Quillback Rockfish: Responses to Additional Requests From the Groundfish Subcommittee for the California Model

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This report is an update of the original report, and includes material that was presented at the Groundfish Subcommittee's (GFSC) August 17, 2021 meeting but was not available for inclusion in the original report. New material includes age data that were provided between the original report's deadline and the meeting, and an additional selectivity blocking run based on an updated interpretation for request 1 that was clarified between the original report's deadline and the meeting.

Requests Based on Additional or Adjusted Data

Request 2:

Add the length data from the historical onboard CPFV surveys from the 1980s and 1990s northern California survey conducted by CDFW noted in Table 2 of the SSC Report.

Rationale: While the CRFS and MRFSS data may provide consistent sampling over time and space, the sample sizes for lengths from the MRFSS era are relatively low due to low sampling frequency and only sampling 30 anglers per day. Addition of these supplementary data sources will help increase the sample size providing more insight on the effects of the low sample size.

Response 2:

Additional length data for quillback rockfish were provided by California Department of Fish and Wildlife (CDFW) on July 12, 2021. These data were collected by observers onboard commercial passenger fishing vessels (CPFV) fishing in central California (Reilly et al. (1998)) from 1987-1998, and were not available for use in the base model that was reviewed and adopted in the June Groundfish Subcommittee meeting of the Scientific and Statistical Committee (GFS-SSC). A total of 753 additional length observations for the recreational fleet from 1987-1998 (Table 1) were added to the California quillback rockfish base model.

Length distributions from the new data were generally similar to existing length distributions within the adopted base model (Figure 1). Given the use of new data, scenarios with and without data weighting were run. Changes to data weights were minimal and resulted in little change in model trajectories. Spawning output (Figure 2), depletion (Figure 3), and recruitment deviations (Figure 4) from models with the new data were similar to those from the adopted base model. Adding the new length data resulted in lower estimates of initial spawning output (SB virgin) and recent spawning output (SB2021) compared to the adopted base model, and resulted in a slightly more depleted stock. Parameter estimates, derived quantities, and likelihood components for each scenario are provided in Table 4. Given that different datasets were used for the scenarios, likelihood and AIC values cannot be compared to the adopted base model.

Table 1: Number of additional length samples by year (new lengths) from 1987-1998 for quillback rockfish onboard CPFVs in central California as provided by CDFW. The number of length samples in the base model (original lengths) is provided for comparison.

Year	New lengths	Original lengths
1987	4	8
1988	87	7
1989	107	51
1990	37	-
1991	6	-
1992	43	-
1993	61	57
1994	22	29
1995	164	18
1996	104	43
1997	73	79
1998	45	60

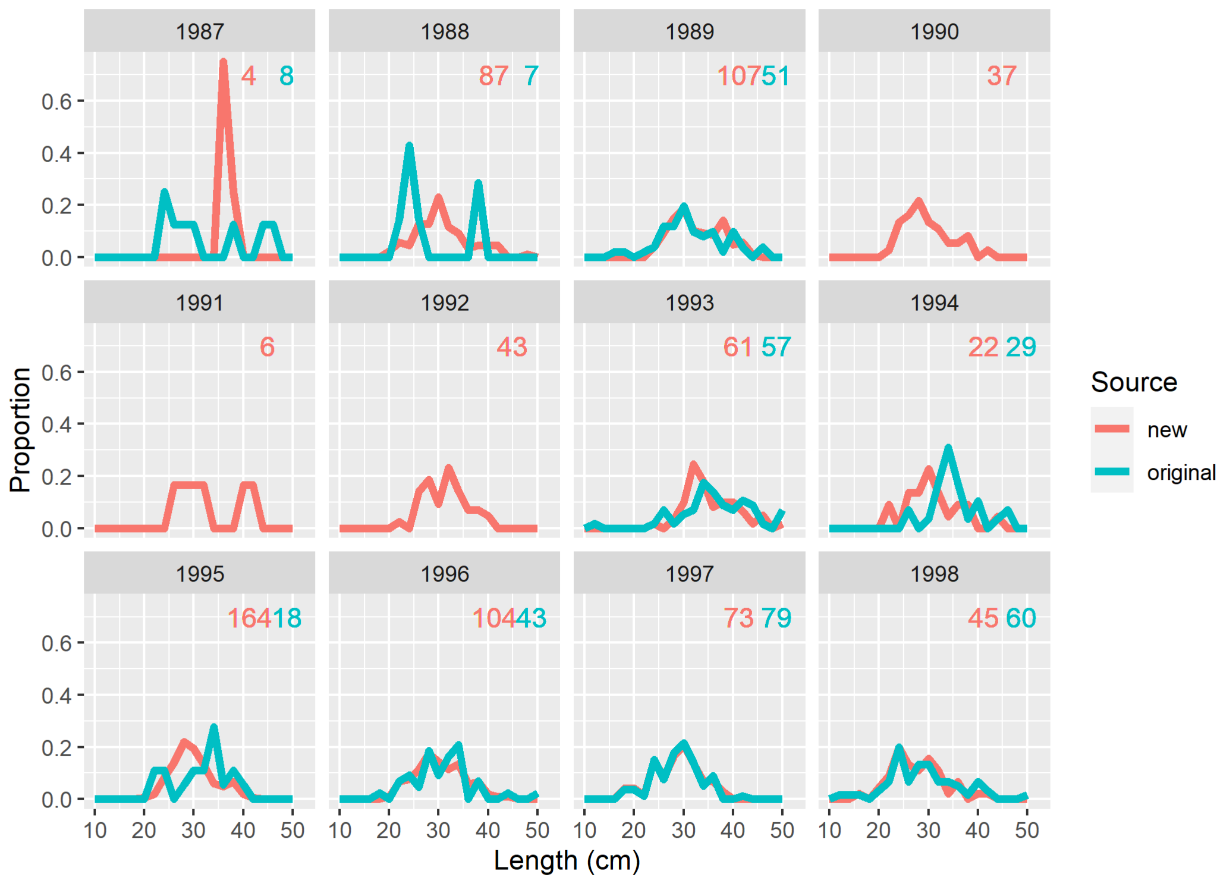

Figure 1: Length distributions of the new data (red line) compared to the original data (blue line) in years where the new data were available (1987-1998). Numbers indicate the number of lengths from each dataset for each year that are also shown in Table 1.

