**SCIENTIFIC AND STATISTICAL COMMITTEE**
**Draft report to the**
**NORTH PACIFIC FISHERY MANAGEMENT COUNCIL**
**June 6th – 8th, 2016**

The SSC met from June 6th through 8th at the Best Western Inn, Kodiak, AK.

Members present were:

Farron Wallace, Chair
*NOAA Fisheries—AFSC*

Robert Clark, Vice Chair
*Alaska Department of Fish and Game*

Chris Anderson
*University of Washington*

Jennifer Burns
*University of Alaska Anchorage*

Sherri Dressel
*Alaska Department of Fish and Game*

Kari Fenske
*Washington Dept. of Fish and Wildlife*

Jason Gasper
*NOAA Fisheries—Alaska Region*

Brad Harris
*Alaska Pacific University*

Anne Hollowed
*NOAA Fisheries—AFSC*

George Hunt
*University of Washington*

Gordon Kruse
*University of Alaska Fairbanks*

Terry Quinn
*University of Alaska Fairbanks*

Seth Macinko
*University of Rhode Island*

Franz Mueter
*University of Alaska Fairbanks*

Kate Reedy
*Idaho State University Pocatello*

Matt Reimer
*University of Alaska Anchorage*

Ian Stewart
*Intl. Pacific Halibut Commission*

Alison Whitman
*Oregon Dept. of Fish and Wildlife*

**B-1 Plan Team Nominations**
The SSC reviewed the Plan Team nominations of Ben Williams and Patrick Lynch to the GOA Groundfish Plan Team, and Alan Hicks to the BSAI Groundfish Plan Team. The SSC finds all of these nominees to be well qualified, with appropriate expertise that will assist the Groundfish Plan Teams. The SSC recommends that the Council approve these nominations.

**C-1 Observer Program Annual Report**
A presentation was given by Craig Faunce (NMFS-AFSC) on the 2015 North Pacific Groundfish and Halibut Observer Program Annual Report (Annual Report). We also received a presentation on initial efforts to calculate variances for estimated quantities (e.g., catch, discards, PSC) from Jason Gasper (NMFS-AKRO) and Jennifer Cahalan (PSMFC). There was no public testimony.

The SSC received the third Annual Report of the restructured observer program, which pertains to trips observed during 2015. We acknowledge the dedication and tireless work of the observer program staff to provide this information. The Annual Report is concise and well written. It provides useful information on the implementation of the restructured observer program in 2015, and analysts have been responsive to SSC comments about the program provided during our February and June 2015 meetings. Observer-collected data provide essential biological samples and fishery-dependent information for management of sustainable fisheries in waters off Alaska. The Annual Report provides an overview of the program including coverage levels, description of the fee collection program, programmatic and contract costs, compliance and enforcement, as well as metrics on the performance of the deployment plan. The SSC greatly appreciates the analysis of selection and observer effects that can cause bias with respect to differences between observed and unobserved trips. A comprehensive suite of performance metrics were used to evaluate deployment rates, representativeness of the samples, and adequacy of the samples. The analyses revealed that there is the potential for a coverage bias in the spatial distribution of landed catch for the 't' stratum as well as an observer bias in trip length for both the 't' and 'T' strata. It also appears that there is potential bias in species composition, trip length, and areas fished between tendered and non-tendered trips.

The SSC noted that the new work on variance estimation is timely given the recent effort to make observer sampling representative of the actual catch using principles of random sampling and is very responsive to previous SSC recommendations. Preliminary results on determining the coefficient of variation of species catch are encouraging and will be helpful in the future for developing sampling objectives. The analysts indicated that a report on this work should be ready in the next two years. This work will also dovetail nicely with the analysis of data collected in the Electronic Monitoring program. The analysts are also working with other staff to incorporate variance estimation directly into the Catch Accounting system. **The SSC views this ongoing work on variance estimation as essential to the annual evaluation of the observer program.**

