

Minutes of the Gulf of Alaska Groundfish Plan Team

North Pacific Fishery Management Council
1007 West Third, Suite 400
Anchorage, Alaska 99501

September 22-23, 2021

Administrative

The GOA Groundfish Plan Team (“Team”) convened on Wednesday, September 22, 2021 at 0900 PDT.

Participation was remote via Adobe Connect. Roughly 54 people attended the meeting.

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 Regional Action Plan (RAP)

Martin Dorn presented the updated GOA Regional Action Plan 2.0. The RAPs are meant to guide climate-oriented research on a regional scale, and are to be updated for an additional three years. Original work on the GOA RAP began in 2017 and was published in 2018. The presentation included the seven climate science objectives, a review of what was included in RAP 1.0, and the goals of the RAP 2.0 updates, which include addressing regional priorities for climate-related information and tools. The presentation also highlighted a few projects that are expected to occur, as well as research gaps and unfunded needs. The sub-leads are working hard on communications and engagement strategies to support efforts to co-produce science with GOA communities and develop bi-directional knowledge to plan for climate change impacts. A small amount of funding associated with the RAPs is available.

The Team discussed engagement with GOA communities, and one of the sub-leads (who is also a Team member) noted that there is planned targeted stakeholder engagement which was impeded by Covid, but they are reaching out to fisheries organizations and have a planned case study across 5 GOA communities. This study, which will be conducted through interviews, focus groups, and workshops, places an emphasis on how communities want to engage in the topic of climate change and may yield information on perception of risk, ecosystem change, and adaptation. The Team suggested engagement with ADF&G and encouraged coordination with them as it would be a good conduit for some of the social structures that could provide useful information for the RAP team.

There was one question about how the prioritization of these projects overlaps with research priorities. The RAP lead responded that these projects were developed by the sub-leads, independent of research priorities, as research priorities focus more on short-term needs of Council.

There were several questions regarding prioritization of certain projects and whether resources should be shifted away from standard surveys for what seem to be peripheral projects. Response: The project lead indicated that climate research priorities are specific to areas affected by climate change including nearshore areas and rather than general groundfish research needs.

The Team appreciated the presentation and had no formal recommendations.

GOA CLIM

Marin Dorn provided an overview of the GOA Climate Integrated Modeling Project (CLIM). CLIM is an ambitious project that could provide insights into how climate and oceanographic changes propagate through the GOA ecosystem, fisheries, and communities. The project includes a wide range of institutional partners, and investigators would like further engagement with the Council and other parties on how to incorporate the potential findings of CLIM into current and future management strategies. The project is closely aligned with ongoing research at AFSC, is closely aligned with the EBS ACLIM Project, and a major component of the GOA RAP.

More practically, the GOA CLIM uses the Regional Ocean Modeling System (ROMS) framework to model ocean circulation in the GOA marine ecosystem. It will allow projections of future conditions and how they relate to physical conditions in the ocean, system-level productivity, and ways that fisheries management can promote resilient fisheries and communities. Three current research pathways include:

- Development and application of an Atlantis model as a component of a multi-model ensemble to evaluate fisheries management strategies with respect to a changing climate.
- Evaluate and predict the impacts of environmental anomalies to the endangered Western DPS of Steller sea lions.
- Develop tools and a knowledge-base to couple the ecosystem models to regional economic models to evaluate the impacts of climate change on fisheries and resource-dependent communities.

Alberto Rovellini provided an in-depth overview of the CLIM project, which uses the Atlantis ecosystem model. This model allows for the creation of a virtual ecosystem, which in turn can be used for scenario evaluation and hypothesis testing. There was an extensive presentation that detailed various technical aspects of the Atlantis model, including model coding and data sources, bathymetry, geometry, ROMS mapping, biological components, spatial distribution, and integration of fisheries data. The next steps in the development of the Atlantis model include calibrating the model via changing input parameters until the model's dynamics match actual observations, output validation, and conducting both hindcast and forecast simulations.

Project investigators are soliciting feedback from the Team about such things as model geometry, species grouping, and assistance from assessment authors with validating model dynamics. Investigators would also like to better understand GOA fishing fleets through expanded dialogue with social scientists and economists.

The Team recommended that the GOA CLIM project investigators consider increasing their dialogue with assessment authors and other relevant scientists through additional meetings or ad hoc communications in the near future, versus waiting until the 2022 September Plan Team meeting.

GOA Bottom Trawl Survey (BTS) results

Wayne Palsson updated the Team on the 2021 Gulf of Alaska bottom trawl survey. Two vessels (F/V *Alaska Provider* and F/V *Ocean Explorer*) participated in the survey this year; F/V *Ocean Explorer* also participated in the 2019 survey.

