Stock Assessment Review (STAR) Panel Report
For Blue/Deacon Rockfish (BDR)

NOAA Fisheries, Southwest Fisheries Science Center
110 McAllister Way
Santa Cruz, CA 95060

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Overview

The STAR Panel reviewed a full assessment of blue and deacon rockfish (*Sebastes mystinus* and *Sebastes diaconus*) off the west coast of the United States during a five-day meeting in Santa Cruz, CA. Deacon rockfish was first identified as a species and separated from blue rockfish in 2015. The two species were assessed as a complex because nearly all data available for assessment consist of mixed blue and deacon rockfish in unknown proportions. The last full assessment of blue rockfish was done in 2007 and extended only as far north as California-Oregon border. In this assessment, two independent assessment models were developed, a California model that extended from Point Conception to the California-Oregon border, and Oregon model that covered the marine waters of the State of Oregon. Blue/deacon rockfish in Oregon have not been assessed previously.

The STAR Panel recommends that both the California and the Oregon assessment for blue/deacon rockfish constitute the best available scientific information on the current status of the stock(s) and that the assessments provides a suitable basis for management decisions.

Summary of Data and Assessment Models

The structure of the California and the Oregon assessment models were nearly identical except as required by the different data sets available for the two areas. The assessments use a recent version of Stock Synthesis 3 (Version V3.30.03.07). The population model in the current assessment extends from 1900 to 2017 (California) or 1892 to 2017 (Oregon), and two sexes are modeled allowing separate estimation of growth and mortality parameters. The main sources of information in the assessment include:

California assessment

- Catch and length composition from five fisheries: recreational charter (retained and discard), recreational private (retained and discard), commercial hook-and-line and longline gear, commercial net gear, and a commercial “discard” fishery.
- Biological information including maturity at length and length at age.
- Fishery-dependent relative abundance (CPUE) indices based on shore-based sampling for the charter and private recreational fisheries, and sampling by on-board observers in the charter fleet.
- A fishery-independent index from the SWFSC juvenile rockfish survey.
- Age data from the charter fleet in the 1980 and from two research studies in 2006.

Key model features for the California assessment include:

- Abundance indices used in the assessment were obtained using delta-GLM and negative binomial modeling approaches.
- Growth was estimated within the model.

- A Beverton-Holt stock recruit relationship was assumed and recruitment deviations were estimated.
- Prior distributions for steepness (Thorson pers. com.) and natural mortality (Hamel 2015) were used. The pre-STAR model estimated natural mortality including a male offset (with no prior), but fixed steepness at the mean of the prior.
- Length-based selectivity curves were estimated for all surveys and fisheries. Selectivity patterns were assumed to be asymptotic except for recreational discard, which was modeled as a separate fishery with a dome-shaped selectivity pattern.
- Age data were modeled as conditional age given length in the assessment.
- Input data were reweighted using several approaches. Additional variance terms were estimated for all abundance indices, length composition data were reweighted using the Francis method, and conditional age at length data were reweighted using the harmonic mean method.

Oregon assessment

- Catch and length composition from five fisheries: commercial (retained and discard), recreational ocean-boat (retained and discard), and a shore-based fishery.
- Biological information including maturity at length and length at age.
- Fishery-dependent relative abundance (CPUE) indices based on commercial logbook data, shore-based sampling of recreational fisheries, and sampling by on-board observers on the charter fleet.
- No fishery-independent indices are available for the Oregon blue/deacon rockfish stock.
- Age data from the recreational and commercial fleets starting in 1999, and from a research project in 2016-2017 to sample juvenile blue/deacon rockfish.

Key model features for the Oregon assessment include:

- Abundance indices used in the assessment were obtained using delta-GLM and negative binomial modeling approaches.
- Growth was estimated within the model.
- A Beverton-Holt stock recruit relationship was assumed and recruitment deviations were estimated.
- Prior distributions for steepness (Thorson pers. com.) and natural mortality (Hamel 2015) were used. The Oregon pre-STAR model estimated female natural mortality, but fixed the male offset for natural mortality, and fixed steepness at the mean of the prior for rockfish.
- Length-based selectivity curves were estimated for all surveys and fisheries. Selectivity patterns were assumed to be asymptotic except for the shore-based fishery and the discard fleets, which were modeled as a separate fisheries with a dome-shaped selectivity patterns.
- Age data were modeled as conditional age given length in the assessment.
- Input data were reweighted using several approaches. Additional variance terms were estimated for all abundance indices, length composition data were reweighted using the

Francis method, conditional age at length data were reweighted using the harmonic mean method.

Requests by the STAR Panel and Responses by the STAT

California assessment

Request 1: Shift both early and main start year for estimating recruitment deviations ±10 years and ±20 years from the base model. Recalculate the ramp for transitioning from bias-corrected recruitment estimates. Shift the start of the main recruitment deviations if necessary to obtain plausible results.

Rationale: There is a period of higher recruitment early in the time series that does not seem to be informed by the data.

STAT Response: There were relatively modest differences in fit and model results with earlier start to recruitments, but very substantial impact when recruitment deviations were started later than the base model. This is manifest through much higher estimate of natural mortality (approximately 0.22 in both later-starting cases) that scales biomass, and ending year depletion, dramatically upwards. The fit degrades by about 10 – 20 likelihood units in these runs. Fits were modestly (less than one likelihood unit) improved with earlier start (slight increase in estimate of M, to 0.123-0.125). When M is fixed at base model point estimate and recruitment deviations started in 1980, result is more comparable to base model, however the fit still degraded (about 20 likelihood units).

Request 2: Do the "drop one" analysis for the data components informing the CPFV and private fleets (i.e., indices, length composition, and age composition).

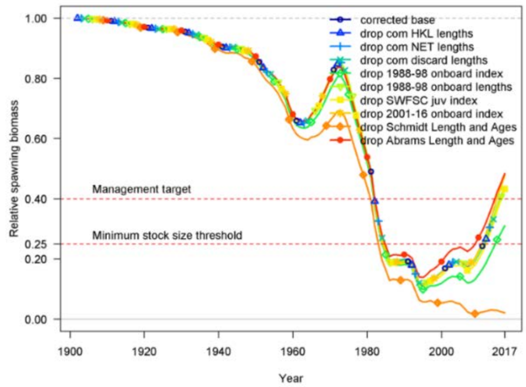
Rationale: To better understand what data are driving the unusual recruitment time series in the original base model.

STAT Response: The California model is most sensitive to removal of 1) sources of age data with the largest sample sizes, CPFV 1980-1984 and Schmidt 2010-2011, and 2) large portions of the CPFV length compositions. Without both the CPFV and Schmidt ages, the model often hits the upper bound of ln(R0). Removal of the Karpov et al. (1995) CPFV length composition data reduces recruitment variability in the early part of the time series, but has minimal effect on the scale or current status of the stock. The Schmidt conditional age at length data appear to inform the large 2008-2009 recruitment deviations, relative to 2013, while a strong 2007 recruitment is supported by other data. Although unfished biomass was relatively stable, stock status in 2017 was sensitive to four data sources:

a) Schmidt age and length data.
b) MRFSS private boat length compositions.

c) MRFSS CPFV index.

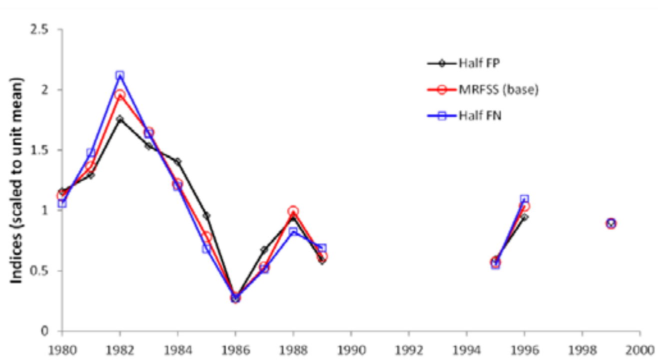
d) 1988-1998 onboard CPFV observer index.



Request 3: Explore the sensitivity of the MRFSS CPFV dockside and CRFS dockside indices to the thresholds in the Stephens-MacCall filtering by halving the false positives and alternatively halving the false negatives.

Rationale: The current thresholds are somewhat ad hoc.

