2025 MSSC values are shown below.

Year	WAI MSSC	CAI MSSC
2024	67	114
2025	71	124

Responses to SSC and Plan Team Comments on Assessments in General

(SSC, December 2022) *The SSC highlights that in several cases adjustments to estimated recruitment were proposed for forward projection as a way to deal with large and highly uncertain recruitment events. The SSC highlights that ad hoc adjustments are less than ideal in this context and that model-based approaches to constraining extreme and uncertain recruitments are preferred. In cases where a revised or fixed recruitment estimate for a year class is assumed, the SSC requests:*

● Authors include a footnote in the projection summary table (Executive Summary table in SAFE chapters) indicating the exact nature of the adjustment to recruitment for transparency.

● Authors include a figure showing how previous recruitment estimates have changed, or been revised downward, in past years with the addition of new data (similar to Fig 3.33, pg. 88 in the 2022 Sablefish SAFE chapter), in addition to the standard retrospective figure for recruitment.

A footnote was added to the Executive Summary noting that mean recruitment and biomass reference points (i.e. $B_{xx\%}$) were based on replacing the large 2010 year class estimate of 21.25 million with 3.44 million (the estimate for the 2002 year class, the next largest).

The 2022 assessment contains a recruitment "squid plot" indicating that unusually large estimates of the 2010 year class began with the 2018 retrospective peel. These squid plots, and plots of changes in recruitment estimates with the addition of new data, will be updated in future assessments.

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. It may also be possible to continue use of the time series of IPHC data after 2019 if model-based estimates are used.*

The utility of the pre-2020 IPHC RPN estimates can be evaluated in future stock assessments. However, it was noted in the 2022 stock assessment that the correlation referenced above by the SSC was based on those years in which both the IPHC survey and AI trawl survey were conducted (i.e., post-1999), and this excluded a portion of the period from the late-1990 – early 2000s in which the IPHC RPNs decreased sharply but the AFSC trawl estimates were relatively stable.

We are not aware of model-based estimates from the IPHC survey. Given the substantial time and effort associated with producing these estimates, it would seem preferable if the stocks for which these may be of interest could be identified and produced in an efficient manner, analogous to the work of the AFSC "ModSquad" group that produces model-based indices for AFSC survey data.

(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.*

The size compositions in the NMFS and IPHC longline data, and the ratios of blackspotted/rougheye catches to Pacific ocean perch catches in the survey data, will be examined in future assessments.

(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 biomass estimates of blackspotted and rougheye rockfish, by species, in the AI survey is show below (CVs in parentheses):

Year	West AI Blackspotted	West AI Rougheye	Central AI Blackspotted	Central AI Rougheye	East AI Blackspotted	East AI Rougheye	Southern Bering Sea Blackspotted	Southern Bering Sea Rougheye	Total AI Survey Blackspotted	Total AI Survey Rougheye
2006	519 (0.29)	0	4,732 (0.40)	227 (0.71)	2,763 (0.33)	40 (0.59)	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)	8,090 (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 (0.99)	577 (0.36)	23 (0.69)	9,414 (0.26)	55 (0.87)
2018	632 (0.34)	0	2,324 (0.37)	25 (0.76)	6,442 (0.68)	93 (0.72)	313 (0.28)	15 (0.78)	9,397 (0.48)	118 (0.59)
2022	1,786 (0.20)	6 (0.61)	3,024 (0.38)	29 (0.71)	10,771 (0.71)	63 (0.92)	430 (0.45)	213 (0.53)	15,582 (0.50)	98 (0.63)

As noted in the 2022 assessment, rougheye rockfish are rarely found in Aleutian Islands west of the southern Bering Sea, and this finding is supported by genetic and morphological studies.
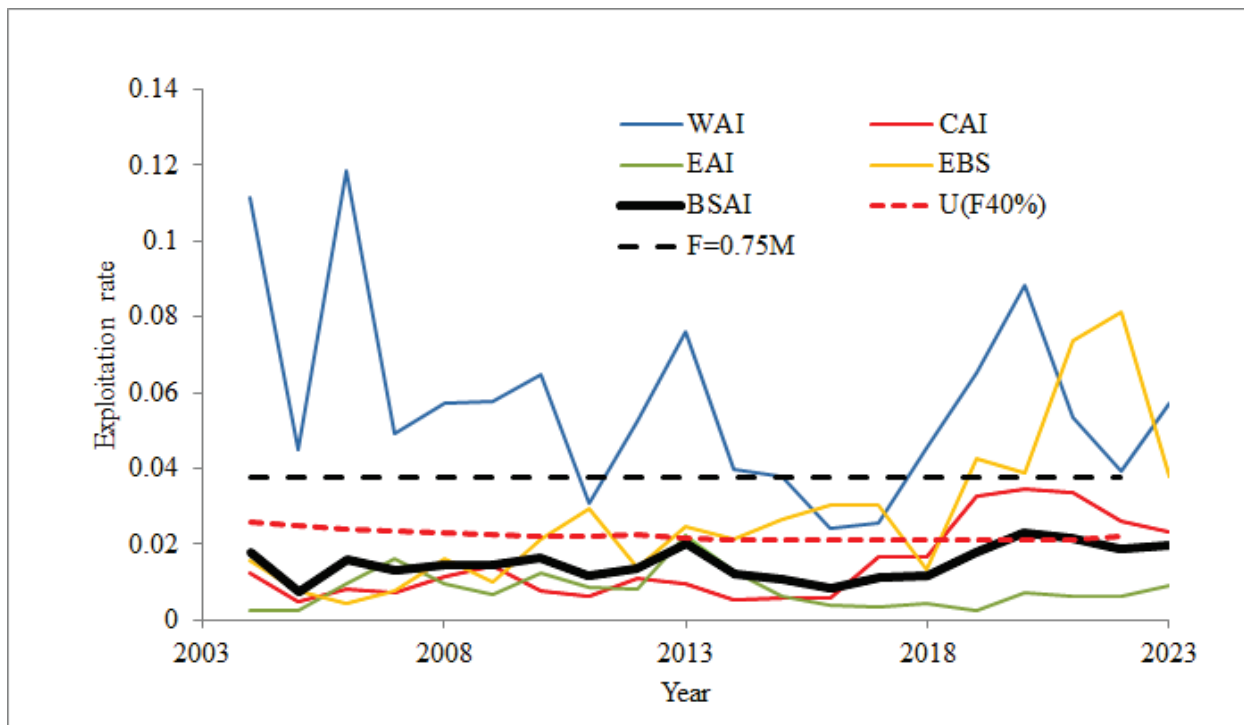
Figure 1. Exploitation rates for BSAI blackspotted and rougheye rockfish. The $U_{F40\%}$ is the exploitation rate for each year that would occur from fishing at $F_{40\%}$, and is a function of the beginning year numbers at age, size at age, and fishing selectivity. Exploitation rates for 2023 are preliminary and based on catch through September 16, 2023.