CHAPTER 13

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

by

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Executive Summary

In 2005, BSAI rockfish were moved to a biennial assessment schedule to coincide with the frequency of trawl surveys in the Aleutian Islands (AI) and the eastern Bering Sea (EBS) slope. These surveys occur in even years and for these years a full assessment of northern rockfish in the BSAI area will be conducted. The 2014 full assessment can be found at http://www.afsc.noaa.gov/REFM/docs/2014/BSAInorthern.pdf. In years without a scheduled Aleutian Islands survey, an "update" 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 2014 assessment methodology, but does include updated catch estimates for 2014-2016.

Summary of Changes in Assessment Inputs

Changes in input data: The new information for this update is replacing the estimated 2014 catch with the final catch value, and revising the 2015 catch estimate. The 2014 catch was 2,342 t, 5.1% smaller than the estimate of 2,469 t was used in the 2014 projection. The 2015 catch through October 17th was 7,040 t, an approximately three-fold increase over the total catch from recent years. The estimated 2015 catch of 7,589 t was obtained by summing the reported 2015 catch through September (6,491 t) plus an estimate of the Oct-Dec 2015 catch. The October 2015 catch through October 17 was 549 t (183 t /week), and this was doubled to obtain the Oct-Dec catch. This corresponds to the rate of catch per week observed to date in October continuing into early November, which corresponds to an estimate of when the Pacific ocean perch and Atka mackerel fisheries (i.e., the fisheries that catch northern rockfish) will end their 2015 fishing operations (Mary Furuness, NOAA-Fisheries, pers. comm.). The 2016 catch was obtained from the projection model and was based on a fishing mortality rate equal to the estimated 2015 *F*.

Changes in assessment methodology: There were no changes in assessment methodology since this was an off-cycle year.

Summary of Results

For the 2016 fishery, we recommend the maximum ABC of 11,960 t and an OFL of 14,689 t based on the updated projection model. The recommended 2016 ABC is 4.2% less than the 2015 ABC of 12,488 and 2.7% less than the projected 2016 ABC of 12,295 from the 2014 projection model. A summary of the updated projection model results is shown below.

Quantity	As estimated or specified last year for: 2015	2016	As estimated or recommended this year for: 2016	2017
M (natural mortality rate)	0.049	0.049	0.049	0.049
Tier	3a	3a	3a	3a
Projected total (age 3+) biomass	218,901	218,898	213,674	209,369
Female spawning biomass (t)				
Projected	94,873	93,540	91,648	88,326
$B_{100\%}$	144,420	144,420	144,420	144,420
$B_{40\%}$	57,768	57,768	57,768	57,768
$B_{35\%}$	50,547	50,547	50,547	50,547
F_{OFL}	0.087	0.088	0.087	0.087
$maxF_{ABC}$	0.070	0.070	0.070	0.070
F_{ABC}	0.070	0.070	0.070	0.070
OFL (t)	15,337	15,100	14,689	14,085
maxABC (t)	12,488	12,295	11,960	11,468
ABC (t)	12,488	12,295	11,960	11,468
Status	As determined last year for: 2013	2014	As determined this year for: 2014	2015
Overfishing	No	n/a	No	n/a
Overfished	n/a	No	n/a	No
Approaching overfished	n/a	No	n/a	No

BSAI northern rockfish was not subjected to overfishing in 2014, and is not overfished or approaching an overfished condition.

Summary table for the Plan Team

Year	Biomass[1]	OFL	ABC	TAC	Catch
2014	197,541	12,077	9,761	2,594	2,342
2015	218,901	15,337	12,488	3,250	7,040[2]
2016	213,674	14,689	11,960		
2017	209,369	14,085	11,468		

[1] Total biomass (ages 3+) from age-structured projection model.
[2] Catch as of October 17, 2015.

Responses to SSC and Plan Team Comments on Assessments in General

(Joint Plan Team, November, 2014) *For assessments involving age-structured models, this year's CIE review of BSAI and GOA rockfish assessments included three main recommendations for future research:*

1. *Selectivity/fit to plus group (e.g., explore dome-shaped selectivity, cubic splines)*
2. *Reevaluation of natural mortality*
3. *Alternative statistical models for survey data (e.g., GAM, GLM, hurdle models)*

The Team agreed that development of alternative survey estimators is a high priority, but concluded that this priority is not specific to rockfish, and should be explored in a Center-wide initiative (see "Alternative statistical models for survey data" under Joint Team minutes). For the remaining two items, the Team recommended that selectivity and fit to the plus group should be given priority over reevaluation of the natural mortality rate.

Selectivity curves and natural mortality rates were evaluated in the 2014 assessment. The development of alternative survey estimators (i.e., model-based standardization of survey catch data) affects all NPFMC assessments that use survey data. Potential methodologies have been discussed in a limited number of meetings in 2014 among AFSC scientists, and between AFSC scientists and NWFSC scientists. Recently, scientists at the NWFSC have developed geostatistical models for survey standardization. Evaluation of survey standardization models is expected to continue in 2016.

