North Pacific Fishery Management Council

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Minutes of the Gulf of Alaska Groundfish Plan Team

North Pacific Fishery Management Council
1007 West Third, Suite 400
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September 10, 2020

Administrative

The GOA Groundfish Plan Team ("Team") convened on Thursday, September 10, 2020 at 1:00pm PST.

Participation was remote via Adobe Connect.

All documents provided prior to or during the meeting as well as presentations given during the meeting were posted to the Council's electronic agenda.

GOA pollock

Shelikof Survey

Abigail McCarthy (AFSC) presented results from this winter's acoustic-trawl survey work in the Gulf of Alaska. An important aspect of the research conducted was further comparison of the new "LFS" sampling net with the standard "AWT" net. The AWT trawl will be replaced completely in coming years so calibration / comparisons were needed.

Main results from the survey indicate a substantial decline from recent winter surveys. From the assessment perspective, the new survey estimate will likely be more consistent with model estimates. The Team discussed the details of the age and size composition from this year's survey. There was an expectation to have a good showing of 2-year old fish (2018 year class) but they were largely absent. There was some indication that the 2017 year class was modestly present and there were few age-ones seen in the survey. The Team wished to express their gratitude to the AFSC's age and growth lab for completing the samples from this year's survey.

The Team discussed last year's risk factors which were reviewed by Martin, including aspects on prey availability, in addition to what was known this year. During the marine heatwave, the smaller zooplanktons appeared to be ok for young pollock. The recent survey suggests that the survival may have changed. It was noted that the ADFG survey was completed this year in area 620 and that pollock ages should be available soon. Early indications are that the biomass estimate is about the same as in 2019. Nat Nichols noted that this survey is conducted with small mesh nets and designed for shrimp.

VAST application to SE Alaska pollock

Martin Dorn (AFSC) presented a brief discussion paper comparing spatial analyses of the Eastern GOA survey data to compare with the common approach using process error random effects to smooth survey time series for Tier 5 stock assessments. Martin proposes that this approach be used in place of the current practice.

The Team appreciated this work but had several concerns including: lack of fit in the probability of encounter rates, the large number of knots per unit area, boundary conditions, and consistency with other practices being developed using VAST for AFSC surveys. Additionally, the lack of treating a new method in the context of how well it performs within a leave-one-out type of analysis was missing. It was

noted that the background of the current random effects approach arose as a way to smooth year-to-year variability while still accounting for population trends (and the likelihood of having ABC/OFL values that were too high or too low for stocks in Tier 5). There was also some discussion on how VAST might be useful for spatially accounting for within-season aspects (for apportioning catches by season and areas).

The Team requested that a comparison of approaches be done for management purposes. Specifically, using the new spatial method, project estimates forward for Tier 5 with and without new data to obtain a score for how well the approach provides the most reliable estimate.

GOA Pacific Cod

Steve Barbeaux presented a historical overview of the cod stock and management and several ongoing cod research topics, including further developments toward a climate enhanced stock assessment model. Steve was unable to address some of the SSC recommendations such as the inclusion of the IPHC longline survey. The November assessment will be a simple update of the 2019 model with the latest catch and partial survey data.

Steve provided an overview of a study of Pacific cod found in middens from historical native communities in the GOA and Aleutians. These middens revealed interesting trends in fish size in different areas over the last 6,000 years. Specifically, data from areas with high catch rates also seem to have reduced fish sizes in modern period data for the longline fishery relative to the midden data. A clear size gradient from west (larger) to east (smaller) was observed both in midden and fishery data.

An overview of the fishery and biomass estimate trends was provided for context, broken down by several phases of the fishery. Several periods of stock expansion followed by sharp reductions were discussed with the recent downturn being highlighted. The 2015 model predictions for the population showed substantial predicted growth fueled by a large 2012 cohort. However, the biomass estimates from fishery independent surveys showed a steep decline starting in 2015. The overall value of the fishery dropped from ~ $75 million to ~ $32 million in 2018, and directed fishery was closed in 2019 and 2020, where it remains presently. This part of the presentation set the context for investigations into the root causes of the recent declines.