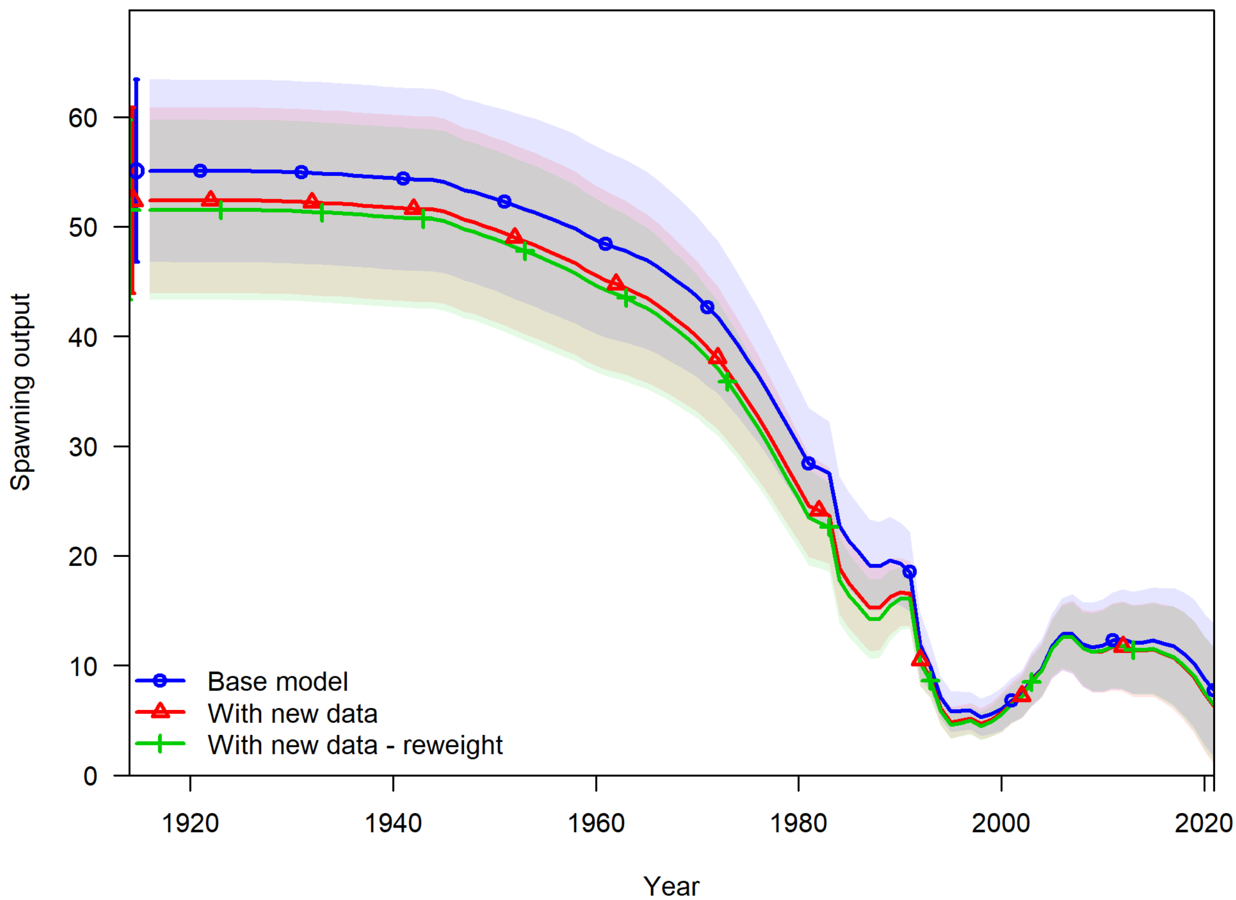

Figure 2: Change in estimated spawning output across scenarios when adding 1987-1998 central California CPFV length data. Shading indicates 95% confidence intervals around each scenario.

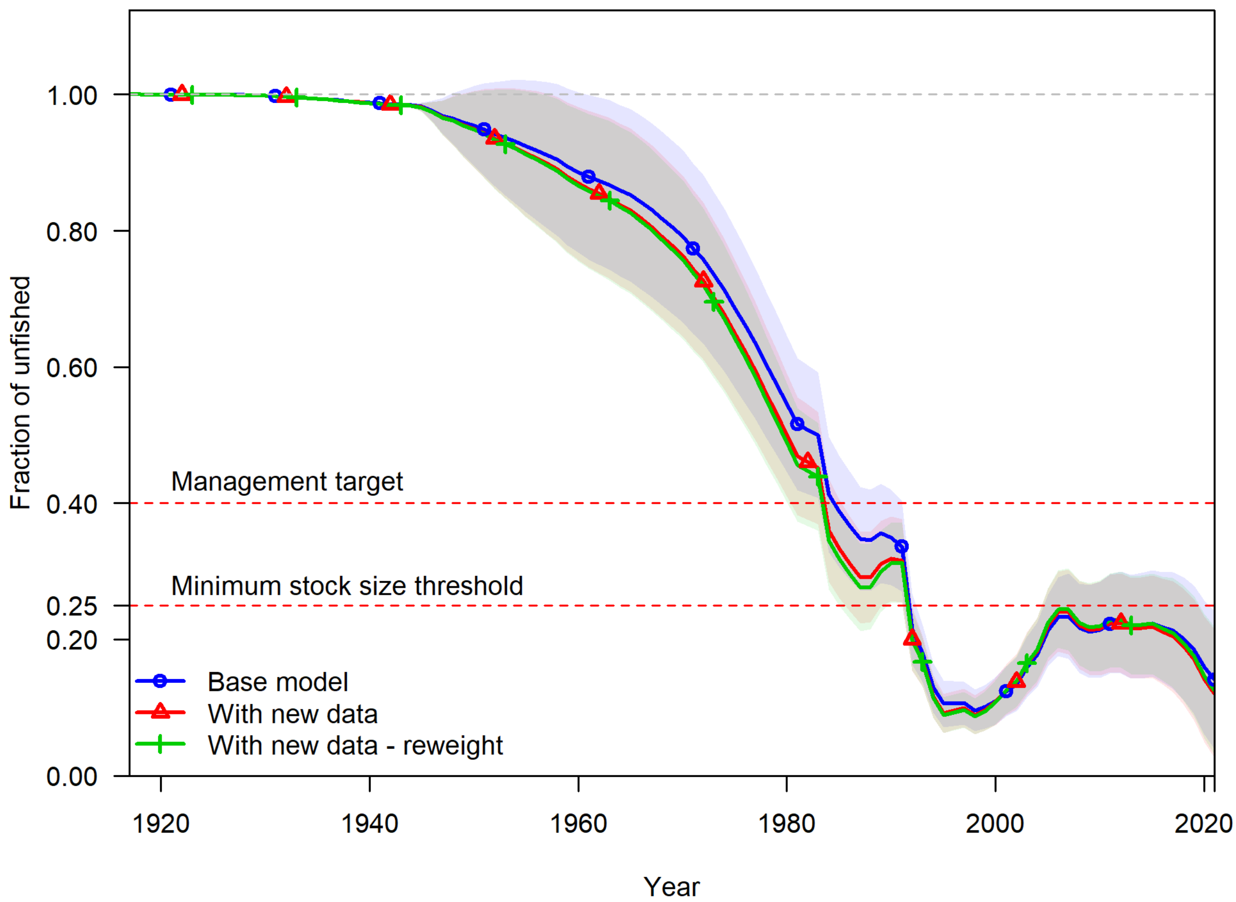

Figure 3: Change in estimated fraction of unfished across scenarios when adding 1987-1998 central California CPFV length data. Shading indicates 95% confidence intervals around each scenario.

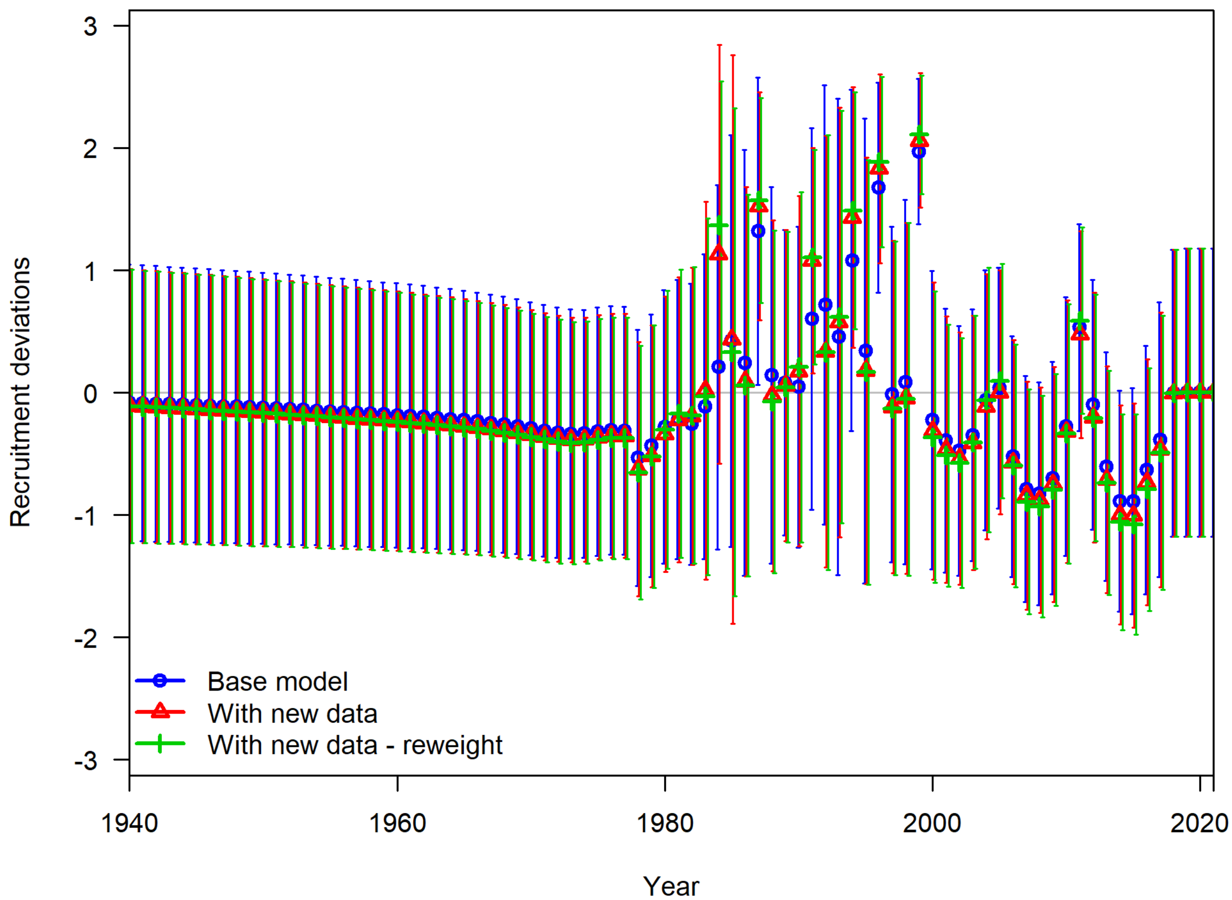

Figure 4: Yearly recruitment deviations (points) across scenarios when adding 1987-1998 central California CPFV length data. Vertical lines represent the 95% confidence intervals of the deviations for each scenario.

