North Pacific Fishery Management Council

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Bering Sea Aleutian Islands Groundfish Plan Team

MINUTES

North Pacific Fishery Management Council
605 W 4th Avenue, Suite 306
Anchorage, AK 99501

November 13-16, 2018

Committee Members in attendance:

Grant Thompson	AFSC REFM Chair	Jane Sullivan	ADF&G
Diana Stram	NPFMC (Coordinator)	Brenda Norcross	UAF
Kirstin Holsman	AFSC REFM	Mary Furuness	NMFS AKRO
Andy Kingham	AFSC FMA	Cindy Tribuzio	AFSC ABL
Chris Siddon	ADF&G	Allan Hicks	IPHC
Alan Haynie	AFSC REFM	Kalei Shotwell	AFSC ABL

General

Administrative

The Team agreed upon some consistent text for both partial assessments as well as non-assessments for purposes of the introduction summaries in this year's SAFE report.

Policy on acceptance of non-previewed models

The Team rescinded the policy on acceptance of non-previewed models that it adopted near the conclusion of the November 2018 meeting, and instead decided to adopt the following substitute:

The Team reminds authors that, for each assessment year, models introduced in that year should ideally be previewed in September or at least requested by the Team/SSC by September/October, and that the standard for acceptance of models that do not meet at least one of these criteria will be higher than for models that do.

Northern Bering Sea surveys

The Team recommends that the NBS survey currently planned for 2019 be given very high priority.

Team actions on recommended models and harvest specifications

The Team agreed with the authors' recommendations regarding preferred models and harvest specifications for all assessments except EBS Pacific cod and AI blackspotted/rougheye rockfish. The Team's recommended models and harvest specifications for those two assessments are identified with stand-alone paragraphs and bold font in their respective sections below.

EBS and AI Ecosystem Status Report

Elizabeth Siddon presented the 2018 Ecosystem Status Report for the Eastern Bering Sea with additional information specific to the Northern Bering Sea. Elizabeth Siddon also presented the Ecosystem Report for the Aleutian Islands which was updated this year. Notable changes from previous years included updates or new development of 50+ indicators in the report covering more than 250 data sets, as well as an expanded section with Local Ecological Knowledge and Local Traditional Knowledge observations of changes in ecosystem conditions. The Hot Topics section has now been renamed “Noteworthy” which presents items that are either new or otherwise noteworthy and of potential interest to fisheries managers.

As in previous years the content is divided into three sections, “Physical and Environmental Trends, Ecosystem Trends, Fishing and Human Dimensions Trends”, which helps organize the information along expected lags in response to bottom-up or top-down forcing. These are each divided into forecasted conditions (physical only) and North and South Bering Sea conditions for the present year (2018) as well as a recap of 2017 conditions.

Both the SE Bering Sea (SEBS) and NE Bering Sea (NEBS) experienced water temperatures that were well above the long-term expected range. The northern Bering Sea had > + 5^o C anomalies in January–April 2018.The Chukchi experienced the warmest year on record, and there was little to no salinity stratification (no >32 ppm salinities) which led to more water column mixing and rapid freezing is possible. Sea ice formation in 2018 reached an unprecedented minimum extent, with a near-complete lack of sea ice in the northern Bering Sea due to: (i) residual heat that delayed freeze-up, (ii) a large high pressure system that shifted the position of the Aleutian Low Pressure System (ALPS) northwest, and (iii) winds from the southwest that brought warm air over the Bering Sea. The cold pool for summer 2018 was nearly non-existent.

In the SE Bering Sea an unprecedented lack of winter sea ice resulted in a near absent cold pool, which has never been observed in the 37-year time series. The cold pool was the lowest areal coverage in the 37-year time-series and 2018 was the first time that bottom temperatures < 0^o C were not observed within the standard bottom trawl survey area.

Both global model forecasts and regional 9-month forecasts predict continued heatwave conditions in the NEBS and warm conditions in the SEBS. The forecasts for summer 2019 predict a lack of a cold pool based on the $\leq$ 0^o C or $\leq$ 1^o C definitions, and a small $\leq$ 2^o C cold pool (similar to 2003). There is a 70% change of El Niño conditions in 2019. Sea surface temperature anomalies show positive anomalies in the northern Bering Sea during summer and winter for the last several years, including the warmest summer of the time series in 2018.

The response of the Bering Sea ecosystem to anomalously warm conditions in 2018 was evident across multiple trophic levels, with some lags and divergent responses to unusually warm conditions in 2016 and 2018, and average conditions in 2017, that are species and sub-region specific. In the NEBS, 2018 was extraordinarily different than in the past experience of scientists visiting the region or in the oral histories of local residents. Notable patterns are listed in the executive summary of the report and a subset of those are highlighted below.

The lack of sea ice led to a delayed and weak spring bloom and reduced large copepod and juvenile euphausiid abundances across the system during spring to late summer 2018 with some potential ‘hot spots’ located near Unimak Pass and in the northwest region. In contrast small copepods were abundant throughout the survey area, except at the most northern stations. Widespread and prolonged seabird die-offs were reported for the NEBS, likely due to starvation especially in species that consume large zooplankton. For the third year in a row, seabirds showed overall poor reproductive success in 2018 at the Pribilof Islands (i.e., kittiwakes, red- faced cormorants) while murres had some reproductive success, but the number of birds breeding was low, and many were late in their reproductive efforts. Multiple community members reported a lack of subsistence harvest of fledglings or eggs. There were dead and emaciated murres, shearwaters, and crested auklets in Nome and on St. Lawrence Island.

There are continued declines or continued below average fish conditions (defined as Length-Weight residuals) observed for multiple species in the SEBS. Notably, there has been a negative trend in Pacific cod condition since a peak in 2003. Condition of age-1+ pollock in 2018 was the second lowest on record and continued a decreasing trend. While cod and pollock in the SEBS were in poor condition, NEBS cod and pollock north of St. Lawrence were "fat and healthy". Pacific cod stomachs in the NEBS were full of *C. oplio* (snow crab), while pollock in the NEBS were eating polycheate worms. Diets of prey of pollock and cod were similar to inner domain (warmer condition) diets. Approximately 50% of the survey biomass of cod was in the NEBS in 2018.

The 2018 catch of Canadian-origin juvenile Chinook salmon in the northern Bering Sea was among the lowest observed since 2003. It is likely that the 2018 estimate will be below average, marking the 2nd consecutive year of below average abundance. The 2018 Bristol Bay salmon inshore run of sockeye was the largest on record since 1963; inshore run sizes in 2015–2018 were above recent and long-term averages. Large inshore runs in 2018 suggest these stocks experienced positive conditions at entry into the southeastern Bering Sea in summer of 2015–2016 and winter of 2016–2017. In Nome, large Pacific cod were caught in crab traps, there were record high returns of pink and silver salmon, and halibut fishing off of Savoonga was "really great".

Multiple indices point to reduced SEBS conditions for Pacific cod and pollock recruitment of the 2018-year class relative to slightly increased conditions in 2017 for 2017 year classes. Larval pollock and Pacific cod were observed in the ichthyoplankton survey, and were higher and lower respectively to 2012 values, but relatively similar between 2014-2018. Northern and southern rock sole observations were near zero in 2018, rockfish larval were lowest observed. Capelin were below average, age-0 pollock near average, and non-chinook juvenile salmonids and herring above average in 2018. Jellyfish CPUE in the bottom trawl survey increased > 200% from 2017-2018 and were similar to mid 1990s catch. CPUE of eelpouts, poachers and seastars decreased relative to 2018.

Crab biomass and abundance decreased for multiple species and stocks in 2018, with the exception of snow crab biomass that increased by 60%; Bristol Bay red king crab (males and females), St. Matthew Island blue king crab males, and tanner crab (males and females) decreased and Pribilof Island blue king crab (males and females) stocks remain depressed.

Fur seal pup production at St. Paul Island in 2018 was approximately 6% less than in 2016. Pup production has been declining at St. Paul Island at an approximate annual rate of 4.0% since 1998. The St. George estimate is approximately 5% greater in 2018 than 2016 but shows no significant trend since 1998. In the NEBS, ice seals (especially ribbon seals) were scarce, and population location and abundance is presently unknown. Spotted seal pups weighed less than in recent years, continuing a declining trend from 2014-2018. More walrus and bearded seals were seen, although this could be sampling effect of having a more northern survey; they may have declined as much as 58% since the early 1980s. Walruses were harvested of St. Lawrence when they are not typically accessible, and they were reported to be fat and in good condition. There were multiple reports of high numbers of dead seals on beaches and appeared to be of poor body condition and with empty stomachs.

The Team commends the authors on the broad synthesis of a substantial amount of information and continued distillation of that information into concise and management-relevant points. In this, the Team recommends that the authors continue to refine, condense, and clarify the executive summary with particular attention to lagged ecosystem outcomes of warm or unusual events and identification of a few key management relevant points. The Team commends and encourages continued inclusion of LEK and LTK in the report. The Team also recommends that the authors continue to include the NEBS and SEBS information and synthesis in the report. In this, the Team suggests that the authors align the definition of NEBS to be parsimonious with definitions used by other assessment authors and add synthesis about similar and divergent trends in the NEBS and SEBS. The Team would also like to see development of indicators of shipping activity in the region as well as information (or need for information) regarding novel and/or invasive species in the region. The Team encourages continued reporting on harmful algal blooms and encourages work to

validate and evaluate the skill of short-term forecasts. The Team supports continued refinement and development of ecosystem indicators across physical, biological, and socio-economic categories.

EBS Pollock

Assessment presentation

Jim Ianelli presented the EBS pollock assessment, which began with an overview of this year's fishery (see assessment chapter for details).

