10. Assessment of the Northern Rockfish stock in the Gulf of Alaska

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Executive Summary

In 2017, the scheduled frequency for some stock assessments was changed in response to the National Stock Assessment Prioritization effort. Prior to 2017, Gulf of Alaska (GOA) rockfish were assessed on a biennial stock assessment schedule to coincide with the availability of new trawl survey data. Under the new schedule, full assessments for northern rockfish will be conducted in even years and partial assessments will be presented in odd years. For Gulf of Alaska northern rockfish in 2017, we present a partial assessment to recommend harvest levels for the next two years. Please refer to the last full stock assessment report (2015) for further information regarding the assessment model (Hulson et al., 2015, available online at http://www.afsc.noaa.gov/REFM/Docs/2015/GOAnork.pdf). A full stock assessment document with updated assessment and projection model results will be presented in next year's SAFE report (2018).

We use a statistical age-structured model as the primary assessment tool for GOA northern rockfish stock which qualifies as a Tier 3 stock. This assessment consists of a population model, which uses survey and fishery data to generate a historical time series of population estimates, and a projection model, which uses results from the population model to predict future population estimates and recommended harvest levels. The data sets used in this assessment include total catch biomass, fishery age and size compositions, trawl survey abundance estimates, and trawl survey age compositions. For a partial assessment, we do not re-run the assessment model, but do update the projection model with new catch information. This incorporates the most current catch information without re-estimating model parameters and biological reference points.

Summary of Changes in Assessment Inputs

Changes in the input data: There were no changes made to the population model inputs as 2017 was an off-cycle year and a partial assessment was conducted. New data added to the projection model included updated catch data from 2015 (3,944 t) and 2016 (3,437), and new estimated catches for 2017-2019. The 2017 catch was estimated by increasing the official catch as of October 7, 2017 by an expansion factor of 11.9%, which represents the average fraction of catch taken after October 7 in the last three complete years (2014-2016). This expansion factor increased from last year's expansion factor of 10% and resulted in an estimated catch for 2017 of 1,789 t. To estimate future catches, we updated the yield ratio to 0.82, which was the average of the ratio of catch to ABC for the last three complete catch years (2014-2016). This yield ratio was multiplied by the projected ABCs from the updated projection model to generate catches of 3,011 t in 2018 and 2,677 t in 2019. The yield ratio was lower than last year's ratio of 0.85.

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

Summary of Results

ABC recommendation

For the 2018 fishery, we recommend the maximum allowable ABC of **3,685** t from the updated projection model. This ABC is 2.8% less than last year's ABC of 3,790 t but larger than last year's 2018 projected ABC of 3,512 t. Recommended area apportionments of ABC are 420 t for the Western area, 3,261 t for the Central area, and 4 t for the Eastern area. The 2018 Gulf-wide OFL for northern rockfish is **4,380** t.

Reference values for northern rockfish are summarized in the following table, with the recommended ABC and OFL values in bold. It should be noted that GOA northern rockfish stock is projected to move from Tier 3a to Tier 3b in 2019, as the female spawning biomass is projected to fall below $B_{40\%}$.

Quantity	As estimated or *specified last* year for:		As estimated or *recommended this* year for:*	
	2017	2018	2018*	2019*
M (natural mortality rate)	0.059	0.059	0.059	0.059
Tier	3a	3b	3a	3b
Projected total (ages 2+) biomass (t)	75,028	73,248	74,748	73,814
Projected female spawning biomass (t)	29,198	27,344	28,017	26,512
$B_{100\%}$	69,957	69,957	69,957	69,957
$B_{40\%}$	27,983	27,983	27,983	27,983
$B_{35\%}$	24,485	24,485	24,485	24,485
F_{OFL}	0.074	0.074	0.074	0.070
$maxF_{ABC}$	0.062	0.062	0.062	0.058
F_{ABC}	0.062	0.062	0.062	0.058
OFL (t)	4,522	4,175	**4,380**	3,984
maxABC (t)	3,790	3,512	3,685	3,350
ABC (t)	3,790	3,512	**3,685**	3,350
Status	As determined *last* year for:		As determined *this* year for:	
	2015	2016	2016	2017
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 3,011 t and 2,677 t used in place of maximum permissible ABC for 2018 and 2019.