Effort is currently being assessed by reviewing the amount of time the trawl net was in contact with the bottom. The next steps are to complete the effort review, finalize the database, update age compositions, re-estimate survey biomass, size, and split factor, and then make survey data available on the AFSC

website and the Alaska Fisheries Information Network (AKFIN). Data from this year's survey are anticipated to be uploaded to AKFIN by September 30.

In 2021, 529 stations were successfully occupied out of an initial target of 540 stations. Prior to the survey, an algorithm was used to pre-select random 10-station groups that could be dropped if the survey vessels fell behind schedule. One 10-station group was dropped inseason, making the revised target of 530 stations. Station assignments were also transferred between vessels to keep the slower vessel on schedule. Forty-five total strata were sampled in 2021, which is less than usual. As in 2019, the survey occupied stations in all depth strata except the 700–1000 m stratum. Notably, instead of beginning survey work simultaneously, the vessels started 17 days apart; at this point it's unclear if the staggered start date will have measurable effects on survey results. Due to COVID-19 mitigation measures, the survey vessels only did one crew change instead of the usual four crew changes.

Catch composition was similar to past years with Pacific ocean perch (POP) being the dominant species, followed by arrowtooth flounder (ATF). Over 11,000 age structures were collected; otolith sample targets were achieved for 9 out of 19 species. Otolith samples were collected either randomly or via length/sex stratification. Nearly 186,000 fish lengths were collected. Preliminary estimated Pacific cod biomass decreased slightly from 2019, but catches were well distributed resulting in lower variance than in 2019. Preliminary estimated pollock and sablefish biomasses were higher than in 2019. Sea surface and bottom temperatures returned to near average from record highs observed in recent years.

The Team applauds Wayne and RACE Division staff for successfully completing the 2021 survey under extraordinarily challenging circumstances. Further, the Team thanks Wayne for his years of dedicated service and wish him well in retirement (planned in December).

GOA Bottom Trawl Survey Design

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 noted that the presentation was mainly informational, but the analysts sought feedback. Consequently the Team:

- Agreed that this general approach is acceptable.
- Supported the authors recommendation to focus on area level solutions as they provide unbiased estimates for each management area, whereas the gulf-wide design results in some bias for certain management areas.
- Suggested that the authors explore area-specific species prioritizations.
- Indicated that it would be a potential concern if changes to survey design would affect interpretation and consistency of the survey time series.
- Supports the author's conclusion that the two vessels, 550 stations, and survey design likely provide adequate abundance estimates (outlined in a Technical Memorandum currently in revision).

Shelikof Survey

Taina Honkalehto presented the results of the winter 2021 Shelikof Strait / Marmot Bay pollock pre-spawning acoustic-trawl surveys noting that the 2021 survey was complicated by arduous Covid-19 safety procedures and challenging weather.

Location and timing of the major acoustic surveys was reviewed; the GOA summer survey for age-1 plus pollock are conducted in odd years while the winter per-spawning biomass survey is conducted in Shelikof Strait and the Shumagin Islands every year, and rotating alternate years in the Bogoslof Island area (even years) and Kenai / Prince William Sound (odd years). In 2021, the survey was scheduled to cover Shelikof Strait, Chirikof Island shelf break, Marmot Bay, the Kenai, and Prince William Sound, however the pandemic and poor weather conditions restricted the survey to the Shelikof Strait and Marmot Bay.

The survey was conducted in Shelikof Strait on March 3rd - 10th and Marmot Bay on March 13 - 15, 2021. The presence of a large age-1 year class prompted collection of data from an additional 5 tows conducted between March 10th and 13th to get additional net selectivity data. Over both surveyed areas, approximately 1,300 nmi of trackline were surveyed with 7.5 nmi spacing between transects in Shelikof Strait and 1-2 nmi distancing between transects in Marmot. Of the area surveyed, 75% was between 200m and 350m bottom depth. Survey activities were conducted 24 hrs/day. All species were accommodated in the acoustic backscatter data.

This is the second year the survey used the new LSF1421 midwater trawl net and with the additional available data, the net selectivity corrections were updated. Typically, net selectivity corrections increase the number of smaller fish and decrease the number of larger fish, resulting in a reduction in overall biomass. In Shelikof Strait this reduced the biomass estimate from 602K t to 527K t. However, in Marmot Pass, the net selectivity correction only decreased the biomass estimate slightly from 7.6K t to 7.4K t. This reduction was due to the smaller biomass in Marmot Pass combined with the small number (6) of tows and the use of data for all species to derive the net selectivity correction. In particular, a single tow with a large relative proportion of caplin decreased the relative proportion (amount of backscatter) of pollock. Abundance estimates were generated using the acoustic data (38 kHz acoustic data 16 m from surface to 0.5 m above seafloor) and data from large-trawl "targeted" hauls (LFS1421 midwater trawl tows). Physical oceanographic information was also collected.