As it had been noted during public discussions in recent days that this year's assessments of EBS pollock and EBS Pacific cod treat the survey data differently (from each other), Jim also spent some time discussing the fact that this is not a new phenomenon. For example, the EBS pollock assessment has been using survey biomass as the index whereas the EBS Pacific cod assessment has been using survey abundance (in numbers of fish) as the index, and the EBS pollock assessment has been using the density-dependence-corrected index (developed by Stan Kotwicki) whereas the EBS Pacific cod assessment has not.

Jim also presented some results, not included in the assessment chapter, intended to show the effects of different treatments of survey data in the EBS pollock and EBS Pacific cod assessments. Two treatments used design-based estimates of survey biomass. One of those used just the EBS survey area (as in the most recently accepted model), and the other summed the results from the EBS and NBS survey areas (as in the EBS Pacific cod assessment author's preferred model, except with the index expressed as units of biomass rather than abundance). The third treatment used the VAST biomass index, with the NBS included. In terms of the *data going into* the model, the first two time series were virtually identical except for the years 2017 and 2018, which were higher in the combined EBS+NBS index, whereas the VAST time series was noticeably higher throughout. However, in terms of the *estimates emerging from* the model, the time series were nearly identical except that the EBS+NBS index run resulted in a slightly higher spawning biomass since 2012.

Other points from the assessment presentation included the following:

- AVO data from this year's bottom trawl survey were used to fill the stations that were missed during this year's AT survey as a result of the NOAA ship breaking down.
- As in previous assessments, Jim examined the impacts of adding data one component at a time.
- The VAST estimates of survey biomass (based on both the NBS survey data and Kotwicki's EBS time series) are very similar to Kotwicki's EBS time series (taken by itself) prior to 2010; the latter is the time series used in model 16.1.
- Jim expressed some concern about the model's fits to recent age comps and survey index values (e.g., the model estimates are higher than the index data).
- Mohn's rho is reasonably close to zero.
- Regarding the stock-recruitment relationship, Jim noted that, when the prior distribution was removed, steepness became very large if Ricker's functional form was assumed and steepness goes all the way to unity if Beverton and Holt's functional form was assumed. Alternative prior distributions were presented. Given sensitivity to priors on steepness, and their relationship to *Fmsy* (and uncertainty) research on assuming a higher value of sigmaR (as presented in 2017) is planned.
- Age group diversity has been below average since about 2010, but this has not seemed to impede the production of some strong year classes.
- Table 44 ("decision table") might prove helpful in contrasting impacts of alternative TAC values.
- Relative to 2018, the amount of effort that would be needed to achieve a fixed catch of 1350 kt increases substantially over the next few years (Fig 52 in SAFE chapter 1).
- Jim recommended setting 2019-2020 ABCs at the Tier 3 maxABC values, based on the concerns

listed in the risk matrix, which spanned the ecosystem, population dynamics, and stock assessment categories.

Discussion of the assessment

During discussion, individual Team members and members of the public offered the following questions and comments, which may or may not reflect Team consensus:

- Why is only a geographic subset of the potential AVO data used in computing the AVO index?
    - Responses: Because the original analysis showed that the subarea data correlate very well with the AT survey. If the survey scientists were to find that the correlation had broken down, the subarea definition should be modified. Including data from closer to Bristol Bay, for example, would be difficult because the acoustic signal would include large amounts of species other than pollock.
- The VAST index, with the NBS included, appears promising.
- Can the VAST index be extended into the Russian zone?
    - Responses: A post-doc will be working on this issue. Also, including Russian catches in the assessment model would likely increase the model's estimates of biomass.
- Some possible ways to address lack of fit between model estimates and the index data might include: 1) comparing residuals from a model based on the EBS data only to those from a model based on both the EBS and NBS data, and 2) allowing time-varying catchability.
- In the future, it would be helpful if the document were to include some indication of the conditions (if any) under which the Russian catches would be included in the model.

Recommendations for next year's assessment

The Team adopted the following recommendations for next year' assessment:

- If the survey index is going to include the NBS, then inclusion of the NBS in compositional data should also be explored (although this should not make much of a difference since the size compositions in the EBS and NBS are sufficiently similar).
- Conduct a sensitivity test of the VAST index, with environmental covariates, by omitting one or two years of NBS data at a time.
- Compare and contrast other model-based index estimates with the VAST approach.
- Regarding the apparent shift in year class dominance between 2012 and 2013, the possibility of a shift in mean length at age should be explored, as should the possible influence of ageing error.
- Full treatment of both the existing model and models with alternative treatments of the data should continue to be provided, along with maxABC values under Tier 3 for all models.
- Re-examine the geographic subset of data currently used to develop the AVO index, specifically to see if including Bristol Bay data improves the correlation.
- Explore "A" season trends in mean weight at length with a GAM or similar technique, to determine if the trends are either predominantly environmental or predominantly fishery-driven.
- Regarding sigmaR, explore alternative fixed values or estimation methods.

ABC discussion and recommendation

During discussion, individual Team members and members of the public offered the following questions and comments, which may or may not reflect Team consensus:

- Is Jim's recommendation to ignore the risk matrix, or to use the risk matrix as a way to justify use of the Tier 3 maxABC?
    - Response: Jim used the risk matrix to show that some amount of reduction is appropriate, but the specific amount was independent of the risk matrix.
- The use of Tier 3 maxABC implies a reduction from Tier 1 of 30% which is consistent with past

recommendations Both the authors and the Team have expressed concern in the past about this being a Tier 1 stock.

- Perhaps the Team should recommend that the SSC move EBS pollock to Tier 3, given that a reasonable estimate of the stock-recruitment relationship cannot be estimated without imposing a very informative prior distribution on stock-recruitment steepness.
- Perhaps concerns regarding Tier status and control rules could be captured by adding a 4th column (category) to the risk matrix.
- The level of concern in the "assessment" category of the risk matrix should be increased here because of the uncertainty in the stock-recruitment relationship, or maybe this would be more appropriately reflected by increasing the level of concern in the "population dynamics" category of the table, or maybe in both the "assessment" and "population dynamics" categories.
- Maybe the Team should express a concern about the FMP's harvest control rules in general.
- There may be situations where the author wants to consider an alternative control rule, because there may be concerns that the control rule does not perform as expected when environmental conditions are changing.
- Tier 1 is interacting with the risk matrix, which has implications for the control rule; given environmental changes, Tier 1 does not capture everything.
- It is not the control rule that is of concern; rather, it is the point estimates used to implement the control rule.
- It was noted that as biomass declines to BMSY F increases. Such a strategy may be problematic since the control rule would then require decreases in F as the biomass drops below BMSY (and add to variability in catch).
- Although maxABC under Tier 3 is less than maxABC under Tier 1 for EBS pollock at the moment, it may be important to remember that this has not always been the case.
- It would be helpful for the public if the Executive Summary included a description of the ABC approach as well as any changes in data and assessment methodology.

The Team concurred with the author's recommended harvest specifications for 2019 and 2020, including setting ABC at the maxABC value from Tier 3.

CEATTLE and ACLIM

Kirstin Holsman presented an overview of this year's results from the "Climate-enhanced multi-species Stock Assessment" (CEATTLE) model, along with a brief update on the "Alaska Climate Integrated Modeling" (ACLIM) project.

The CEATTLE model includes interrelated sub-models for pollock, Pacific cod, and arrowtooth flounder. The model can be run in either single-species or multi-species modes. When run in single-species mode, M for each species is set equal to the respective mean that is obtained when the model is run in multi-species mode.

ROMS/NPZ covariates were used for recruitment prediction in CEATTLE. CEATTLE seems to capture many of the peaks and troughs in the recruitment time series estimated in the individual EBS pollock and Pacific cod assessment chapters until the last year or two, but the fit to the recruitment time series estimated in the individual arrowtooth flounder assessment chapter is not as good (note that arrowtooth flounder is modeled on a combined-sexes basis in CEATTLE, but as separate sexes in the individual assessment chapter).

Regarding ACLIM, Kirstin posed the following discussion question, to which the Team did not have time to respond: Are there control rules or scenarios that ACLIM could evaluate over the next year (e.g., climate-specific reference points, effects of changes in weight at age or changes in distribution)?

In response to a suggestion from Kirstin, the Team recommends that the authors consider projecting pollock abundance with climate-specific recruitment based on hindcast estimates of ROMS/NPZ for the current year and 9-month forecasts for the current year + 1, and also consider comparing forecast skill against an AR process.

The Team also recommends including results from the respective individual assessment chapters along with CEATTLE results in both single-species and multi-species mode where feasible.

Bering ROMS/NPZ model

Kerim Aydin presented an update on the Bering "Regional Oceanographic model with nutrients and plankton dynamics" (ROMS/NPZ) model. This is a 3-D model with 10 km^2 resolution and 30 vertical layers (up from 10 recently). It includes a 48-year hindcast forced by measured conditions (IEA), a 9-month forecast forced by CFS forecasts (MAPP), and forecasts to 2100 forced by IPCC model outputs (FATE, ACLIM).

Much of the presentation dealt with bottom temperature heatwaves. There was a major heatwave in 1979 for both the NEBS and SEBS and a major heatwave in 2016 for the SEBS in 2016, and these may have affected recruitment. Recent *winter* heatwaves have also been experienced, which is unusual. Marine heatwaves will likely increase in frequency and duration. A continued heatwave is expected for the NEBS in 2019.

Kerim plans to produce a similar update every year, perhaps even as early as September, and including it in the Ecosystem Status Report.

Bogoslof pollock

The authors presented the full assessment for Bogoslof pollock. The most recent acoustic trawl survey was conducted in March 2018 and the assessment included both the three-survey average and random effects estimates for biomass. The authors' (and Team's) recommended using the random effects model estimate for calculating the Tier 5 ABC as in the past. The Team noted and appreciated that the natural mortality estimate (important for Tier 5 calculates) was re-evaluated this year using an age-structured model.