Request 3:

Reevaluate the catch history taking into account input from the CDFW Report 1 and Report 2 as well as input from the California STAT member to address apparent outlier estimates and methods for filling blanks between 1990 and 1992 for the MRFSS era.

Rationale: The CDFW reports identify a number of historical catch reconstruction considerations that appear to be outliers that affect depletion and scale. This request is intended to evaluate the effects of their inclusion on the assessment and reconsider the basis for their inclusion.

Response 3:

No new catch values were provided by CDFW for inclusion in this document. As such, no additional explorations were conducted.

An alternative catch history was previously explored in the original California quillback rockfish report (see sensitivity #14 on page 18 of that report). The average catch in the three years before and three years after years with high catch were used in the alternative catch time series. Catch was higher than neighboring years in 1991 for the commercial fleet, and 1983 and 1993 for the recreational fleet. Alternative catch values were therefore applied to these years. Reducing the magnitude of catch resulted in lower estimates of initial and recent spawning output compared to the adopted base model, and resulted in a slightly more depleted stock. For detailed results of this sensitivity, see Table 13, and Figures 47-49 from the California quillback rockfish report.

Request 5:

Age otoliths and use corresponding lengths from samples collected in California and compare results to the growth curve from samples collected in Oregon and Washington. Otoliths should be provided as requested in the NMFS Report 1 (Agenda Item C.10, Supplemental NMFS Report 1, June 2021).

Rationale: Comparison of ages and lengths of fish sampled in California to the growth curve derived from samples collected in Oregon and Washington will provide a means of examining whether the growth curve provided by them are representative of growth in California.

Response 5:

CDFW provided otoliths from 35 quillback rockfish collected from the commercial (N = 6) and recreational (N = 29) fisheries, sampled nearly exclusively from Crescent City, California. In addition, 48 otoliths from CCFRP sampling were provided. An additional 39 otoliths from port sampling efforts were provided by Southwest Fisheries Science Center (SWFSC) staff, as were 123 otoliths from the Abrams collection housed at the SWFSC. Tables for the number of new otoliths by year (Table 2) and by length bins (Table 3) are provided. Lengths for CCFRP samples were not yet available.

Table 2: Number of new otoliths available by year and source.

Year	Abrams	CDFW Comm.	CDFW Rec.	SWFSC boxes	SWFSC trays
1985	0	0	0	5	0
2004	0	0	0	4	1
2006	0	0	0	0	2
2007	0	0	0	27	0
2010	44	0	0	0	0
2011	79	0	0	0	0
2018	0	0	11	0	0
2019	0	6	18	0	0

Table 3: Number of new otoliths available by length bin and source. Structures are not available for all modeled length bins

Length bins (cm)	Abrams	CDFW Comm.	CDFW Rec.	SWFSC boxes	SWFSC trays
20	1	0	0	0	0
22	0	0	0	1	0
24	1	0	0	0	1
26	2	0	0	0	0
28	1	0	1	1	0
30	6	1	4	5	1
32	12	4	0	7	1
34	14	1	1	8	0
36	32	0	4	4	0
38	18	0	5	7	0
40	13	0	2	0	0
42	12	0	4	1	0
44	7	0	7	2	0
46	3	0	0	0	0
48	1	0	1	0	0

Otoliths were sent to the Northwest Fisheries Science Center's ageing lab in Newport, Oregon. The 35 otoliths from CDFW and the 39 otoliths from the SWFSC (for a total of 74) were aged in time for presenting results at the GFSC meeting, but not in time for including in the first version of this report.

New length-age samples were overlaid onto samples used in the quillback rockfish stock assessment and do not clearly indicate separate growth (Figure 5). A separate California-specific length-age relationship could not be robustly estimated given the limited sample size of young quillback rockfish from California. Twenty-one samples from California were already available from the West Coast Groundfish Bottom Trawl Survey and included within the growth curves estimated for the stock assessment (red circles in Figure 5). Of these samples, only 2 were less than 5 years old. On their own, these 21 samples are too sparse to estimate a reliable growth curve (red line Figure 6). Similarly, the new 74 samples lack young fish to estimate a reasonable growth curve on their own (blue line in Figure 6). Even in combination, the 95 total samples for California are highly reliant on the two youngest age samples and have insufficient numbers of young fish to reliably estimate a separate growth curve (purple line in Figure 6). When adding the new samples to all existing length and age samples, the growth curve is very similar to the estimated curve from the stock assessment report (yellow line in Figure 6; L_∞ = 43.00 cm and K = 0.194 when combined, compared to L_∞ = 43.04 cm and K = 0.199 from the stock assessment).

Otoliths from the 123 Abrams samples and 48 CCFRP samples have not yet been aged. Lengths for the Abrams samples are similar to those already aged (Table 3), and it was stated during the GFSC meeting that CCFRP lengths were also similar to those in Table 3. As such, it is unlikely that the currently unaged samples will provide an adequate number of young fish to robustly estimate a separate California growth curve.

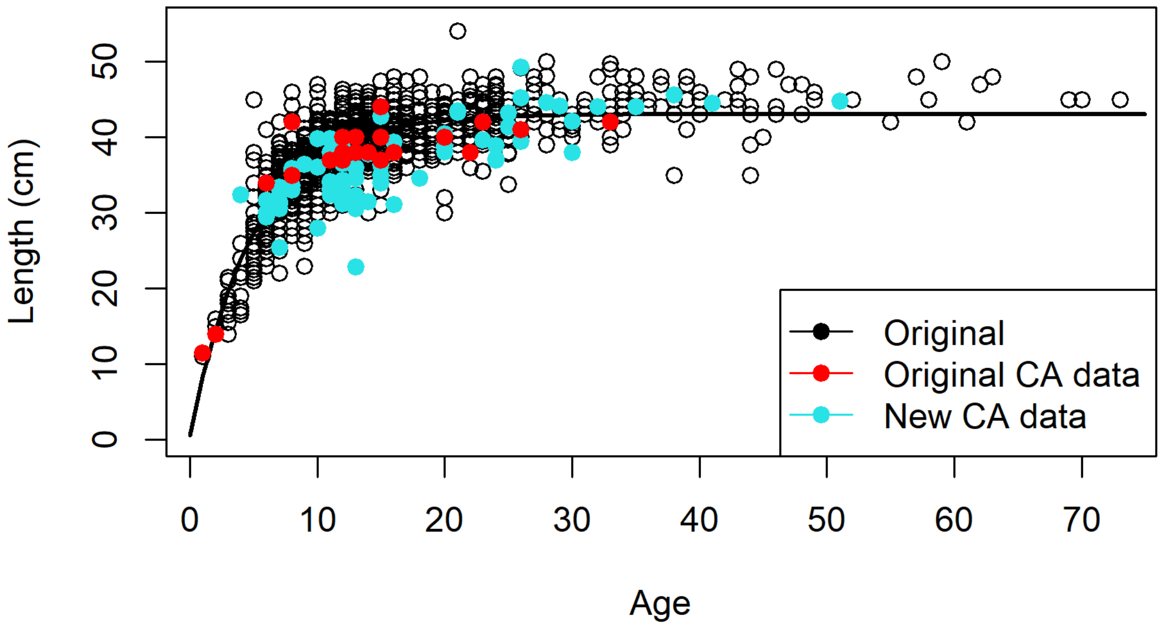

Figure 5: Length-age data for quillback rockfish. Black and red circles indicate samples used in the stock assessment report that are from Oregon and Washington (black) and California (red). Blue circles indicate new California samples.

