SCIENTIFIC AND STATISTICAL COMMITTEE REPORT ON NEW METHODOLOGY INFORMING SIGMA VALUES – FINAL ADOPTION

The Scientific and Statistical Committee (SSC) reviewed analyses relating to the scientific uncertainty in estimating the overfishing limit (OFL), denoted sigma (σ). Sigma, in combination with the Council's policy choice for the overfishing probability (P*), determines the size of the buffer between the OFL and the acceptable biological catch (ABC) for groundfish and coastal pelagic species (CPS). The Council's current sigma value for category 1 stocks (0.36) is based on the analysis by Ralston et al. (2011) that estimated among-assessment variation in historical spawning biomass for a set of groundfish and CPS stock assessments completed through 2009. That analysis was based on spawning biomass and not OFL and did not directly account for increases in scientific uncertainty that accrue as assessment results are projected into the future.

The SSC received a presentation from Ms. Kristin Privitera-Johnson (University of Washington) summarizing results from several different approaches for estimating sigma for the first year after an assessment is conducted (the baseline sigma; Agenda Item G.3, Attachments 1 and 2). Another presentation from Dr. Chantel Wetzel (Northwest Fisheries Science Center) summarized results from an analysis of increased scientific uncertainty (hence sigma) with assessment age (Agenda Item G.3, Supplemental REVISED Attachment 3). Initial versions of both analyses were reviewed by the Groundfish and CPS Subcommittees in November 2018 (see Agenda Item G.3.a, SSC Groundfish and Coastal Pelagic Species Subcommittees' Report 1).

Baseline Value for Sigma

Agenda Item G.3, Attachments 1 and 2 compared various approaches for setting a baseline sigma, including the "historical biomass approach" used in Ralston et al. (2011). The analyses considered approaches that set sigma based on between-assessment variation in projections of spawning biomass or OFL, with alternative methods of accounting for recruitment variability.

The projection approach presented to the SSC's Groundfish and CPS Subcommittees in November conducted 25-year projections for each assessment starting in 1998, 2003, and 2008, and set fishing mortality to the F_{MSY} proxy for those years, with deterministic or stochastic recruitment. The Subcommittees requested an additional approach ('Method B', which is more consistent with uncertainty in recruitment in the final years of an assessment) that used 1-year projections derived across 15 years for each of the two or three assessments used for each species. The SSC considers sigma derived from the 1-year projections, using Method B, to be the best approach to set sigma representing scientific uncertainty for 1-year projections of category-1 assessments. This value is 0.439.

The new analyses were restricted to benchmark assessments conducted using recent versions of the stock synthesis software (from 2009 to present) and technical constraints prevented the use of seasonal models (e.g., for Pacific sardine). To account for the limitations associated with having only a subset of groundfish species in the analysis, the SSC recommends that the value chosen for sigma from the full set of species (including CPS) be scaled by the ratio of the sigma from the updated historical biomass approach (0.389) and from the subset of species used for this analysis (0.342).

The SSC recommends a baseline sigma value of 0.50 (= 0.439*(0.389/0.342)) for category 1 groundfish and CPS stocks. As in the 2011 recommendation, the SSC recommends baseline sigma values of twice the category 1 value for category 2 stocks (1.0) and four times that value for category 3 stocks (2.0) (Table 1).

Increase in Sigma Due to Stock Assessment Age

Agenda Item G.3, Supplemental REVISED Attachment 3 was based on deterministic projections of spawning biomass starting from a low state of nature relative to base-model projections of spawning biomass. The low state of nature was constructed so that starting spawning biomass is consistent with the previous value for sigma (0.36) with a probability of 25%. Projections for both the base model and the low state of nature were based on an assumption of full attainment of the ABCs derived from the base model, which causes the two projections to diverge with the rate of divergence reflecting the population dynamic characteristics of the stock.

Due to concerns that the projections would be highly sensitive to the assumption of full ABC attainment, the Subcommittees in November requested additional analyses with Dover sole and chilipepper rockfish be excluded, as attainment rates for these stocks have been consistently low. Removing these two stocks made very little difference in the increase in sigma over time. The SSC recommends using the analysis with all species included, and applying the relative rate of increase in sigma (7.5% of the baseline value with each additional year) to the baseline category 1 and 2 sigmas of 0.5 and 1.0, i.e.:

Sigma (years since assessment) = (baseline sigma) * (1.0 + (years since assessment – 1)*0.075).

For example, for assessments conducted in 2019 the baseline sigma will apply in 2020. However, for the first year of application (2021) the sigma will be 7.5% larger and the resulting buffer will increase accordingly (e.g., to 6.5% rather than 6.1%) (Table 1).

As the OFLs from category 3 analyses are constant, there is no reason for the category 3 sigma to increase with time. Depending on the Council's selected value for P*, the reductions in catch to account for increasing scientific uncertainty with projection year should conform to the values shown in the first attached table.

