12. Assessment of the Dusky Rockfish stock in the Gulf of Alaska

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Executive summary

We use a statistical age-structured model as the primary assessment tool for GOA dusky rockfish (*Sebastes ciliatus*) 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 used in this assessment includes 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. Full assessments for dusky rockfish are conducted in even years and partial assessments in odd years. For Gulf of Alaska dusky rockfish in 2021, we present a partial assessment with updated projection model results to recommend harvest levels for the next two years.

Summary of Changes in Assessment Inputs

Changes in the input data: There were no changes made to the assessment model inputs as this is an off-cycle year. New data added to the projection model included updated catch data from 2020 (2,198 t) and new estimated catches for 2021-2023. Catch data were queried on 2021-10-22, with the most recent catches in the query on 2021-10-16. The 2021 catch was estimated by increasing the official catch as of 2021-10-16 by an expansion factor of 1.033, which accounts for the average fraction of catch taken after October 16 in the last three complete years (2018-2020). This expansion factor decreased from last year's expansion factor of 1.052 and resulted in an estimated catch for 2021 of 2,997 t. To estimate future catches, we updated the yield ratio to 0.67, which was the average ratio of catch to ABC for the last three complete catch years (2018-2020). This yield ratio was multiplied by the projected ABCs from the updated projection model to generate catches of 4,725 t in 2022 and 4,337 t in 2023.

Changes in assessment methodology: There were no changes from the 2020 assessment (Fenske *et al.* 2020) as this was an off-cycle year.

Summary of Results

ABC recommendation
For the 2022 fishery, we recommend a 50% stair step adjustment for a maximum allowable ABC of

5,372 t from the updated projection model. This ABC is 0.32% lower than the 2021 accepted ABC of 5,389 t from the 2020 full assessment. This stair step methodology was requested by the SSC and specifies the maximum ABC be set halfway between the 2020 ABC (3,676 t) and 2022 model estimated maximum ABC (7,069 t).

The stock is not being subject to overfishing, is not currently overfished, nor is it approaching a condition of being overfished. The test for determining whether overfishing is occurring is based on the 2020 catch compared to OFL. The official total catch for 2020 is 2,198 t which is less than the 2020 OFL of 8,655 t; therefore, the stock is not being subjected to overfishing. The tests for evaluating whether a stock is overfished or approaching a condition of being overfished require examining model projections of spawning biomass relative to $B_{35\%}$ for 2022 and 2023. The estimates of spawning biomass for 2022 and 2023 from the current year projection model are 38,371 t and 36,853 t, respectively. Both estimates are above the $B_{35\%}$ estimate of 21,299 t and, therefore, the stock is not currently overfished nor approaching an overfished condition.

Reference values for dusky rockfish are summarized in the following table, with the recommended ABC and OFL values in bold.

	As estimated or specified *last* year for:		As estimated or specified *this* year for:	
Quantity/Status	2021	2022	2022*	2023*
M (natural mortality)	0.07	0.07		
Tier	3a	3a	3a	3a
Projected total (age 4+) biomass (t)	97,702	98,825	97,767	95,682
Projected female spawning biomass (t)	38,362	37,530	38,371	36,853
$B_{100\%}$	60,855	60,855	60,855	60,855
$B_{40\%}$	24,342	24,342	24,342	24,342
$B_{35\%}$	21,299	21,299	21,299	21,299
F_{OFL}	0.114	0.114	0.114	0.114
$maxF_{ABC}$	0.093	0.093	0.093	0.093
F_{ABC}	0.093	0.093	0.093	0.093
OFL	8,655	8,614	**8,465**	8,146
maxABC (t)	5,389	5,372	**5,312**	5,181
ABC (t)	5,389	5,372	**5,312**	5,181
Status	As determined *last* year for:		As determined *this* year for:	
	2019	2020	2020	2021
Overfishing	No	n/a	No	n/a
Overfished	n/a	No	n/a	No
Approaching overfishing	n/a	No	n/a	No

*Projections are based on an estimated catch of 2,986 t for 2021, and estimates of 4,725 t and 4,337 t used in place of maximum permissible ABC for 2022 and 2023.

Fishery trends

Catch data for dusky rockfish in the GOA were updated as of 2021-10-22 (NMFS Alaska Regional Office Catch Accounting System via the Alaska Fisheries Information Network [AKFIN] database, www://akfin.org). The dusky rockfish catch/biomass ratio has ranged from 0.02-0.06 since 1991 (Figure 12-1). The 2021 projected catch/biomass ratio (exploitation rate) is a 38% difference

(increase) from the 2020 value. To calculate this catch/biomass ratio observed catches through 2020 and estimated catches for 2021 are divided by age 4+ biomass estimates. Biomass from 1991-2020 are from the 2020 full stock assessment and the estimate for 2021 is from the 2021 projection model. The approximate 95% confidence intervals are calculated assuming a normal distribution with standard errors estimated in the 2020 full stock assessment for 1991-2020 and a coefficient of variation in 2021 that is assumed the same as estimated in the terminal year of the 2020 full assessment.