STAT Response: Two new indices were produced, halving the number of false positives (FPs), then halving the number of false negatives (FNs) for the dockside MRFSS CPFV index. Trends in the MRFSS index are not sensitive to the choice of threshold. There was insufficient time during the STAT Panel review to complete the CRFS dockside re-analysis.



Request 4: Produce a table like Table 5 in the 2015 black rockfish assessment (in the Oregon and California assessments; except for the final 2 columns).

Rationale: To concisely understand how the different indices were constructed.

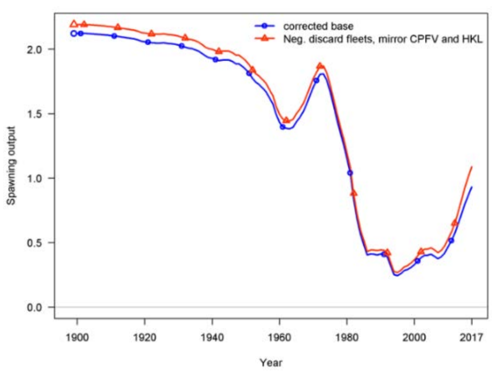
STAT Response: Table shown below:

Region	Fleet	Years	Index Name	Fishery-independent	Filtering	Standardization Model
CA	1	1980-89, 1995-96, 1999	Dockside MRFSS CPFV CPUE	No	Stephens-MacCall, county, year	Negative Binomial
CA	3	2004-2016	Dockside CRFS Private Boat CPUE	No	Stephens-MacCall, wave, inside/outside 3nm	Negative Binomial
CA	9	1988-1998	Onboard Central CA CPFV CPUE	No	year, area, depth, catch rate (extremes)	Negative Binomial
CA	11	2001-2016	Onboard CDFW CPFV CPUE	No	Distance from reef, depth, % groundfish, drift duration, year, trimester	Negative Binomial
CA	10	2001-2016	NMFS SWFSC Pelagic Juvenile Rockfish	Yes	None	Delta-GLM

Request 5: Provide a run where the discard fleet is removed. Add the estimated discards to the total removals for affected fleets.

Rationale: To understand sensitivity to that model structure.

STAT Response: Discard length composition data from the CRFS onboard CPFV and WCGOP observer programs were removed (negative fleet value in Stock Synthesis), and discard fleet selectivity was mirrored to the CPFV and hook and line fleets, respectively. The effect was modest, but larger than the STAT anticipated, given that discards represent a small fraction of total removals (e.g., 6.2% in last 10 years). This is due, in part, to the information about recent recruitments in the recreational discard composition data.



Request 6: Provide a run where both zero years in the juvenile recruitment index have half the value of the lowest year in the index.

Rationale: No blue/deacon rockfish were observed in these years and therefore the index should be less than any of the other years. That information should be captured in the model.

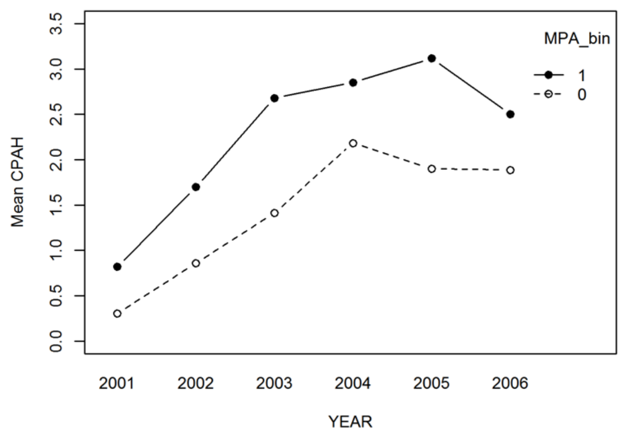
STAT Response: Runs were explored including those years with the Rstan estimated point estimates and CVs, as well as using half of the lowest value for years that did have positive observations, with the CV set to the largest estimated CV for those years. There was negligible (verging on undetectable) change in the base model results, as the predicted recruitments are already low for these years, and so recruitment estimates do not change substantively. Change is consistent with how the index had been developed in the past (prior to the application of Rstan to develop the index). The change was adopted for the revised base model.

Request 7: Consider whether implementation of MPAs in central California in 2007 caused the change in the onboard CPFV index trends after 2007. Reconstruct the index by removing all the historical drifts that occurred in current MPAs.

Rationale: Implementation of MPAs may have affected index trends.

STAT Response: The STAT calculated catch rates from 2001-2006 inside areas that were later classified as MPAs. CPUE "inside" was larger than outside the (eventual) MPAs. However, a relatively small proportion of observed drifts occurred "inside," (see table below) and the effect on the index is minor, based on a comparison of area-weighted point estimates (MLEs).

	# of observed drifts		
Year	outside MPA	inside MPA	% inside
2001	395	66	14%
2002	319	134	30%
2003	1184	183	13%
2004	2148	223	9%
2005	1161	91	7%
2006	1310	216	14%
2007	1278	102	7%
2008	1158	84	7%
2009	1280	20	2%
2010	1700	3	0%
2011	1534	17	1%
2012	1312	4	0%
2013	1347	10	1%
2014	1279	0	0%
2015	1160	0	0%
2016	1549	0	0%



Catch rates inside (solid dots) and outside (open dots) the MPAs.

Request 8: Rerun the corrected base model with the reconstructed CPFV index that excludes drifts inside of MPAs.

Rationale: This conceptually improves the index since the same areas accessible to the fleet are consistent through the entire time series.

STAT Response: The STAT replaced the point estimates with the revised area-weighted MLEs, using the log-scale standard errors from the base case index. The change had little effect on model results.

Request 9: Reproduce the table displaying the bivariate profile over natural mortality (M) and steepness (h) showing the depletion and ending biomass with a CI defined by a 75% chi square bivariate CI equivalent to a 1.386 change in likelihood.

Rationale: To explore these axes of uncertainty for a decision table.

STAT Response: The results of the bivariate profile over natural mortality and steepness were modified to reflect the change in confidence region from 95% to 75%, to mirror the percentile range customarily displayed in decision tables (12.5% to 87.5%). The tables are shown below.

b)

	Beverton-Holt Steepness								
Female Natural Mortality	0.3*	0.4	0.5	0.6	0.65	0.7	0.718	0.8	0.9**
0.08	0.02	0.02	0.03	0.04	0.04	0.06	0.07	0.16	0.29
0.09	0.02	0.03	0.03	0.05	0.07	0.13	0.15	0.27	0.39
0.10	0.03	0.03	0.05	0.09	0.16	0.24	0.26	0.37	0.48
0.11	0.03	0.04	0.07	0.19	0.27	0.35	0.37	0.47	0.57
0.12	0.03	0.05	0.13	0.31	$\boxed{0.38}$	0.45	0.47	0.57	0.66
0.13	0.04	0.08	0.24	0.42	0.49	0.55	0.57	0.66	0.73
0.14	0.05	0.14	0.36	0.52	0.59	0.65	0.66	0.74	0.80
0.15	0.07	0.26	0.47	0.62	0.68	0.73	0.75	0.81	0.87
0.16	0.12	0.38	0.58	0.72	0.77	0.81	0.83	0.88	0.93
0.17	0.22	0.50	0.69	0.81	0.85	0.89	0.90	0.94	0.98
0.18	0.35	0.62	0.79	0.90	0.93	0.96	0.97	1.00	1.03

* A population with steepness of 0.3 would be driven to extinction by F(SPR_50%)

** All models with steepness = 0.9 gave warnings of poor convergence in Fmsy estimate

Estimated depletion in 2017.

e)

	Beverton-Holt Steepness								
Female Natural Mortality	0.3*	0.4	0.5	0.6	0.65	0.7	0.718	0.8	0.9**
0.08	58	76	83	97	113	149	174	393	661
0.09	77	85	97	129	179	306	364	607	845
0.10	87	97	119	216	373	540	594	808	1010
0.11	98	113	164	440	614	759	806	989	1155
0.12	110	139	297	685	$\boxed{833}$	957	996	1148	1283
0.13	126	192	558	902	1028	1131	1164	1290	1400
0.14	151	345	808	1099	1205	1292	1319	1424	1516
0.15	198	631	1040	1288	1378	1452	1475	1564	1644
0.16	319	917	1269	1482	1559	1623	1644	1722	1795
0.17	619	1207	1513	1701	1770	1828	1847	1921	1992
0.18	1000	1535	1805	1977	2043	2100	2118	2194	2269