The SSC offers the following comments and recommendations to the Council:
- The SSC agrees with all of the recommendations of the Observer Science Committee and NMFS, some of which are mentioned and expanded on below.
- The analysts were very responsive to SSC comments made on the 2014 Annual Report and provided a section in the 2015 report to specifically address each SSC comment made. The SSC appreciates this attention to our recommendations and logging of responses by the analysts.
- The SSC agrees with the analysts' choice of permutation tests for assessing differences between attributes of observed and unobserved trips. This method of statistical testing is appropriate for assessing potential bias in realized observer deployments. However, we note that the outcomes of the permutation tests depend on the assumption that data arise from a random sample, which in some instances may not be the case.
- As stated previously by the SSC concerning the 2016 Annual Deployment Plan, **we agree with the analysts' decision to change stratification to three gears (trawl, pot, hook and line) instead of two vessel lengths. Trip selection will continue as the sole basis for random assignment of observers to vessels in 2016.**
- **The SSC continues to recommend that sampling issues and bias that arise with tendered trips be addressed.** We realize that regulatory action may not be practical to implement and **agree with the analysts' decision to place tendered trips in a separate stratum for estimation.** We look forward to seeing how this approach to stratification will address the potential for bias in the draft Annual Deployment Plan for 2017.
- The report detailed continuing problems associated with trip cancellation in the Observer Declare and Deploy System (ODDS). We agree with the recommendation of the OSC to allow the date of a logged trip to be changed rather than cancelling the trip as way to perhaps reduce temporal bias due to delay in observed trips.
- **The SSC continues to recommend that methods to link data from the ODDS to the e-Landings system be developed.** Although there is a voluntary effort being pursued, some analyses will require matching landings data with trips selected for observing.
- Continuing work to improve the sampling design and to provide estimates of variance needs to consider the linkage between the sampling design (i.e., level of stratification and sampling rate) and the needs of management (e.g., precision and accuracy needed for estimation of PSC or discards in particular areas and/or fisheries).
- The SSC expressed concern about continuing delays in the release of collected observer fees by the Treasury and the Office of Management and Budget. These delays have the potential to negatively impact observer provider contracting and thereby adversely impact data collection and strata coverage. We join the OSC in recommending that the Council re-emphasize to NMFS leadership that the timeliness of OMB's release of fees collected from harvesters and processors is important to the success of the partial coverage program.

The SSC offers the following recommendations to the Observer Program:
- Evaluate performance relative to the success of observer deployments. Specifically, improve the system for logging complaints by observers so that differences in trip metrics associated with trips where there were observer complaints versus those without complaints can be evaluated.
- As a potential deterrent to issues with compliance, consider publishing a list of vessels that are repeat offenders of specific complaints as logged by observers.
- The SSC requests that the following analyses be added to the list of analytical tasks:
  - Address issues with estimation of discards in the directed halibut fishery as detailed in issue #1 of public comment from the IPHC.
  - Use data from the 100% observer coverage fleets to conduct simulations with various levels of sampling rate to assess practical constraints to precision and accuracy of partially observed fisheries, with particular attention paid to estimation of rare events and PSC.
  - Once estimates of variance are available, discuss and evaluate the potential for development of accuracy and precision objectives for key estimated quantities with stock assessment authors.
  - Report on the full workflow from strata-level observer data collection through to information support for fishery stock assessments.

**C-2 BSAI Crab Plan Team Report**
The Crab Plan Team (CPT) report was presented by Diana Stram (NPFMC) and Robert Foy (NMFS-AFSC). There was no public testimony. Items for SSC consideration included OFL/ABC recommendations for three crab stocks (Tables 1 and 2), a report on a new stock assessment for St. Matthew Island blue king crab using a new General Model for Alaskan Crab Stocks (GMACS), a new stock assessment model for Aleutian Islands golden king crab, and several items relevant to the stock assessments for Bristol Bay red king crab and eastern Bering Sea snow and Tanner crab.

