Agenda Item E.4
Attachment 2
April 2019

WHITEPAPER ON FREQUENCY OF ASSESSMENTS AND UPDATES TO OFLs, ABCs AND ACLs FOR THE CENTRAL SUBPOPULATION OF NORTHERN ANCHOVY

André E. Punt
School of Aquatic and Fishery Sciences
University of Washington, Seattle, WA 98195, USA

Background

The Scientific and Statistical Committee (SSC) of the Pacific Fishery Management Council is required to set the Overfishing Limit (OFL) and the sigma on which the Acceptable Biological Catch (ABC) is based, while the Council selects the risk of overfishing (P*) and the Annual Catch Limit (ACL). The value of sigma accounts for the extent of scientific uncertainty and determines the "buffer" between the OFL and the ABC, while the setting of the ACL takes a variety of management and policy factors into account.

Ideally, the OFL can be set as the expected catch when fishing mortality equals F_{MSY} (the fishing mortality corresponding to Maximum Sustainable Yield), which leads to a long-term OFL or as the product of a recent estimate of biomass and F_{MSY}, which leads to near-term OFL. The risk of overfishing is higher if the OFL is based on a long-term calculation than if it accounts for relative biomass if the buffer between the OFL and ABC is the same for the two methods for setting the OFL. At present, the OFL for the central subpopulation of northern anchovy (CSNA) is based on an estimate of long-term MSY with a buffer of 75% (a multiplier between the OFL and the ABC of 0.25) between the OFL and the ABC. This contrasts with how OFLs are set for Pacific Sardine and Pacific Mackerel (the two coastal pelagic species (CPS) in the Actively Managed category) and for the groundfish stocks in Categories 1 and 2[1].

The SSC was tasked to "*establish a process for evaluating the potential impacts of infrequent changes to reference points against the risk of changing reference points in the absence of new data*" (April, 2018 Council Decision). In the context of this document, the reference points are F_{MSY} (related to setting of the OFL), B_{MSY} (related to the setting of the MSST), the OFL, and the sigma and P* on which the ABC is based. Setting of ACLs given the other reference points is a management decision and is not discussed here.

Analysis

General remarks

The information needed to update the reference points differs between the reference points. Specifically, the values for *MSY*, F_{MSY} and B_{MSY} can only be updated if there is a new model-based stock assessment if these parameters are based on an assessment for the CSNA (e.g. Anon [2016]) or if there are new stock assessments for other anchovy stocks, and F_{MSY} was to be based on a meta-analysis. In contrast, a near-term of value for the OFL could be updated by conducting a new stock assessment or when a new acoustic estimate of biomass or a DEPM estimate of spawning biomass became available. The latter approach is that which implicitly underlies the SSCs re-evaluation of F_{MSY} for the CSNA (Punt, 2019).

---

[1] Assignment of stocks to Stock Assessment Categories (1, 2 and 3) is not related to which Category (Actively Managed or Monitored) a CPS is assigned to (at present both CPS stocks in the Actively Managed Category are assigned to Stock Assessment Category 2).

Options for updating OFLs and ABCs

There is a trade-off between increased risk, average catch and stability of reference point estimates associated with the frequency of assessments and updates to OFLs. In principle, updates to stock assessments (taken here to be model-based analyses) change the estimates of F_{MSY} and B_{MSY} as well as the estimates of current biomass and hence the OFL, while the OFL (and hence ABC/ACL) could be updated based on estimates of current biomass from acoustic surveys / the DEPM.

Trade-off analysis options

Qualitative approach

Figures 1 and 2 shows the qualitative impact of different frequencies of updating OFLs (and hence ABCs; here ACL=ABC). The risk of overfishing (fishing mortality greater than F_{MSY}) depends on the frequency of assessments (lower for more frequent updates), while the variation in OFLs is greater for more frequent updates (directly related to the uncertainty of the estimates of abundance). The buffer between the OFL and the ABC needs to be larger for less frequent OFL updates.