* A population with steepness of 0.3 would be driven to extinction by F(SPR_50%)

** All models with steepness = 0.9 gave warnings of poor convergence in Fmsy estimate

Spawning biomass (millions of eggs) in 2017.

g)

	Beverton-Holt Steepness								
Female Natural Mortality	0.3*	0.4	0.5	0.6	0.65	0.7	0.718	0.8	0.9**
0.08	21	23	24	26	30	38	44	95	156
0.09	26	27	29	37	50	83	98	160	220
0.10	31	33	38	66	111	158	173	233	289
0.11	37	41	56	142	196	241	255	310	361
0.12	44	53	106	238	$\boxed{288}$	329	342	392	437
0.13	53	77	213	340	385	422	434	480	520
0.14	68	146	333	448	490	524	535	576	613
0.15	94	285	463	569	608	639	649	688	723
0.16	160	446	611	711	747	777	786	824	859
0.17	330	634	790	886	921	951	961	999	1037
0.18	575	875	1025	1120	1157	1189	1199	1242	1284

* A population with steepness of 0.3 would be driven to extinction by F(SPR_50%)

** All models with steepness = 0.9 gave warnings of poor convergence in Fmsy estimate

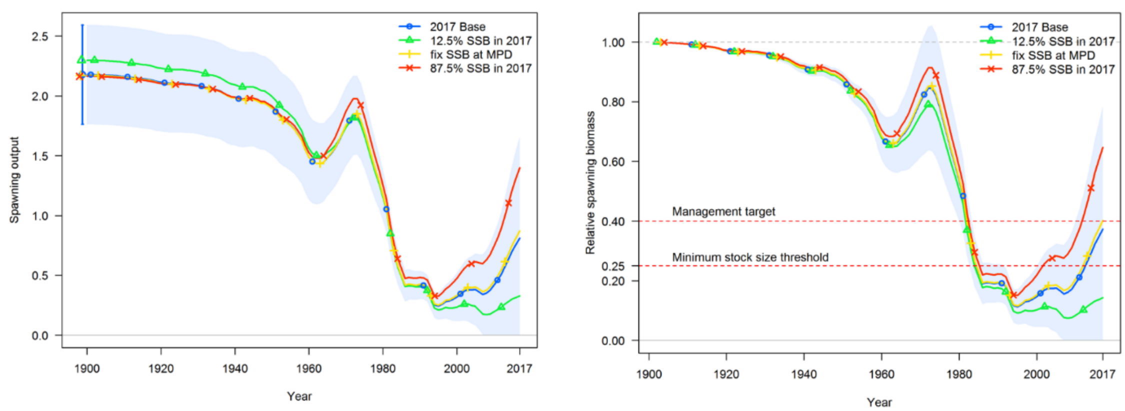
OFL(2017)

Request 10: Prepare a new base model as follows:

- Estimate h and M with the priors included;
- Include the revised juvenile rockfish time series;
- Fix the gap in the hook-and-line catch time series;
- For alternative states of nature in a decision table, use the 12.5 and 87.5 percentiles of the ending biomass assuming a normal distribution;
- Retune and jitter the base model.

Rationale: The STAT and STAR Panel agreed on this model configuration.

STAT Response: The STAT fit and retuned the revised base model as specified in Request 10. Alternative states of nature were estimated by creating a “survey” in the model (fleet #14, “SSB_Survey_2017) with survey year 2016, timing 12.999 (essentially Jan. 1, 2017), and log-scale SD of 0.001. The survey selectivity was set equal to spawning output (survey units option #30), with catchability fixed equal to 1. Values of the 12.5 and 87.5 percentiles of SSB in 2017 were determined from the base case model using the point estimate of SSB in 2017 (812.487) and adding/subtracting the product of its estimated asymptotic standard deviation (432.669) and 1.15035, the approximate value of the 87.5 percentile point of the normal distribution. The jittered results showed that the estimated objective function minimum was robust.



Request 11: If time permits, run a jitter to start from the following extreme states of nature: 1) h = 0.3 and M = 0.15 and an analogous high h and low M state of nature.

Rationale: This is an extreme test for the global minimum.

STAT response: There was insufficient time during the STAR Panel review to address this request.

Oregon assessment

Request 1: Create a proxy survey with absolute numbers in the ending year of the assessment, then profile over values of that number ranging from the current ending estimate of numbers of fish to the ending estimate of numbers of fish in the 2015 black rockfish assessment. Fix catchability to 1 and assume full selectivity of age 3+ and specify the survey as numbers of fish. Provide likelihood components, biomass estimates, and depletion. Maintain the current configuration of the base model.

Rationale: The scale of the assessment is uncertain and there is anecdotal information that blue/deacon rockfish may be as abundant as black rockfish.

STAT response: The model was run assuming that the point of that proxy survey was equal to a proportion of the total population of the black rockfish ranging from 0.2 to 1. The Table below presents the results of the calculations. The first run corresponds to the baseline without a proxy survey.

	Proxy Survey Numbers of Fish (thousands 3+ in 2015)					
	1,794 (BDR base)	3,630 (.20 BR)	5,468 (.40 BR)	7,305 (.60 BR)	9,142 (.80 BR)	10,980 (1.0 BR)
Total Likelihood	573.956	568.4	569.18	569.629	569.915	570.112
Survey Likelihood Components						
Logbook CPUE	-13.7514	-13.3434	-13.187	-13.1037	-13.0528	-13.0187
Onboard CPUE	-10.9006	-10.7352	-10.7055	-10.6916	-10.6834	-10.678
ORBS CPUE	-17.2672	-17.5854	-17.7263	-17.7999	-17.8435	-17.872
MRFSS CPUE	6.15208	5.72829	5.62434	5.57687	5.55006	5.53293
Proxy Survey	-	-6.90775	-6.90775	-6.90775	-6.90775	-6.90775
Length Likelihood Components						
Commercial - Landing	83.0823	83.3992	83.315	83.2554	83.2108	83.1776
Commercial - Discard	14.2556	14.3968	14.4342	14.455	14.468	14.4771
Recreational Ocean _ Landing	51.3042	52.1456	52.251	52.2843	52.2976	52.3036
Recreational Ocean - Discard	59.2398	60.3681	60.5357	60.5974	60.6276	60.6454
Recreational Shore	45.4116	45.3464	45.3384	45.3364	45.3356	45.3351
Age Likelihood Components						
Commercial - Landing	142.842	141.41	141.287	141.264	141.263	141.267
Recreational - Landing	204.951	205.633	206.244	206.595	206.823	206.982
Research	10.6839	10.5513	10.5287	10.5187	10.5131	10.5094
Female M	0.142	0.162	0.168	0.171	0.173	0.173
Total Biomass_{2017}	953.8	2150.6	3256.5	4363.9	5471.8	6580.4
SB_0	294.261	525.8	753.6	984.5	1216.6	1449.2
SB_{2107}	158.639	381.9	588.9	796.3	1003.9	1211.5
SB_{2017}/SB_0	0.5391	0.726	0.781	0.809	0.825	0.836

The Panel discussed the implications of these results and how information about the stock size of other species that might relate to the blue/deacon rockfish population could be used in the assessment. A request was made for an additional sensitivity run that will use the same point estimate from the black rockfish and the CV associated with that value and use it as an input value for a proxy survey for blue/deacon rockfish (Request 11).

Request 2: Evaluate how a linear ramp in historical recreational catches from 1970 affects model results.

Rationale: Assessment may be sensitive to uncertain historical catches.

STAT response: The results showed that there is a small change in the stock size for that period (1970-80), but the current stock status remained almost unchanged. The STAT indicated that, even though it does not make a large difference, they would be inclined to include the change in the base case model to reflect comments by the participants indicating that this change was more realistic. The Panel agreed with the proposed change.

Request 3: Reduce the compression age bin to age 25+.