General recommendations
The SSC appreciates the authors' attention to the request that the SSC made last year for consistency in units used in the stock assessment. The reporting of consistent units and the presentation of tables of catch data both in pounds and tons is very helpful. Tables highlighting the data and years used in the analysis were also very helpful.

**The SSC recommends that the Council consider developing updated species profiles for crab, just as was done recently for groundfish.** These profiles would be helpful to some SSC members and others who are less familiar with crab biology and fisheries.

It was pointed out that BSAI crab stock assessment models often suffer from lack of convergence. As a consequence, the CPT recommended that assessment authors should employ jittering in all stock assessments and for many alternatives within each. The SSC points out that this approach should not be viewed as a long-term solution. Adjusting the phasing, parameterization, and initial values to find a reliable combination that performs well is the preferred method for improving model convergence. This allows for efficient model development and sensitivity analysis. The SSC expressed concern that, typically, jittering should be used as a tool for evaluating convergence at the end of an assessment, not as a primary approach from the beginning. Further, jittering provides only a one-sided test for lack of convergence (a local minimum), and cannot assure convergence. A large proportion of jittered runs that converge to the same solution do not necessarily indicate a more robust model; instead they may only indicate a weak test. Finding a relatively small fraction (e.g. 10-20%) of jittered model runs that return to the best likelihood, of which many fail, and importantly none that do better may represent a more compelling result. Further investigation of the underlying causes (i.e., data types vs. model structure) for crab model convergence problems might be addressed through simulation testing and or comparisons of model behavior between existing models and the developing GMACS platform. The SSC also requests the CPT work with stock

assessment authors to standardize model input formats and reporting, an effort that will be aided by the new GMACS platform. Finally, the SSC requests that any new recommendations made to the stock assessment authors (i.e. standardizing jittering and input formats) should be reflected in an updated Crab SAFE guidelines document.

Aleutian Islands Golden King Crab
The AIGKC stock has been assessed under Tier 5 using the same approach for purposes of making OFL recommendations since 2012/13. The approach involves a calculation based on average annual estimates of retained catch, bycatch mortality due to crab fisheries, and bycatch mortality due to groundfish fisheries for time periods defined for Alternative 1 (status quo) on pages 15 and 19 of the AIGKC assessment. The ABC was set using a 10% buffer below OFL during 2012/13 and 2013/14 and has been set using a 25% buffer since 2014/15. Given that there is no approved stock assessment model for use in setting catch specifications for AIGKC, the author and CPT recommended using the same approach for setting OFL and ABC as last year. **The SSC agrees with the author and CPT and recommends an OFL of 5,689 t (12.543 M lb) and an ABC of 4,267 t (9.407 M lb) for 2016/17.**

The SSC appreciates the author's responsiveness SSC and CPT comments, including splitting the fishery CPUE trend data into areas east and west of 174 degrees west. CPUE increased sharply in both areas after crab rationalization in 2005/06. Recently, CPUE and average weight trends have diverged. In the east, CPUE, total catch, and average weight increased from 2010/11 to 2014/15 even though the number potlifts declined. In the west, CPUE and average weight declined over 2011/12 to 2014/15 although potlifts and total catch increased through 2013/2014. The SSC expressed concerns about the CPUE and average weight decline in the west, the uncertainty in interpretation of this trend, and the uncertainty in whether the current joint OFL and ABC based on Tier 5 methods provides sufficient protection for crab in the west.

*AIGKC Model*
Shareef Siddeek (ADF&G) gave a presentation on a length-based stock assessment model for Aleutian Island golden king crab (AIGKC), which the SSC is seeing for the first time. The model is being considered for potential use this fall for assessment and status determination under Tier 3 or 4 instead of the current Tier 5. This assessment is unique for Bering Sea crab stocks in that it is the only stock with no fishery-independent information from a survey. Instead, a standardized catch-per-unit-effort index of abundance from the fishery is used for assessment and OFL/ABC recommendations. There are separate models for the eastern and western areas (EAG and WAG, respectively). The base model has asymptotic selectivity, initial conditions based on an equilibrium population assumption in 1960 and recruitment deviations until the data begin in the mid-1980s, and fixed natural mortality M of 0.23, the latter obtained by averaging estimates from separate models for the two areas. Data from a pot survey was deemed unreliable and is not used. A total of 17 model scenarios were considered, which the SSC believed was acceptable to evaluate model performance, but may not yet contain a base case. **The SSC approves bringing the model forward to the CPT in September for consideration for use in assessment and status determination.** The SSC advised the analyst to consider the CPT comments and would like to see further clarification and/or work on the following issues:

1. Reconsider the approach for estimating natural mortality. Rather than averaging estimates from the two areas, consider joint estimation of M between the two areas and use a likelihood test or information criteria to see if there is a difference between the areas. Also, investigate whether there really is information in the data to estimate M (looking at likelihood surfaces or variances), noting that this conclusion may be very sensitive to data weighting. If not, determining M (or deriving a prior distribution) externally from life history information may be warranted.
2. Look at the tradeoff between natural mortality versus dome-shaped selectivity, because both can explain a lack of older fish .
3. Conduct further analysis on area-shrinkage and standardization of CPUE. Further support is necessary to determine whether the assumption that CPUE is proportional to abundance is

warranted. The effect of area-shrinkage may be informed by in-depth examination of spatial data. For standardization, further investigation of whether vessel and/or captain is confounded with abundance (the year effect) is desirable, because not all combinations of factor levels may exist (vessels or captains not fishing in some years or months) and there may be very few levels of these factors in some years.

4. Nominal sample sizes (the number of crab measured) are extremely large and heterogeneous among years. It is common practice to use the number of sets/pot lifts or other measure of sampling units as a starting point for sample sizes instead of the number of length measurements. This change, and reporting of the actual input sample sizes used for all model runs should be added to the analysis. Further, adding the scale of the standardized residuals to the figures will allow better evaluation of the how the scaling of sample sizes may be influencing the assessment.

5. The fit to the groundfish bycatch length frequencies was relatively poor. It appeared that the selectivity curve for this fleet was fixed in the model runs, which could cause lack of fit in other aspects of the model. Estimation of the selectivity and/or addressing data weighting for this component should be evaluated further.

6. Depending on the outcome of this additional work, additional scenarios may need to be brought forward, along with models 1, 10, and 16 recommended by the author and CPT.

7. The SSC noted very small buffers between OFLs and ABCs. Such small differences are rare even for data rich groundfish stocks. The SSC looks forward to author and CPT recommendations on appropriate methods (and alternatives) to estimation of ABCs in the full 2016 assessment.

Pribilof Islands Golden King Crab

**The SSC concurs with the author's and CPT's recommendation to manage the PIGKC as a Tier 5 stock for the 2017 season, with a recommended OFL of 93 t (204,527 lb) and an ABC of 70 t (153,395 lb).** The OFL recommendation is based on the same procedures used since 2010 based on estimates of bycatch mortality due to directed crab fisheries, retained catch, bycatch mortality due to non-directed crab fisheries, and bycatch mortality in groundfish fisheries for time periods defined on pages 12-13 of the stock assessment. The ABC was based on a 10% buffer below OFL during 2013-2014 and has been based on a 25% buffer since 2014-2015.

The SSC appreciates that the author has noted years when confidentiality prevents reporting of fishery data. However, the SSC remains concerned about the preponderance of years in which all data are confidential (see Tables 1a, 1b and 2). In June 2015 the SSC had requested that the author approach the harvester about whether they would voluntarily allow confidential data to be presented in assessments. However, this was not done. The SSC reiterates this request. In addition, as this fishery is prosecuted under a Commissioner's Permit, the SSC asks ADF&G to consider the possibility of adding a requirement to authorize release fishery data for reporting in annual stock assessments as a condition of issuing future fishing permits in this fishery. Finally, the SSC reiterates last year's request for NMFS to assess the feasibility to provide groundfish PSC data for PIGKC by calendar year.