AI Pollock

The authors presented the AI pollock assessment for 2018. Last year this chapter was a "partial assessment" as it was a scheduled "off-year" under the Stock Assessment Prioritization guidelines. Model 15.1 (same as the 2015 accepted model) is presented for ABC/OFL advice. For the first time in eight years there was a limited (188 t) directed pollock fishery and as of October 3, 2018 there had been only 1,590 t of incidental catch, primarily in the Atka mackerel and rockfish fisheries.

This year's changes to assessment inputs were: 1) 1978-2018 catches from the catch accounting system (CAS) were updated; 2) the 2018 AI trawl survey biomass (1,740 t) was included; and 3) The 2016 AI trawl survey age compositions were included.

In 2018 there was a doubling of survey biomass in area 514. Closer evaluation reveals that a single point generated most of the increase, which is likely "spillover" from Bogoslof. This year's assessment estimates that spawning biomass reached a minimum level of about $B_{33\%}$ in 2003 and then generally increased during the period with no directed fishery ended (1999-2017). with a projected value of $B_{47\%}$ for 2019. The increase in spawning biomass since 1999 has resulted more from a dramatic decrease in harvest than from good recruitment, as the 2015-year class is the first since 1989 to exceed the 1977-2015 average. Spawning biomass for 2019 is projected to be 95,253 t.

EBS Pacific cod

Grant Thompson presented the EBS Pacific cod assessment. It was noted that models 17.2, 18.6, and 18.8 were updated after a mistake in the fishery age comps was found. The updated results did not change the general conclusions and resulted in minor changes to the estimated numbers (less than 5% in most cases).

Responses to SSC and Plan Team requests were provided. Following an SSC request, Stock Synthesis (SS) was used to do the projections to include parameter uncertainty and used fixed catches corresponding to the appropriate F's. Also, model-based survey index estimates were not used this year because they were not available in time to incorporate them into the models.

Three areas of the Bering Sea shelf have had survey observations, but the years varied. The EBS standard area has been surveyed annually from 1982-2018. Strata 82 and 90 have been surveyed annually since 1987, and when combined with the EBS standard area is noted as the "EBS expanded area". Observations of Pacific cod in strata 82 and 90 were historically a small fraction of the total EBS expanded area biomass estimate, thus all years from 1982 were also used as the expanded survey index (even though strata 82 and 90 were not surveyed from 1982-1986). The survey index for the EBS expanded area declined from 2017 to 2018. The northern Bering Sea (NBS) was surveyed in 2010 and 2017 and a rapid-response survey covered a truncated area, with a lower sampling density in the NBS in 2018. A three-year index of the NBS was created by using only the stations sampled in 2018 for all three years; the index increased dramatically from 2010 to 2017 and again in 2018. Summing the NBS and EBS survey estimates shows a decline in numbers, but a slight increase in biomass in 2018 compared to 2017. Larger fish were observed in the NBS than in the EBS in 2018.

Eight (8) models were presented for Plan Team consideration. One model was the status quo (16.6), five were requested by the Plan Team and/or the SSC, and two were added by the author (18.7 and 18.8). Model 17.2 was brought forward because it was the author's recommended model in 2017 and was seriously considered by the Plan Team for management in 2017. Models 18.6 and 18.8 were extensions of 17.2 with different ways to include the NBS survey as a separate time-series. Models 16.6i, 16.6j, and 16.6k were extensions of 16.6 with different methods to include the NBS survey. Model 18.7 was an extension of 16.6k, but fixed the NBS catchability parameter at the average NBS proportion of the the summed NBS and EBS survey abundances.

Results from the models were considerably varied. The estimates of M ranged by a factor of 1.38 (0.34-0.47) and average recruitment estimates ranged by a factor of 2.46. Time-series predictions showed similar trends across the models, except in the last few years some models showed a stable spawning biomass while others showed an increasing spawning biomass. Total biomass (age 0+) was predicted to decline in the last three years of all models. Retrospective analyses showed positive retrospective patterns for the terminal year spawning biomass estimates for all models.

The author presented four criteria to justify the choice of the author's preferred model, 16.6i. These were plausibility of catchability estimates, retrospective pattern, changes in complexity, and incremental changes in model structure. Catchability was nearest 1.0 with model 16.6i (or to the proportion of abundance in each survey when treated separately), Mohn's rho from the retrospective analysis was lowest for model 16.6i, and model 16.6i did not increase model complexity, but was an incremental improvement by adding NBS survey data.

The correlation between recruitment and the October-December NPI was evaluated with updated recruitment estimates, and the 2017 estimate was anomalous and outside of the confidence interval predicted from the regression analysis. This analysis may be discontinued in future assessments.

A major discussion point was the NBS survey results, what that implies about the population, and how it should be used in the assessment model. One hypothesis considered was that Pacific cod in the NBS are insignificant to the stock and should not be considered in management. In other words, the presence of

Pacific cod in the NBS is unrelated to the EBS stock and management of the EBS Pacific cod stock should consider only EBS data. A second hypothesis was that Pacific cod have the capability to migrate from the EBS to the NBS each year, and the stock extends over these two areas. A third, and related hypothesis was that the population in the EBS and the NBS may simply be a mixture of the same stock, or the Pacific cod in these two areas are sub-populations of the same stock with different life-history characteristics. More observations (e.g., genetic studies, tagging) are needed to reject any of these hypotheses.

If Pacific cod are undertaking an annual migration, that migration may occur at the same time as the survey, and there is a possibility that the survey is double-counting some fish, making catchability greater than one. Also, catchability could be affected by the truncated area surveyed in 2018. It is believed that Pacific cod and pollock were observed by other surveys outside of the truncated area in 2018, and a bias in the 2018 estimate may be present. Furthermore, there were only three years surveyed in the NBS, and if a single summed index is considered in the assessment model, that implies that years without NBS survey estimates have zero biomass in that area. Models with time-varying catchability may have captured some of these concerns, but a spatial analysis of the survey data with temporal and spatial correlation may provide a useful index. Investigating fishery CPUE data throughout the year at specific locations may help understand migration patterns and the intersection of a migrating population with the survey.

Public comment noted that the recent genetics study showed that the Pacific cod in the EBS and the NBS are of similar genetic composition, the longline fleet has recently started fishing on the population in the NBS, and this evidence suggests that the population has expanded in the NBS. There is a sense that the fishery follows P. cod northward, but the break between A and B seasons makes it difficult to tell (industry participants reported that when they arrive on the grounds in the North for B-season, the fish are already there). However, industry participants reported that they also follow fish south at the end of the season. Additionally, connections may occur with GOA (e.g., Unimak Pass), but implications of these connections are unknown.

Models 16.6, 16.6i, 16.6j, and 16.6k capture these three hypotheses:

- *Model 16.6* is a strong bookend and either assumes that the P. cod in the NBS are insignificant to management of the stock, or the fish in that area are unlikely to reproductively contribute to the population in the future (e.g., they could all suffer mortality if the climate quickly shifted back to cold years with quick formation of ice in that area or were harvested in Russian waters).
- *Model 16.6i* assumes that the P. cod in the NBS and EBS are all from the same population and should be modeled as one with no cod in the NBS in years without a NBS survey
- *Model 16.6j* incorporates time-varying catchability that may account for assuming zero P. cod in the NBS in years without observations in that area.
- *Model 16.6k* models the observations in the two areas separately but as a single population.

A fair amount of discussion centered around these four models and the Team considered including them all in an equally weighted ensemble to capture the structural uncertainty associated with these hypotheses. Although seriously considered and debated, the ensemble approach was not pursued in the end because the Team had serious concerns about the behavior of some models. After carefully considering each model individually, the Team agreed with the author that model 16.6i was the best available model for this year, but noted some significant concerns with the model (as listed below). Model 16.6i was an incremental change from Model 16.6 to include the NBS survey data without introducing too much complexity (as requested by the SSC). While all of the models exhibited positive retrospective bias, model 16.6i had the lowest retrospective bias of the models presented. Model 16.6i assumes a combined NEBS and SEBS survey catchability assumptions of 1.0, which may need to be evaluated in the future. The Team was not comfortable with time-varying catchability in 16.6k, but the model did consider NEBS and SEBS surveys separately and as such the team felt this approach was worth continuing to investigate in the future. Since model 16.6i satisfied many SSC requests, and due to the aforementioned considerations, the Team felt model 16.6i was the best model provided, but the Team expressed many caveats which are listed below with recommendations.

There are considerable concerns with the assessment, population dynamics, and environmental/ecosystem conditions associated with EBS Pacific cod. These concerns are listed below, and each category was determined to be at least a level 2 concern (substantially increased concern) and possibly a level 3 (major) concern. This would warrant a reduction from the maxABC according to the risk classification matrix.

Assessment (Level 2-3)

- Age compositions: potentially significant problems as in GOA
- How to treat survey in NBS (e.g., ignore, separate catchability, selectivity)
- Competing hypotheses that are not addressed in a single model
- Differences in stock status (44% to 23% of $B_{100\%}$ across models)
- Retrospective patterns suggest overestimation of spawning biomass (potentially due to constant M across ages)
- When comparing Mohn’s rho for the different models presented, the author and Plan Team were both unsure how the missing data for the NBS impacts the interpretation; thus, it’s not clear if the author’s interpretation about retrospective bias is correct.
- Uncertainty in the levels of current and historical fishery effort in Russia, especially given industry reports of many cod vessels across the border.
- Uncertainty in stock definition overall, given recent information regarding genetic similarities between GOA, EBS, and NBS fish; also given the poorly understood migration patterns between EBS/NBS areas and Shumagins/EBS areas.