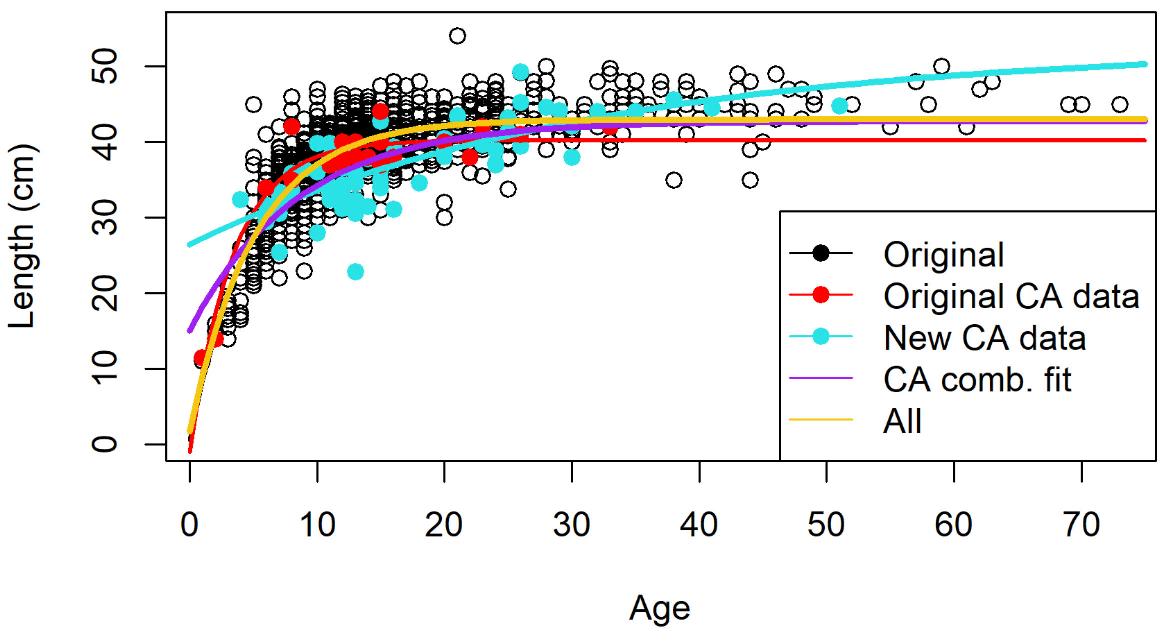

Figure 6: Length-age data (circles) for quillback rockfish alongwith estimated growth curves (lines). Black and red circles indicate samples used in the stock assessment report that are from Oregon and Washington (black) and California (red). Blue circles indicate new California samples. The black line (plotted under the yellow line) is the growth curve from data (red and black) used in the stock assessment. The purple line is the growth curve from California data (red and blue), while the yellow line is the growth curve from all data. Blue and red lines are based on the similarly colored data points.

Requests Based on Additional Model Runs

Request 1:

Evaluate alternative selectivity time blocking based on the timing of depth restrictions from 2001-present north of Pigeon Point, California where they are commonly encountered. In particular add a time block (allowing for dome-shaped selectivity) starting in 2001 and consider additional time blocks.

Rationale: Input from the GAP and GMT indicate that asymptotic selectivity for the recreational fishery is not a realistic assumption and was made to fit the need for the model to have at least one sector be asymptotic as required by the TOR (pg 36) . It seems more realistic to consider the period before severe regulations in the early 2000s as asymptotic (or domed) and then consider domed shape assumptions thereafter, perhaps with a separate dome shape after 2016 when regulations were slightly relaxed.

The rationale for this request was updated by the groundfish subcommittee on August 13, 2021 to include the commercial fishery. The updated rationale was as follows:

Rationale: Input from the GAP and GMT indicate that asymptotic selectivity for the recreational and commercial fishery is not a realistic assumption and was made to fit the need for the model to have at least one sector be asymptotic as required by the TOR (pg 36) . It seems more realistic to consider the period before severe regulations in the early 2000s as asymptotic (or domed) and then consider domed shape assumptions thereafter, perhaps with a separate dome shape after 2016 when regulations were slightly relaxed.

Response 1:

Alternative selectivity forms and blocks were explored during original model explorations. The choice of using asymptotic selectivity for the recreational fleet was based on findings from ROV surveys conducted by CDFW that did not show clear signs of increasing size with depth at depths greater than 10 fm. Assuming dome-shaped selectivity also resulted in a similar trajectory as when assuming asymptotic selectivity. Consequently, there was limited support for the additional complexity when adding parameters due to blocking of selectivity. Additional runs here also show limited support for the additional complexity in blocking selectivity.

We explored numerous options for blocking selectivity based on changes in the estimated percent of area open to fishing (Table A-1 from CDFW Report 1), as well as changes in mean length from the length data in the adopted base model (Figure 20 from the California quillback rockfish report). Specific blocking along with the reasons for blocking (in parenthesis) are described below. In all instances, the model was allowed to estimate dome-shaped selectivity by estimating selectivity parameters controlling the peak size of selectivity (parameter 1), the width of the peak (parameters 2), the width of the ascending and descending limbs of selectivity (parameters 3 and 4), and the selectivity for large individuals (parameter 6). Given the initial interpretation of the request as based on the original rationale, all but the final option applied blocking only for the recreational fishery. The final option was added after being provided with the updated rationale.

1. Blocking selectivity from 1916-2000 assuming asymptotic selectivity, and 2001-2020 allowing for dome-shaped selectivity (as requested).
2. Blocking selectivity from 1916-2000 assuming asymptotic selectivity, 2001-2016 allowing for dome-shaped selectivity, and 2017-2020 allowing for dome-shaped selectivity (due to depth restrictions starting in 2001 and a relaxation of those restrictions starting in 2017).
3. Blocking selectivity from 1916-2000 assuming asymptotic selectivity, 2001-2002 allowing for dome-shaped selectivity, 2003-2007 allowing for dome-shaped selectivity, 2008-2016 allowing for dome-shaped selectivity, and 2017-2020 allowing for dome-shaped selectivity (due to depth restrictions starting in 2001, changes in the percent of area open to fishing in 2003 and again in 2008, and a relaxation of depth restrictions starting in 2017).

4. Blocking selectivity from 1916-2000 assuming asymptotic selectivity, 2001-2004 allowing for dome-shaped selectivity, and 2005-2020 allowing for dome-shaped selectivity (due to depth restrictions starting in 2001, and a noticeable change in mean length in 2005).
5. Blocking selectivity from 1916-2000 assuming asymptotic selectivity, 2001-2004 allowing for dome-shaped selectivity, 2005-2016 allowing for dome-shaped selectivity, and 2017-2020 allowing for dome-shaped selectivity (due to depth restrictions starting in 2001, a noticeable change in mean length in 2005, and a relaxation of depth restrictions starting in 2017).
6. Blocking selectivity as in option 1 above, but with the new length data from request 3 in the model.
7. Blocking selectivity as in option 2 above, and also applying the same blocks to the commercial fleet.

Data weights were not reweighted for any of the selectivities from this request, in keeping with typical practices when running sensitivities. Suggested reweighting values were within 5% of the original weights from the adopted base model when changing recreational selectivities, and within 7% when changing both recreational and commercial selectivities. Under option 2, the selectivity parameter (parameter 2) controlling the width of the peak hit its lower bound, which was resolved by fixing this parameter at its lower bound.

The additional options explored here show limited support for the additional complexity in blocking selectivity. Spawning output (Figure 7) and depletion (Figure 8) from models with alternative blocking for the recreational fleet were similar to those from the adopted base model, though the option with adjusting both recreational and commercial selectivities were more different than when adjusting just recreational selectivity. Adding selectivity blocks with the flexibility for dome-shaped selectivity generally resulted in slightly larger estimates of initial spawning output (SB virgin) and recent spawning output (SB2021) compared to the adopted base model, and resulted in a slightly less depleted stock. Exceptions were the option blocking the recreational fleet at 2001, 2005, and 2017, and the option blocking both recreational and commercial selectivity at 2001 and 2017, which estimated lower recent spawning output and therefore a more depleted stock.

Selectivity of the recreational fleet for each option blocking only the recreational fleet is shown in Figure 9. Selectivity when blocking both the recreational and commercial fleet is shown in Figure 10. A reduction in selectivity (i.e. dome-shapes) was estimated for all explorations, however peak selectivity in recent years for options 5 and 7 was shifted to larger sizes, near 45 cm, which seems unreasonably high. Other parameter estimates, derived quantities, and likelihood components for each scenario are provided in Table 4.

The added parameter flexibility resulted in improved fits to length compositions, but AIC was improved by more than 2 units for only two options (option 2 and 7). Pearson residuals (Figures 11 and 12) were visually similar among scenarios as were fits to mean lengths (Figures 13 and 14) with only slight changes occurring in the years between blocks. When blocking the commercial fleet, changes in mean length when blocks were applied were more noticeable than for the recreational fleet, but increases due to the blocks did not align very well with changes in the mean length data (Figure 14). The scenario with both blocking and new data added (option 6) is not shown in Figures 11 and 13 for ease of comparisons.