The stock is *not* being subject to overfishing, is *not* currently overfished, nor is it approaching a condition of being overfished. The tests for evaluating these three statements on status determination require examining the official total catch from the most recent complete year and the current model projections of spawning biomass relative to $B_{35\%}$ for 2017 and 2019. The official total catch for 2016 is 3,437 t which is less than the 2016 OFL of 4,783 t; therefore, the stock is not being subjected to overfishing. The estimates of spawning biomass for 2017 and 2019 from the current year (2017) projection model are 28,420 t and 24,804 t, respectively. Both estimates are above the estimate of $B_{35\%}$ at 24,485 t and, therefore, the stock is not currently overfished nor approaching an overfished condition.

The northern rockfish catch/biomass ratio has ranged from 0.019-0.052 between 1991 and 2016 (Figure 10.1). The 2017 projected catch/biomass ratio of 0.024 is 46% less than that observed in 2016 (0.044). For the catch/biomass ratio, catch data for 2017 are projected based on observed catch through October 7, 2017 using the 11.9% expansion factor. Biomass data for 1991-2015 are the 2015 full stock assessment estimates of age 2+ total biomass; biomass for 2016-2017 are based upon the 2017 projection, which incorporates complete catch data for 2015 and 2016. The approximate 95% confidence interval values are calculated assuming a normal distribution of biomass estimated in the 2015 full stock assessment for 1991-2015; standard error values for 2016-2017 assume the same coefficient of variation for total biomass estimated for the terminal year of the last full assessment (2015).

Fishery Trends

Updated catch data (t) for northern rockfish in the Gulf of Alaska as of October 7, 2017 (NMFS Alaska Regional Office Catch Accounting System via the Alaska Fisheries Information Network (AKFIN) database, http://www.akfin.org) are summarized in the following table.

Year	Western	Central	Eastern	Gulfwide Total	Gulfwide ABC	Gulfwide TAC
2016	121	3,316		3,437	4,004	4,004
2017	225	1,373		1,598	3,786	3,786

Catch of northern rockfish in the Gulf of Alaska through October 7, 2017 of 1,598 t is significantly below the 2017 gulfwide TAC of 3,786 t. Accounting for the 11.9% of northern rockfish catch usually occurring after October 7, the projected 2017 total catch of 1,789 t is still expected to be 48% below the gulfwide total catch of 3,437 t in 2016. The observed 2016 gulfwide total catch of 3,437 t was only 2.7% below the catch of 3,533 t projected as of October 8, 2016.
The majority of Gulf of Alaska northern rockfish catch remains in the Central region.

Survey Trends

The 2017 trawl survey design-based biomass index of 150 kt for Gulf of Alaska northern rockfish increased 207% from the 2015 index 50 kt, but is 59% below the 2013 index of 370 kt (Figure 10.2). The 2017 trawl survey index is 12% lower than the long-term average of 170 kt.

Area Allocation of Harvests

The apportionment percentages are the same as in the 2015 full assessment. The following table shows the recommended apportionment of ABC and TAC for 2018 and 2019. Please refer to the 2015 full stock assessment report (http://www.afsc.noaa.gov/REFM/Docs/2015/GOAnork.pdf) for information regarding the apportionment rationale for northern rockfish.

Method	Area Allocation		Western GOA	Central GOA	Eastern GOA*	Total
Random Effects Model			11.4%	88.5%	0.1%	100%
	2018	Area ABC (t)	**420**	**3,261**	**4**	**3,685**
	2019	Area ABC (t)	**382**	**2,965**	**3**	**3,350**

*For management purposes the small ABC in the Eastern area is combined with other rockfish.

Summaries for Plan Team

Species	Year	Biomass[1]	OFL	ABC*	TAC	Catch[2]
Northern rockfish	2016	77,596	4,783	4,004	4,004	3,437
	2017	75,028	4,522	3,786	3,786	1,598
	2018	74,748	4,380	3,685		
	2019	73,814	3,984	3,350		

Stock/ Assemblage	Area	2017 OFL	2017 ABC	2017 TAC	2017 Catch[2]	2018 OFL	2018 ABC	2019 OFL	2019 ABC
Northern rockfish	W		432	432	225		420		382
	C		3,354	3,354	1,373		3,261		2,965
	E*						4		3
	Total	4,522	3,786	3,786	1,598	4,380	3,685	3,984	3,350

[1]Total biomass (ages 2+) from the age-structured model

[2]Current as of October 7, 2017. Source: NMFS Alaska Regional Office Catch Accounting System via the AKFIN database (http://www.akfin.org).