Population dynamics (Level 2-3)

- Recent low recruitments, and recent lowest observed. There may be a risk to assume that average recruitment may occur in immediate future years.
- Continued decline in survey abundance (numbers), even summing EBS and NBS, although survey estimated biomass appears to possibly be constant in last 5 years
- Uncertainty in migration between EBS, NBS and GOA, as well into areas outside of the U.S.A.
- Current distribution is unprecedented
- Uncertainty in mortality in the EBS and NBS areas, with recent environmental trends

Environmental/ecosystem considerations (Level 2-3)

- Unprecedented lack of sea ice in the EBS and associated virtually absent cold pool (never seen before in the 37-year survey time-series)
- Delayed ice melt and spring bloom (1 month)
- Reduced primary and secondary production; lack of large copepods and Euphausiids
- Indications of continued poor conditions for recruitment and growth. Starving birds, low forage in south Bering, temperatures are exceedingly warm, transport of productivity and delay of bloom due to wind changes, continued warm conditions.
- Reduced energic value and lipid content in lower trophic species that indicate poor food quality for 2019-2020.
- Forecasts of continued warm conditions in SEBS (small cold pool forecasted for summer 2019) and continued marine heatwave (NEBS).
- Multiple signs that the system is not productive
- Unprecedented extent and duration of sea bird die off and indications of insufficient prey resources

- Although NEBS is more favorable than SEBS in terms of these indicators, the trends in NEBS are also deteriorating.

For next year's assessment, the Team recommended that:

- the EBS Pacific cod ages be examined for potential biases and reader effects as seen with GOA Pacific cod (i.e., Barbeaux et al 2018/GOA cod assessment and Kastelle et al., 2017/Age validation of Pacific cod (*Gadus macrocephalus*) using high-resolution stable oxygen isotope (δ18O) chronologies in otoliths).
- fisheries data be examined to determine if there are within-year patterns that may indicate seasonal movement, and if the survey timing may intersect with that seasonal migration.
- a model-based survey time-series be developed that can predict combined abundance of the expanded EBS survey area and the Northern Bering Sea survey area for all years. Length and age compositions should also be created that account for and are appropriately weighted by these model-based estimates. Validate the predictions using various methods as well as consistency with observations from other external surveys (e.g., BASIS).
- the NEBS survey be conducted again in 2019 to provide data for the Pacific cod assessment.
- Pacific cod fishery catches and Pacific cod survey data in Russia be researched and summarized.
- the significance of retrospective patterns when using a time-series with data mainly in recent years (for example, removing 2017 and 2018 leaves only one observation for the Northern Bering Sea survey time-series) be investigated and explained. For example, are the Mohn's ρ estimates useful to compare across models?
- the author considers an ensemble of models using the three hypotheses discussed above to address the structural uncertainty resulting from these hypotheses, as well as additional uncertainties captured by various models. The three hypotheses are 1) P. cod in the NBS are insignificant to the managed stock, 2) P. cod in the NBS are simply the same stock as in the EBS and should be managed as one stock, and 3) P. cod in the NBS and EBS are from the same stock and should be managed as one stock, but P. cod in the NBS should be modeled separately within one model with separate catchability and selectivity to capture differences observed in the fish in that area.
- the author considers bringing forward an ensemble of models to capture structural uncertainty with a justifiable weighting as well as a "null" approach with equal weights. The Plan Team may also consider an ensemble even if not recommended by the author. If an ensemble is used, all model outputs in the ensemble that are management related should be averaged, and the ABC should be determined from those averaged outputs (i.e., the application of the control rule to averaged biological reference values). The Team would appreciate feedback from the SSC on appropriate methods to average model outputs to determine an ABC.
- the authors coordinate with Council staff to augment the fishery information section of the assessment for next year. Council staff will be providing a cod allocation review in 2019 and will work with the author to provide pertinent summary sections over the summer.
- the authors coordinate with Alaska Department of Fish and Game on assessment data needs from the state managed Area O Pacific cod fishery as the fishery GHL is expanded under new allocation rules from 6.4% to a maximum 15% of the Bering Sea Pacific cod ABC.

After considering many options for a management model, including averaging various models, the Team recommended that Model 16.6i be used for management because it is the author recommended model and the author clearly itemized the justifications for selecting this model as the preferred model.

Model 16.6i is similar to the status quo model and shows incremental complexity by including data related to the recently observed shift in distribution in the form of the NBS survey data, as requested by the Plan Team and the SSC. The Team accepted these justifications, but agreed that other models, such as

16.6j and 16.6k, may more appropriately handle years where there are no survey data from the NBS as well as capture changes in distribution.

The following significant concerns with 16.6i were identified:

- Years without an NBS survey implicitly assume that the biomass in the NBS was zero, which may result in a conservative view of the decline in recent years (e.g., 2014-2018) of the survey index. This may be alleviated by using models (or data interpolation or additional sources of data) that are able to predict the survey abundance in years without groundfish survey data in the NBS.
- Larger fish were observed in the NBS, but the composition data were simply summed, which may not accurately reflect selectivity of the combined survey. Model 16.6k deals with this by separating the expanded EBS survey and NBS survey, but time varying catchability remained a concern in that model. Appropriate expansion of length compositions may alleviate this concern.
- This simple summation of the survey abundances assumes a survey of a population at a particular moment in time. However, the timing of the north-south migration is not completely understood. The survey may be following and interacting with migrating P. cod, possibly resulting in double-counting and a bias at the survey area mutual boundaries.
- The EBS and NBS survey observations are based on slightly different grids and occur in slightly different time periods and therefore may have different selectivity patterns and availability of P. cod, warranting the separate treatment of the two indices.
- The abundance index of P. cod has declined in recent years in both the summed EBS-NBS survey and standard (EBS) survey, but the biomass index remains somewhat constant over the recent 5 years, and even increased slightly for the joint surveys in 2018 (while the EBS standard survey has declined). This may be a bias resulting from the larger fish in the NBS age composition data relative to EBS (and which now represent 50% of the age compositions given the roughly 50:50 biomass index proportions between NBS and EBS surveys).
- It is uncertain if the P. cod in the NBS will contribute to current and future spawning biomass.
- Given the unprecedented shift in distribution of P. cod and uncertain future climate conditions, there could be additional natural mortality in the NBS that is not accounted for in the present model that assumes the same mortality across the EBS and NBS areas.

Alternative to a single model (i.e., 16.6i), the Team discussed and seriously considered averaging all or some of the 16.X series models to characterize structural uncertainty related to the three hypotheses stated earlier.

The Team recommends a 20% reduction in the 2019 ABC from the 2019 maxABC, resulting in a reduced ABC of 144,800 t. This is because of the assessment, population dynamics, and ecosystem/environmental concerns listed in the risk table above. A value of 20% was chosen because some risk table elements should be classified stronger than Level 2 and a meta-analysis of past reductions with level 2 concerns were typically in the 15-35% range. Additionally, models, 16.6, 16.6i, 16.6j, and 16.6k were all extensively discussed and considered for management, and the 20% reduction is similar to the average ABC from these four models.

The Team recommends a 20% reduction in the 2020 ABC from the 2020 maxABC, as projected from the reduced 2019 ABC, resulting in a 2020 reduced ABC of 123,200 t. This is because similar concerns for the assessment model and population dynamics remain for the 2020 prediction, and anomalous environmental conditions are likely to persist.

AI Pacific cod

Grant Thompson presented the Tier 5 assessment of Aleutian Islands Pacific cod. It was noted that CPUE has mostly been steady, with variation, over the time-series. The biennial survey estimates increased from

2010 to 2016, and declined from 2016 to 2018. However, the model predicted biomass estimates showed a continued increase in biomass from 2010 through 2016, and similar biomass estimates from 2016 to 2018.

The natural mortality value (0.34) used for ABC determination of this Tier 5 stock was taken from the 2018 EBS Pacific cod stock assessment.

The Western subarea harvest limit (Area 543) has been determined from the terminal year of the model-based estimates in past assessments. For 2018, this proportion is 15.7%, which is a drop from the 2016 percentage of 22.1%.

Discussion centered around three concepts: 1) the appropriate M for this Tier 5 assessment, 2) the estimate of the proportion in the western area (Area 543), and 3) the priority for developing an age-structured assessment.

The estimate of natural mortality is higher in the GOA Pacific cod assessment, and natural mortality for the AI Pacific cod stock may be more similar to the GOA P. cod stock because of potential latitudinal gradients in P. cod natural mortality. Genetics also showed the AI P. cod stock to be a separate population from EBS P. cod. A value from the prior for M may be more appropriate, which has a mean of .58, median 0.51, mode of 0.40, CI 0.2-1.35. Using the current M of 0.34 is conservative and the investigation of an alternative M should be done in the future.

The proportion of biomass in Area 543 is used to allocate catch limits after the state GHL is subtracted from the ABC. It was discussed whether this estimated proportion should be determined from survey observations or model estimates, and if averaging over a period of years would be useful to dampen variability. Using the model-based estimate intrinsically introduces some level of smoothing compared to the survey observations. Furthermore, it was noted that a decline in the estimated proportion in combination with the recent increase in GHL, which is removed from the overall ABC before allocation, will result in a larger reduction in the removals from Area 543 than just if the reduced proportion was applied and the GHL remained constant. This is because a majority of the GHL catch is taken from Area 541.

The Team recommends using a natural mortality of 0.34 (from the EBS Pacific cod assessment model 16.6i) for Tier 5 status determination, resulting in an ABC of 20,600 t.

The Team recommends investigating natural mortality to determine if there is a more appropriate value of M for this Tier 5 stock assessment. Potential sources of information are the GOA P. cod assessment, the prior for *M* currently developed for P. cod, and a prior for M using various approaches for estimating *M* (i.e., http://barefootecologist.com.au/shiny_m.html).

Given the continued concerns of the EBS Pcod assessment, the Team recommends continued focus on the EBS P. cod assessment and giving a lower priority to developing an age-structured AI P. cod model. Progress on the EBS and GOA P. cod assessments may provide useful insights into developing an age-structured assessment for AI P. cod.

The Team recommends using the random effects model estimate of the proportion in Area 543, which intrinsically introduces smoothing between years of the observations.