The suspected primary cause of the collapse was the warm ocean conditions in 2014-2016, which extended from the surface to a depth of 300 m. This change was responsible for ecosystem -wide impacts, including increased seabird and whale mortality, reduced euphausiid abundance and copepod lipid content, and reduced forage fish abundance and energetic content. For the Pacific cod stock, these conditions led to increased metabolism and low food availability, which in turn resulted in low condition factor and increased natural mortality in juveniles and adults. The heat wave is also suspected to be responsible for several years of low recruitment though temperature impacts on successful egg hatching and juvenile survival. A clear inverse relationship was presented with SST anomaly and Age-0 cod recruitment.

The next portion of the presentation showed findings from the implementation of a climate enhanced stock assessment model for cod, with linkages between climate predictions and temperature-dependent recruitment, natural mortality, and growth. This model is currently in the research phase and is not being proposed for management this year. The details presented are a broad overview of the model function, with the details of the model structure not being discussed at this time.

One of the primary inputs into this model is the marine heatwave cumulative index (MHCI) which represents the number of days where the SST was warmer than 90^{th} percentile 5 days in a row. The MHCI was used as scaler for the R0 term in the B-H recruitment curve, as a scaler for age-dependent natural mortality, and in a temperature linked growth model (based on the Schnute model). Projections using this model structure showed that increased growth could potentially offset a degree of increased heat-related

mortality. Finally, the reduction of age at 50% maturity with temperature was observed based on higher growth and length at 50% maturity being fixed in the model.

Model projections of female SSB under multiple IPCC climate scenarios were presented, showing that in the long term biomass will not remain above the B20% even without fishing, while forecasts under average conditions show a strong increase to conditions before the recent collapse, and unfished conditions rebounding even higher. The model predicted much higher biomass (above 20%) using climate forecasts with fishing allowed when the dependency of natural mortality on temperature was removed. The author indicated that this effect needs to be explored further.

Finally, the current climate conditions in the GOA were presented, along with the results of surveys and fishery data that are available at this time. Elevated SST conditions persist this summer, after being below average last winter. The AFSC RPA Kodiak beach seine survey showed the highest CPUE of age-0 cod in the entire 14 year time series. The AFSC longline survey showed a modest increase from 2019, but is still the 2nd lowest in time series. This was surprising as in the past this survey showed higher catch rates with warmer water conditions with cod moving into deeper waters and becoming more available to the longline survey. The ADF&G large mesh trawl survey likewise showed an increase in 2020, with few fish under 40 cm caught. The author noted that the ADF&G survey is not currently used in the stock assessment.

Alaska state cod fishery showed good fishing up to the quota limit, with most of the fish caught within the first 12 weeks of the year. Data on bycatch rates of cod in groundfish fisheries were presented, including the walleye pollock, shallow water flatfish, arrowtooth, and POP fisheries. While there was an increase in cod bycatch in the pollock fishery in area 610, a public comment during the presentation noted that fishing levels in that area were very low due to the low pollock quota, and thus this data point may not be informative. Author notes that in area 630 there was an EFP in place for use of EM in place of traditional observer coverage, which may have resulted in lower numbers of cod bycatch presented as the EM data were not yet available. Public comment noted that there were sampling issues with the pollock fleet as there weren't enough available observers for the EM EFP, and the observer data on the non-EM side may be delayed due to COVID -19. More data should be available later in the fall. Likewise, a mixed signal was seen in bycatch data from several other fisheries including rockfish and arrowtooth. The author noted that these observations are likely biased by fishers avoiding cod bycatch due to limits as the cod TAC represents a hard cap for the rockfish fishery. The shallow water flats bycatch showed a strong upward trend in ‘19 and ’20.

More data on fish lengths will be available from the state fishery and possibly from the observer program, especially in the flatfish target, but may be affected by a data collection protocol change within the observer program. This concluded the presentation.

The Team noted appreciation for presenting the work on historic midden data. A clarification was requested as to the units used in the bycatch plots, which were not standard across the different fisheries. Comments were also made regarding the availability of additional port sampling and jig fishery data to supplement observer sampling.

GOA Pacific Ocean Perch Model Update

Pete Hulson provided an update on the status of the GOA Pacific ocean perch assessment. In 2019 the author noted the assessment model has consistently underestimated increasing trends in the trawl survey estimates of abundance. In response, the SSC, AP, and Council recommended an AFSC internal assessment review team be formed to improve the performance of the POP model in preparation for the upcoming external CIE review. Due to the pandemic the CIE review has been postponed until 2021 but the internal review team continued to meet and develop the POP assessment since March of 2020.