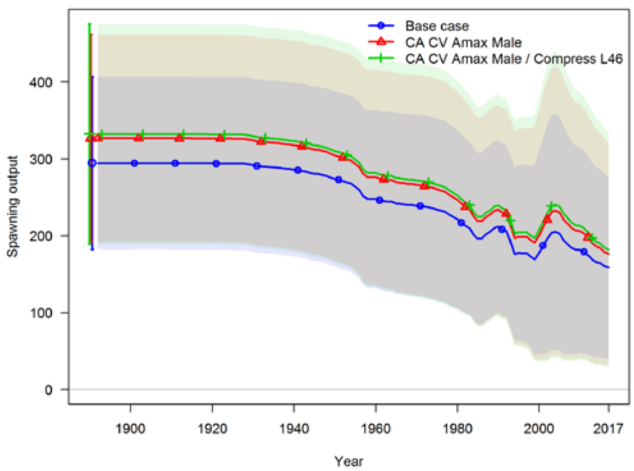
Rationale: Assessment may be sensitive to the small sample size of older ages.

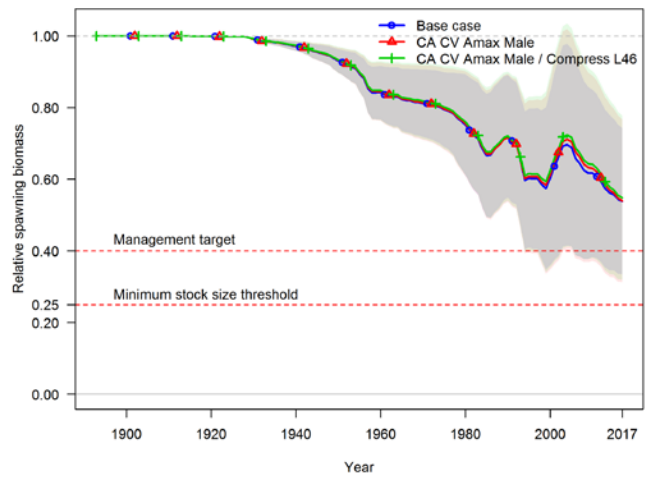
STAT response: The compression of the age plus bin to 25 did not lead to a noticeable change in the residual patterns in the age compositions for each fleet. The STAT did a run that compressed the length plus bin to 42 cm, and that did lead to an improved length composition residual pattern for, most noticeably, the commercial landings fleet. The STAT also did a run that compressed the plus groups to 30 years and 42 cm, and that did not change the overall results further. There was also little change in selectivity.

Request 4: Set the coefficient of variation for the length at maximum age for the male growth curve to the value calculated in the California assessment.

Rationale: The base Oregon model did not allow this parameter to vary from the female value because it went to a bound, but the California assessment was able to estimate this value.

STAT response: This change affected the scale, but the depletion pattern remained the same. The STAT also presented a further version of this request that changed male CV as before, but also compressed the length plus bin to 46. The latter run produced better residual patterns for commercial fishery length composition and recreational ocean fishery length composition, and the STAT suggested that this be included in a new base case. The Panel agreed with that suggestion. The results of these calculations are shown below.





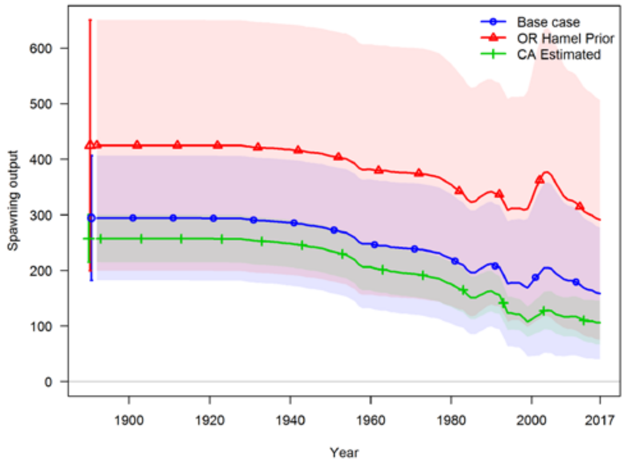
Request 5: Fix natural mortality for males and females in the model based on the Hamel prior. Alternatively, fix male and female natural mortality based on the values in the California assessment.

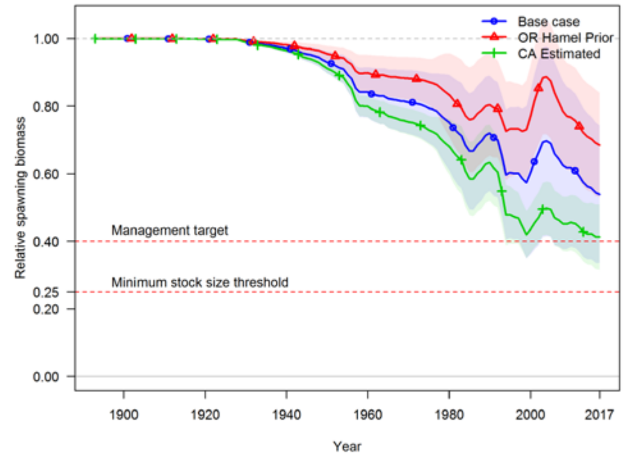
Rationale: The sensitivity runs indicate natural mortality may not be estimable in the model.

STAT Response: These changes led to changes in both scale and relative depletion of the population. The Panel discussed the choice of natural mortality, and the STAT was in favor of using the median of the Hamel prior because there was not much contrast in the input data to help the model produce a robust estimate of natural mortality. The Panel agreed with that logic. The results of these calculations are shown below

	Hamel Median of Prior*		CA Assessment	
	Value	Offset	Value	Offset
Female	0.159	-	0.117	-
Male	0.186	0.159	0.161	0.318

*selectivity parameter hit bound – increase growth CV, per request 4, gave reasonable result





Request 6: Provide a model run where all the indices are dropped.

Rationale: To understand how influential the indices are.

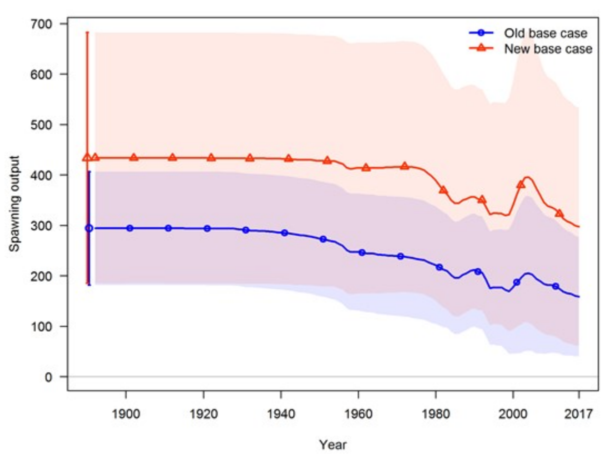
STAT response: The results showed that the indices had negligible influence on the model results confirming that the model is being driven by composition data. The only change that was noticeable was a small change in the selectivity of the commercial fleet.

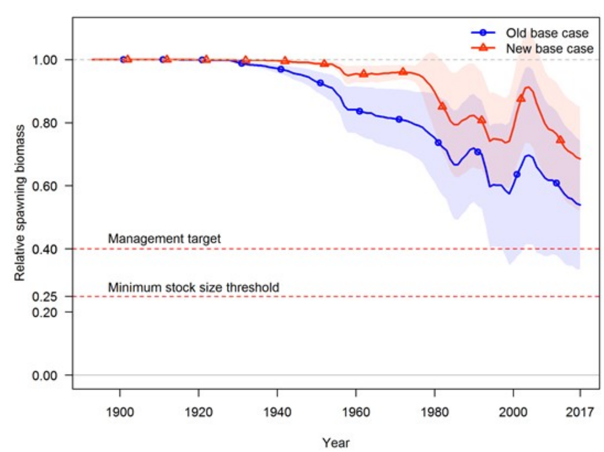
Request 7: Provide a model run where the research survey selectivity is fixed at 1.0 for all ages and lengths.

Rationale: It appeared this was mis-specified in the model.

STAT response: The survey selectivity had a descending limb that was corrected and a new run was done with the corrected selectivity. This led to a small change in the scale of the stock size and led to a slightly less depleted stock. The updated base line model will include this correction.

While presenting the responses to the Panel’s requests, the STAT also presented the results of additional runs they did using the new updated model that included all the changes identified above. The results are shown below.