BSAI Yellowfin sole

Tom Wilderbuer presented the yellowfin sole assessment. The 2018 survey biomass estimate decreased by 32% from 2017. This was unexpected given the warmer than average conditions on the shelf and the tendency for the survey to estimate higher yellowfin sole biomass in years with warm shelf waters. The authors proposed a new base model (Model 18.1) based on the old base model (Model 14.1), but with survey catchability dependent on survey start date and bottom trawl survey mean temperature for stations less than 100 m as described by Nichol et al. (2018), as opposed to just temperature as in the old base model. Model 18.1 fits the survey biomass estimates better than Model 14.1, with substantial improvements to the likelihood and AIC. Although spawning biomass continues to be estimated high ($B_{67\%}$), spawning biomass has been in a shallow downward trend (~6% per year) since 1985. Total biomass has followed a similar trend. The average exploitation rate (1978 – 2017) is only 0.04 and the catch has been, on average, only 58% of the ABC.

In response to Plan Team recommendations from 2017, the author plotted the estimated spawning biomass trajectory with M fixed at 0.09 and q at 1.0 on top of the estimated female spawning biomass trajectory, with confidence intervals, from Model 14.1. This comparison was theorized to help determine if the model results generated from different combinations of M and q values were within the estimated uncertainty of the base model, or describe a completely different population size. Although there were a number of years (1978-1995) with estimates outside the confidence intervals, the general population trends appeared similar to Model 14.1.

On recommendation of the Team in 2017, the authors explored model retrospective patterns through a profiling exercise over M (0.08 - 0.14) and q (0.8 - 1.2), where Mohn’s rho and likelihoods were calculated over each combination of these values. The results show a pattern with Mohn’s rho between 0.01 and 0.22, with the lowest Mohn’s rho at a q of 0.9 and M of 0.08 and minimum log likelihood at a q of 1.2 and M of 0.1. The authors concluded from this exercise that using Mohn’s rho as the sole determination for model selection was not recommended.

The Team discussed the 2018 survey results, specifically the drop-in survey biomass despite the increase in temperature on the shelf. The Team also discussed the Northern Bering Sea survey extension (NBS) and the authors’ choice not to include these data in this model despite the high abundance of yellowfin sole in this region. The author did not think the 2018 NBS survey was fully appropriate for this stock as the NBS did not include shallow stations that would have been informative for yellowfin sole. Small (age 1) yellowfin sole were caught north of St. Lawrence Island on a research cruise in June 2018.

The assessment model employs a Ricker spawner-recruit curve based on a shortened time series of observations (1978-2012). The fit results in a shallow curve which resembles a Beverton-Holt type spawner-recruit curve. The Team asked if changing the type of spawner-recruit curve was warranted. The authors stated that the stock was still thought to fit a Ricker type recruitment pattern with density dependence and therefore warranted remaining as is.

The Team accepted Model 18.1 as a clear improvement.

BSAI Greenland turbot

Meaghan Bryan presented the Greenland turbot assessment. Updated catch estimates, survey estimates, and survey size-at-age data were added to the base model for 2018. In addition. the author presented evaluations of different model inputs, as requested by the SSC. Model 16.1 (the base model from 2016) was evaluated against 16.1b and 16.1c. Model 16.1b was the same as 16.1 but estimates the ABL longline survey catchability (rather than deriving it analytically). 16.1c estimates the ABL longline survey catchability like 16.1b and also adds an environmental link to unfished recruitment.

The author provided reasoning for recommending model 16.1b as the preferred model. Estimating the ABL survey catchability increased the stability of the model. Model 16.1c, with the environmental link added in, had a better fit to the shelf survey but there was a trade-off in the fit to the longline and slope surveys. 16.1c also estimated a more asymptotic selectivity in the trawl fishery. The author noted that, even though the environmental covariate model 16.1c was not recommended, it is a concept still worth pursuing in the future. The Team supported this notion, and leaves it to the author’s discretion to determine how to integrate environmental covariates into future assessments. A Team member commented that we may not be ready for 16.1c yet, in terms of confidence in the parameters. There was discussion about integrating a spatial model that explores the Russian influence, if and when those data become available, as well as investigating time blocks to improve the model's ability to estimate selectivity parameters. However, no recommendations were made at this time.

The models indicate that, while the strong 2007-2010 cohorts are moving through the stock, recruitment from other years continues to be low. \Total biomass is projected to begin declining after 2018 and spawning biomass is projected to begin declining after 2019. The lower 2020 ABC and OFL (relative to 2019) reflect this.

The Team accepted the author's recommendation of model 16.1b and the associated harvest tables.

BSAI Arrowtooth Flounder

Ingrid Spies presented a full assessment for BSAI arrowtooth flounder. The 2017 assessment was a partial update and this year's assessment is a full update of the 2016 assessment. Overall there are fewer parameters in the author's preferred model for 2018, following the recommendations of a CIE review in April 2017. Changes to the input data include:

- Length compositions from the 2017 and 2018 Eastern Bering Sea shelf survey, and 2018 Aleutian Islands survey.
- Biomass point-estimates and standard errors from the 2017 and 2018 Eastern Bering Sea shelf surveys, and 2018 Aleutian Islands survey.
- Fishery size compositions for 2017 and 2018.
- 2018 catch data through October 19, 2018, and estimated catch for remainder of 2018.
- Estimated total catch of 6,387 t for 2019 and 10,878 t for 2020.
- Age data from the 2016 and 2017 Bering Sea shelf and the 2012 and 2016 Aleutian Islands surveys.
- Removed Bering Sea slope survey data for 1979-1991.

Five models were evaluated for the assessment, and the author presented some outputs of each. The 2016 base model (Model 15.1b) was the starting point and additional models incrementally introduced recommended changes: Model 15.1c uses a smoothed age-length conversion matrix; model 18.3 was 15.1c with an ageing error matrix; Model 18.6 was model 15.1c with length-based survey selectivity (without ageing error matrix); and Model 18.9 builds upon Model 18.3 by using a smoothed age-length conversion matrix and an ageing error matrix, and also removing the early years of the slope survey (1979-2002). The author noted that removing these data (as in model 18.9) provides an improved fit to the shelf and Aleutian Islands survey biomass, and a much better fit to the slope survey biomass.

The author described her justification for not selecting 18.6 (with length-based selectivity) as the preferred model: "The size-based algorithm predicts that males will not move off the shelf until they are very large… (This) unrealistically predicts more males on the shelf than females. It is more likely that movement off the shelf occurs at older ages and is associated with spawning." Thus, the author's preferred model (18.9) does not use length-based selectivity, but does use the other described changes from the base model.

Model 18.9 was selected as the authors' preferred model because it provided the best fit to the data and incorporated appropriate changes to the model configuration, as requested by both the Plan Team and the SSC. The author noted that this improved fit could be due to Arrowtooth and Kamchatka flounder not being identified to species in the years of the EBS slope survey. Model 18.9 also had the lowest negative log likelihood score of all 5 models.

Overall stock trends have recently been fairly stable, with estimated total biomass ranging between 800,000 t and 950,000 t in all years between 2004 and 2018. Projected total biomass for 2019 is up 33% from last year's partial assessment projection, although this is due largely to an apparently immense 2016-year class, which would not have been detected by the previous full assessment in 2016. The catch-to-biomass ratio is low. The stock is not overfished and is not approaching a condition of being overfished. Total catch has been trending downward since the most recent spike around 2011. The author presented some spatial maps showing the distribution of the 2016-year class in the shelf survey. There were more 20 cm fish in the last two years than ever before, not just in one haul, but across areas. The author commented that, given what we know about the life history strategy of the species (e.g., they avoid the cold pool) and recent recruitment, the stock does not appear to be suffering under the recent warm conditions in the BSAI.

There was some discussion about whether the CEATTLE model could assist in making better predictions of catch in future assessments. Kristin Holsman clarified that the CEATTLE model does not use AI biomass, is not a split-sex model, and also uses some different data, so may not be appropriate as of yet.

A Team member expressed appreciation that the author is looking at some additional covariates for analysis.

The Team agreed with the author on the model choice of 18.9. The Team noted that it is a big change from the base model but is consistent with what the author was previously asked to do.

The Team re-iterated a previous recommendation that Models 18.7 and 18.8 from this year's September document be evaluated in a future year.

BSAI Kamchatka Flounder

Meaghan Bryan presented the full assessment for Kamchatka flounder. The 2017 assessment was a partial update and this year's assessment is a full update of the 2016 assessment. There were no changes to the model structure in this year's assessment, but two new models were presented based on changes to data inputs:

- Model 16.0 (status quo): the model accepted in 2016
- Model 16.0a: the 2016 model with modified fishery and Aleutian Islands survey length compositions included
- Model 16.0b: same as Model 16.0a but with updated age-length conversion matrix from the von Bertalanffy relationship where variance is age-dependent, where CV declined with age.

Updated data for this assessment includes:

1. Catch for all years with 2018 total catch estimated as the product of the TAC (5000 t) and the average proportion of the TAC captured over the last 5 years (~87%).
2. All years of fishery length compositions
3. 2017 and 2018 shelf survey length compositions
4. All years of shelf survey biomass and standard error estimates
5. All years of the Aleutian Islands survey length compositions
6. 2018 Aleutian Islands survey biomass and standard error estimates

Age and length composition data are sparse for this assessment and updated this year as follows. Previous models included fishery length composition data for the years 2012-2017, but they were removed for this assessment because of an error in the data query that brought in incorrect species. Survey length compositions were updated for the Aleutian Islands to remove arrowtooth flounder data that had previously been included. Age composition data were updated to include one year of data from the Aleutian Islands (2010) and two years from the slope survey (2002 and 2012).

The model fits to the survey indices were similar. Both missed the recent decline in the survey's estimate of shelf biomass. The fits to the length composition data were similar, suggesting that the age-length conversion matrix did not solve the trends in the residual patterns, and both models underestimated the peaks. Selectivities were similar between the two models, and similar to Model 16.0 for the shelf and slope surveys. The fishery selectivities for both males and females shifted to older ages in Models 16.0a and 16.0b, and in the Aleutian Islands survey both selectivities flattened out. Model 16.0a has the lower total likelihood, but there are trade-offs between the two models and the inclusion of a different age-length conversion matrix in 16.0b makes the likelihoods difficult to compare. Model 16.0b fits the survey biomasses better, while 16.0a fits the length and age composition data better.