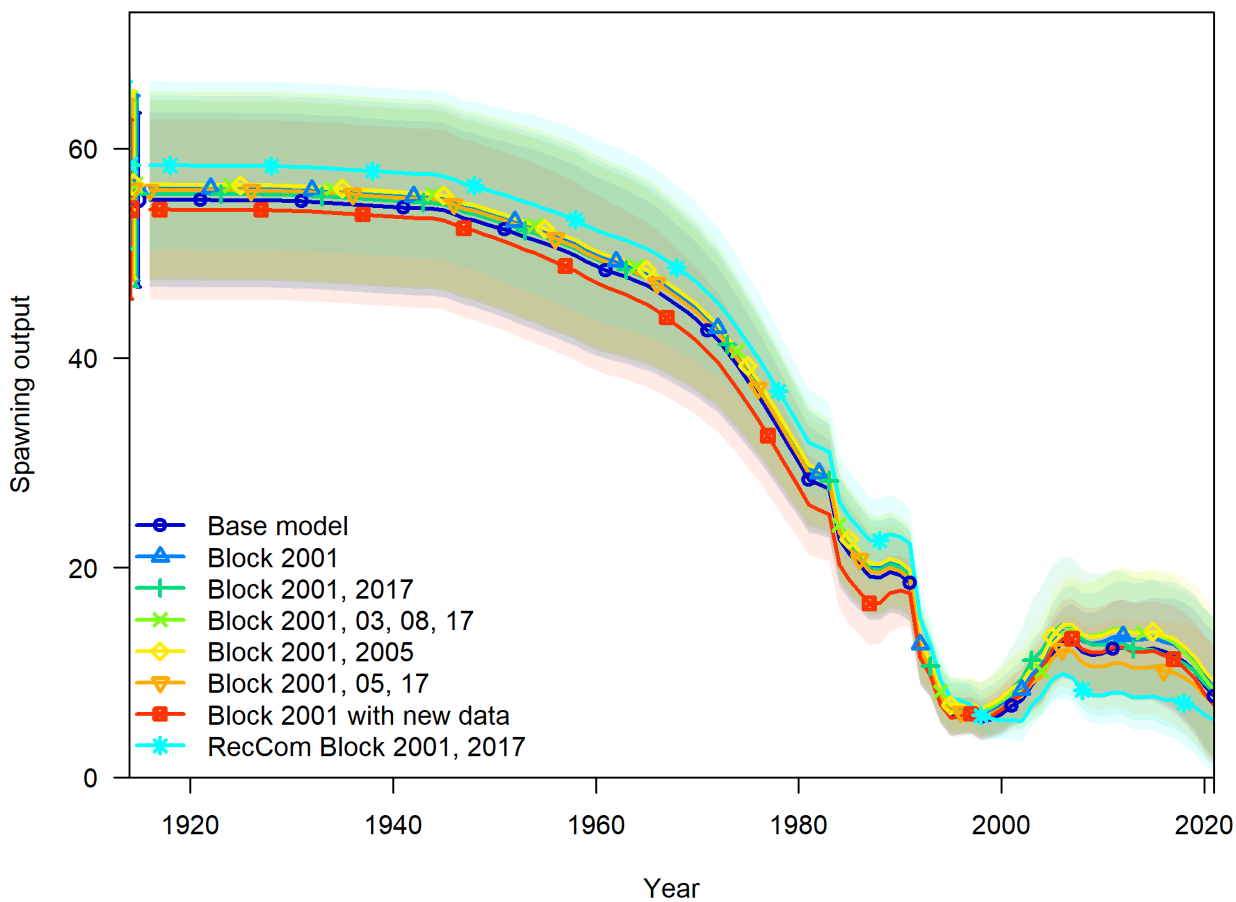

Figure 7: Change in estimated spawning output across scenarios for blocking selectivity. Shading indicates 95% confidence intervals around each scenario.

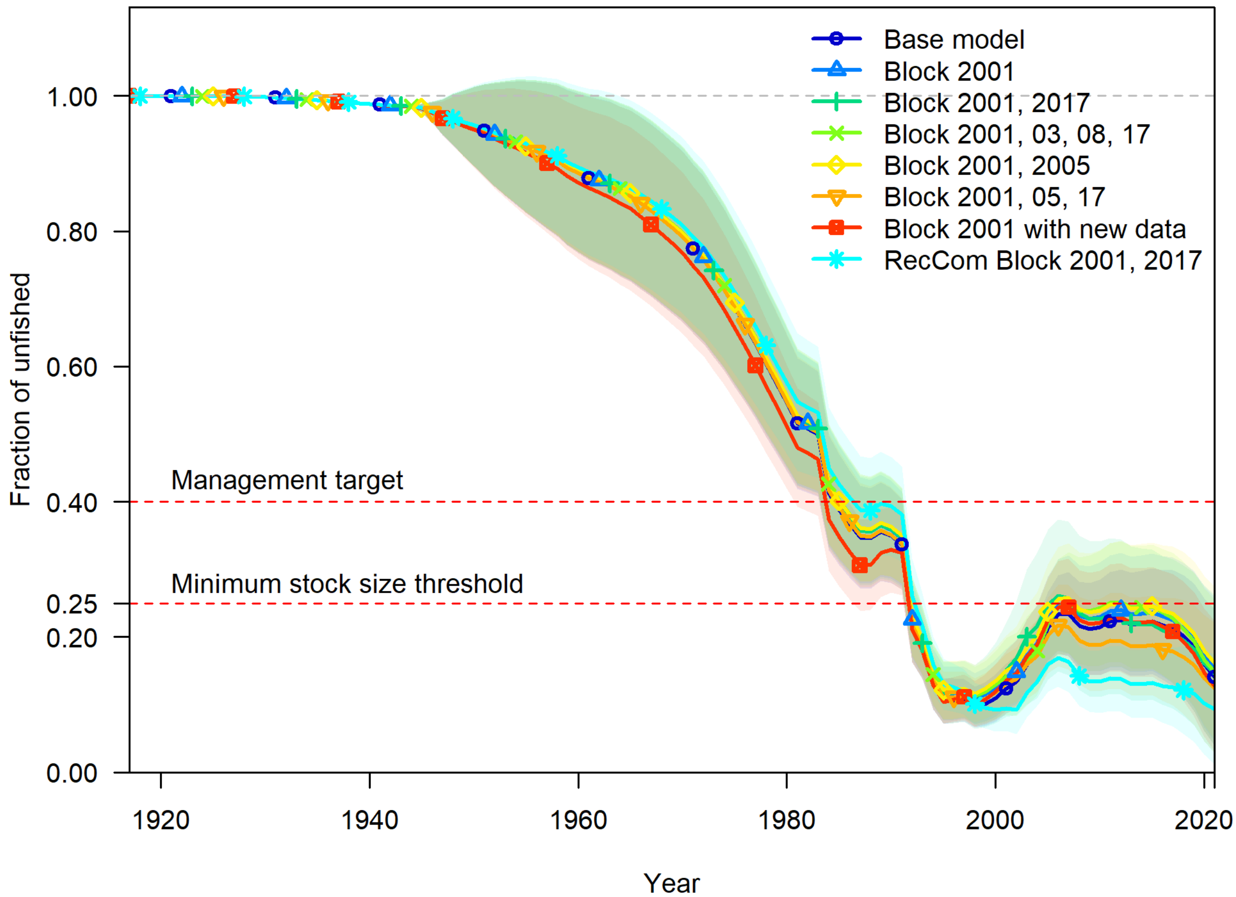

Figure 8: Change in estimated fraction of unfished across scenarios for blocking selectivity. Shading indicates 95% confidence intervals around each scenario.