Subsequent results are presented relative to the new base case model

Request 8: Use the onboard observer data to compare black rockfish and blue/deacon rockfish indices for Oregon calculated by multiplying the predicted catch rate from the GLM by the amount of suitable habitat in each sub region (north and south). Report the results by sub region.

Rationale: This may help inform the scale of Oregon blue/deacon rockfish relative to black rockfish.

STAT response: The STAT suggested that they expand upon this request by combining the north and south sub regions to produce an Oregon-wide analyses. Further, the STAT made the case that raw CPUE data should be used for this comparison, and not standardized model-based CPUE, because the CPUE standardization procedure was different between black rockfish and blue/deacon rockfish.

Leading from these results and discussion, a table was produced of the relative density between blue/deacon rockfish and black rockfish in terms of biomass. To produce the table, the STAT used available habitat maps to obtain habitat weights, which are then multiplied by CPUE to estimate relative density for the two species, thereby providing biomass scaler for blue/deacon rockfish to black rockfish. They produced two tables, one using species-specific habitat, and second table assuming that the species are using the same habitat. Both tables are shown below.

Species-specific habitat

	Black Rockfish			BDR		
		Coastwide			Coastwide	
Year	CPUE	Habitat	Rel.Dens	CPUE	Habitat	Rel.Dens
2001	2.55	285.00	727.84	0.47	442.79	208.37
2003	3.04	285.00	867.20	0.63	442.79	281.10
2004	2.65	285.00	755.38	0.41	442.79	179.97
2005	2.90	285.00	825.48	0.68	442.79	301.78
2006	2.99	285.00	851.97	0.26	442.79	115.50
2007	2.51	285.00	715.68	0.32	442.79	141.33
2008	2.39	285.00	680.36	0.45	442.79	197.91
2009	2.53	285.00	721.13	0.37	442.79	161.69
2010	2.81	285.00	800.63	0.36	442.79	159.85
2011	1.98	285.00	563.11	0.38	442.79	168.81
2012	1.57	285.00	446.57	0.41	442.79	181.04
2013	1.95	285.00	554.78	0.26	442.79	116.85
2014	3.02	285.00	859.35	0.19	442.79	83.77
Average	2.53	285.00	720.73	0.40	442.79	176.77
		Biomass	738.0264		Biomass	126.7414

Assumed same habitat

	Black Rockfish			BDR		
		Coastwide			Coastwide	
Year	CPUE	Habitat	Rel.Dens	CPUE	Habitat	Rel.Dens
2001	2.55	442.79	1130.80	0.47	442.79	208.37
2003	3.04	442.79	1347.32	0.63	442.79	281.10
2004	2.65	442.79	1173.60	0.41	442.79	179.97
2005	2.90	442.79	1282.50	0.68	442.79	301.78
2006	2.99	442.79	1323.66	0.26	442.79	115.50
2007	2.51	442.79	1111.92	0.32	442.79	141.33
2008	2.39	442.79	1057.04	0.45	442.79	197.91
2009	2.53	442.79	1120.39	0.37	442.79	161.69
2010	2.81	442.79	1243.89	0.36	442.79	159.85
2011	1.98	442.79	874.88	0.38	442.79	168.81
2012	1.57	442.79	693.81	0.41	442.79	181.04
2013	1.95	442.79	861.94	0.26	442.79	116.85
2014	3.02	442.79	1335.13	0.19	442.79	83.77
Average	2.53	442.79	1119.76	0.40	442.79	176.77
		Biomass	1146.634		Biomass	126.7414

Raw CPUE

Habitat	Scale BDR to Black
Species-specic	0.172
Same	0.111

The STAT was also asked to use the output from the above exploration as a proxy survey based on the biomass of black rockfish times the ratio found above (this was Request 12)

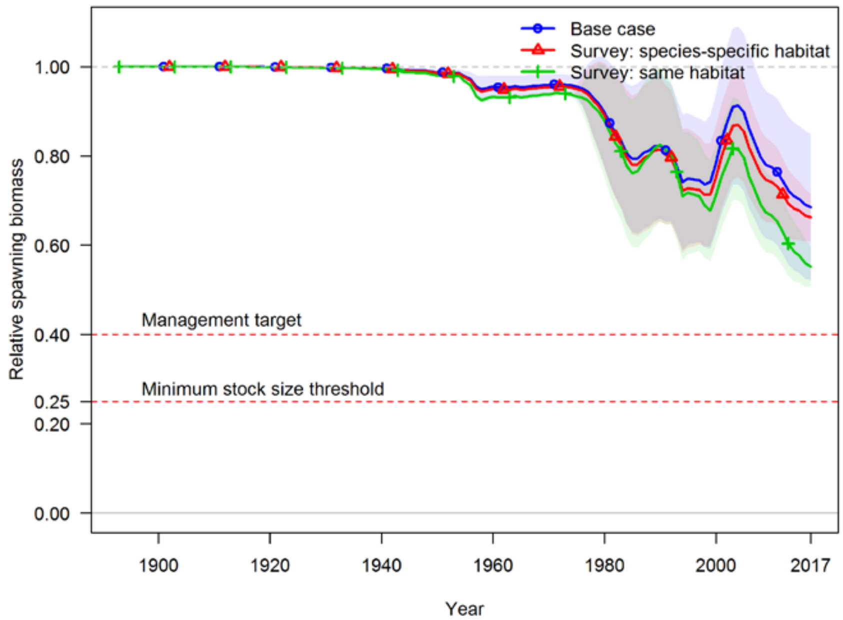
The STAT applied the following steps to provide stock estimates to use in the proxy survey and run the model as requested:

Created proxy survey and input into Blue/Deacon rockfish assessment for the year 2015

1. Calculate average 3+ biomass over 2001, 2003-2014 (2015 black rockfish assessment).
2. 7,973 t = mean black rockfish 3+ biomass.
3. Scale that biomass to blue/deacon biomass using the onboard raw CPUE data and habitat data.
4. Create a proxy survey for fully age and length selected for 3+ biomass for blue/deacon rockfish.

5. Do two model runs:
    A. Run 1 (specific habitat): proxy survey biomass is 0.172 x 7,973 t = **1,369 t**
    B. Run 2 (same habitat): proxy survey biomass is 0.111 x 7,973 t = **881 t**

For both approaches (species-specific and same habitat) the estimates of ln(R0) are very similar, while there were small changes in the relative depletion as shown below.



According to these analyses, a habitat-based approach that relates the blue/deacon rockfish to black rockfish did not produce very different results in terms of stock depletion. For the assumptions used here, the habitat specific estimates led to a smaller unexploited stock.

Request 9: Update the table of reported parameters from the base model to show the standard errors for estimated parameters.

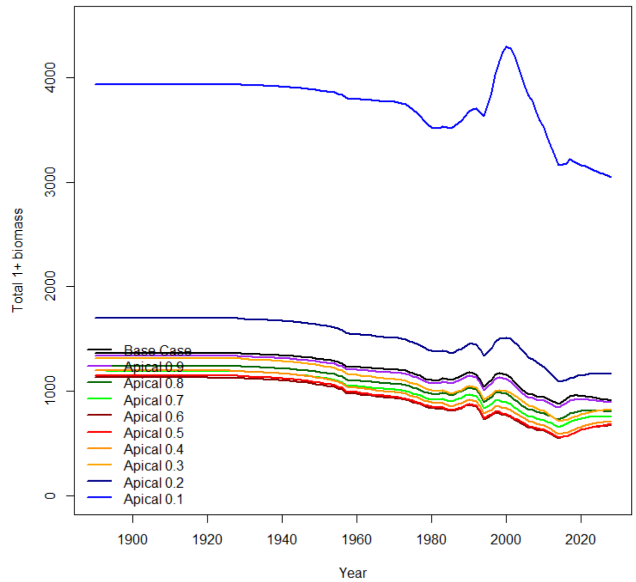
Rationale: To assist in understanding uncertainty.

STAT response: The STAT presented the table and it was agreed to include it in the assessment report

Request 10: Provide the graphs for total biomass for the different apical parameter runs.

Rationale: To see how the trends change if the total biomass of males is captured.