Figure 1 provides an illustrative example of managing the CSNA when OFLs are updated every year (upper panels); every two years (center panels) and every five years (lower panels). For these calculations F_{MSY} is known correctly, there is observation error (with a CV of 36% associated with these estimates of biomass), and the stock is managed using a Category 1 buffer based on P*=0.4 (ABC = 0.91*OFL). Figure 2 show results when the ABC is set to MSY, 0.5 MSY and 0.25 MSY, where MSY is assumed to be known without error

There is recruitment variation, but no long periods of good and poor recruitment (which seems an unrealistic assumption given the history of the CSNA). The probability of being overfished (i.e. spawning biomass less than half of B_{MSY}) is 20.5% for annual OFLs[2], 27.5% for two-year OFLs, 38.7% for five-year OFLs, and 38.8% for ten-year projections. The buffer between the ABC and the OFL needs to be increased from 9% (1-0.91)*100 to 19.5% (two-year OFLs), 38.6% (five-year OFLs), and to 40.0% (ten-year OFLs) to keep the risk of being overfished at 20.5%. This size of the buffer would likely need to be larger if recruitment was assumed to be autocorrelated.

The probability of being overfished is 57.1% when the ABC equals MSY, 21.5% when the ABC equals 0.5 MSY, and 5.0% when the ABC equals 0.25 MSY. Note that this approach assumes that MSY is known exactly whereas the calculations on which Fig. 1 assume biomass is measured with a CV of 36%.

MSE-lite

The approach proposed by the SSC to estimate F_{MSY}, B_{MSY} and CNSA (Punt, 2019) could be extended to evaluate the trade-off between assessment frequency and risk of overfishing. This would involve conducting projections for different assessment frequencies (the frequency is currently annual) and OFL-ABC buffers, and reporting catch variation, risk of overfishing, and average catch. This is essentially Figure 1, but more fully accounting for uncertainty. This analysis could also examine the trade-off between basing reference points on the most recent biomass estimates only or on recent average estimates (perhaps with more emphasis given to the most recent estimate). This is not a full management strategy evaluation (MSE) because no attempt is made to simulate the process of conducting stock assessments (or of updating F_{MSY} and B_{MSY}).

[2] The probability of spawning biomass dropping below half of B_{MSY} is not quite zero even without fishing owing the high variation in recruitment and high rate of natural mortality.

Conducting an MSE-lite would take approximate six months of analyst time as well as time for review by the Council Advisory Bodies.

MSE-full

This would involve conducting a full MSE, which would also allow an evaluation of the consequences of the frequency with which model-based assessments that allow updated estimates of F_{MSY}, B_{MSY} and MSY to be considered. A full MSE would also consider the choice for the ACL control rule. Conducting a full MSE would take approximately a year of analyst time as well as time for review by the Council Advisory bodies.

Other aspects to consider

Variation in the OFL can be reduced or average catch increased (likely at the cost of a small increase in risk of overfishing) given a pre-specified level of risk by basing the OFL on the average biomass over several years. The trade-offs associated with various choices for the period over which biomass estimates are averaged could be evaluated with an MSE-lite or a full MSE.

References

Anon. 2016. Review and Re-evaluation of Minimum Stock Size Thresholds for Finfish in the Coastal Pelagic Species Fishery Management Plan for the U.S. West Coast. Agenda Item E.1.a. September 2016 Council meeting.

Punt, A.E. 2019. An approach for computing E_{MSY}, B_{MSY} and MSY for the CNSA. Agenda Item E.4 Attachment 1, April 2019 Council meeting.