Biomass estimates were also similar between Models 16.0a and 16.0b, but both were substantially different from Model 16.0. The early biomass estimates are greater than in the previous assessment and recent estimates are lower, but all models show the same decline in 2010. Mohn's rho for Model 16.0a was 0.10 and 0.24 for Model 16.0b. The retrospective pattern was mostly positive for Model 16.0b, but less so for Model 16.0a. Based on the likelihoods and retrospective patterns, the author recommended Model 16.0a. This model results in a 2019 spawning biomass of 54,779 t, which is above B40% (43,069 t), and current fishing mortality is below FABC (0.09). The Team accepted the author-recommended Model 16.0a, which resulted in 2019 ABC and OFL values of 9,260 t and 10,965 t, respectively.

The author proposed some areas for future assessment developments: 1) more length (or age) data from the fishery are needed; 2) the conversion matrix needs to be updated to include all age length data available.

The Team recommends:

- Examining data weighting to deal with underfitting the data.
- Investigating whether the slope survey catchability could be estimated inside the model instead of fixed at 0.18.
- Re-evaluating historical estimates of species composition, in particular the assumption that Kamchatka flounder comprised 10% of the catch of combined arrowtooth/Kamchatka catch from 1991-2007. Maybe look at proportions for years in which data do exist and compare to survey proportions to see if there is any correlation. Or maybe conduct sensitivity runs to determine if changing that rate impacts the model significantly.

BSAI Northern rock sole

Tom Wilderbuer presented a full assessment of northern rock sole, a Tier 1 stock. The 2018 assessment included the new 2017 and 2018 catch and survey biomass and 2016 and 2017 age composition information from both the survey and fishery. The average exploitation rate was 3.9% from 1975-2018. The 2018 fishery catch continued the downward trend of the last several years. The cumulative catch rate has continued to slow over the last four years. Because of Amendment 80, 96% of the catch was retained in 2017. The 2018 survey biomass was down 21% from 2017, and was the lowest since 1985.

The stock assessment base model uses fishery and trawl survey age compositions and survey biomass and standard error. It is a split-sex model; selectivity is fixed asymptotic for older fish. A 3-year moving average of empirical weight at age is used. The Ricker form of the stock-recruitment curve is fit inside the model. There is gender-specific time-variant fishery selectivity. Catchability (*q*) is constrained to a value near the estimate of *q* from a trawl herding experiment using the shelf survey trawl (Somerton and Munro 2001). Natural mortality (*M*) is estimated as a free parameter in some model runs and fixed at 0.15 in other runs.

The base model (15.1), which has been used since 2006, and four new models (18.1–18.4) were evaluated. In September 2018, the authors presented analyses of alternative models with *M* specified for males and females to the Plan Team; the result was that *M* for males should be included in future models. Therefore, the four new models all contain estimates of *M* for males. Model 18.2 also includes *q*. Model 18.3 is like 18.2, but additionally includes an offset for male selectivity (allowing the asymptote to differ from females). Model 18.4 was described as an ensemble of models 15.1, 18.1, 18.2 and 18.3. The authors found Model 18.3 to be somewhat compelling and a candidate for future assessments and gave similar results to 18.4. However, because 18.3 differed from the models presented in September, base model 15.1 was selected for ABC/OFL recommendations. Additionally, Model 15.1 provides estimates of FSB, ABC and OFL close to the other model runs, and has a better fit to survey and population sex ratio and survey age composition. As northern rock sole is a biennial assessment, the intervening time may be used to consider model 18.3 and potentially more appropriate models. Female spawning biomass is expected to increase based on a 5-year average fishing mortality (*F*).

Northern rock sole is sexually mature at about age 10 and highs and lows in recruitment are related to spring winds. As requested, a retrospective analysis was performed; Mohn's rho was very small (0.036). Northern rock sole do not spawn near the Northern Bering Sea and do not go that far north. Juveniles may recruit south of St. Lawrence Island.

The Team recommends that the authors document the priors for new models. In the models presented here, q is estimated for all, but prior is much more diffuse in new models.

The Team thanks the authors for volunteering to examine a model averaging approach. The Team recommends that the authors consider alternative weightings if they decide to pursue model averaging further; noting that, if the ensemble consists of nested models, the choice of weighting approach may be simplified somewhat. The Team also encourages the authors to consider whether the present ensemble might usefully be expanded by including models that span a greater range of structural uncertainty. Finally, the Team recommends that the authors further investigate Model 18.3, which may be the most biologically plausible model in the present ensemble.

BSAI Flathead sole

Carey McGilliard presented a full assessment and model exploration of flathead sole (combined with Bering Flounder). Major updates that occurred this year were the changeover to Stock Synthesis (previewed in September), removal of temperature from the model, data explorations of weight and length at age data, and various options for selectivity. However, despite the various new models and data exploration, there was remarkably little change in results. There was a change in scale in spawning biomass and total biomass, but separate male and female selectivity evened that out because the effects were opposite. In the future, the relationship between flathead sole and the cold pool will be explored as will additional methods for assessment of species complexes.

Specifically, models 18.0, 18.1, and 18.2 all have time-invariant fishery selectivity. Model 18.0 has external growth estimates and input sample size set to 200 for all years. Model 18.1 has internal growth estimates and input sample size set to 200 for all years. Model 18.2 has internal growth estimates and input sample size equal to the number of hauls from which the data came. The argument in favor of weighting by the number of hauls is that a sample of fish taken from a single haul is more likely to have similar sizes or ages than the same number of fish taken from multiple hauls. In the early years, fewer hauls tended to be sampled. Overall, the results from these 3 models were very similar, but the author preferred Model 18.2 based on methodological considerations.

Models 18.0b, 18.1b, and 18.2b differed from the previous models in that, instead of time-invariant fishery selectivity, they all had separate fishery selectivity curves for the time periods 1964–1988, 1989–2007, and 2008 onward. These time periods comprised a foreign fishery period, a middle period, and a post Amendment 80 period. Again, the results were similar, though weighting by the number of hauls lowered the variability in estimates of F for 1989–2007. Of this subset, the author preferred Model 18.2b.

Model 18.2c differed from 18.2 and 18.2b in that separate fishery selectivity curves were used for only two time periods, 1964–1988 and 1989 onward, i.e., not differentiating Amendment 80. Models 18.2b and 18.2c are two ways to account for differences in fishing patterns. Fits to the fishery comp data are better with these latter two models.

Models 18.2b and 18.2c estimated similar selectivity curves for the earliest time block, when flathead sole were caught at substantially smaller lengths. The middle time period had only slightly smaller sizes than in the Amendment 80 time block. Fits to fishery age comp data and length comp data and growth patterns are similar among models. Fits to fishery length comp in the early time period is poor in Model 18.2 with time-invariant selectivity.

Model 18.2c, with only two time blocks, was chosen for the stock assessment because it had fewer parameters than 18.2b and had an improved retrospective pattern.

The Team commends Carey for a clearly presented assessment along with a well-written and thorough SAFE report chapter.

BSAI Alaska plaice

Tom Wilderbuer presented the Alaska plaice assessment. This species is managed under Tier 3 and assessed every other year; this year is a partial assessment. As seen every year, the catch is lower than the TAC, which is lower than the ABC. The average exploitation from 1975-2017 was 2.7%, and catch is retained in the yellowfin sole fishery. The 2018 survey biomass was down 15% from the 2017 estimate, and the trend has been decreasing for the last five years. Spawning stock biomass is projected to continue to decrease. Although recruitment is low, female spawning biomass is well above $B_{40\%}$, so it this is not a concern.

The Team accepts authors' recommendation.

Because 38 and 40% of Alaska plaice were in the Northern Bering Sea in 2010 and 2017, respectively, the Team recommends that the authors examine how to include surveys of that area in the model.

BSAI Other flatfish

Tom Wilderbuer presented the "Other flatfish" partial assessment. This species complex is managed under Tier 5, with harvest recommendations calculated from estimates of biomass and natural mortality. The random effects model was fit to the new survey estimates (and time-series) and resulted in an ABC and OFL increase of 24% over 2017-2018. A full stock assessment will be conducted in 2019. The Team accepted the authors' assessment and had no recommendations.

BSAI Pacific ocean perch

Paul Spencer presented the BSAI Pacific ocean perch (POP) full assessment. The economic performance report for rockfish was added this year as an Appendix. There was an increase in catch in the central Aleutian Islands (AI) this year compared to previous years. The number of vessels (20) has been fairly consistent over the past few years and the POP share of the rockfish value is generally around 90%. Price per pound has decreased from where it was a decade ago, but has increased since 2015.

There were increased discards in the Bering Sea this year in the pollock fishery. Survey CPUE in 2018 was really close to what was seen in 2016, with the exception that the southern Bering Sea had slightly lower CPUE. There is some evidence that the area of POP distribution has expanded over time. When looking at the core area of tows that catch POP, the total area occupied by the stock has increased over time, and the percentage of the tows that do not catch POP has decreased. Depth where the fish were caught has not changed much in the survey, but has been converging somewhat in recent years toward the deeper depths where the fishery catches POP.

Data have all been updated in the assessment, including the following:

- Updated catch data through 2017
- Projected 2018-2020 catch estimates

- Fishery age data from 2015 and 2017
- Fishery length data from 2016
- Biomass estimate and length data from the 2018 AI bottom trawl survey
- Age data from the 2016 AI survey and EBS slope surveys
- Updated length-at-age, weight-at-age, and age-to-length conversion matrices
- Reweighted age and length data using an iterative reweighting procedure

Cohorts can be tracked through the fishery and survey ages, and there is some evidence of new recruits in both the fishery and AI survey data. This can somewhat be seen in the EBS slope survey, but the cohorts do not always match up with those in the AI survey. Models evaluated in this assessment are the updated 2016 model and a model with an additional year node for the fishery selectivity spline.