*For management purposes, the small ABC for northern rockfish in the Eastern Gulf of Alaska is combined with other rockfish. Thus, for 2017 the Eastern Gulf ABC (and associated TAC) is not reported in these tables, but the Eastern Gulf ABC for 2018 and 2019 are included as future recommendations.

SSC and Plan Team Comments on Assessments in General

"In an effort improve record keeping as assessment authors formulate various stock status evaluation models, the Plan Team has recommended a systematic cataloging convention. Any new model that diverges substantial from the currently accepted model will be marked with the two-digit year and a "0" version designation (e.g., 16.0 for a model from 2016). Variants that incorporate major changes are then distinguished by incremental increases in the version integer (e.g., 16.1 then 16.2), and minor changes are identified by the addition of a letter designation (e.g., 16.1a). The SSC recommends this method of model naming and notes that it should reduce confusion and simplify issues associated with tracking model development over time." (SSC December 2016)

The northern rockfish assessment will begin using this convention in 2018 with the recommended model from 2015.

"The SSC also recommends explicit consideration and documentation of ecosystem and stock assessment status for each stock, perhaps following the framework suggested below, during the December Council meeting to aid in identifying areas of concern." (SSC October 2017)

A newly proposed framework for considering ecosystem and socioeconomic factors has been submitted as an appendix in some assessments this year. This is an attempt to document these factors with respect to stock status and also provide indicators for continued monitoring to identify areas of concern. These reports are currently submitted as an appendix and in future years it is anticipated that they would be available for all stocks as the framework is adaptable for data-limited to data-rich stocks. We plan to evaluate and potentially incorporate this new ecosystem/socioeconomic report as an appendix if and when it becomes available for Gulf of Alaska northern rockfish stock.

"The Team recommends that a workgroup or subset of authors investigate applying the geostatistical approach to selected stocks. (Plan Team, November 2015)

The SSC supports the GOA PT recommendation to form a study group to explore the criteria necessary for adopting the geostatistical generalized linear mixed model approach in assessments. If this study group is formed, the SSC requests that the group be expanded to include BSAI assessment authors and members from the AFSC survey program. Among the many questions this group could address, the SSC suggests including the following questions:

1. Is the stratified random survey design used for the surveys correctly configured for application of the geostatistical approach?

2. Should the geostatistical approach be applied to all species or a select suite of species that exhibit aggregated spatial distributions and rockfish-like life histories? If application of this approach is recommended for only a subset of managed species, what life history characteristics or biological criteria would qualify a species for this approach?

3. What level of aggregation is necessary for application of the geostatistical approach?

4. If the geostatistical approach is adopted should results also be used for area apportionments?" (SSC, December 2015)

"The SSC strongly encourages further development of these approaches, which could be extended to include covariates such as depth or other habitat features to increase precision. Care should be taken to estimate biomass over the same area when comparing results between the design-based and geostatistical approach. The SSC also suggested that, when considering anisotropy in the model, that the most appropriate approach for the Gulf of Alaska may be to allow for differences in spatial correlation scales in the along-shelf and cross-shelf directions, respectively, rather than by latitude and longitude. It was suggested that modeling survey data could be a topic for the workshop in February 2018 to discuss options for moving from design-based estimators to geostatistical estimators across stocks." (SSC, October 2017)

We have grouped these three comments together as they deal with the same topic. A working group is currently in the process of investigating the criteria for use of the geostatistical generalized linear mixed model (delta-GLMM) within assessments performed by the AFSC. Evaluation of the geostatistical delta-GLMM approach has focused on a range of species with different life histories and spatial distribution, and addressed: 1) How do geostatistical delta-GLMM indices compare with design-based estimates?, 2) Are the scale or trend in geostatistical delta-GLMM indices sensitive to the level of spatial complexity specified?, 3) How does alternative specifications for temporal autocorrelation in intercepts and spatio-temporal random effects for encounter probability and positive catch rate components of the geostatistical delta-GLMM influence index estimates, and 4) How do apportionment estimates from the geostatistical delta-GLMM compare with estimates from the current random effects model? Results from these initial evaluations were presented by C. Cunningham at the September 2017 PT meeting. Further investigations into the geostatistical delta-GLMM will continue with the intention of providing stock assessment authors with guidance on which trawl survey biomass index would be appropriate for their stock.