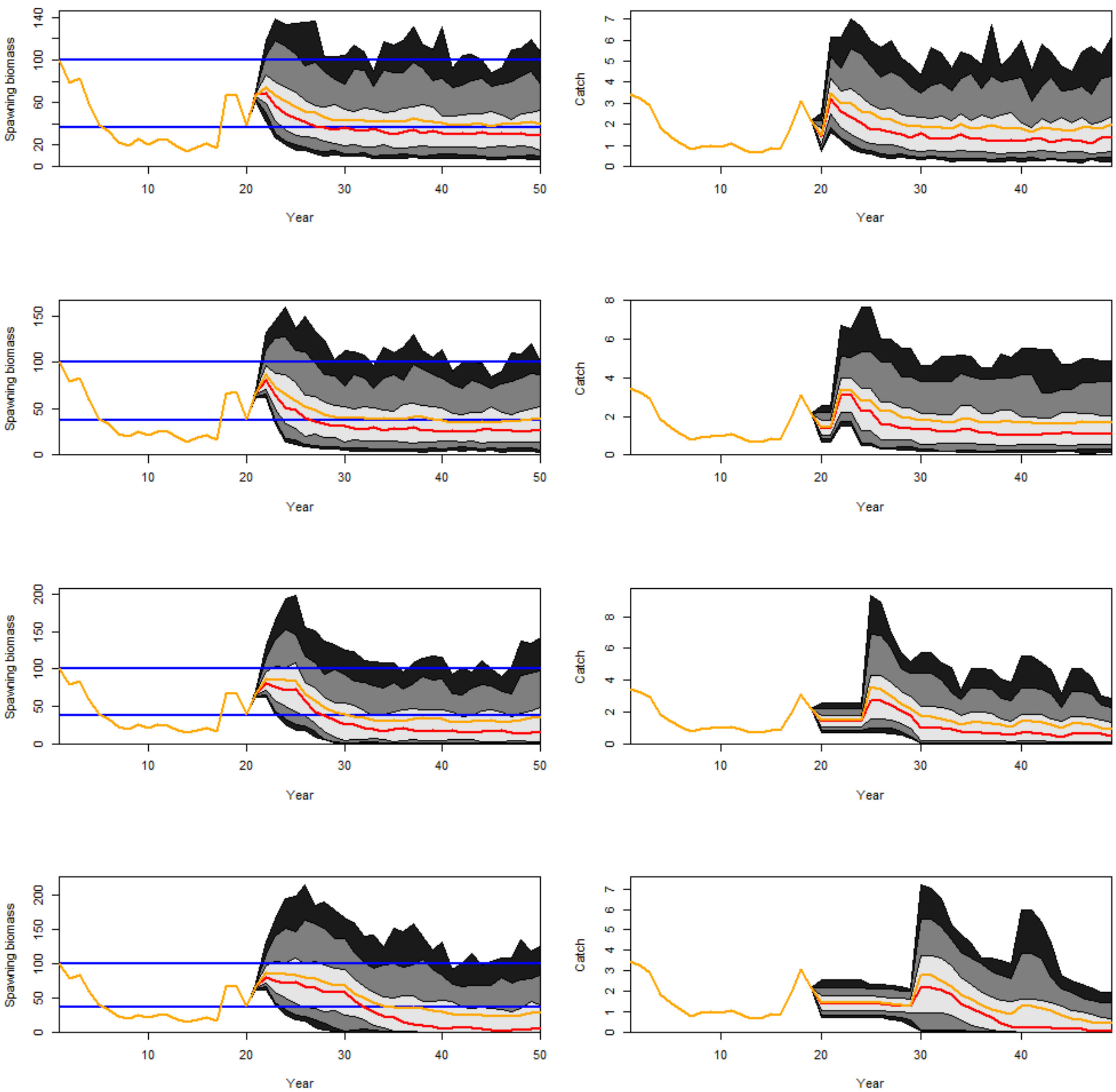

Figure 1. Time-trajectories of spawning biomass (left panels) and catch (right panels) when OFLs (and hence ABCs) are updated annually (upper panels), every two years (2nd row of panels), every five years (3rd row of panels), and every 10 years (last row of panels). The orange line is the mean and the red line is the median. The shading covers 90%, 80% and 50% of the distribution of outcomes (black, dark gray and light gray shading). The blue horizontal lines in the left panel denote the unfished level (upper line) and B_{MSY} (lower line).