Shelikof Strait

The preliminary Shelikof Strait pollock biomass estimate was 526,973 t (8,364.7 million fish) based on 1127 nmi of trackline and 24 LFS tows. The pollock biomass in Shelikof Strait is just under its long-term mean (710,000 t) and is much larger than the biomass in Marmot Pass. Most of the pre-spawning pollock biomass was located mid-Strait near Cape Kekernoi with 88% of adult females (>40cm) in pre-spawning condition (n=219). This large proportion of the stock in pre-spawning condition indicated good survey timing.

The presumed age-1 year class comprised 92% of the numbers of fish but only 13% of the biomass; the number of 8-16 cm pollock was very high relative to other survey years. Pollock greater than 33 cm (~ age 4+) consisted primarily of the 2012 and 2017 year classes. A small proportion of pollock were 2 and 3 year olds (<4%), however this is higher than in 2020.

Length distribution data are available for the Shelikof Strait area from 1995 to present; estimates have been corrected for juvenile escapement since 2008. Survey length distributions track year class strengths reliably, particularly the 2012 and 2017 year classes (in biomass). The 2013 and 2018 year classes are not as pronounced. Age class distribution data are available from 1980 to present and are also corrected for juvenile escapement.

Marmot Pass

The preliminary pollock estimate for Marmot Pass was 7,401t (180.5 million fish) based on 157 nmi of trackline and 6 LFS tows. The total biomass in Marmot Pass is small relative to Shelikof Strait. The largest abundance of pre-spawning biomass was found in Spruce Gully between the inner and outer most transect lines with 25% of the adult biomass (>40 cm) in pre-spawning condition (n = 19). The remaining female adults were developing or immature which is unusual.

The size distribution of pollock in Marmot Pass also showed a strong age-1 year class (17% of biomass) and a majority of pollock in the 4+ age classes (85% of biomass). There was no survey in 2020 but compared to 2019 biomass is slightly higher.

2022 Surveys

The 2022 winter survey plan is to survey the Shumigans / Sanak regions between Feb 4 and 15th (12 sea days) and Shelikof Strait from March 2 - 17 (16 sea days, typical number of sea days for a winter survey of this area). The acoustic-trawl summer survey will be in the Bering Sea which was last surveyed in 2018.

Additionally, the testing of an autonomous diesel-powered vehicle to collect acoustic data during the survey, potentially increasing the amount of trackline surveyed for bottom mapping (2022) and for collection of acoustic data (2023) is planned. This effort will build on previous work using autonomous sail-driven acoustic data collection vessels as a method of deploying remotely controlled data collection equipment.

Shelikof Time Series/Summer Acoustics

Shelikof survey time series

Dan McGowan gave a presentation on Evaluating VAST (Vector Autoregressive Spatio-Temporal) as a model-based estimator for acoustic-trawl survey data: winter Shelikof Strait survey.

Dan gave an overview of reasons to consider a model-based estimator for acoustic trawl (AT) surveys, including the ability to estimate biomass within standardized areas, improved interpolation within areas with low or no data, the ability to quantify model uncertainty using an MLE, improved estimates of non-

target species, and ability to provide standardized indexes of relative abundance from multiple data sources. The objectives of the study were to:

1. Identify optimal model specification for spatio-temporal generalized linear mixed models (st-GLMMs) using VAST to analyze acoustic-based measurements of age-1+ pollock biomass density from winter Shelikof Strait survey (1995-2021)
2. Assess model performance by comparing model- and design-based estimates of pollock biomass for an AT survey with coverage
3. Conduct a sensitivity analysis of model performance to examine effects of model structure, extrapolation area, and spatial resolution of estimates

Model-based estimates of pollock biomass closely tracked the design-based index trends ($r > 0.99$) and scale (~6-7% higher than design-based estimates). The differences between model- and design-based estimates were most sensitive to the inclusion of spatial random effects and the boundaries of extrapolation grid, and to a lesser extent, model spatial resolution. Both the length- and age-structured models provided similar biomass indices to the simpler univariate model when estimates were combined over all classes; however, these models are computationally demanding.

There are different roles for each of the different model specifications. Length structured models (Length-stGLMMs) are useful for characterizing distribution patterns by size class and providing preliminary (off-the-boat) assessment of year class strength. Outputs from age structured models (Age-stGLMMs) are useful as inputs in stock assessment models; the variance estimates provide both variance of and correlations between ages. Finally, the simpler univariate models (univariate stGLMMs) are useful for monitoring abundance trends, quantifying changes in distributions, evaluating influence of catchability or habitat covariates, and/or examining effects of changes in sampling on biomass estimates. The Team noted these models are not expected to be used in this year's stock assessment.