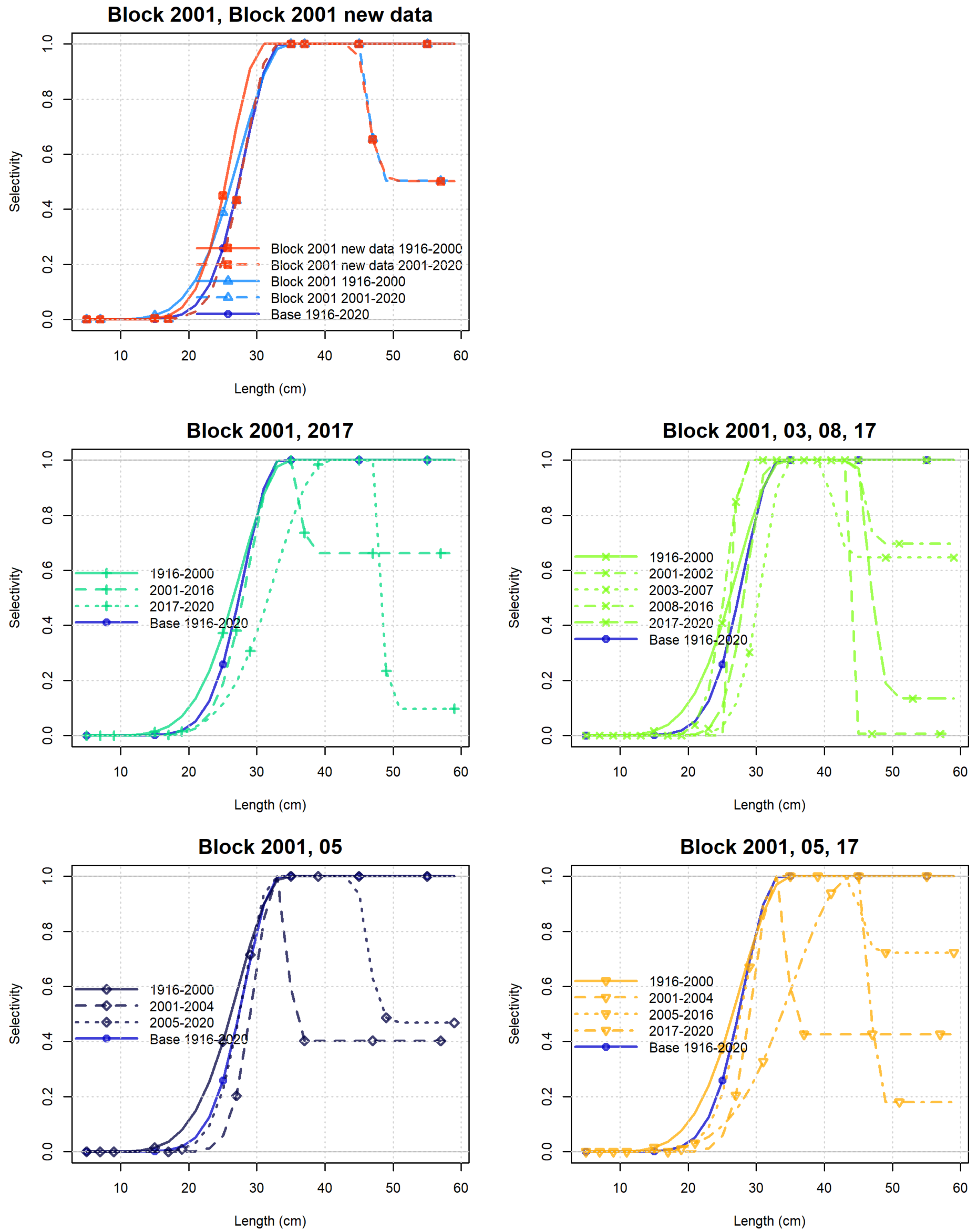

Figure 9: Recreational selectivity across scenarios for blocking the recreational fleet.

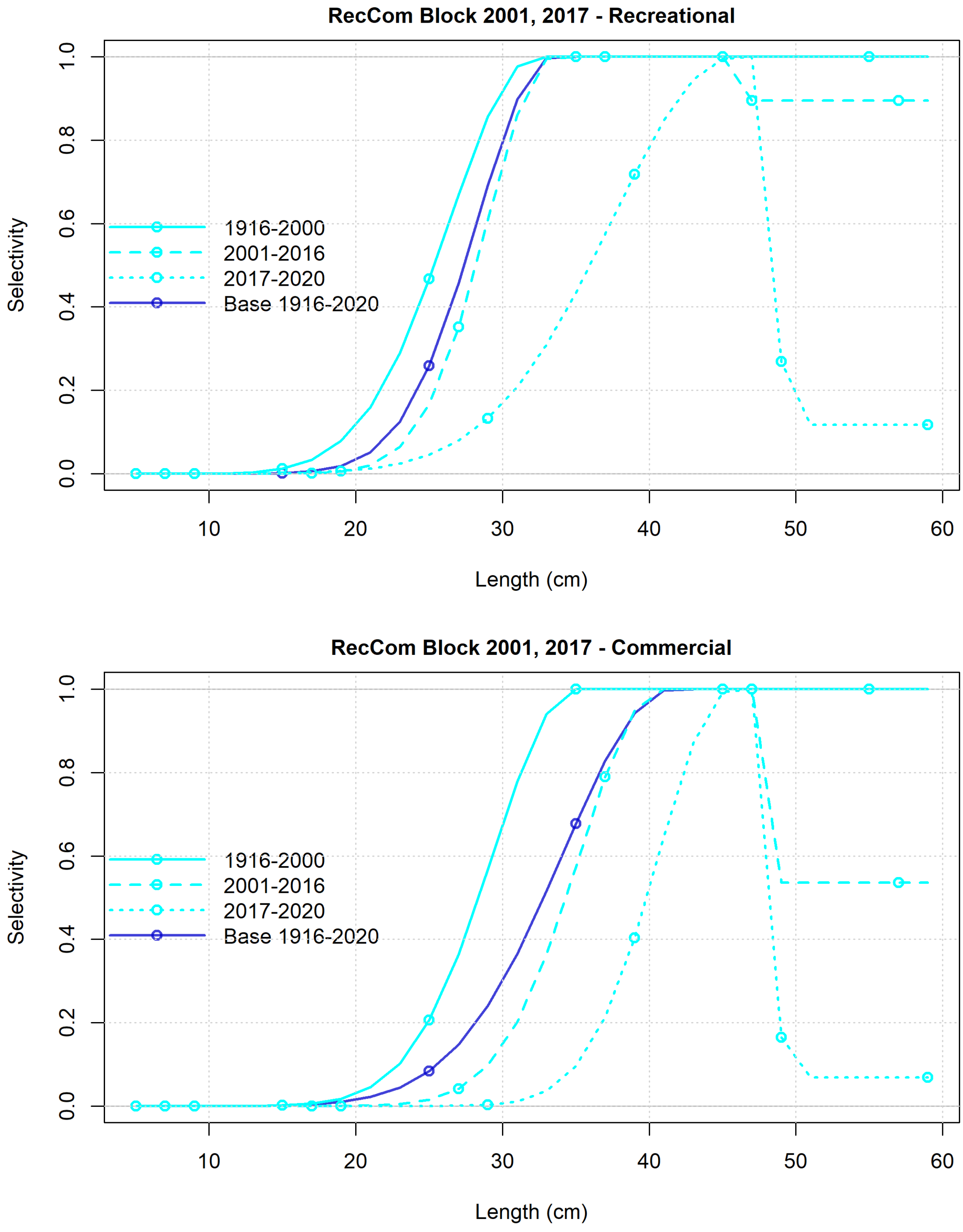

Figure 10: Recreational and commercial selectivity for the scenario blocking both at 2001 and 2017.

