13. Assessment of the Northern Rockfish Stock in the Bering Sea and Aleutian Islands

by

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Executive Summary

In 2005, Bering Sea/Aleutian Islands (BSAI) rockfish were moved to a biennial assessment schedule with full assessments in even years to coincide with the frequency of trawl surveys in the Aleutian Islands (AI) and the eastern Bering Sea (EBS) slope. In 2017, the scheduled frequency for some stock assessments was changed in response to the National Stock Assessment Prioritization effort. Bering Sea/Aleutian Islands (BSAI) northern rockfish will maintain a biennial schedule but with full assessments in odd years, with the next full assessment scheduled for 2021. The 2019 full assessment can be found at https://apps-afsc.fisheries.noaa.gov/refm/docs/2019/BSAInork.pdf. In years without a full assessment, a "partial assessment" is produced by revising the recent catch data and re-running the projection model using the results from the previous full assessment as a starting point. Therefore, this update does not incorporate any changes to the 2019 assessment methodology, but does update the catches for 2018-2020 and provides estimated catches for 2021-2022. The partial assessment also includes estimates of catch/biomass (i.e., exploitation rates), using estimated total biomass.

Summary of Changes in Assessment Inputs

Changes in input data: The updated information for this partial assessment is replacing the estimated 2019 catch with the final catch value, and revising the 2020 and 2021 catch estimates. The 2019 catch was 9,058 t, 3% larger than the estimate of 8,828 t that was used in the 2019 projection. The 2020 catch is projected to be 8,946 t, 29% larger that the estimate of 6,930 in the 2019 projection. This increase results from the estimated 2020 F of 0.033 being approximately 32% larger than the projected 2020 F of 0.025. The estimated 2021 and 2022 catches are assumed to result from fishing at the estimated 2020 F, resulting in 8,574 t and 8,258 t, respectively.

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

Summary of Results

For the 2021 fishery, we recommend the maximum ABC of 15,557 t and an OFL of 18,917 t based on the updated projection model. The recommended 2021 ABC is 4.2% smaller than the 2020 ABC of 16,243 and 0.8% smaller than the projected 2021 ABC of 15,683 from the 2019 projection model. A summary of the updated projection model results is shown below.

Quantity	As estimated or specified last year for:		As estimated or recommended this year for:	
	2020	2021	2021*	2022*
M (natural mortality rate)	0.048	0.048	0.048	0.048
Tier	3a	3a	3a	3a
Projected total (age 3+) biomass (t)	250,235	246,384	244,600	240,022
Female spawning biomass (t)				
Projected	111,476	108,063	107,003	103,467
$B_{100\%}$	159,850	159,850	159,850	159,850
$B_{40\%}$	63,940	63,940	63,940	63,940
$B_{35\%}$	55,947	55,947	55,947	55,947
F_{OFL}	0.075	0.075	0.075	0.075
$maxF_{ABC}$	0.061	0.061	0.061	0.061
F_{ABC}	0.061	0.061	0.061	0.061
OFL (t)	19,751	19,070	18,917	18,221
maxABC (t)	16,243	15,683	15,557	14,984
ABC (t)	16,243	15,683	15,557	14,984
Status	As determined last year for: for:		As determined this year for:	
	2018	2019	2019	2020
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 8,574 t and 8,258 t used in place of maximum permissible ABC for 2021 and 2022.

BSAI northern rockfish was not subjected to overfishing in 2019, and is not overfished or approaching an overfished condition.

BSAI northern rockfish exploitation rates have averaged 0.017 from 2004-2020 (Figure 13.1), which is below the exploitation rate associated from fishing at $F_{40\%}$ (defined as $U_{F40\%}$). Exploitation rates are computed as the ratio of catch within a year to the beginning year biomass (ages 3+). The estimates of biomass for 2020 were updated by re-running the projection model with updated catch data, where biomass estimate for other years were obtained from the 2019 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. The exploitation rates from the BSAI subareas are below $U_{F40\%}$. The exploitation rate in the eastern Aleutian Islands peaked in 2015 and 2019, but was substantially lower in 2020. The exploitation rates in the central Aleutian Islands have been increasing since 2014. The biomass estimates in the southern Bering Sea area are not viewed as reliable due to relatively large standard deviations and high variability between years, which accounts for the unusually high exploitation rates from 2009 - 2017.

Summary table for the Plan Team

Year	Biomass[1]	OFL	ABC	TAC	Catch[2]
2019	244,196	15,507	12,664	6,500	9,058
2020	256,262	19,751	16,243	10,000	8,227
2021	244,600	18,917	15,557		
2022	240,022	18,221	14,984		

[1] Total biomass (ages 3+) from age-structured projection model.
[2] Catch as of October 10, 2020.