Ongoing research will focus on the continued assessment of VAST estimator performance for summer GOA pollock survey (2013–2021). Near term research projects include 1) conducting a simulation analysis to further assess sensitivity of the VAST estimator to a range of model specifications (late-Fall 2021), 2) comparing the sensitivity of model- and design-based biomass estimates for simulated and empirical data to changes in survey design and unplanned reductions in sampling extent and resolution (winter 2021-22), and 3) development of model-based estimates for other non-target species (i.e. capelin, POP) from summer GOA survey (spring 2021-22). Looking to the future, work on the development of the VAST framework to incorporate additional sources of uncertainty in AT surveys is planned for FY23.

The Team supported this ongoing and future planned work. The Team inquired about if depth of fish distribution (e.g., off bottom) was evaluated as part of the work. Dan responded that bottom depth was included in some runs as a covariate and that this might be something worth looking at in the future.

Gulf of Alaska summer acoustic survey

Darin Jones gave preliminary results of the summer 2021 acoustic-trawl survey of walleye pollock in the Gulf of Alaska.

Since 2013, the summer AT survey has been conducted from the beginning of June to mid-August. There were several survey challenges in 2021 including impacts and constraints of Covid-19. Fishing and other operations were significantly reduced, but they were able to still conduct the acoustics work. The 2021 survey was truncated and conducted from June 4 – July 9, 2021. The survey covered the area from the Islands of Four Mountains to Yakutat Trough. The area covered in the 2021 survey contained 98% of the 2019 survey pollock biomass.

Despite the differences in the timing and length of the 2021 survey, the Islands of Four Mountains and Shelikof Strait were surveyed consistent with previous surveys. The 2021 survey was conducted in similar areas to the 2019 survey but with decreased effort. The numbers of fish (>20 cm) in areas 620 and 630 on the shelf were down in 2021 relative to 2019. Generally 90% of the pollock are on the shelf.

The progression of the 2017 and 2012 year classes were evident in the length distributions from the 2019 and 2021 surveys. The 2018 year class was evident in the 2019 survey. However, that year class did not appear at expected levels in the 2021 survey. Age data from the 2021 survey is needed to confirm the presence of the 2018 year class. The 2020 year class (12-21 cm) represented 22% of the 2021 biomass.

Weight-at-length data from the 2021 survey was similar to historic GOA summer data. However, an examination of pollock (≤ 20 cm) showed that mean length and weight was lower than previous surveys. This explains why biomass of ≤ 20 cm pollock is down although the numbers are up in 2021. In 2021, the average sea surface temperature (SST) and the average temperature at 100 m depth in Shelikof Strait were down.

Estimates of abundance of POP were almost double the 2019 POP biomass estimates. The POP were found in large numbers in the Snakehead Bank area and east of Kodiak and ranged from 30-45 cm.

A summary of the 2021 survey relative to 2019 showed:

- Pollock <20 cm (age 1) numbers were up 33%
- Pollock age 1+ biomass was down 26%
- POP biomass was up 93%
- Capelin biomass was down 20%

Experimental use of Uncrewed Surface Vehicles (USVs) in tandem with NOAA ships is planned for the summer of 2023 in the GOA. A powered USV working in tandem with a NOAA ship has the potential to reduce ship time requirements for acoustic-trawl and ocean mapping surveys by $\sim 1/3$. The USV must be fast enough to keep up with the ship. The USV can survey adjacent transects while freeing up the ship to trawl. The specification and purchase of a suitable USV is in progress in FY2021. Initial testing of an USV will be conducted on the 2023 GOA acoustic survey.

A question was asked whether the differences in the 2021 survey timing and temperatures could be reasons for the differences in length and weight of <20 cm pollock. The differences in temperatures were only observed in Shelikof Strait. But it is acknowledged that temperature and growth could be contributing factors, and there could be population dependence affecting mean body weights of the year classes being sampled.

There was further discussion of the decrease of fish on the shelf observed in the 2021 survey. The 2021 survey showed that the mean depth of adult fish was slightly lower, and the mean height above the seafloor was slightly higher indicating that fish were slightly more off bottom. The fish were on the shelf break over deeper water. The fish could be moving (change in distribution), or there are actually less fish on the shelf. It was asked whether the indication of potential changes in distribution could just be due to the timing of the survey. The response was no, this does not likely have to do with timing. The Islands of Four Mountains and Shelikof Strait were surveyed consistent with previous surveys.

GOA Pollock

Model

Cole Monnahan, the new lead author for GOA Pollock, teamed with Martin Dorn and made a number of evaluations to familiarize himself with the bespoke model that Martin had developed. These mostly revolved around responding to past recommendations from the SSC and Plan Team and are presented below.

One request was to re-evaluate the time-varying fishery selectivity to resolve the poor pattern of residuals in the age composition fits. Presently the fishery selectivity variability only propagates via a random-walk term applied to the parameters of the curve. Cole relaxed the constraint and was able to obtain more variability but this failed to improve the poor residual pattern. The Team noted that there are a wide variety of ways to specify the constraint on the separability (by age) component of fishing mortality within the assessment.