Two primary categories were identified by the internal review team to improve the performance of the assessment model: (1) update of parameter priors and input data, and (2) investigation of alternative modeling methods. The review team found model improvement occurred when data updates were made but also found the model exhibited unexplained sensitivity to the various modeling methods explored, especially in relation to catchability and selectivity. Further work looking at use of historical fishery data and time dependent recruitment and selectivity is warranted. In addition, when the model-based estimates of survey biomass using VAST was implemented large and as yet unexplained changes in the estimates of catchability occurred. As a result, the review team recommends further exploration of the assessment model which will be presented to the upcoming CIE review, now planned for the spring of 2021.

However, while further model development is warranted the author recommended bringing forth a full POP assessment for 2020 with the following updates:

- Update prior for catchability from 1 to 1.15 following from Jones et al. (in review)
- Update prior for natural mortality from 0.05 to 0.0614 following from Hamel (2015)
- Estimate fishery age composition through use of age-length key (common method in AFSC assessments)
- Update ageing error matrix with additional reader-tester agreement data

The Team discussed how the model tends to increase natural mortality which results in higher productivity through increased estimates of recruitment in order to better fit the survey biomass. The author noted that the increases in recruitment estimates seem reasonable and hasn't seen any that are unrealistic. The Team also questioned exploring different values for natural mortality. The author responded that he explored a range of natural mortality estimates from a range of life-history based methods and he chose to use the Hamel (2015) method, which is the method that has been adopted for natural mortality priors in assessments conducted by the NWFSC. Finally, the Team commented that the increase in biomass in the GOA may be linked in some way to the increase in biomass in the Aleutian Islands (AI), as increases in survey biomass estimates are similar between the two regions since 2010.

The Team agrees with the author to bring forth a full GOA POP assessment in 2020 that implements the proposed prior and data updates as an incremental progression towards further model development that can be evaluated during the 2021 CIE review and assessment cycle. The Team also recommends the review team continue to investigate similarities and linkages between the GOA and AI POP stocks.

GOA Survey Optimization Scheme

Lewis Barnett (Groundfish Assessment Program, RACE Division) provided an update on multispecies survey design optimization simulation analyses for the Gulf of Alaska bottom trawl survey. Goals of this effort are to increase flexibility and efficiency of the survey design and provide a better understanding of how to maximize survey efficiency in the case of survey effort reductions. The simulation approach used a multivariate spatial temporal model and optimization routine to compare the current design to alternative design elements. The estimation model was used to calculate expected uncertainty and bias in the abundance index for a number of species and to examine how bias and uncertainty changed as a function of sampling effort, the number of strata, and the location of strata boundaries.

Biomass trends are consistent between the design-based and the model-based indices lending confidence to the operating model's performance. The proposed optimized survey design has from 5-20 strata versus the current 59 strata. Optimized strata characteristics were based on depth and longitude and sample allocation criteria were based on a Bethel rather than Neyman allocation scheme. In addition, optimization would be based on 15 species groups rather than 52-57 individual species used in the design-based method. Under the optimized approach, the optimal sampling density places the highest density of survey hauls in the western GOA, where the biomass of many species is highest. Under the optimized

scheme there is virtually no bias in abundance estimates except for deep dwelling species, which corresponds to the areas or strata where effort has been removed in reduced survey years. In general, the accuracy of uncertainty estimates are similar or improved compared to the design-based estimates. Overall, the optimized design offers several advantages over the current design. Abundance estimation is improved by reducing bias in estimates and the accuracy of biomass uncertainty estimates can be increased. This tool also allows analysts to utilize user-specified precision constraints to design a survey, thus allowing improved flexibility in responding to survey effort reductions.

The Team had several comments relevant to this work. One potential avenue of research is to examine survey design in relation to species specific questions of interest, such as species value or implications of choke species such as harlequin rockfish. It was also suggested to look closer at the value of a species or species groupings and how value is defined. Alternatively, this tool may be useful for providing insight into species movements in response to changing environment such as shifting to deeper habitats during warming trends. Finally, the Team noted the optimized strata are defined by longitude but are not aligned with management areas, which are also typically defined by longitude in the GOA. The author responded this is possible and can be done pre- or post-stratification.

The Team recommends further research to incorporate the management boundaries in the stratification scheme as biomass estimation and apportionment by management area are fundamental management priorities.

