Tanner Crab Simulations: Effects of Bycatch in the Groundfish Fisheries

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# 1.0 Introduction

Sarah Marrinan and Sara Cleaver (North Pacific Fishery Management Council staff) presented information to the Crab Plan Team at its May 2020 meeting on a proposed Council action to change crab PSC (Prohibited Species Catch) limits in the groundfish fisheries to the lowest possible level when the directed crab fishery is closed. There are currently area PSC limits in place for Bristol Bay red king crab, Tanner crab, and snow crab for groundfish vessels using trawl gear. The current limits are rarely exceeded, and even if they were set at the lowest level would rarely be constraining. Council staff asked the CPT about the importance of bycatch in crab population dynamics. Currently there is very little crab bycatch in groundfish fisheries compared to the directed fisheries. However, it was noted that there is very little information on the unobserved mortality of crab species. Thus, Council staff asked if assessment authors could examine the effects of increased bycatch on model results. In furtherance of this request, the Crab Plan Team (CPT) requested at its May 2020 meeting that:

“Assessment authors should rerun the assessments for BBRKC, Tanner crab, and snow crab with higher assumed levels of bycatch abundance (increases of 50% and 100%) as a sensitivity analysis. These should be provided to Council staff within the next two months for inclusion in the October Council document.”

This report addresses this request for Tanner crab.

# 2.0 Methods

The request by the CPT to “rerun” the 2019 assessments with different levels of PSC does not address the issue at hand, which is “what effect would different levels of PSC have on the stock?”; rather, it addresses issues related to uncertainty in the model and effects on the assessment due to potential biases in the observed PSC bycatch, i.e. “how sensitive are the model results to mis-estimating the level of bycatch?”. This is because “rerunning” the assessment with different levels of PSC involves re-estimating *all* model parameters, including those reflecting strictly biological processes. Here, though, the attempt is to address the first question. This was done by using the estimated parameters for the biological processes (i.e., recruitment, natural mortality, growth, and molt-to-maturity) governing the Tanner crab stock in the 2019 assessment (model 19.03) as an “operating model” for the population in the absence of fishing mortality. The assessment model was then re-run for a set of scenarios with different levels of PSC bycatch. For each scenario, only fishery-related parameters (fishery capture rates, retention rates, and selectivity and retention curves) were estimated by fitting to the fishery data (catch biomass and size compositions). Retained and total annual catch data, as well as associated size compositions, were the same across all scenarios for the directed fishery, the snow crab fishery, and the Bristol Bay red king crab fishery, but varied by scenario for assumed bycatch (PSC) in the groundfish fisheries.

Three “PSC” scenarios were considered which assumed Tanner crab bycatch in the groundfish fisheries was decreased by 50% (“2xSmaller”), increased by 100% (“2xLarger”), and increased by 800% (“8xLarger”). Although not requested by the CPT, the 2xSmaller and 8xLarger simulations provide bracketing scenarios. Results from the 2xLarger scenario were so close to those from the assessment that the 50% larger scenario requested by the CPT was not run.

# 3.0 Results

The time series for recruitment and various population components (including mature male biomass) are compared among the PSC scenarios in Figures 1 and 2, respectively. Scenarios 2xSmaller and 2xLarger indicate changes to bycatch in the groundfish fisheries of -50% and +100% would have had little effect on the Tanner crab stock dynamics and biomass trajectories. Increases to 800% in groundfish bycatch (8xLarger) resulted in little difference in recent (post-1985) biomass trajectories for the immature (both sexes) and mature female components of the stock. However, this level of increase would have resulted in decreased biomass in the mature male component of the stock. In the 1970s, MMB would have been lower by ~100,000 t in this scenario relative to the others, while in recent years it would have been ~6,000 t less.

The effects on OFL-related quantities as would have been determined for the 2019 assessment, are illustrated in Table 1. As one should expect, average recruitment, B100, and Bmsy are identical in all scenarios because these quantities do not depend on fishery-related quantities. Differences in the other quantities were generally quite small for the 2xSmaller and 2xLarger scenarios when compared to the 2019 assessment results, while they were reasonably large under the 8xLarger scenario (e.g., current MMB was ~6,000 t less and Fmsy was 0.15 yr-1 larger for this scenario, with concomitant differences in OFL and Fofl).

# 4.0 Discussion

Based on this simulation analysis, moderate changes (at least as large as a 100% increase) in levels of Tanner crab bycatch in the groundfish fisheries appear to have little effect on stock dynamics and biomass trajectories. Indeed, increases of 800% result in little difference in recent (post-1985) biomass trajectories for the immature (both sexes) and mature female components of the stock. However, this level of increase would have resulted decreased biomass in the mature male component of the stock. In the 1970s, MMB would have been lower by ~100,000 t in this scenario relative to the others, while in recent years it would have been ~6,000 t less.

# Tables

Table 1. Comparison of results from the PSC scenarios for quantities related to status determination and OFL as determined for a “2019” assessment. Results for 19.03 are from the actual 2019 assessment.



# Figures



Figure 1. The recruitment time series for each scenario (all are identical).

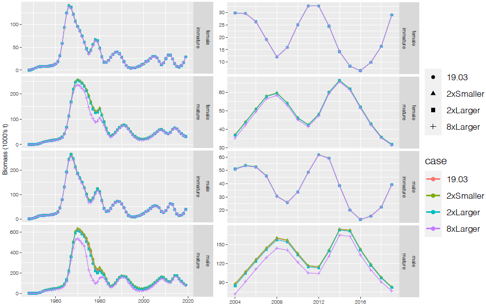


Figure 2. Comparison of time series of various population components from the PSC scenarios. Graphs in the lefthand column cover the entire model time period; graphs in the righthand column focus on the last 15 years.