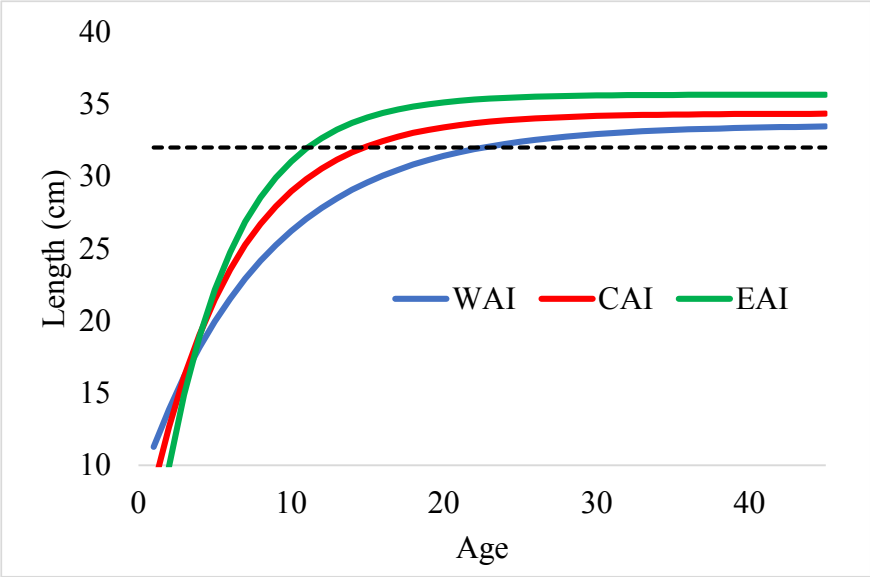
SSC and Plan Team comments are listed below. In general, responses to comments relating to analyses of the age-structured assessment model are deferred until the next full assessment, currently scheduled for 2021.

Responses to SSC and Plan Team Comments Specific to this Assessment

SSC (December, 2019). *The SSC was surprised to see a dramatic change in the survey age compositions from what appeared to be relatively small differences in length-at-age by sub-area.*

The interpretation that the differences in the length-at-age between subareas is "relatively small" is not consistent with the conclusion of the BSAI Plan Team, who stated in the minutes of their September 2019 meeting that ". . . *there are strong spatial patterns in length at age and abundance: western AI fish are smallest and get larger for a given age eastward, meanwhile most of the population abundance is in the western AI"*.

The graph below of size at age by subarea is a modified version from one that was in the 2019 assessment that might help illustrate the effect of growth curves on estimation of age composition. Because northern rockfish are often observed at sizes above 25 cm, at which point size at age begins to decelerate more rapidly, the difference in the estimated age for fish at a given size between the subareas can be substantial. An example is shown below for a fish of 32 cm, which would be an estimated 22.4 years old in the western Aleutian Islands but 11.9 years old in the eastern Aleutian Islands. Most of the population occurs in the western Aleutian Islands, and procedures that downweight this area (which occurred when weighting the subareas by the otolith sample size when length-stratified otolith sampling occurred) would produce age compositions with relatively more young fish and relatively fewer older fish compared to procedures that weight the subareas by the stock abundance.



Estimated size at age subarea; the estimated age of a 32 cm fish is 22.4 in the WAI and 11.9 in the EAI.

SSC (December, 2019). *The SSC noted that yearly age samples by subarea were sometimes under 100 otoliths and that an age-length key that sparse would be very challenging for estimating the age composition, particularly for infrequently caught young northern rockfish.*

The estimation of subarea age-length keys uses data from the "global" key to fill in gaps when age data within a subarea does not exist for a length bin.

The number of ototiths collected in the AFSC AI survey for the WAI, CAI, and EAI subareas has exceeded 100 for each year since 1997. The number of otoliths collected in the southern Bering Sea area has not exceeded 100, primarily because the abundance of northern rockfish in this very small (i.e., never exceeding 6% of the smoothed survey abundance). For the same reason, the estimated age composition in this area would have a minor effect on the average age composition because the subareas are weighted by abundance.

SSC (December, 2019). *The SSC requests further evaluation for 2022 of these sub-area age-length keys for the survey and whether the big differences are related to small sample size, sampling design (by comparing random to length-stratified estimates), or some other factor.*

The big differences in the age compositions with weighting by subarea abundance result from 3 factors: 1) a strong spatial pattern in size at age, with the smallest fish in the WAI; 2) the concentration of most of the stock in the WAI; and 3) a pattern of disproportionate sampling of otoliths (i.e., in the years with length stratified sampling, the WAI was underrepresented in the otolith sample relative to its abundance, whereas other areas were overrepresented).

Given the small sample size in the southern Bering Sea area, one could arguably omit this area when computing the weighted averages, although as noted above this would likely have only a minor effect on the results.

An analysis of the effect of length-stratified sampling on the disproportionate sampling of otoliths is

contained in the 2019 assessment, both between the fishery and survey data and within the survey before and after the initiation of random sampling. Briefly, the use of random sampling largely reduces the disproportionate sampling of otoliths such that the differences in results from weighting subareas by abundance or otoliths are largely reduced.