Survey trends

For informational purposes, updated trends from the 2021 bottom trawl survey are presented here for both a geostatistical model and a design-based model. A geostatistical model was approved for use in the dusky rockfish assessment model in 2015 for estimating survey biomass. This geostatistical model estimates a 69% increase in biomass from the 2019 survey (Figure 12-2) and is above the long term mean.

Area Allocation of Harvest

The following table shows the recommended ABC apportionment for 2022 and 2023. The apportionment percentages are the same as in the last full assessment. Please refer to the 2020 full stock assessment report (Fenske *et al.* 2020) for information regarding the apportionment rationale for GOA dusky rockfish. The random effects model was fit to the survey design-based biomass estimates (with associated variance) for the Western, Central, and Eastern GOA. The random effects model estimates a process error parameter (constraining the variability of the modeled estimates among years) and random effects parameters in each year modeled.

Area Apportionment	Western 5%	Central 84.4 %	Eastern 10.6%	Total 100%
2022 Area ABC (t)	269	4,534	569	5,372
2022 OFL (t)				8,614
2023 Area ABC (t)	259	4,373	549	5,181
2023 OFL (t)				8,146

Amendment 41 prohibited trawling in the Eastern area east of 140° W longitude. The ratio of biomass still obtainable in the W. Yakutat area (between 147° W and 140° W) is 0.75. This results in the following apportionment to the W. Yakutat area:

	W. Yakutat	E. Yakutat/Southeast
2022 Area ABC (t)	427	142
2023 Area ABC (t)	412	137

Summaries for Plan Team

Stock	Year	Biomass[1]	OFL	ABC	TAC	Catch
	2020	54,626	4,492	3,676	3,676	2,198
Dusky	2021	97,702	8,655	5,389	5,389	2,997[2]
Rockfish	2022	97,767	8,614	5,372		
	2023	95,682	8,146	5,181		

			2021			2022		2023	
Stock	Area	OFL	ABC	TAC	Catch[2]	OFL	ABC	OFL	ABC
	W		270	270	144		269		259
Dusky	C		4,548	4,548	2,727		4,534		4,373
Rockfish	WYAKC		468	468	30		427		412
	EYAK/SEO		103	103	1		142		137
	Total	8,655	5,389	5,389	2,902	8,614	5,372	8,146	5,181

[1]Total biomass (age 4+) estimates from age-structured model.

[2]Current as of October 22, 2021. Source: NMFS Alaska Regional Office Catch Accounting System via the AKFIN database (http://www.akfin.org).

Responses to SSC and Plan Team Comments on Assessments in General

> *The SSC revised and clarified the recommendation to maintain the status quo and only produce risk tables for full assessments (rather than all assessments, as indicated in the subgroup recommendation)." (SSC, June 2021)*

A risk table will be provided in the next full assessment.

Responses to SSC and Plan Team Comments Specific to this Assessment

> *The SSC registers concern with the large positive retrospective pattern in the recommended model and suggests that further investigation of this be a very high priority. (January 2020)*

Issues with the retrospective pattern will be explored in the 2022 full assessment.

> *The SSC requests the assessment author justify the use of the new parameterization of VAST specifically as it relates to dusky rockfish. Past SSC discussions regarding the general implementation of VAST in assessments precluded a highly prescriptive approach and specifically recommended allowing for some species-specific adaptations of the VAST framework (October 2020)*

A suite of VAST parameterizations and associated diagnostics will be explored and provided in the 2022 full assessment.

> *The SSC notes that the use of the maximum ABC would nearly double the ABC from 2020 (a 93% increase).* ***Given the large increase in the retrospective pattern, resulting primarily from two additional years of data but also potentially arising from new VAST parameterization, the SSC recommends a stair step approach for setting the ABC in 2021 and 2022, and therefore a reduction from the maximum ABC.*** *Since this stock is on a biennial schedule and another full assessment will not be completed until 2022, the SSC recommends utilizing a 50% stair step for both of the 2021 and 2022 ABCs.* ***Under this approach, the 2021 ABC would be set halfway between the 2020 ABC (3,676t) and the 2021 maximum***