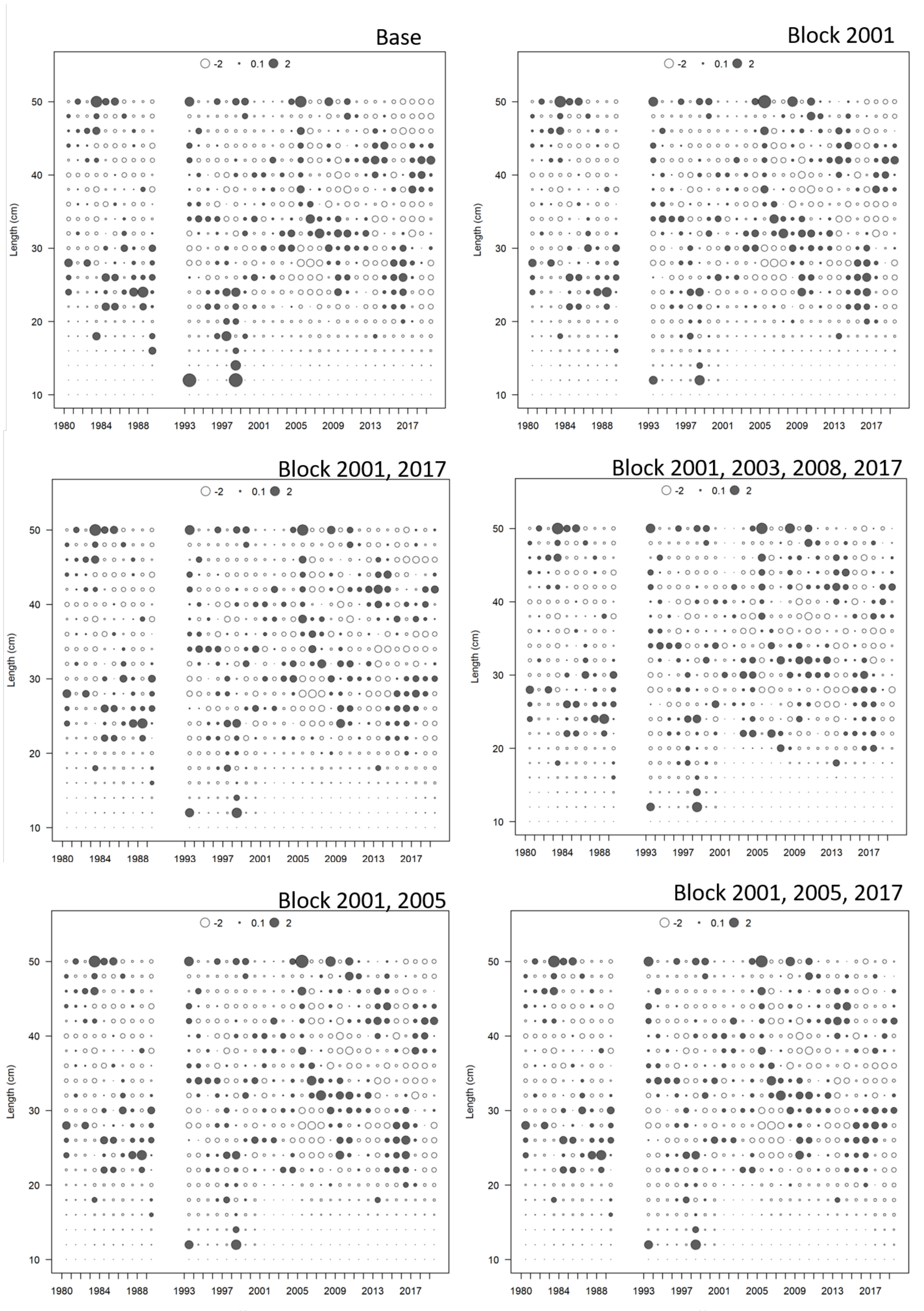

Figure 11: Pearson residuals for the recreational fleet across options of blocking selectivity. Closed bubbles are positive residuals (observed > expected) and open bubbles are negative residuals (observed < expected).

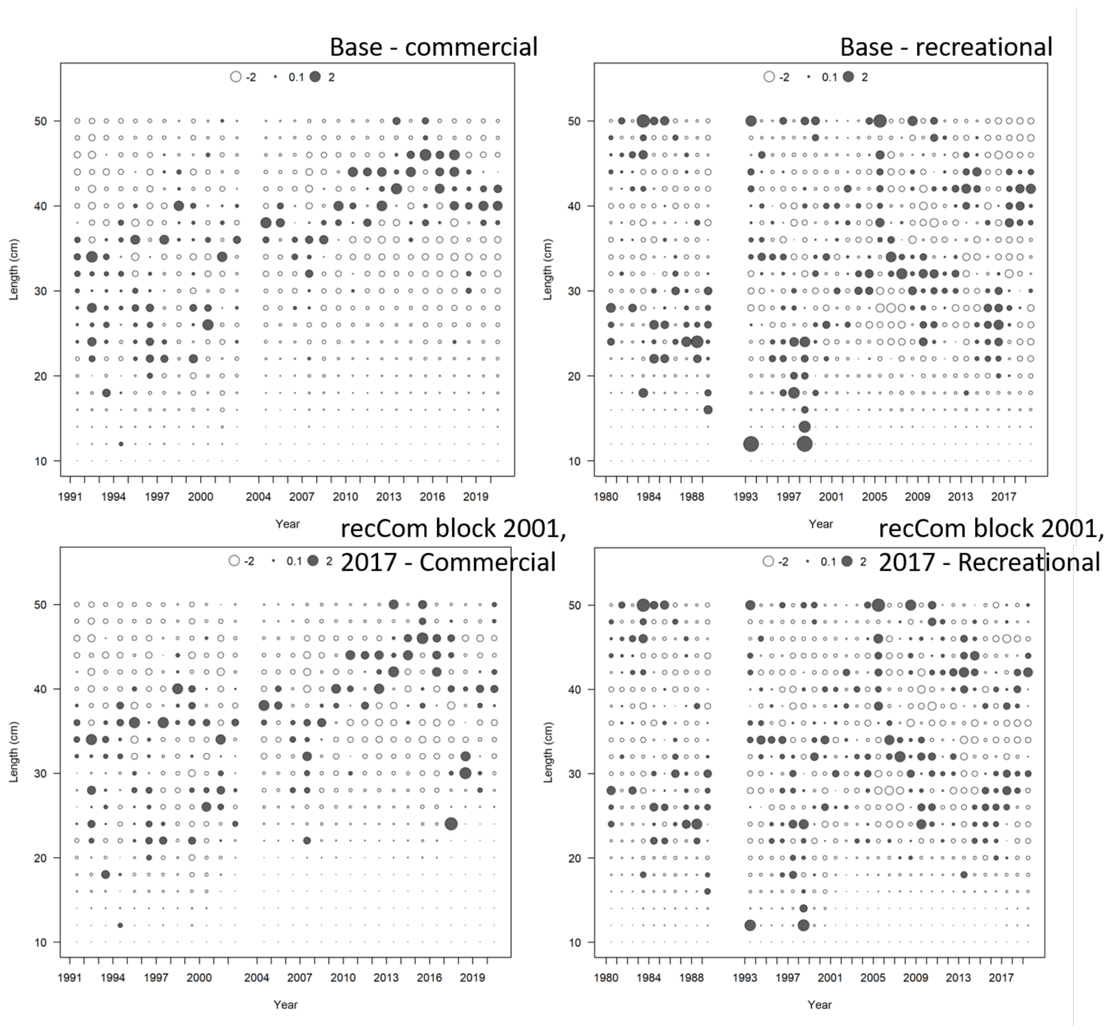

Figure 12: Pearson residuals for the recreational and commercial fleets when blocking selectivity for both fleets at 2001 and 2017, compared to the base. Closed bubbles are positive residuals (observed > expected) and open bubbles are negative residuals (observed < expected).

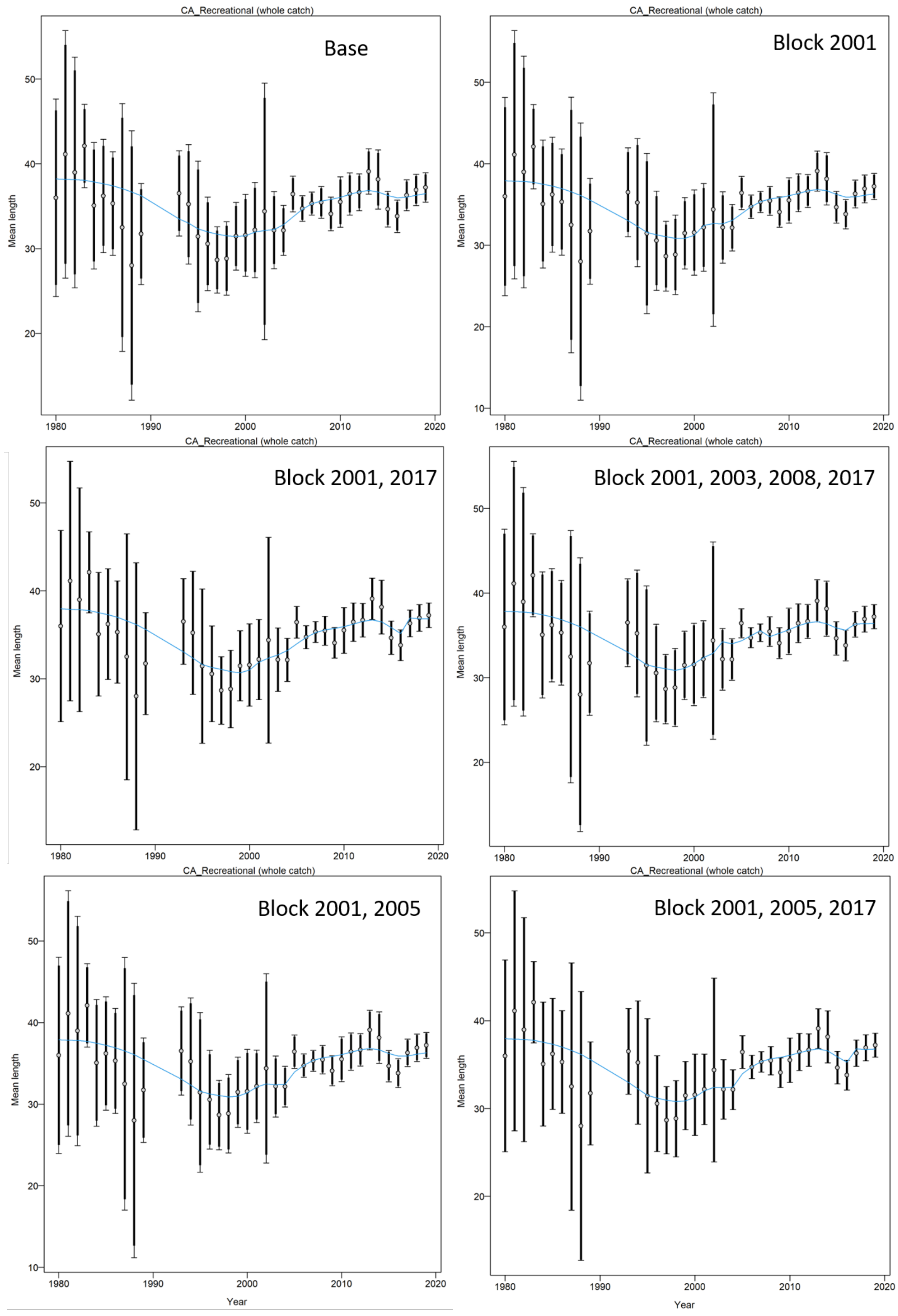

Figure 13: Mean length and fit (blue line) for the recreational length data with 95% confidence intervals (solid black bar) based on current samples sizes. Thinner intervals (with capped ends) show result of further adjusting sample sizes based on suggested multiplier for Francis data weighting.