SSC (December, 2019). *The SSC also notes that the aging error matrix is currently based on GOA northern rockfish information and requests that it be updated using BSAI information, if possible.*

These will be addressed in the next full assessment for BSAI northern rockfish, scheduled for 2021.

BSAI PT (November 2019). *The Team recommended addressing the issues concerning the restrictive priors on key parameters in the model and exploring alternatives for estimating survey selectivity.*

These will be addressed in the next full assessment for BSAI northern rockfish, scheduled for 2021.

BSAI PT (November 2019). *The Team recommended exploring global age-length keys that weight by population size between areas*

These will be addressed in the next full assessment for BSAI northern rockfish, scheduled for 2021.

Figures

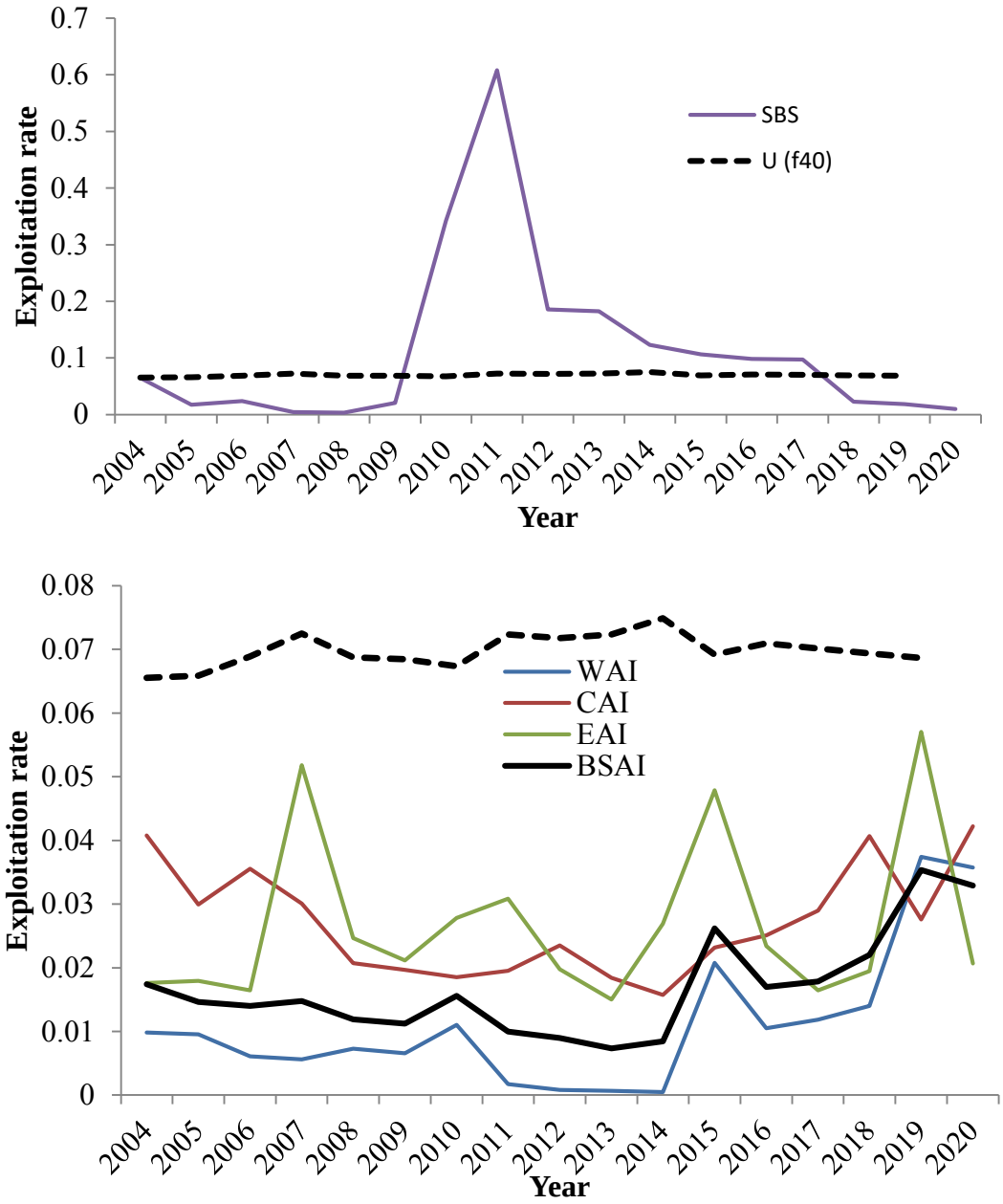


Figure 13.1. Exploitation rates for northern rockfish. The $U_{F40\%}$ is the exploitation rate for each year that would occur from fishing at $F_{40\%}$, and is a function of the beginning year numbers at age, size at age, and fishing selectivity. The high exploitation rates in the southern Bering Sea (SBS) area result from highly variable survey biomass estimates for this area. Exploitation rates for 2020 are preliminary and based on catch through October 10, 2020.