> ***ABC from the recommended model (Model 15.5a). This would amount to a 24% decrease from the maximum ABC for 2021. The 2022 ABC would be set similarly, at halfway between the 2020 ABC and the 2022 maximum ABC, resulting in a 23% decrease from the 2022 maximum ABC.*** *In 2021, a partial assessment for dusky rockfish will be completed, and the projection model will be re-run with updated catch data, which will update the 2022 maximum ABC.* ***The SSC recommends continuing with the 50% stair step methodology (applying a 50% stairstep between the 2020 ABC and the updated 2022 maximum ABC and the same for the estimated 2023 maximum ABC) when setting specifications until a new full assessment is presented for 2023.*** *(January 2020)*

A 50% stair step methodology has been applied that reduces the maximum ABC for 2022 and 2023. The model estimated maximum ABCs were 7,069 t and 6,686 t for 2022 and 2023, respectively. Using the 50% stair step approach results in a 2022 maximum ABC of 5,372 t and a 2023 maximum ABC of 5,181 t. This stair step approach will be reviewed when a full assessment is presented in 2022.

References

Fenske, K.H., Hulson, P.-J.F., Williams, B. and O'Leary, C.A. (2020) Assessment of the Dusky Rockfish stock in the Gulf of Alaska. In: *Stock assessment and fishery evaluation report for the groundfish resources of the Gulf of Alaska.* North Pacific Fishery Management Council, Anchorage, AK.

Figures

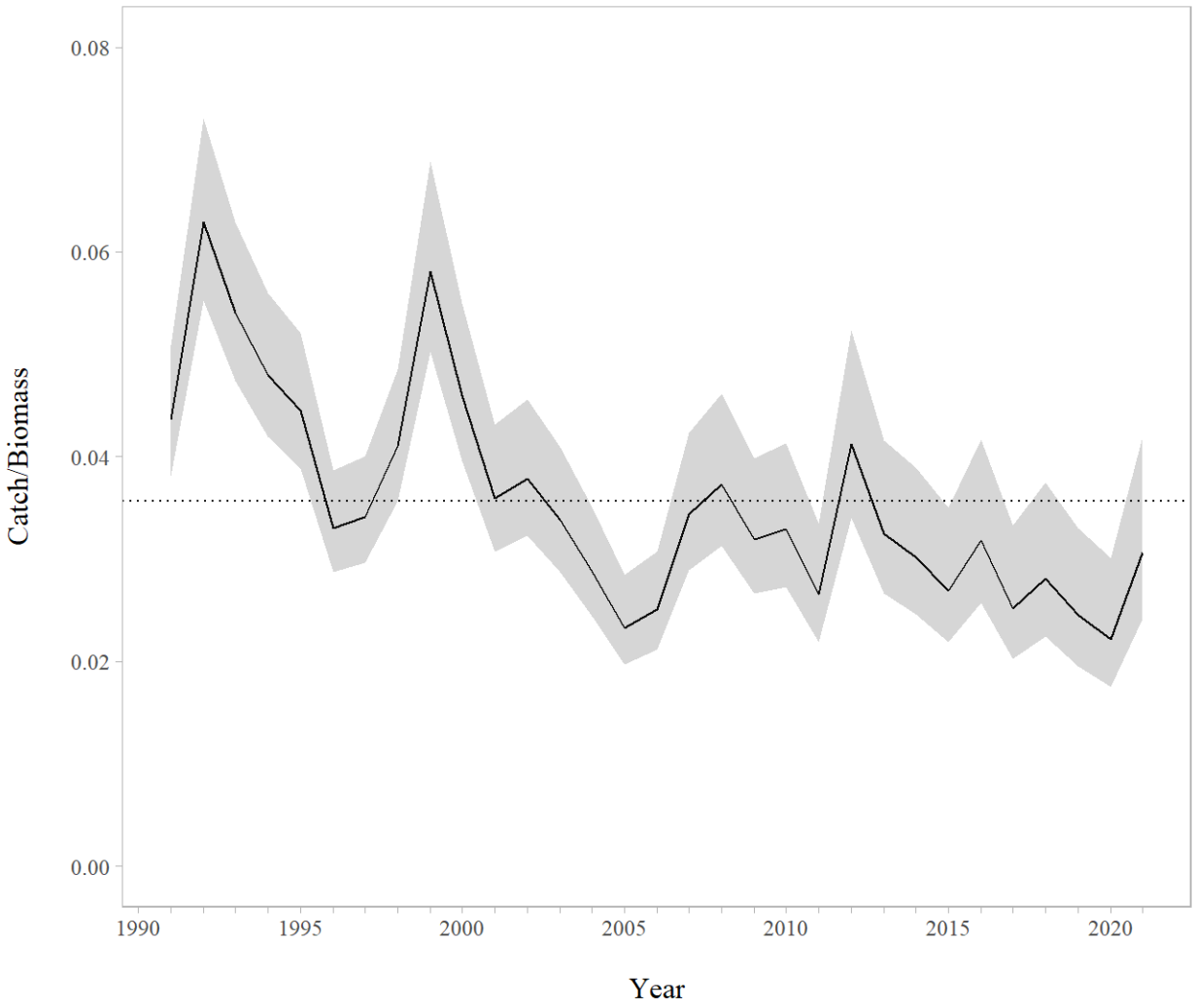

Figure 12-1: Gulf of Alaska dusky rockfish catch/age 4+ biomass ratio with approximate 95% confidence intervals. Observed catch values were used for 1991-2020, the 2021 catch values were estimated using an expansion factor. The horizontal dashed line is the mean value for the entire dataset.