The projection year resets to 1 when a full or update assessment is conducted. The projection year will not reset following a catch-only update.

The SSC will review the baseline values of sigma and the rate of increase in sigma with assessment age prior to the next assessment cycle.

Literature Cited

Ralston, S.; A.E. Punt; O.S. Hamel; J.D. DeVore; and R.J. Conser. 2011. A meta-analytic approach to quantifying scientific uncertainty in stock assessments. Fish. Bull. 109: 217–231.

Table 1. SSC-recommended reductions to OFL for scientific uncertainty for category 1, 2, and 3 groundfish and CPS stocks based on sigma and P* values by projection year and P*. The sigmas in the first header row are the baseline sigmas.

	Category 1 (σ=0.5)		Category 2 (σ=1)		Category 3 (σ=2)	
Year | P*	0.45	0.40	0.45	0.40	0.45	0.40
1 (baseline)	6.1%	11.9%	11.8%	22.4%	22.2%	39.8%
2 [a/]	6.5%	12.7%	12.6%	23.8%	22.2%	39.8%
3	7.0%	13.6%	13.5%	25.3%	22.2%	39.8%
4	7.4%	14.4%	14.3%	26.7%	22.2%	39.8%
5	7.8%	15.2%	15.1%	28.1%	22.2%	39.8%
6	8.3%	16.0%	15.9%	29.4%	22.2%	39.8%
7	8.7%	16.8%	16.7%	30.7%	22.2%	39.8%
8	9.1%	17.6%	17.4%	32.0%	22.2%	39.8%
9	9.6%	18.3%	18.2%	33.3%	22.2%	39.8%
10	10.0%	19.1%	19.0%	34.6%	22.2%	39.8%

[a/] Projection Year 2 is the first year of the management cycle following groundfish stock assessments.

Table 2. A comparison of the old and new sigma values for category 1, 2, and 3 groundfish and CPS stocks.

	Category 1 σ		Category 2 σ [a/]		Category 3 σ	
Year	Old	New	Old	New	Old	New
1	0.36	0.50	0.72	1.0	1.44	2.00
2	0.36	0.5375	0.72	1.075	1.44	2.00
3	0.36	0.575	0.72	1.15	1.44	2.00
4	0.36	0.6125	0.72	1.225	1.44	2.00
5	0.36	0.65	0.72	1.30	1.44	2.00
6	0.36	0.6875	0.72	1.375	1.44	2.00
7	0.36	0.725	0.72	1.45	1.44	2.00
8	0.36	0.7625	0.72	1.525	1.44	2.00
9	0.36	0.80	0.72	1.60	1.44	2.00
10	0.36	0.8375	0.72	1.675	1.44	2.00

[a/] Note that some older category 1 assessments have been reassigned to category 2 in the past to account for the increased uncertainty. This will no longer be necessary.

Table 3. A comparison of the old and new scientific uncertainty reductions for P* = 0.45.

P*=0.45	Category 1		Category 2		Category 3	
Year	Old	New	Old	New	Old	New
1	4.4%	6.1%	8.7%	11.8%	16.6%	22.2%
2	4.4%	6.5%	8.7%	12.6%	16.6%	22.2%
3	4.4%	7.0%	8.7%	13.5%	16.6%	22.2%
4	4.4%	7.4%	8.7%	14.3%	16.6%	22.2%
5	4.4%	7.8%	8.7%	15.1%	16.6%	22.2%
6	4.4%	8.3%	8.7%	15.9%	16.6%	22.2%
7	4.4%	8.7%	8.7%	16.7%	16.6%	22.2%
8	4.4%	9.1%	8.7%	17.4%	16.6%	22.2%
9	4.4%	9.6%	8.7%	18.2%	16.6%	22.2%
10	4.4%	10.0%	8.7%	19.0%	16.6%	22.2%

Table 4. A comparison of the old and new scientific uncertainty reductions for P* = 0.4.

P*=0.4	Category 1		Category 2		Category 3	
Year	Old	New	Old	New	Old	New
1	8.7%	11.9%	16.7%	22.4%	30.6%	39.8%
2	8.7%	12.7%	16.7%	23.8%	30.6%	39.8%
3	8.7%	13.6%	16.7%	25.3%	30.6%	39.8%
4	8.7%	14.4%	16.7%	26.7%	30.6%	39.8%
5	8.7%	15.2%	16.7%	28.1%	30.6%	39.8%
6	8.7%	16.0%	16.7%	29.4%	30.6%	39.8%
7	8.7%	16.8%	16.7%	30.7%	30.6%	39.8%
8	8.7%	17.6%	16.7%	32.0%	30.6%	39.8%
9	8.7%	18.3%	16.7%	33.3%	30.6%	39.8%
10	8.7%	19.1%	16.7%	34.6%	30.6%	39.8%

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