Responses to SSC and Plan Team Comments Specific to this Assessment

(BSAI Plan Team, November, 2014) *The Team expressed some concern about the substantial increase in the natural mortality estimate from 2012. The Plan Team recommends that Paul report back on what values for natural mortality were used in Then et al. (2014) to determine whether longevity-based estimators were superior.*

(SSC, December, 2014) *The SSC shares PT concern about the substantial increase in the natural mortality estimate from 2012 and requests the author provide further evaluation.*

The study of Then et al. (2015) evaluated the predictive performance of empirical predictors of natural mortality (M). The study considered estimators based on longevity (Hoenig 1983), growth coefficients (Jensen 1996, 2001), temperature (Pauly 1980), and both longevity and growth coefficients (Alverson and Carney 1975). The study evaluated several aspects of predictive performance, including: 1) how well the original estimators predicted M for stocks not used in the original analysis in which the estimators were developed; and 2) how well the various estimators fit a common dataset. The common dataset with complete parameter estimates of M, von Bertalanffy K, t_{max}, temperature, and L_{inf} comprised 215 fish species, spanning 143 genera with M estimates ranging from 0.014 to 5.07. Estimates of M were obtained from age-based catch curves (79% of species), length-based catch curves (5%), tagging studies (8%),and regressions of total mortality against effort (2%). The original source publications and data were evaluated to ensure that the estimates of M were obtained from direct analysis and not indirect empirical estimators, and heavily-exploited stocks (as identified by the source documents) were not used. In some cases, estimates of M and von Bertalanffy growth parameters were re-estimated based on the original data in order to validate the historical estimates. The authors found estimators based on t_{max} had approximately twice the predictive ability over estimators based on von Bertalanffy K. In particular, low estimates of predicted M from the Alverson-Carney (1975) method (as are obtained for long-lived rockfish) are often underestimates of the M values obtained from direct methods.

The estimate of northern rockfish natural mortality increased from 0.041 in the 2012 assessment to 0.049 in the 2014 assessment based some combination of additional survey and fishery data and iterative re-weighting of the age and length composition data (which was not used in the 2012 assessment). The information from Then at al. (2014) was not used in the model, as the prior distribution for *M* was identical to that in the 2012 assessment. Northern rockfish have observed maximum ages in the BSAI lower than POP and blackspotted/rougheye rockfish, and thus would be expected to have higher rates of natural mortality than either of these stocks. However, the assessment model estimate of *M* for northern rockfish is below that of POP (despite increasing to 0.049 in the 2014 assessment). Estimates of *M* larger than 0.041 are consistent with the Hoenig (1983) and Then et al. (2014) estimators, as well as with the estimates from the GOA northern rockfish assessment. This information is summarized in the table below. In future assessments, the effect of increasing the mean and/or lowering the CV for the prior on *M* can be considered.

	Max age		Empirical Estimates		Prior Distribution for M		Model estimates	
Species	AI survey	BSAI fishery	Hoenig (1983)	Then at al. (2014)	mean	CV	2014 BSAI	2013 GOA
POP	104	90	0.044	0.070	0.05	0.05	0.062	0.061
Northern rockfish	75	88	0.052	0.081	0.06	0.15	0.049	0.06
blackspotted/rougheye	121	117	0.038	0.061	0.03	0.05	0.033	0.034

Data Gaps and Research Priorities

The 2013 CIE review of Alaska rockfish assessments highlighted several areas which warrant further attention, including estimation of key model parameters such as natural mortality and maturity, the functional form and estimation of selectivity, and weighting of data (including reconstructed catch data). Evaluation of fishery selectivity was examined in the 2014 assessment. In addition, a CIE comment that had high emphasis was whether trawl survey biomass estimates sufficiently accounted for aggregated spatial distributions, and several alternatives were proposed including zero-inflated statistical distributions and GAM or GLM modeling. The analysis of trawl survey data will likely be a subject of rockfish assessment scientists in the near future, and would ideally also involve scientists from the RACE survey division. Finally, estimation of trawl survey catchability is a research priority for rockfish assessments, and should benefit from ongoing studies examining the relative densities of rockfish in trawlable and untrawlable grounds.

References

Alverson, D. L., and M.J. Carney. 1975. A graphic review of the growth and decay of population cohorts. Journal du Conseil International pour l'Exploration de la Mer, 36:133-143.

Hoenig, J. M. 1983. Empirical use of longevity data to estimate mortality rates. Fishery Bulletin, 82: 898-903.

Jensen, A. L. 1996. Beverton and Holt life history invariants result from optimal trade-off of reproduction and survival. Canadian Journal of Fisheries and Aquatic Sciences, 53:820-822.

Jensen, A. L. 2001. Comparison of theoretical derivations, simple linear regressions, multiple linear regression and principal components for analysis of fish mortality, growth and environmental temperature data. Environmetrics, 12: 591-598.

Pauly, D. 1980. On the interrelationships between natural mortality, growth parameters, and mean environmental temperature in 175 fish stocks. Journal du Conseil International pour l'Exploration de la Mer, 39: 175.

Then, A. Y., J.M. Hoenig, N.G. Hall, and D.A. Hewitt. 2015. Evaluating the predictive performance of empirical estimators of natural mortality rate using information on over 200 fish species. ICES Journal of Marine Science 72:82-92.

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