PIGKC is a data-poor stock, although periodic slope trawl surveys have been used to produce biomass estimates. A Tier 4 assessment based on a random effects model was presented to the CPT in September 2015, but it was unable to estimate process error. That Tier 4 assessment was based on 5 years of slope trawl surveys. The plan is to reevaluate the random effects model after results from the 2016 slope trawl survey become available in 2017. The SSC looks forward to a future Tier 4 assessment.

Western Aleutian Islands Red King Crab

T**he SSC agrees with the author's and CPT's recommendation to manage WAIRKC as a Tier 5 stock for the 2016/17 season, with an OFL of 56 t (123,867 lb) and an ABC of 34 t (74,320 lb).** The OFL has been set using the same procedures since 2010 and is based on the average total catch, bycatch mortality in directed and non-directed crab fisheries, and bycatch mortality in groundfish fisheries over 1995/96-

2007/08. The ABC has been estimated with a 40% buffer below OFL since 2012/13 to accommodate bycatch in groundfish fisheries and catch for a proposed test fishery. **The SSC expresses some concern about the size of the ABC given the status of the stock and requests the author and CPT review the buffer for next year's assessment.** The 2014/15 total catch did not exceed ABC for 2014/15 (34 t). Fishery catch data for estimating total catch in 2015/16 are not yet available, but it is believed that overfishing is not occurring. No overfished status determination is possible for this stock, given the lack of a biomass estimate.

In September 2015, industry and ADF&G worked to perform a cooperative "reconnaissance survey" for red king crab in the vicinity of Adak during the course of the 2015/16 Aleutian Islands golden king crab fishery. There was no red king crab retention, but handling mortality was accrued in the 2016/17 assessment. As reported by the CPT, 730 pot pulls yielded 442 red king crab of which only 23 were legal males. The SSC appreciates collection of these red king crab data. The industry expressed no desire to pursue a red king crab fishery in the Adak area at this time. However, the Petrel Bank region will be surveyed during September 2016. Genetic samples were collected from Adak red king crab in 2015, and genetic samples will be collected from Petrel red king crab in 2016.

The SSC appreciates the added limited information that was provided on stock structure. In this regard, the plot of retained catch by degrees longitude (Fig. 2) is helpful. Clearly this is an area for future ongoing research, especially if future commercial fisheries are envisioned. The SSC also appreciates the addition of size frequency data in Appendices A1-A4. The SSC requests plotting these data to enable visualization of progression of size modes in next year's assessment. Finally, the SSC points out that Table 1b purports to report crab harvests in pounds, however the values in this table are identical to Table 1a (t). Table 1b should be fixed.

GMACS
Dr. Andre Punt (University of Washington) gave a presentation on the development of a new General Model for Alaskan Crab Stocks (GMACS). There was no public testimony.

Initial applications include Saint Matthew blue king crab (SMBKC, see below) and Bristol Bay red king crab. One of the next steps is to include the computation of spawning stock biomass and OFL into the model framework. The SSC commends the authors on this significant advancement in crab stock assessment. It reflects hard work over years of development. Also, the SSC appreciates the CPT review of GMACS and endorses their recommendations on page 5 of the CPT minutes from their May 2016 meeting.

Table 1. SSC recommendations for three crab stocks (8-10) for 2016/17. Dark shaded fill indicates parameters not applicable for that tier. Light shaded sections are to be filled out for the final SAFE in September 2016. Values are in thousand metric tons (kt).