SSC and Plan Team Comments Specific to this Assessment

"The Team recommends evaluating how the definition of the length composition plus group, and alternative data-weighting methods, affect model performance." (Plan Team, November 2015)

"The Team recommends continuing to evaluate geostatistical estimators of survey biomass for this stock" (Plan Team, November 2015)

"Based on the model changes made for 2015, the PT recommended further examination of how the definition of the length composition plus group and alternative data-weighting methods affect model performance. They also expressed concern about the high inter-annual variation for survey biomass, and recommended the authors continue to evaluate geostatistical estimators of survey biomass for future assessments. Length bins for fishery length compositions have not been examined, but the authors plan to continue exploring this for the next full assessment. A past recommendation from the SSC and assessment authors was to investigate maturity and the potential for time-dependent changes in maturity, and the

authors note that they are working on a sampling project proposal that would collect the data necessary to evaluate this research priority. The SSC agrees that these remaining issues are still applicable and recommend that the authors continue investigations into these issues, particularly the explorations of geostatistical GLMM for the survey biomass estimates, given the high variability in the survey biomass estimates". (SSC, December 2015)

For the 2018 assessment the authors plan to continue investigation of the effect of different plus-group specification for length composition data and alternative length bin designations. Pertaining to different data weighting methods and the application of the geostatistical delta-GLMM approach, we will defer to the recommendations of the working group that is currently investigating modeling the bottom trawl survey biomass. As the weighting methods employed will be sensitive to the trawl survey biomass index utilized, and in particular, sensitive to the estimated uncertainty of the trawl survey biomass index we are going to delay investigating alternative data weighting methods until a recommended approach is provided by the working group. The sampling project proposal that is referred to in the above comments was not funded. Additional data is needed to investigate time-dependent maturity, because the 2 years of data currently available are insufficient for in-depth investigations. This continues to be a data gap and research priority for this stock.