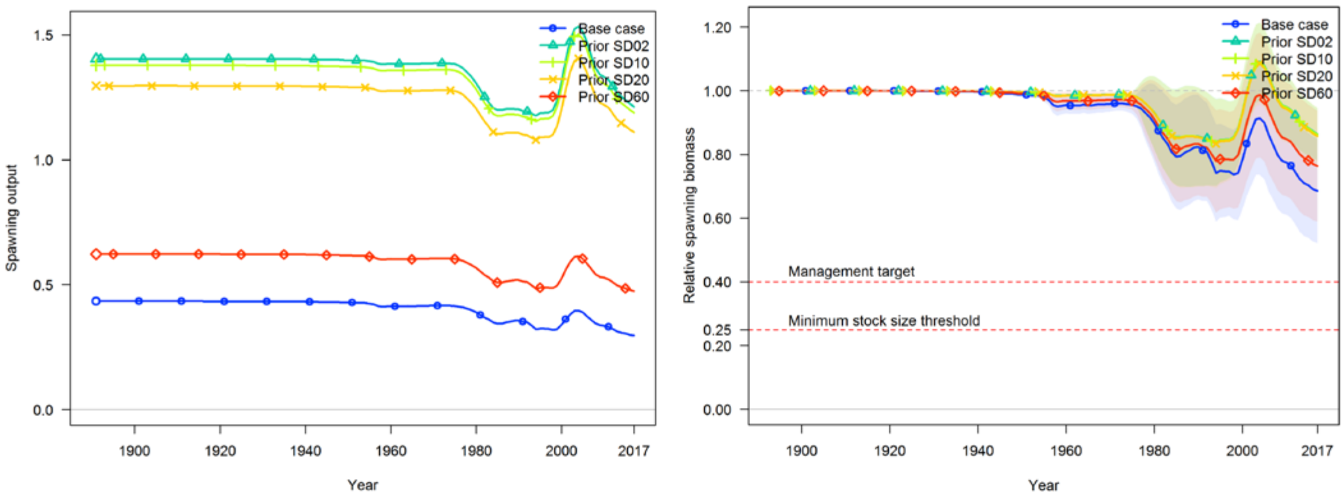
STAT response: The outcomes of these analyses showed that there is small change in the stock size and status for a wide range of apical values down to 0.3. After that, the change in the model results from the base case model is bigger as shown below. The apical value used for the base case model remained at 1.0, because there was little data to inform this parameter.



Request 11: Provide a model run where the prior for ln(R0) is set equal to the estimate of ln(R0) in the 2015 black rockfish assessment with double the standard error as estimated in the 2015 black rockfish assessment.

Rationale: To better understand how the blue/deacon rockfish data inform scale.

STAT response: The STAT presented the results but indicated that developing a prior using the black rockfish assessment information is not straightforward. Nevertheless, the model was run using the prior on ln(R0) from black rockfish and different values for standard error and the results are shown below. The blue/deacon rockfish data prefer the lower abundance when the standard error becomes big enough to give the other input data relatively more weight. This suggests that the model does include input data with some information that supporting a smaller stock size than that for black rockfish.



Request 12: If time permits, use the habitat-weighted ratios of blue/deacon rockfish to black rockfish in the onboard observer CPUE index in recent years to develop a proxy survey based on the biomass of black rockfish times the ratio. Evaluate this in the new base model.

Rationale: To further explore the possibility of using the black rockfish assessment to inform blue/deacon rockfish scale.

STAT response: This is covered in the response to request 8 since this request was an extension to request 8.

Request 13: If possible, produce the likelihood profiles over ln(R0) of the individual indices.

Rationale: To explore whether there is a conflict in the indices with respect to scale.

STAT response: The profiles showed that the dockside MRFSS and logbook data supported higher ln(R0) values than those supported by the other indices but there was not considerable conflict. All indices were kept for the analyses with the revised base case model.

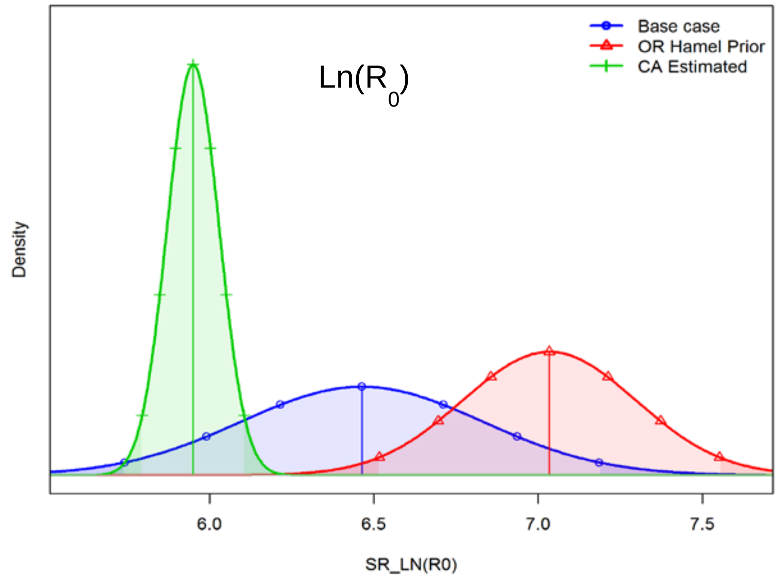
Request 14: Produce a table of SEs for ln(R0), SSB, and depletion for the models in Request 5 (former base, the natural mortality set equal to the median of the Hamel prior, and the natural mortality set equal to the values in California blue/deacon rockfish assessment).

Rationale: There are concerns about whether the figure showing these results estimated the uncertainty correctly.

STAT response: The STAT produced results shown in the table below. They also presented the pdfs for ln(R0) showing that there is some overlap in the pdf of ln(R0) for the base case model and the same model except that natural mortality is estimated. Following the presentation of these results the Panel discussed the features of a new base case model with the STAT and produced the following configuration (defined as Request 15).

Estimates (SEs)

	ln(R0)	SSB_{2017}	SSB_0	Depletion ($SB0/SB_{2017}$)
Former Base Case	6.464 (0.3687)	158.6 (60.3)	294.3 (57.3)	0.539 (0.104)
Hamel prior	7.035 (0.2643)	291.1 (109.9)	425.1 (115.0)	0.684 (0.079)
CA Estimates	5.950 (0.079)	106.2 (20.3)	257.4 (21.8)	0.413 (0.050)



The Panel also discussed the best way to characterize uncertainty in the decision tables and asked the STAT to consider two possible options, one that relies on finding the ln(R0) values for which the likelihood is 0.66 units from the base in either direction, and second option based on the asymptotic standard error of ln(R0), and selects values of ln(R0) that are ±1.15 * the SE of ln(R0) relative to the value of the base case. A separate request to this effect is described below.

Request 15: The new base model has the following configuration:

- Ramp the recreational ocean boat catch time series starting at zero in 1970 to 1979;
- Use the male length at CV at maximum age from the California blue/deacon assessment;
- Compress the length bin at 46 cm;
- Set the research survey to full selectivity for all ages and lengths;
- Set the male and female natural mortality at the median of the Hamel prior distribution;
- Retune and jitter the base model.

Rationale: The STAT and STAR Panel agreed on this model configuration.

STAT response: The STAT presented the results from the new base case model and confirmed that the model converged. Also, jitter runs did not find combinations of estimated parameters that will produce a better likelihood value. The STAT and the Panel concurred that this configuration of the model will continue to be the base case model

Request 16. To document the differences between the initial base model and the new base model, provide a run with all the changes in Request 15 except setting the male and female natural mortality at the median of the Hamel prior; instead allow the model to estimate natural mortality. Provide plots showing the spawning output time series and the ln(R0) distributions for the three model runs (initial base, new base, and this intermediate case).