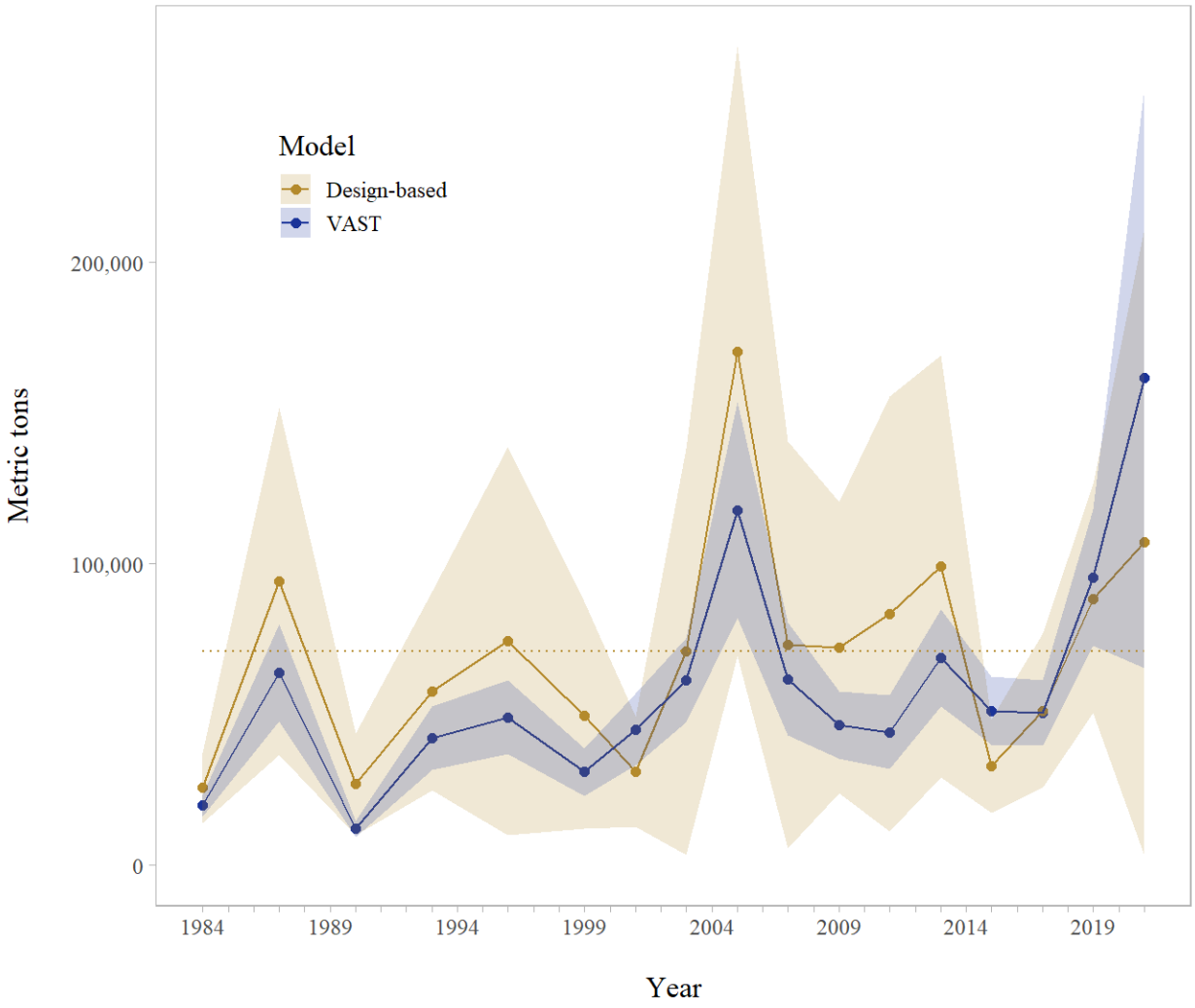

Figure 12-2: Geostatistical model (VAST) and design-based model estimates of trawl survey abundance for dusky rockfish in the Gulf of Alaska. Shaded areas are 95% confidence intervals, the dashed line is the data mean (VAST).