Results of the two models were compared to the 2016 assessment, and the updated data cause the most change, while the additional spline node does not make much of a difference. Fishery catch and survey biomass are increasing. Estimates of recent recruitment have become larger since the 2016 assessment. There is some lack of fit to the EBS survey age compositions, as the 2000 year class is not as strong in the EBS survey as in the AI survey. There was discussion on not using the prior on M in the future, as the value of M without the prior was falling within the range of empirical estimates and using the prior may be unduly constraining. There was also discussion on the reasons behind the different fits between the two surveys that included potentially using different ageing error structures and considering if there were different depths where the age samples were collected. It was also noted that the loss of the plus group occurred in the same year as the switch in sign from under- to over-fitting the surveys.

There is still an issue with the fit to both the AI and EBS survey indices. There is a residual pattern in two time periods, shifting from over- to under-fitting at the same point in the both time series and the retrospective pattern is worse than in the last full assessment (rho = -0.45). There have been longstanding comments on the retrospective pattern for POP. Paul was able to look at this more in depth this year and presented the results in the appendix. Paul considered why the POP population was increasing so rapidly over time and over many ages, and focused on exploring time-varying catchability. He used a crude, two-period catchability model and fit the earlier period estimates better with a reduction in the retrospective pattern. However, there is still an issue with underestimating the most recent increases in biomass and Paul felt that it is difficult to explain why the AI survey catchability would change over time.

The Team then discussed the retrospective pattern and potential issues with the high recruitments from the 2004-2008 year classes. Since there is a time period of high recruitment followed by a series of low recruitments (from the 2009-2012 year classes), as data are peeled back from the model, the data needed to inform those recruitments are lost, which could be impacting the retrospective pattern. There seems to be an interaction between the selectivity curve and the recent small recruitments that suggests there are no fish, which is inconsistent with the large survey biomass estimates. Paul stated that there seems to be a "lift" of the whole survey age composition that may not be fully explained by the recruitment issues. The 2006 and 2008 acoustic surveys for pollock in the AI saw large increases of POP.

Apportionments are similar to the last full assessment. The Team accepted the author's recommendation of model 16.3a and the associated harvest tables.

The Team recommends producing a squid plot (see sablefish SAFE chapter for example) for the next full assessment, to examine the retrospective pattern with respect to recruitment trends.

The Team also recommends updating the prior on M using alternative methods for the next full assessment (e.g., Hamel method, Jason Cope online application, http://barefootecologist.com.au/shiny_m.html).

BSAI Northern rockfish

Paul Spencer presented the BSAI northern rockfish partial assessment. The next full assessment for northern rockfish will be in 2019. The 2018 AI survey was not used for the purpose of harvest specifications in this partial assessment, but some changes in distribution were noted. The biomass decreased in all three areas of the AI while the EBS biomass increased dramatically. New data in the 2018 partial assessment included updated 2017 catch and estimated 2018-2020 catches. No changes were made to the assessment model, as this is a partial assessment. Exploitation rates (i.e., catch/biomass) have averaged 0.015 from 2004-2018, which is below the exploitation rate associated with fishing at $F_{40\%}$. New projections were very similar to last year's projections, because observed catches were very similar to the estimated catches used last year.

The Team accepted the author's recommendation and the associated harvest specifications.

BSAI Blackspotted and Rougheye rockfish

Paul Spencer presented a full assessment of the BSAI blackspotted and rougheye rockfish (BS/RE) stock complex – the first full assessment since 2016. BS/RE is on the sloped part of the control rule so the adjusted fishing mortality is increasing as spawning biomass increases. The stock was expected to move from Tier 3b to 3a, but this year's assessment indicates the stock remains in Tier 3b. The model was updated with most current fishery and survey data available including the 2018 Aleutian Island trawl survey. Both survey and fishery data suggest a general decline in larger/older fish (>20 yrs old) and increase in smaller/younger fish over the past few years. As requested by the SSC and Team, the author re-examined the approach of a combined BSAI assessment versus separate AI (Tier 3) and BS (Tier 5) assessments. The author recommended, and the Team agreed that a separate AI assessment was warranted due to: 1) the AI model functionally becomes a blackspotted only model, and 2) the difficulty in estimating q across the BSAI since there are lots of sampling/gear differences between AI and slope surveys.

Of the two AI-only models, model 18.1 utilized the McAllister-Ianelli weighting and model 18.2 utilized Francis weighting; these were the only differences. The Francis method heavily down-weighted the age and length composition data and was the author's recommended model due to more realistic recruitment estimates and a slightly better fit to the survey index data (although neither model fit the index data very well). However, results of model 18.2 suggested a marked reduction (~60%) in biomass estimates compared to the previous assessment's estimates, and model 18.1 fit the age composition data better than model 18.2. The Team had long discussions focusing on large recruitments vs. few larger fish, and the process of model averaging vs. developing a risk matrix for reducing ABC. Most notable was the in-depth discussion leading to a decision to average the results from Models 18.1 and 18.2 to produce the Team's OFL and ABC recommendations for 2019 and 2020. In addition to the differences between the models listed above, some of the main topics of this discussion included: 1) concern that dome-shaped selectivity could potentially explain the lack of fit to the age compositions at older ages but was not considered in any of the models; 2) marked reduction in OFL and ABC from last year for an extremely long-lived species; 3) concern that the Team's process for modifying ABCs from the authors' recommendations may not be consistent across assessments; and 4) the fact that the authors and Team faced essentially the same choice of models in 2016 (except that the EBS subarea was included in 2016), and at that time chose the equivalent of model 18.1, but now the authors are recommending model 18.2.

The Team recommends that the results of models 18.1 and 18.2 be averaged in order to arrive at the 2019 and 2020 harvest specifications.

The final realization, after deciding to use model averaging, was that further thought needs to be given to which estimates are to be averaged and how this should be documented consistently in the SAFE report (for the BS/RE section of the SAFE report's Introduction, the Team averaged the quantities in the AI executive summary tables for models 18.1 and 18.2). Guidance from the SSC on this issue is welcomed.

Additionally, the utility of the MSSC as a guideline for fishery removals on a finer spatial scale was discussed. The industry generally liked having a guideline to work towards, but the Team was mixed regarding its utility and discussed whether or not these should just be set as subarea ABCs rather than MSSCs. While there was no consensus, the Team recommended maintaining the same process in setting MSSCs across the subareas.

For the next assessment, the Team recommends:

- updating the age error matrix, as this has helped with the corresponding model in the GOA.
- evaluating dome-shaped selectivity for the survey, to better account for the survey's difficulty in sampling large/old fish accurately.
- examining larger bounds on M and investigating a profile of M and its subsequent impacts on model results.

The Team concurs with the author's research plans to evaluate the strong retrospective patterns.

In light of continued discussion of the low abundance in the WAI, catches exceeding the MSSC specified for that area and available management tools to address this, **the Team recommends that Council staff provide the author's previously written analyses on regional ABCs for discussion and Team consideration in September 2019.**

BSAI Shortraker rockfish

Ingrid Spies presented the BSAI shortraker rockfish full assessment. New data included the following:

- Updated catch data through 2018
- Biomass and variance estimates from the 2018 Aleutian Islands (AI) bottom trawl survey

There were no changes in the assessment methodology since the last full assessment. The random effects model was applied to survey biomass estimates and used a natural mortality estimate of 0.03. There was no clear trend in the biomass estimates in the AI, southern Bering Sea, or BS slope. Catch has generally decreased over time and typically below TAC. Since 2015, TAC has been set below ABC and catch and TAC are considerably lower than OFL. Area specific exploitation rates were generally below the reference point of fishing the stock at F_{ABC}, with the exception of the western AI from 2010 through 2013. The random effects model was applied to different regions and, taken together, the BSAI shortraker estimates are relatively stable with a slight increase in the most recent years. There were also no significant trends in length frequencies over time. ABC and OFL increased slightly.

The Team accepted the author's recommendation and the associated harvest specifications.

BSAI Other Rockfish

A full stock assessment was conducted in 2018 and presented to the Plan Team by Ingrid Spies. The "other rockfish" complex is a combination of 24 rockfish species not in the other specific rockfish categories. This complex is dominated by shortspine thornyhead (SST, *Sebastolobus alascanus*). There are many years in the EBS survey for which the biomass estimate of the non-SST portion of the complex is zero (with standard errors also equaling zero), which makes modeling the complex challenging. Ingrid is concerned that dusky rockfish may be locally overexploited in the Aleutian Islands, but also noted that current biomass estimates are not compatible with the dusky harvest that has been caught by the fishery. Steve Whitney from the AKRO noted that some fish caught in area 541 could be coming from GOA Area 610 and it is clear that the biomass estimates of dusky rockfish from the random effects model are unreasonably small for at least the AI portion of the stock, given that the catch is often larger than the biomass estimate.

There were no changes in the assessment methodology this year. The Team accepted the model.

BSAI Atka mackerel

Sandra Lowe presented the Atka mackerel assessment. Routine updates to the data were made, including finalized 2017 catch, projected total 2018 catch, and 2017 fishery age composition. There was an Aleutian Islands trawl survey in 2018. The survey resulted in a 21% decrease in biomass for the overall survey area. Of particular concern was that the Central AI had an 80% drop in biomass from 2016. It was noted that the 2018 temperatures at depth remained warmer than average, consistent with the 2014 and 2016 surveys. Surface temperatures were lower in 2018 than in 2016.