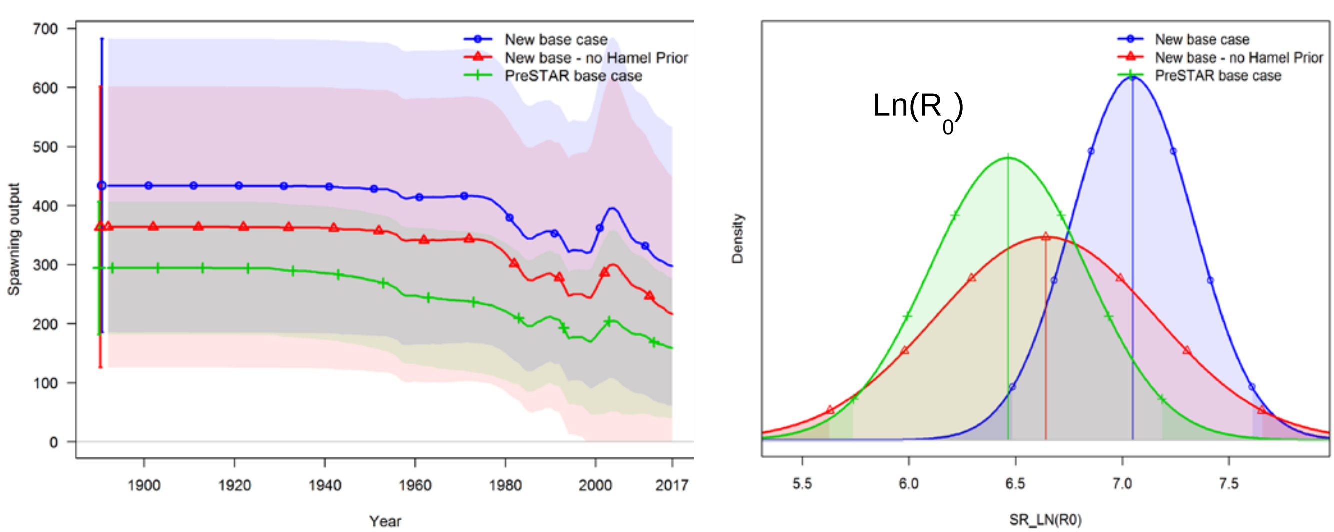
Rationale: To show the changes in a step-wise fashion.

STAT response: The STAT presented graphs showing the requested parameters. The new estimated value for M when the model is allowed to estimate it was 0.144 which was only slightly different from the originally estimated value for M. The value of M that comes from the Hamel prior was 0.158 which is somewhat different from the M value the model prefers.

The results of the distribution for ln(Ro) showed that the probability distribution when M is fixed at the median of the Hamel prior includes the mean value of ln(R0) when the natural mortality is estimated.

Estimates (SEs)

	ln(R0)	SSB_{2017}	SSB_0	Depletion ($SB0/SB_{2017}$)
PreSTAR base case	6.464 (0.3687)	158.6 (60.3)	294.3 (57.3)	0.539 (0.104)
New base (minus Hamel Prior M fix)	6.641 (0.517)	216.4 (118.1)	363.8 (121.3)	0.595 (0.129)
New base case	7.047 (0.286)	297.2 (120.2)	433.8 (126.8)	0.685 (0.084)



Request 17: Use the default harvest control rule (ACL = ABC; P* = 0.45; sigma = 0.72; ABC buffer = 0.9135*OFL) for the new base model as described above to produce decision tables with the following alternative approaches:

- Find the ln(R0) values for which the likelihood is 0.66 units from the base in either direction;
- ±1.15 * the asymptotic SE of ln(R0) to the value of ln(R0) for the base case.

Rationale: To explore potential decision tables.

STAT response: The STAT presented the calculations using the higher and lower values calculated using the two approached described above. The boundaries they found are shown in the table below

Method A (Likelihood units)	State of nature		
	Low	Base case	High
	$\ln(R_0) = 6.775$	$\ln(R_0) = 7.047$	$\ln(R_0) = 7.480$

Method B (Asymptotic SD of ln(R0))	State of nature		
	Low	Base case	High
	$\ln(R_0) = 6.716$	$\ln(R_0) = 7.047$	$\ln(R_0) = 7.374$

Those boundaries did not encompass the mean value of the ln(R0) when the new base case model is allowed to estimate natural mortality (ln(R0) = 6.641) instead of fixing it to the median of the Hamel prior, so there are concerns that these boundaries are not wide enough to adequately represent uncertainty. As shown in the previous request, the uncertainty around ln(R0) was reduced when natural mortality was fixed (set equal to the Hamel median value). Therefore, it was recommended that the SE of ln(R0) from the model that did not fix the value of natural mortality be used to calculate the envelope of uncertainty. The STAT recalculated the boundaries using Method B (the only viable option) and the new wider SE. These results are shown below for two different scenarios about future catches

Scenario 1: Catch during 2017-2018 is set to 2015-2016 average catch given recent management constraints on fishery, and ACL=ABC.

Method B updated		State of nature								
(Asymptotic SD of ln(R0))		Low			Base case			High		
		$\ln(R_0) = 6.453$			$\ln(R_0) = 7.047$			$\ln(R_0) = 7.641$		
Relative prob. of ln(SB_2017):		0.25			0.5			0.25		
Management decision	Year	Catch (mt)	Spawning Biomass (mt)	Depletion	Catch (mt)	Spawning Biomass (mt)	Depletion	Catch (mt)	Spawning Biomass (mt)	Depletion
	2017	28.55	116.9	0.49	28.55	297.2	0.69	28.55	635.0	0.80
	2018	28.55	115.1	0.49	28.55	297.5	0.69	28.55	635.1	0.80
	2019	42.28	116.9	0.49	105.27	305.5	0.70	217.22	649.3	0.82
	2020	41.86	115.8	0.49	101.78	293.9	0.68	206.89	613.0	0.77
	2021	41.53	114.2	0.48	98.51	281.8	0.65	197.35	577.5	0.73
ABC/ACL	2022	41.27	112.6	0.47	95.37	270.0	0.62	188.59	544.8	0.69
	2023	41.11	111.7	0.47	92.51	259.6	0.60	180.90	516.6	0.65
	2024	41.05	111.2	0.47	90.04	250.8	0.58	174.44	493.1	0.62
	2025	41.07	111.1	0.47	87.98	243.6	0.56	169.14	474.0	0.60
	2026	41.13	111.2	0.47	86.29	237.7	0.55	164.82	458.6	0.58
	2027	41.20	111.3	0.47	84.90	232.9	0.54	161.27	446.0	0.56
	2028	41.27	111.4	0.47	83.74	229.0	0.53	158.32	435.7	0.55

Scenario 2: The catch during 2017-2018 is set to 2015-2016 average catch given recent management constraints on fishery, and GMT-recommended catch stream where 2019-2028 catches set to average historical (2005-2014) catch level.

Method B updated		State of nature								
(Asymptotic SD of ln(R0))		Low			Base case			High		
		$\ln(R_0) = 6.453$			$\ln(R_0) = 7.047$			$\ln(R_0) = 7.641$		
Relative prob. of ln(SB_2017):		0.25			0.5			0.25		
Management decision	Year	Catch (mt)	Spawning Biomass (mt)	Depletion	Catch (mt)	Spawning Biomass (mt)	Depletion	Catch (mt)	Spawning Biomass (mt)	Depletion
	2017	28.55	116.9	0.49	28.55	297.2	0.69	28.55	635.0	0.80
	2018	28.55	115.1	0.49	28.55	297.5	0.69	28.55	635.1	0.80
	2019	27.37	116.9	0.49	27.37	305.5	0.70	27.37	649.3	0.82
	2020	27.37	119.6	0.50	27.37	314.9	0.73	27.37	665.2	0.84
	2021	27.37	121.4	0.51	27.37	321.4	0.74	27.37	675.3	0.85
GMT Catch	2022	27.37	122.9	0.52	27.37	325.8	0.75	27.37	681.7	0.86
	2023	27.37	124.7	0.53	27.37	329.2	0.76	27.37	686.4	0.87
	2024	27.37	126.7	0.53	27.37	332.0	0.77	27.37	690.0	0.87
	2025	27.37	128.7	0.54	27.37	334.4	0.77	27.37	692.8	0.87
	2026	27.37	130.8	0.55	27.37	336.3	0.78	27.37	695.2	0.88
	2027	27.37	132.7	0.56	27.37	338.1	0.78	27.37	697.2	0.88
	2028	27.37	134.5	0.57	27.37	339.6	0.78	27.37	698.9	0.88

Subsequent to the STAR Panel meeting, the STAT did a more extensive jitter analysis and found slight model instability associated with the male growth parameter for the length at minimum age. This instability was resolved by setting this parameter equal to equivalent female growth parameter. This change had a negligible impact on model results. The STAR Panel reviewed and agreed with the proposed change. Assuming the male and female lengths are equal at small sizes is a relatively standard and reasonable assumption.