In closing, the Team expressed concern in response to the survey prioritization exercise presented to the joint Teams, specifically in response to an alternative to only sample depths <500 meters in the GOA.

The Team continues to recommend a full survey of all depths be conducted in the GOA on a biennial basis.

Dover sole

Andrea Havron presented research conducted with Carey McGilliard on movement models for Dover sole, and on estimates of abundance using a Vector-Autoregressive Spatio-Temporal (VAST) model. The movement model is motivated by ontogenetic movement to deep water as fish age, and was modeled with Stock Synthesis. The size at age of older cohorts is reduced in deeper water. Three types of two-area models were developed, with the areas consisting of depths 0 – 500 m and 501-1000 m. Fish recruit to the shallow area, and movement only occurs from the shallow to the deep area. Movement at ages 0-3 were fixed to 0 and increased up to a plateau beginning at age 10. Model 0 has a single growth pattern for each sex, and estimated the probability of movement for ages ≥ 10. Models 1 and 2 have 2 growth patterns for each sex, and either estimate the movement for ages ≥ 10 while fixing the probability of recruitment into each growth pattern (Model 1) or estimate the probability of recruitment into each growth pattern while fixing the probability of movement for ages ≥ 10 to 1. Model 0 shows an increased trend in recent survey and total biomass relative to Models 1 and 2, resulting in a worse fit to the shallow-area biomass estimates from the most recent 3 surveys. Model 2 shows the best fit to the data, and is influenced by improved fits to the age and length composition data.

The authors identified several areas for future research, including estimation of sex-specific movement rates (which is currently not possible in Stock Synthesis), modifying the ages of movement probabilities, and estimating aging error for GOA Dover sole. In some models the von Bertlanffy growth parameters were not estimable due to limited data, and the authors recommend further exploration on how estimated growth, selectivity, and movement vary in response to fixing some parameters. A further refinement to Stock Synthesis to model growth by area would allow growth to vary within a cohort as a function of movement between habitats; for example, Dover sole in central California appears to show reduced growth when they move to cooler, oxygen minimum zones at older ages.

The motivation for the VAST model is to account for spatial autocorrelation in survey CPUE data. Lognormal and gamma VAST models were run under a variety of "meshes" (which discretize the continuous spatial field into discrete spatial areas), including meshes based on a pre-specified number of knots and user-defined meshes based on specified maximum distances of the edges of the discrete areas. Model results were compared to both design-based estimates of survey biomass and the results of the Random Effects (RE) survey smoother (which also accounts for missing strata in some years).

Model validation was evaluated with the *DHARMa* R package, which measures the plausibility of observing the data given the model. The only model for the validity was not rejected was the gamma model with 250 knots, which was surprising because it was a relatively low-resolution spatial model. As the mesh resolution (i.e., the number of knots) increases, the biomass estimates from VAST come closer to the RE estimates. For the gamma models, the difference between the VAST and RE estimates stabilized at 0 at about 750 knots.

The authors identified several areas for further research. First, the use of depth as a covariate would likely improve model performance, as the absence of relevant covariates may indicate that the random effects terms are modeling variability that could be explained by covariates. Additionally, second-order anisotropy (i.e., anisotropy that has a curved rather than linear relationship relative to the spatial axes) is not addressed in the VAST software, and may be relevant due to the curved GOA coastline. The authors suggest addressing this by running separate models for the Western/Central GOA and the Eastern GOA. Third, additional models with finer mesh structure should be evaluated. Finally, predictive performance was evaluated via comparison to the results from the RE model. The authors expressed interest in using cross-validation for assessing predictive performance, in particular methods designed for spatially autocorrelated data such as the *blockCV* R package.

The Team agrees with the suggested research directions for each of these projects, and notes that the results to date from this research do not suggest large errors in current assessment and survey estimation procedures. For the work on biomass estimation using VAST, the Team recommends that authors coordinate with other AFSC scientists that are applying the VAST estimation approaches, specifically studies on survey optimization, application to GOA walleye pollock, and the production of VAST biomass estimates from the RACE program.

2021 and 2022 Harvest Specification Recommendations

The Team approved the proposed harvest specifications for 2021 and 2022 by recommending the 2021 GOA final harvest specifications for OFLs and ABCs as published in the Federal Register in March 2020.

Adjourn

The meeting adjourned at approximately 11:30 Pacific time.