The Team recommended that in future analyses (not necessarily in 2021), alternative smoothers/penalty forms be considered. For example, non-parametric time-varying selectivities-at-age may help resolve this problem.

Another Team recommendation (2019) was to explore better methods for constraining the time varying catchability parameter to be under 1.0 for the Shelikof Strait acoustic survey. In response to this, Cole parameterized the catchability to be in logit space so that it would naturally be bounded (by 0 and 1.0 in this case). He noted that the variance term for this form (as well as for the original model) was subjective and he tested a range of values and selected one that provided reasonable fits to the time series of Shelikof Strait surveys.

The Team and authors discussed variables that affect this survey catchability term from one year to the next. Martin Dorn explained that there were abundances that appeared outside the Shelikof region for a period of years and these had some carryover from one year to the next. Another suggestion was that the Shelikof timing of peak spawning may have impacted the low ATS data in 2007-2009 period (hence a lower catchability during that period).

The Team recommended continuing with this form at the author's discretion. We also recommended that future consideration might include state-space models or fully Bayesian forms be considered so that the variance term can be estimated along with the other processes.

Cole noted he is working with Lauren Rogers who is leading an analysis on survey timing and potential impacts on catchability.

In response to a 2019 Team request to explore combining bottom trawl survey data with acoustics, Cole noted that this would be a long-term research project and would take considerable time and effort. He will discuss data feasibility with the relevant AFSC colleagues. In response to a question posed to the Team, we noted that this work could provide an improved index AND help gain insight on the spatiotemporal vertical availability of pollock.

The GOA Plan Team in its November 2018 minutes recommended investigating model behavior sensitivity to abundance indices by incrementally dropping survey indexes to clarify how the data affect the model(s). Cole presented a set of diagnostics to understand the influence of the different survey time series dropping single surveys and running models with only one survey to show those trends/patterns.

Cole provided likelihood profiles broken down by their components plotted against key parameters. This showed that the BTS survey catchability had a large influence on stock size. The Team suggested

examining the profile with the acoustic survey using the newer formulation as that may avoid some of the conflict among the data as observed.

Cole concluded with responses to the Dec 2020 SSC minutes noting that new maturity estimates are included and also that he's a co-PI on a project linking environmental and other factors on trends in pollock weight-at-age.

The Team commended Cole for being able to adopt the code so quickly and create some useful new diagnostics.

GOA Other Rockfish

Cindy Tribuzio presented continued work regarding the other rockfish spatial management proposal. The demersal shelf rockfish (DSR) complex is only assessed separately in the SE region, whereas the species within the DSR complex are folded into the other rockfish (ORx) complex for the western and central GOA and the west Yakutat regions. In 2015, it was proposed that the DSR species be split out from ORx and that a GOA-wide DSR assessment be conducted. Upon this recommendation, the Team and SSC requested further evaluation. After further evaluation was presented in 2017, the Team and SSC approved Alternative 3a (splitting out DSR from ORx GOA-wide) and moving to NPFMC Spatial Management Policy Step 2. In 2019, the Team and SSC reiterated this support to move to Step 2. Since 2019, recent work to support this proposal includes multivariate analysis of life history and vulnerabilities, and VAST modelling of distribution.

Kristen Omori (VIMS) presented multivariate analysis for spatial management where the data used in the analysis included catch and survey data from both trawl and longline gears. Multivariate analyses resulted in confirmation that DSR species should be separated from the ORx complex gulf-wide. This result was reinforced by the temporal and spatial components of analysis using VAST. The Team noted that the removal of the 7 species of DSR out of the ORx complex as defined by eastern GOA east of 140 would align the FMP with State management policy where DSR is defined and applied for state water fisheries. Thus, joined alignment will make it simpler for users who participate in these fisheries to abide by management regulations and plans. The Team noted that it remains unclear as to where to go and what more is required to split DSR from other rockfish. The Team discussed what the assessment would look like, and it was noted that there would be an ADF&G author that would work on the DSR complex in SE and a Federal author that would work on the Tier 6 tables for the DSR complex in the remainder of the GOA.

The Team recommends, based on the analyses presented, that the DSR complex be split from the ORx complex GOA-wide. The Team requests guidance from the SSC on any further analyses needed to support this proposal.

Pacific Ocean Perch (POP)

Pete Hulson provided a summary of the 2021 GOA POP CIE review highlighting reviewer comments and proposed updates for the November assessment. Overall, reviewer consensus was the assessment model is tracking the population and providing high quality management advice. A number of the recommendations focused on a variety of sensitivity analyses, while others involved more in-depth model development. Several consistent in-depth recommendations included: further exploration of data weighting of compositional data; develop a state-space model to be run in parallel to the current assessment; and, continue to investigate use of VAST estimates of survey biomass, in particular investigating reasons behind the divergence between design-based and model-based estimates of abundance.