Description of the Base Model and Alternative Models used to Bracket Uncertainty

California assessment

Several changes were made to the pre-STAR base model during review by the STAR Panel:

- An error in the input hook-and-line commercial landings time series was corrected;
- The SWFSC juvenile rockfish survey of young-of-the-year rockfish survey time series was revised to better account for years with zero catches of blue/deacon rockfish;
- Steepness and natural mortality were estimated.

Alternative Models for Bracketing Uncertainty

The high and low biomass scenarios were identified by considering uncertainty in ending spawning biomass. The low biomass scenario was defined by the 12.5% quantile of ending biomass, while the high biomass scenario was defined by the 87.5% quantile of ending biomass. The high and low scenarios were implemented by forcing the model to fit a proxy survey in the ending year with the specified spawning biomass.

Oregon assessment

Several changes were made to the pre-STAR base model during review by the STAR Panel:

- The recreational ocean boat catch time series was ramped up linearly starting at zero in 1970 to 1979 to better reflect historical removals;
- The growth curve parameter CV at the maximum age was borrowed from the California assessment rather than set equal to the female CV;
- The upper tail of the length bins was compressed to the 46 cm length bin for model fitting;
- The research survey was set to full selectivity for all ages and lengths;
- The male and female natural mortalities were fixed at the median of the Hamel prior distribution
- The male growth parameter for the length at minimum age was set equal to equivalent female growth parameter.

Alternative Models for Bracketing Uncertainty

The high and low biomass scenarios were based by uncertainty in the estimate ln(R0), which establishes the scale for the population. The standard error of ln(R0) came from a model where natural mortality was estimated rather than fixed as in the final base model to more realistically characterize uncertainty. The high and the low biomass scenarios were obtained from ±1.15 * the asymptotic SE of ln(R0).

Technical Merits of the Assessments

- These are very thorough assessments with extensive exploration of sensitivity runs to evaluate model assumptions.
- Both assessment models are relatively parsimonious, which is a reasonable approach given the assessment data available and the exploitation histories of the stocks.
- Both assessment models appear to be mature and stable enough for an update assessment the next time that they are assessed. A full assessment would be required if a significant new source of information became available, such as an absolute biomass estimate from a survey.

Technical Deficiencies of the Assessments

- The assessments were conducted on a complex of two species. The historical data contains a mixture of two species of unknown proportions.
- The stock boundaries for the assessments may not correspond to actual stock structure.
- There are no fishery-independent indices of abundance for the Oregon assessment, and only the SWFSC juvenile rockfish survey for the California assessment, which indexes young-of-the-year abundance (i.e., recruitment), and not adult biomass.
- The ageing of blue/deacon rockfish has not been validated, and there were apparent differences in ageing criteria between ageing labs.

Areas of Disagreement Regarding STAR Panel Recommendations

Among STAR Panel members (including GAP, GMT, and PFMC representatives):

There were no disagreements among the members of the STAR Panel regarding the technical aspects or results of the assessment.

Between the STAR Panel and the STAT Team:

There were no areas of disagreement between the STAT and the STAR Panel regarding the technical aspects or results of the assessment.

Management, Data, or Fishery Issues raised by the GMT or GAP Representatives during the STAR Panel Meeting

The GAP representative forwarded information from the fishing industry concerning seasonal onshore and offshore movement of blue/deacon rockfish, their propensity to be captured by hook-and-line fishing gear, and whether blue/deacon rockfish can be distinguished black rockfish in echograms. The GMT representative presented material regarding the relative abundance of blue/deacon rockfish and black rockfish from ODFW studies, including ROV surveys, inshore and offshore habitat comparisons, and acoustic surveys.

Unresolved Problems and Major Uncertainties

- The assessments were conducted on a complex that included two species. The spatial separation between the two species, with blue rockfish predominant south of San Francisco and deacon rockfish predominant to the north, suggests that the development of regional assessments may be able to address this problem, but they would likely need to have different boundaries than the current assessments.
- The natural mortality for blue/deacon rockfish is highly uncertain and the models are sensitive to the assumed value.
- The overall scale of the population is poorly resolved in the Oregon assessment, at least part because the fishing has not had a large historical impact on the stock abundance. This is less of an issue for the California assessment, were the stock has been fished down to low stock size and has increased in abundance again after fishing intensity was reduced.
- Recreational CPUE indices used in both assessments can provide a misleading signal about true population abundance trends.

Recommendations for Future Research and Data Collection

1. A fishery independent survey should be developed for nearshore species off Oregon. Several possibilities should be explored. For a nearshore survey to viable over the long term, it will be important to keep the cost of the survey low and engage in a collaborative effort with the fishing industry. An effort should be made to distribute sampling sites according to a design that would allow both local and state-wide estimates of abundance, and to evaluate density both in nearshore and offshore waters. Some alternatives for a near-shore survey include:
    a. An acoustic survey for rockfish distributed in mid-water such as black rockfish and blue/deacon rockfish. Anecdotal information suggests that black rockfish and blue/deacon rockfish schools are distinguishable. Descending cameras can be used for species identification. The preliminary acoustic project to survey black and blue/deacons rockfish needs to be peer-reviewed. Acoustic surveys can produce an estimate of absolute abundance if properly calibrated and acoustic target strength is sufficiently well known.
    b. ROV surveys of rocky reef habitat. ROV surveys are usually used to survey near-bottom species, which may be a problem for species that are often found in the water column, such as black rockfish and blue/deacon rockfish. An ROV survey can produce absolute estimate for abundance for near-bottom species if the

sighting function can be estimated, quantitative methods are used to estimate density.

   c. A standardized hook-and-line survey such as is used by the California Collaborative Fisheries Research Program to study changes in density inside and outside MPAs, and is being developed by the Washington Department of Fish and Wildlife. This would only provide an index of relative abundance, so a time series would be needed to inform the assessment.

2. Better characterization of habitat is needed for fishery CPUE index development. Oregon and southern California do not have the same coverage of mapping as the rest of California in nearshore waters. Other environmental descriptors in addition to rocky reef substrate and depth strata should be evaluated.

3. Ad hoc criteria are used to identify a threshold when applying the Stephens and MacCall method of selecting records for CPUE index development. Further research is needed to determine whether threshold selection criteria can be optimized.

4. Modeling discard as a separate fleet, as was done for blue/deacon rockfish, is a simple and intuitive approach, but the strengths and weaknesses of this approach are unclear. This method should be compared to the more standard approach of modeling discard with retention curves to ensure the model results are not strongly affected by the method used.

5. The Markov chain Monte Carlo (MCMC) method implemented in Stock Synthesis is not reliable in many cases. Characterizing uncertainty of the final assessment model is important, and MCMC offers advantages over asymptotic approximations using the Hessian or likelihood profiles.

6. Several alternative approaches were used this year to construct decision tables, and some approaches may be better than others. The stock assessment TOR should outline the various methods that can be used, and provide recommendations if possible on preferred approaches.

7. Additional genetic work is needed to separate the geographical distribution on blue and deacon rockfish. The SWFSC juvenile rockfish survey is a good platform for genetic samples because it is a fisheries independent survey and the survey spans the geographic area where transition occurs from predominately blue rockfish to predominately deacon rockfish. If the relatively clear break in geographic distribution at San Francisco is reinforced by additional information, consideration should be given to separate assessments north and south of this boundary. DNA sampling of historically collected otoliths should continue.

8. Evaluate the effect of MPAs creation on nearshore recreational fishery CPUE indices in California.

9. Age validation study is need given differences in ageing criteria between the SWFSC and the Oregon age readers for blue/deacon rockfish.

10. There appears to be no routine sampling procedures in place to sample the catch for ageing structures or biological data in the California nearshore fishery. Collection of representative ageing data is important for stock assessment and should be instituted for nearshore species.

11. Consider a formal process of soliciting local and traditional knowledge regarding blue/deacon rockfish behavior, seasonal and ontogenetic movement, and density by depth strata to inform the next assessment.

Acknowledgements

The STAR Panel commends the STAT members for their excellent presentations and complete and well-written documentation. Their willingness to respond to STAR Panel requests and to engage in productive discussions greatly contributed to the review process. The STAR Panel also thanks SWFSC staff at the Santa Cruz Lab for hosting the meeting and providing administrative support.