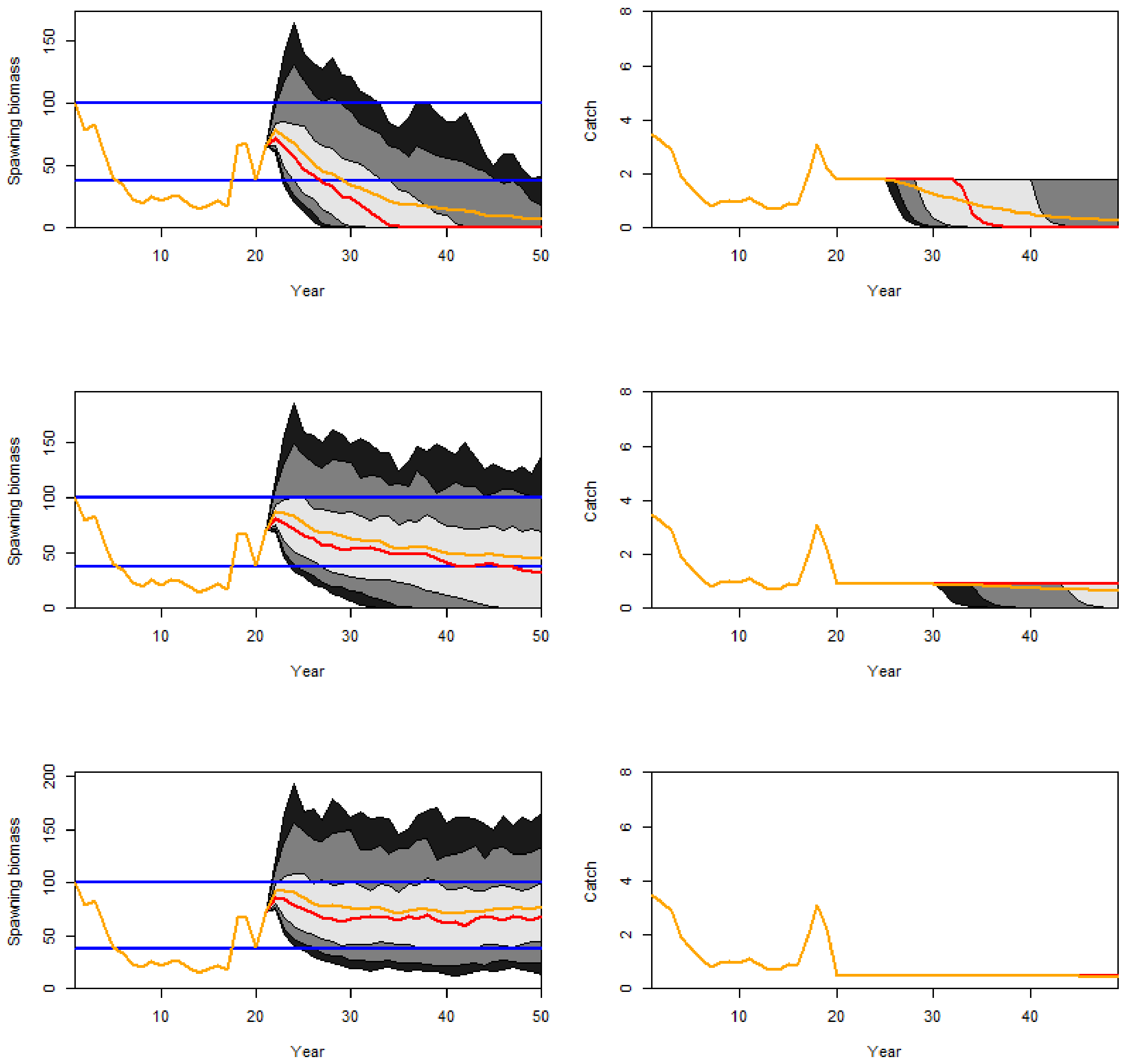

Figure 2. Time-trajectories of spawning biomass (left panels) and catch (right panels) when ABC is set to MSY (upper panels), 0.5 MSY (center panels), and 0.25 MSY (lower panels). The orange line is the mean and the red line is the median. The shading covers 90%, 80% and 50% of the distribution of outcomes (black, dark gray and light gray shading). The blue horizontal lines in the left panel denote the unfished level (upper line) and B_{MSY} (lower line).