The author intends to evaluate the majority of recommendations before the next full assessment in 2023. This includes working with GAP staff in RACE to further examine the VAST model-based index. The author is not putting forth any substantial changes for the upcoming assessment but may bring forth proposed model changes in September 2022.

The Team discussed the utility of tracking CIE review recommendations and being aware of author responses and subsequent changes to the assessment model as this process may take several years. The Team supports further analysis of the CIE recommendations and looks forward to future improvements to the POP model.

The Team recommended the author include the table provided in the November assessment as an appendix and include a column that provides author responses to reviewers.

GOA Flathead Sole

Maia Sosa Kapur will be conducting a partial update for the 2021 assessment. The last full assessment was conducted in 2017 and is being transitioned to the latest version of Stock Synthesis (SS). Estimated survey biomass index through 2019 remains high, and spawning stock biomass remains high and stable suggesting no major conservation concern. Fishery catch since 2010 has consistently been approximately 10% of TACs and has been well below ABCs over the entire time series.

The Team supported the author's recommendation in continuing with a partial update this cycle, agrees there is no major conservation concern, and looks forward to the updated model using the latest version of SS in the next full assessment.

Northern and Southern Rock Sole

Meaghan Bryan presented a preliminary assessment for 2021 and investigative work regarding CIE recommendations. A CIE review workshop was held in April 2021 with contributions from various programs including: Fisheries Monitoring and Analysis, Age and Growth, Groundfish Assessment, and Status of Stocks and Multispecies Assessment. The main CIE recommendations included:

- improving the model for growth;
- investigate the possibility of estimating catchability to relax assumption that survey biomass is an absolute index;
- develop model-based indices and use as an input to partially address survey biomass index concern;
- encourage research of untrawlable habitat to improve understanding of relative abundance of rock soles in these habitats;
- further justification for splitting catch 50/50 for northern and southern rock sole.

Growth data was explored for males and females by year and species where bifurcation trends were observed indicating differences in growth. The differences in growth were more prominent in female NRS compared to males and similar trends were also observed for SRS. The summary of the growth analyses for NRS included significant spatial differences in female growth between the Central and Western regions whereas differences in male growth was less significant. For SRS differences in growth were supported for the model but less prominent compared to NRS.

Differences in growth were most apparent for NRS and further explored using a 2-area model in SS3 for the Central and West regions where recruitment distribution was estimated to determine how the population is distributed between areas. The results showed poor model fits and difficulty in estimating a recruitment distribution parameter. The author noted the poor model fits to males in the west region and

noted that this could be attributed to a fair proportion of NRS escaping the survey trawl net. The author presented further investigative work that included estimating catchability, updating age-error matrices, and sensitive analyses. Estimating catchability was recommended for further research, and to explore additional spatial components and review survey selectivity due to the low proportion of NRS males being caught. Conclusions from the sensitivity analyses showed that improvements can be made to the retrospective pattern with better fitting biomass data (using re-weighting), and iterative re-weighting approaches led to poorer estimation of growth and residual patterns in length and conditional age at length still persisted.

The Team commended the author with the in-depth and exploratory analyses conducted in a limited time frame. The Team recommended the author continue to explore the differences in growth utilizing spatial analyses, examining survey net selectivity, and use a reasonable set of parameters and then bootstrap to get new data and iteratively refit the model.

The Team recommended the author bring forward Models 17.1d (updated age error matrix) and 17.1f (17.1d with estimated catchability and VAST estimate of survey biomass) for November.

GOA Pacific Cod ESP

Kalei Shotwell presented on the GOA Pacific Cod ESP. The SSC recommended a full ESP for all Pacific Cod stocks in 2019 given the economic and community importance of this fishery. The Pacific cod ESP team was formed in January 2020. In November 2020 a draft ESP was developed. The Final ESP has been produced for this Plan Team meeting.

The Pacific cod ESP integrates the SSC's evolving comments on the ESP including the use of traffic lights, aggregating indices into a score, supporting the ESP dashboard, continued re-evaluation of ESPs as the process develops, and continued integration of community and socioeconomic indicators. The SSC's comments specific to this ESP were about expanding the spawning habitat suitability index, exploring indicators to inform other parameters, encouraging developing climate enhanced model 20.1, exploring additional indicators to describe trends in recruitment, separating fishery engagement from dependency, and exploring how coastal communities can provide review of and feedback on the ESP. The economic section of the Pacific cod ESP is a pared down version of the EPR inclusive of product breakdown, stock-specific engagement from ACEPO. SSC supported inclusion of small communities as aggregated, to address confidentiality issues.