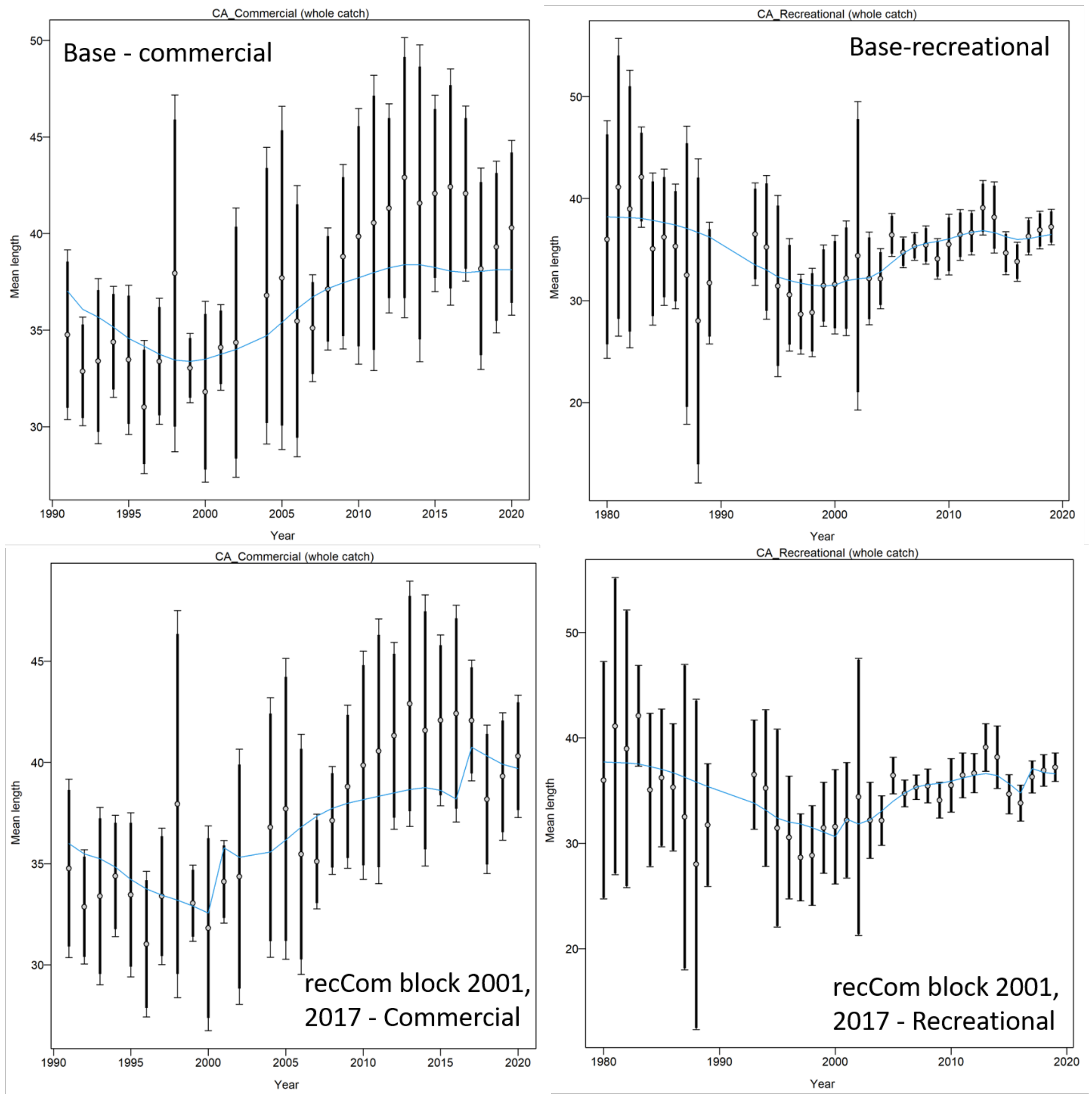

Figure 14: Mean length and fit (blue line) for the recreational and commercial length data when blocking selectivity for both fleets at 2001 and 2017 compared to the base, with 95% confidence intervals (solid black bar) based on current samples sizes. Thinner intervals (with capped ends) show result of further adjusting sample sizes based on suggested multiplier for Francis data weighting.

Request 4:

Further evaluate the ability of the model to estimate growth. In particular, run one model while estimating L-infinity and another while estimating both L-infinity and k.

Rationale: The current model uses estimates of growth from fish collected in Oregon and Washington. Given the higher water temperatures in California, this request is for examination of the ability of the model to estimate growth given the sensitivity of the model and the apparent information in lengths to inform them as seen in profiles of L infinity and k, while, admittedly, estimating k without age data may be problematic.

Response 4:

The two requested runs were completed in the original California quillback rockfish report (sensitivities #4 and #6 on page 17 of that report). Estimating growth parameters resulted in similar estimates of initial spawning output and larger estimates of recent spawning output compared to the adopted base model, and consequently resulted in a less depleted stock. Detailed results for these sensitivities are shown in Table 13 and Figures 47-49 in the California quillback rockfish report and are not repeated here.

Table 4: Parameter values and derived quantities from requested explorations for adding CPFV central California length data, and blocking of recreational and commercial selectivity, and the adopted base model.

	Base model	DebWV	DebWV reweight	DebWV, Block 2001	Block 2001	Block 2001, 2017	Block 2001, 03, 08, 17	Block 2001, 2005	Block 2001, 05, 17	RecCom Block 2001, 2017
Total Likelihood	186.85	210.52	231.63	194.87	181.16	176.78	167.37	179.26	176.09	159.10
Length Likelihood	163.10	178.14	195.73	165.89	158.82	153.37	146.66	157.20	153.77	144.03
Recruitment Likelihood	23.75	32.39	35.90	28.98	22.35	23.40	20.71	22.05	22.31	15.07
Parameter Bounds Likelihood	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00
N parms	98.00	98.00	98.00	103.00	103.00	107.00	118.00	108.00	113.00	118.00
AIC	569.70	617.04	659.27	595.74	568.33	567.55	570.74	574.51	578.17	554.20
delta AIC	0.00	NA	NA	NA	-1.38	-2.15	1.04	4.81	8.47	-15.50
ln(R0)	3.17	3.12	3.10	3.15	3.19	3.18	3.19	3.19	3.18	3.23
SB Virgin	55.08	52.40	51.54	54.16	56.23	55.66	56.48	56.54	56.01	58.38
SB 2021	7.75	6.31	6.42	6.88	8.58	8.13	8.36	9.12	6.98	5.47
Fraction Unfished 2021	0.14	0.12	0.12	0.13	0.15	0.15	0.15	0.16	0.12	0.09
Total Yield at SPR 50	8.41	8.00	7.89	8.10	8.38	8.64	8.34	8.38	8.78	10.02
Peak commercial selex	41.57	42.72	43.03	41.78	40.79	40.80	40.58	40.49	41.58	45.57
Ascend se commercial selex	4.71	4.76	4.78	4.73	4.67	4.65	4.68	4.66	4.73	3.86
Peak recreational selex 2020	33.36	32.71	32.81	32.65	32.64	40.31	32.12	32.63	44.14	45.81
Ascend se recreational selex 2020	3.95	3.89	3.90	3.64	3.64	4.68	3.11	3.67	5.04	4.94

References

Reilly, P N, D Wilson-Vandenberg, C E Wilson, and K Mayer. 1998. "Onboard sampling of the rockfish and lingcod commercial passenger fishing vessel industry in northern and central California, January through December 1995." *Marine Region, Admin. Rep.* 98-1: 1–110.