Figures

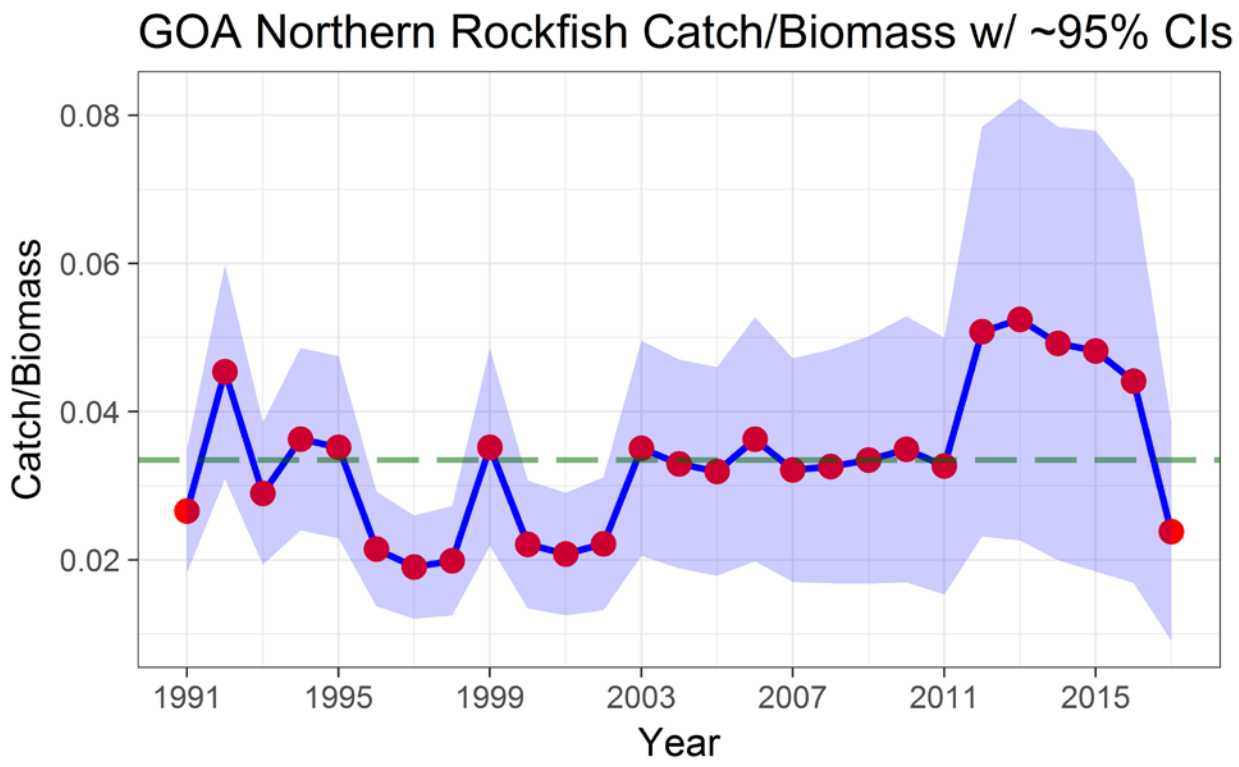

Figure 10.1. Modeled catch over total biomass (point estimates in red circles) with 95% sampling error confidence intervals (shaded area) for Gulf of Alaska northern rockfish from 1991-2017. Green dashed line is long-term average for the time series. Total biomass is ages 2+ from the age-structured model.

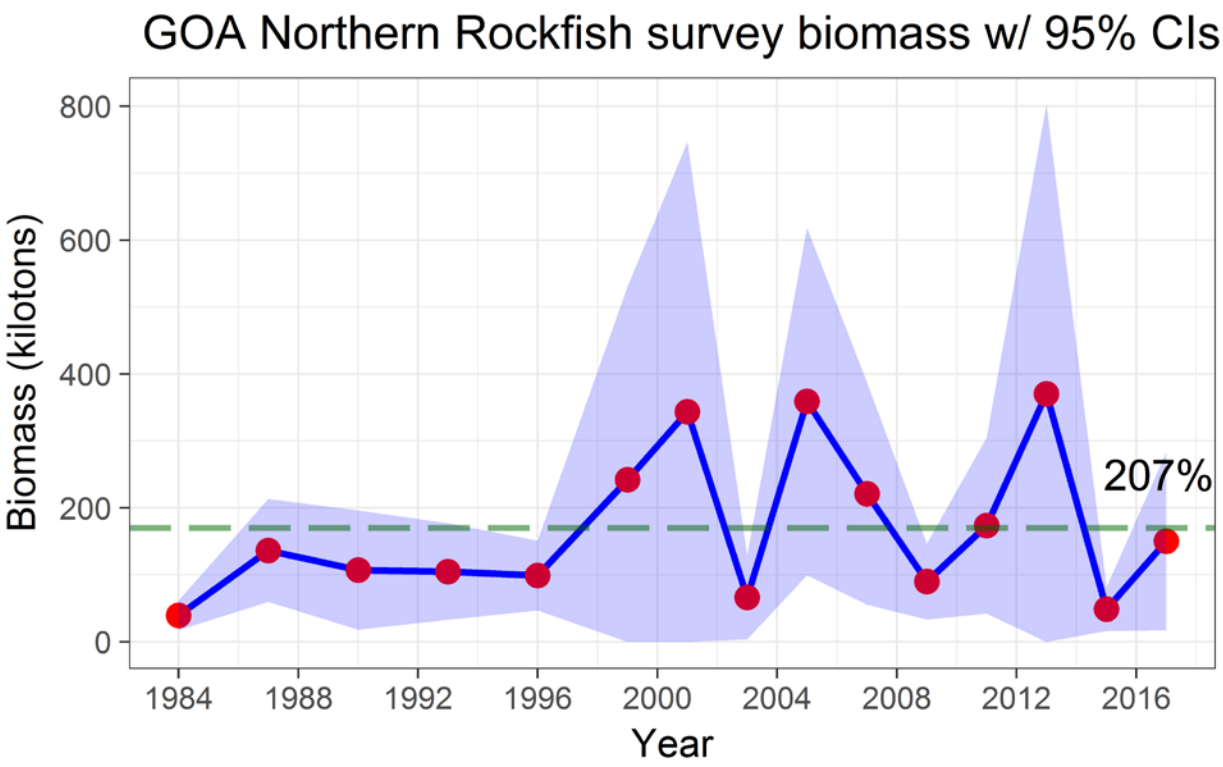

Figure 10.2. Design-based biomass index for GOA northern rockfish from the NMFS bottom trawl survey, point estimates in red circles) with 95% sampling error confidence intervals (shaded area), from 1984-2017. Green dashed line is long-term average for the time series. Text percentage is the change of the 2017 index from the 2015 index.