Kalei spoke specifically to the dynamics of marine heatwave, habitat suitability, and bottom temperature conditions on Pacific cod, noting a potential lag in continued bottom temperature warming post heatwave which can be detrimental to Pacific cod. There was also strong indication of regional differences in conditions for Pacific cod. Socioeconomic indicators similarly point to declining prices and ex-vessel values for Pacific cod participants.

The Team discussed the utility of socioeconomic indicators within ESPs given the objectives of the ESP to 1) inform risk tables, and 2) provide a proving ground for ecosystem-linked assessments. Specifically, there was concern that the SSC has expressed interest in using the socio-economic indicators as red flags of stock health, given that the socioeconomic indicators are a year behind the current year whereas other ecological indicators are available concurrent to the year of the ESP. Similarly, there was concern expressed that socioeconomic phenomena are driven by a multitude of factors and can reflect more than changes in stock health, and there is yet to be a statistically significant relationship in the peer reviewed literature that links socioeconomic phenomenon directly to the health of *any* stocks in the North Pacific. Given this lack of scientific evidence, it is unclear by what mechanism these phenomena are then determined to be "good" or "bad" or a "red flag" for a particular groundfish or crab stock, or for the ecosystem as a whole.

The SSC's interest in socioeconomic information within ESPs may stem from the potential incorporation of local ecological knowledge to serve as red flags of changing conditions, but this is very different than utilizing existing sources of socioeconomic data available for inclusion in the ESP. Therefore, the Team expressed confusion about whether the SSC's intent for socioeconomic information within ESPs is really in terms of the use of socioeconomic data (prices, revenues, no. of permit holders, etc.) versus near-real time local ecological knowledge. Whereas the former can be calculated for ESPs from available data (with an annual lag), the latter would take concerted, new efforts for systematically gathering LEK focused around a specific species and region. Furthermore, there was concern expressed about the redundancies of socioeconomic indicators within ESPs and information already provided in the Economic SAFE and the new ACEPO documents.

The Team recommended that the SSC provide clarity about how the incorporation of socioeconomic information should be used to meet the objectives of the ESPs. If the SSC's interest in incorporating community information within ESPs is actually in terms of local ecological knowledge that should be clarified and prioritized in terms of species and regions, given that this will necessitate a new data collection.

The Team recommended ESP authors provide clarity around the terminology for socioeconomic indicators given the lack of familiarity of these terms within the Team.

GOA Pacific Cod Model Updates

Steve Barbeau gave a presentation on GOA Pacific cod, starting with a brief overview of last year's accepted model for reference. The presentation included an outline of several alternate models that were evaluated, and focused on the effects of these proposed models on various model outputs.

Steve evaluated eight models, which were primarily characterized by incremental changes/additions that started with the incorporation of a new age-0 cod index based on the beach seine survey conducted around Kodiak and along the western Alaska Peninsula (in collaboration with University of Alaska Fairbanks). The new models also included explorations of adding environmental links to growth, mortality and recruitment model parameters, data re-weighting, and finally expanding the M parameter block from 2014 - 2016 in the base model to years 2015 - 2020.

Results from the beach seine survey were compared with model estimates of recruitment, which seemed to generally follow similar patterns up to 2016, with an r^2 of 0.67, and were less coherent later on. The addition of the beach seine index to the model for recruitment resulted in good model fits to the seine survey data. However, the fit to other survey indices, including longline and bottom trawl survey, was poorer. The presenter noted that the new index further increased the lack of fit to high biomass in the bottom trawl surveys in 2009-2013, and the extremely low biomass in 2017, from the base model, and similarly failed to fit the rapid recent declines in the longline survey. A suite of other impacts from the addition of the new index were discussed, including reduced variance on reference points and a reduction in M during the 2014-2016 heatwave mortality block.

The next set of models explored the additions of temperature and heatwave information to growth, mortality and recruitment components of the model. The growth component was informed by experimental work by Ben Laurel et al. (2015) that indicated temperature links to larval cod growth rates. The proposed changes to mortality included a link to the annual heatwave index using a logistic function to increase M with the heat wave index value. The effects of this linkage on model estimates of M were compared with the base model and with the final proposed model with the expanded mortality block. Similarly, a heat wave derived index focused on the winter spawning event was used to inform model estimates of recruitment by modifying the Beverton-Holt spawn-recruit function, such that in years which

had a non-zero spawning heatwave index, higher values of the index would result in a reduction in recruits.

Two proposed models explored input data re-weighting/model tuning by modulating survey index CV's and size composition sample sizes. The presenter noted the inability to get a Stock Synthesis modeling software procedure using the Dirichlet method to work for this exercise, and mentioned that after much frustration in this endeavor the issue was due to a misspecification in the software. The tuning exercise resulted in higher CV's for all survey indices and substantial increases to age-length data sample sizes. The suite of models incorporating data re-weighting exhibited higher catchability parameter estimates for the bottom trawl survey (> 1.4), which the presenter noted was not a good outcome.