The assessment includes no new models for 2018, relying instead on last year's base Model 16.0b with updated data and removal of the 1986 survey age composition data. Although no new models were developed for this year, substantial work was conducted on testing sensitivities of the base model and presented to the Team in September (Appendix 17C), including an analysis that led to the decision to remove the 1986 survey age composition data. Model 16.0b continues to fit the data well. The addition of new data in 2018 resulted in a 15% drop in estimated 2019 spawning biomass from the 2017 projections. The spawning biomass for 2019 is now projected to be 106,800 t ($B_{38\%}$), dropping the stock to Tier 3b. Model 16.0b with the updated data shows a continued decline in spawning biomass from a peak in 2005 (288,490 t) following near-average to poor recruitment since 2007. The near-average (slightly above) recruitment of the 2012-year class dominates the 2016 survey age composition data. The 2012- and 2013-year classes dominate the 2016-2017 fishery age composition data.

Although the authors did not recommend a change from maximum ABC, they did complete a risk matrix for this stock. All three categories were classified at Level 1: Normal. After review, the Team concurred with the author's assessment. The recommended ABC for 2019 was 68,500 t, 26% lower than the 2018 ABC specified in 2017 (92,000 t). The projected ABC for 2020 is 63,400 t, based on an assumption that 86% of the 2019 maximum ABC will be taken due to Steller sea lion regulations, which is a further 7.5% drop. Recommended OFLs for 2019 and 2020 were 79,200 t and 73,400 t, respectively.

The Team concurred with the authors and recommends the use of Model 16.0b for deriving the Aleutian Islands Atka mackerel OFLs and ABCs for 2019 and 2020 and setting the ABCs at maximum for both years.

A random effects model fit to the bottom trawl survey biomass levels for the three Aleutian Islands management areas had been employed since 2015 to determine apportionment proportions. Continued use of this method would have resulted in changes in apportionment such that the Central Aleutian Islands area's share was reduced to 10% for 2019 from 34.78% in 2018, which would have constituted a 71% decline in the amount allocated to this region from 2018. This prompted the authors to conduct a thorough examination of the survey and fisheries data to determine if the 80% survey decline in the Central Aleutian Islands area was an accurate representation of the distribution of Atka mackerel. The first investigation revealed no deviations in survey methodology or protocols for the bottom trawl survey. The authors noted that similar drops in Atka mackerel biomass had occurred in the Eastern Aleutian Islands region in 2000 and 2012; however, there were no easily discernible similarities in environmental conditions (2000 and 2012 being below-average temperature years, 2018 above average), nor were there any correlations in local conditions that would explain the sudden drop. Examinations of fishery data showed steady CPUE in the fishery for the Central Aleutian Islands with no obvious differences in catch rates, locations, or fish behavior. Interviews with fishers revealed that they did not experience any extraordinary or even notably different conditions in the Central Aleutian Islands in 2018 while pursuing Atka mackerel. Given the lack of corroboration for the change in survey biomass distribution, the authors chose not to use the random effects model for this year's apportionment recommendations and instead returned, at least temporarily, to the pre-2015 method of a weighted average of the previous four surveys. This method resulted in a considerably smaller drop in the Central Aleutian Islands' share (from 34.78%

in 2018 to 21% in 2019 instead of 10%), a decrease in the Eastern Aleutian Islands and southern Bering Sea area's share instead of an increase (from 40.01% in 2018 to 35% in 2019 instead of 50%), and a larger increase in the Western Aleutian Islands share (from 25.2% in 2018 to 44% in 2019 instead of 40%).

The authors' recommended change in apportionment method generated significant discussion. It was recognized that this was inconsistent with how a similar issue with Aleutian Islands Pacific cod apportionment was handled earlier in the week by the Team. The Team discussed balancing the need for consistency and with the need for flexibility in dealing with the specific issues unique to each species. There was also a discussion as to whether the random effects tool as configured has been applied appropriately in this case. It was suggested that the Aleutian Islands survey was designed to provide a consistent biomass estimate at the spatial scale of the entire Aleutian Islands survey area and not to provide reliable area specific estimates. Partitioning the survey into sub-regions sometimes results in very large sub-region variances, and therefore estimates that have a higher probability of fluctuating between years due to observation error. It was noted that this is particularly true for species like Atka mackerel with a high degree of patchiness in their distribution. At the scale of each sub-region, exceptionally low and high values would be expected to be realized more often, and may not reflect true changes in the spatial distribution of the species from year to year. At the scale of the individual management regions, CVs often greater than 50% and up to 99% have resulted (Table 17.6 of the assessment). This suggested to one Team member that the random effects model as applied here was not appropriate. Additional discussion tended to echo some of the suggestions given in the assessment chapter, such as: 1) the random effects model could potentially be adjusted to better address patchy species like Atka mackerel and regional estimates by constraining the process error parameter to be less flexible in fitting the estimates; 2) advances in autoregressive spatio-temporal modeling approaches such as the VAST methods being developed for the region could potentially better address apportionment in the near future; and 3) more research is required, either in adapting the random effects model for patchy species, such as Atka mackerel, if it is to be used for apportionment, or in developing and validating new methods.

The Team agreed with the authors' choice of the four survey weighted average, which was used prior to 2015 for this stock, as the appropriate apportionment method for this year.

The Team recommends that further research be conducted on developing appropriate apportionment methods for this stock, with an emphasis on investigating the application and validation of the a**utoregressive spatio-temporal modeling approach developed in the VAST modeling framework for such purposes.**

BSAI Skates

Olav Ormseth presented a full assessment for the BSAI skate complex. The last full assessment was in 2016. This assessment consists of 15 species, managed as two groups: Alaska skate (Tier 3) and "other skates" (Tier 5). There are no changes to the assessment model used for Alaska skates, which is the same model in use since 2014. The approach used for the Tier 5 species was changed in this assessment such that the random effects model was run individually for each species with sufficient data, then summed for the total other skate biomass (in the last assessment, the random effects model was run on the *summed* "other skate" survey biomasses). There were substantial changes to the input data for this assessment. Most notably, the species compositions were updated with a new estimation procedure as approved during the September Plan Team meeting (Appendix 2). The Team commends the author for the improvements to the species specific catch. Other data changes include finalizing the 2016 catch, including the 2017 and 2018 preliminary catch, and updating the EBS shelf and AI surveys through 2018.

For the Tier 3 Alaska skate assessment, this year's model run resulted in a slightly worse fit than the previous assessment. The survey biomass fit is poor after 2005, the model underfits length-at-age for older age classes, and Mohn's rho and the RMSE are both worse for this assessment. The 2019 SSB estimate of 115,957 t is greater than $B_{40\%}$ (71,105 t). The Team accepted the author's recommended Model (14.2) which resulted in the 2019 ABC and OFL of 33,730 t and 39,173 t, respectively.

Most of the Tier 5 stocks' biomass trends, as estimated by the random effects model, were increasing or flat. The exceptions were whiteblotched and leopard skates in the Aleutian Islands surveys. The majority of the whiteblotched biomass occurs in the Aleutian Islands and the leopard skate is endemic to the region. The Team accepted the author's recommended Tier 5 model, resulting in contributions to the overall ABC and OFL for the complex of 8,984 t and 11,979 t, respectively.

The Team accepts the author's recommendations for the full complex ABC of 42,714 t and OFL of 51,152 t. The ABC is not apportioned.

The Team had requested an examination of the exploitation rates by species for the complex, in particular the endemic species in the Aleutian Islands. This was presented in the assessment; however, leopard skates were not included. As a result of this analysis, the author identified that the Bering skate exploitation rate exceeds the F_{OFL} for the species and may be a concern. The leopard skate exploitation rate is still of concern given the declining biomass.

The Team requested that the discussion of B_{msy} proxies be moved to September 2019.

The Team suggested that the author review how other Tier 5 complexes deal with species with differing life histories when running the random effects models.

The Team reiterated the request from the November 2016 minutes to "examine the utility of including IPHC and AFSC longline survey indices in both Model 14.2 and the random effects model for the Tier 5 species." (The author examined the AFSC longline survey data and determined that it would not provide useful information to the assessment, but has not yet examined the IPHC survey data.)

The Team requested that the author conduct sensitivity runs to examine potential biases in ageing.

BSAI Sculpins

Due to stock prioritization, no BSAI sculpins assessment was provided this year. The next assessment will be in 2019.

BSAI Sharks

Cindy Tribuzio presented a full assessment for sharks. The next full assessment for sharks will be in 2020. The IPHC survey RPNs are updated through 2017, and the biomass estimates have been updated for the Aleutian Islands and EBS shelf surveys through 2018. There was no EBS slope survey in 2018. The main shark species taken in the BSAI fisheries (mainly pollock and Pacific cod) are Pacific sleeper sharks and salmon sharks. Beginning around 2000, catch rates of sleeper sharks in both the IPHC longline survey and the bycatch fisheries declined steeply for several years, causing possible concern about depletion. In 2017, the IPHC RPN showed a slight increase, which was the first increase in a decade. The Team accepted the author's choice of OFL and ABC (the same as 2017 and 2018) and looks forward to the author's new analysis with a greatly expanded set of data-limited methods for 2020.

BSAI Octopus

Olav Ormseth presented the octopus assessment. The Tier 6 alternative consumption method (from 2011) has not changed since the 2016 stock assessment. The 2017 and 2018 catches are low and well below the ABC. The 2012 and 2013 Pacific cod diet data were not available for this assessment. The author will include them when they become available. The ABC and OFL estimates remain the same for 2019 and 2020. The 2017 - 2018 catch rates are stable at about 208 t and 270 t, respectively, with retention increasing in 2017 and 2018. The Team accepted the author's choice of OFL and ABC.

BSAI Squids

Amendment 117 to BSAI FMP effective August 8, 2018 reclassified squids in the Ecosystem Component category of the FMP. It prohibits directed fishing for squid, establishes a 20% maximum retention allowance, retains recordkeeping and recording requirements. Starting with the 2019 harvest specifications, no OFL, ABC, or TAC are required. **The Plan Team agrees with the author's recommendation to report squid catch and any status reports with the forage species document in the future.**