The next component of the presentation was dedicated to evaluating the different models using various standard metrics, including AIC and retrospective analysis. The best performing model for those that were comparable with AIC was the one with an expanded M block and environmental linkages to growth and recruitment. A series of slides showing the likelihood estimates for individual components of the model, including survey indices, recruitment, age-at-length and length composition across all of the models. In most of the cases the final proposed model had the lowest negative log likelihood (best fit), with the exception of the fit to the bottom trawl survey, which was the poorest for the model with expanded M block and all other modifications, of all compared models. Also highlighted was that the final proposed model with the heat wave linkages, expanded M block, and reweighting resulted in a negative retrospective analysis index (Mohn's rho) as contrasted by positive values (thus positive bias) for all other models. All models showed increased SSB in 2021 relative to 2020.

A sequence of slides then showed the estimates for the environmental (temperature/heatwave index) linked parameters across the models that contained them, which appeared fairly stable across the models. The impacts of data re-weighting on the longline survey catchability were noted, where the reduction in catchability was potentially indicative of less influence of temperature. The time series of new model fits to survey indices showed substantial divergence in models in the last 2-3 survey data points for the bottom trawl and longline surveys. Model outputs for SSB were also different, with best fitting models generally being the least optimistic.

In summary, the inclusion of the beach seine age-0 cod index improved recruitment estimates at the cost of poorer fits to other surveys. The environmentally linked model parameter estimates matched empirical observations (lower recruitment, higher mortality with heat wave conditions, and higher growth with temperature). Data re-weighting/model tuning resulted in a high catchability parameter value (>1.4) for the bottom trawl survey. The presenter listed new data that will be available for the assessment prior to the November Plan Team meeting, and outlined which of the models would be formally presented. The presenter indicated that the recent update of the SS program would allow the data re-weighting models to use the Dirichlet distribution for age length sample size selection process, which was not available for this presentation.

Steve asked the Team which model selection aspects they wanted to be presented in November. An additional slide that generated much interest was the results of the western gulf cod tagging study, which show a majority of the tag returns from individual cod tagged around the Shumagin Islands during spring 2021 spawning being recovered in the EBS and even in Russian waters in the summer, which suggests substantial migration of these fish. Steve noted that there is possibly a difference between western and central gulf cod, but that the next round of assessments for cod (EBS, AI and GOA) might have to be more closely coordinated given the potential mixing of the stocks, and potentially examined using an MSE approach as has been proposed by Ingrid Spies who will be taking over the GOA cod assessment next year.

Several questions were raised by Team members. They proposed leave-one-out analyses for model selection might be helpful. A request was made for doing a retrospective analysis on predictions of recruitment with and without the addition of the beach seine index, specifically to identify if high or low year classes are better predicted.

The Team inquired about plans to expand tagging to the central gulf but this was clarified as being a logical next step. Related to cod movement out of the GOA,, there was a question whether linking natural mortality to GOA environmental conditions (i.e., heat waves) was justified. If fish were migrating over large distances they would likely be exposed to different conditions. This led to a discussion on uncertainty in stock delineations and the possibility of more resident components of the GOA stock, possibly in areas such as Prince Williams Sound or around Kodiak. These components may be better understood with genetic studies that are underway.

The Team also inquired as to the availability of the IPHC longline survey data for 2021 given the coronavirus concerns. The survey was conducted but as in previous years, length data for cod and spiny dogfish were unavailable due to limitations in survey time and resources.

The Team asked if any fishery catch-rate data similar to the presentation and analyses done for EBS Pacific cod had been done. Steve showed the available data but noted that the observer collections are fewer and, partly due to the substantial drop of boats participating in each type of cod fishery, inferences from Pacific cod fishery CPUE data are problematic.

The Team recommended that the rationale for increases in the bottom trawl catchability parameter, particularly when re-weighting, should be noted; specifically, compare values with earlier experimental results.

The Team also acknowledged their appreciation for the quality of the overall presentation, and the importance and hard work required to carry out the tagging study.

2022 and 2023 Harvest Specification Recommendations and Halibut Discard Mortality Rates

The Team approved the proposed harvest specifications for 2022 and 2023 by recommending the 2022 GOA final harvest specifications for OFLs and ABCs as published in the Federal Register in February 2021.

The Team approved the 2022 and 2023 halibut discard mortality rates with one change. The Team agreed that the GOA non-pelagic trawl CP sector now has a sufficient sample size to calculate the GOA trawl CP DMR instead of using the BSAI DMR. The revised recommendation using the two year average is 83%.

Adjourn

The meeting adjourned at approximately 1630 Pacific time.