| Chapter | Stock | Tier | Status (a,b,c) | $F_{OFL}$ | $B_{MSY}$ or $B_{MSYproxy}$ | Years[1] (biomass or catch) | 2016/17[2][3] MMB | 2016 MMB / MMB$_{MSY}$ | $\gamma$ | Mortality (M) | 2016/17 OFL | 2016/17 ABC | ABC Buffer |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | EBS snow crab | | | | | | | | | | | | |
| 2 | BB red king crab | | | | | | | | | | | | |
| 3 | EBS Tanner crab | | | | | | | | | | | | |
| 4 | Pribilof Islands red king crab | | | | | | | | | | | | |
| 5 | Pribilof Islands blue king crab | | | | | | | | | | | | |
| 6 | St. Matthew Island blue king crab | | | | | | | | | | | | |
| 7 | Norton Sound red king crab | | | | | | | | | | | | |
| 8 | AI golden king crab | 5 | | | | See intro chapter | | | | | 5.69 | 4.27 | 25% |
| 9 | Pribilof Islands golden king crab | 5 | | | | See intro chapter | | | | | 0.09 | 0.07 | 25% |
| 10 | Western AI red king crab | 5 | | | | 1995/96–2007/08 | | | | | 0.06 | 0.03 | 40% |

[1] For Tiers 3 and 4 where $B_{MSY}$ or $B_{MSYproxy}$ is estimable, the years refer to the time period over which the estimate is made. For Tier 5 stocks it is the years upon which the catch average for OFL is obtained.
[2] MMB as projected for 2/15/2017 at time of mating.
[3] Model mature biomass on 7/1/2016

Table 2. Maximum permissible ABCs for 2016/17 and SSC recommended ABCs for three stocks where the SSC recommendation is below the maximum permissible ABC, as defined by Amendment 38 to the Crab FMP. Values are in thousand metric tons (kt).

| Stock | Tier | 2016/17 *Max*ABC | 2016/17 ABC |
|---|---|---|---|
| EBS Snow Crab | | | |
| Bristol Bay RKC | | | |
| Tanner Crab | | | |
| Pribilof Islands RKC | | | |
| Pribilof Islands BKC | | | |
| Saint Matthew BKC | | | |
| Norton Sound RKC | | | |
| Aleutian Islands GKC | 5 | 5.12 | 4.27 |
| Pribilof Islands GKC[1] | 5 | 0.08 | 0.07 |
| Western Aleutian Islands RKC | 5 | 0.05 | 0.03 |

[1] For Pribilof Islands golden king crab, this is for the 2017 calendar year instead of the 2016-2017 crab fishing year.


St, Matthew Island Blue King Crab

A draft stock assessment for SMBKC using GMACS was presented by Dr. Punt. There was no public testimony.

Five models were presented: (1) 2015 model – as provided previously by the stock assessment authors, (2) GMACS match – which tries to match the 2015 model as closely as possible using the new GMACS model framework, (3) GMACS base – in which survey selectivities are estimated for stage-1 and -2 crab; (4) GMACS CV – in which additional CV is estimated for both the directed fishery and surveys; and (5) GMACS M – in which natural mortality is fixed at 0.18 per year, additional CV is estimated for both surveys, and the selectivity is estimated for the directed pot fishery and both surveys. In the last three models, selectivities are bounded to be no larger than 1. An error was found in the 2015 model and this error was fixed before making comparisons.

**The SSC supports the CPT recommendation to bring forward a stock assessment based on GMACS for stock status and OFL/ABC determination in fall 2016. Specifically, the four GMACS models will be brought forward as alternatives with the GMACS match model replacing the 2015 model as the "status quo."**

The SSC offers the following comments to the stock assessment authors.

1. The SSC is not convinced that the model runs with extra CV are very informative. The inclusion of extra CV seems to be rather arbitrary based on the numbers of points that fall within confidence intervals estimated from trawl surveys. The SSC recommends coming up with some alternative way to consider extra variability, which could be informed by simulation testing.
2. The descriptions of seasons in the model is confusing and currently reads as if M differs among seasons (see p. 39). More justification is needed on how seasons are defined and how they were selected, as well as clarification on M during these seasons.
3. During the presentation to the SSC, uncertainty was expressed about the origins of the growth transition matrix, but page 7 of the report indicates that the matrix was derived by Otto and Cummiskey (1990). As this matrix is critical to the model, the origin and integrity of the growth transition matrix should be carefully explained in the assessment for fall 2016. In some other models, the transition matrix can be estimated. If there are doubts about the veracity of the transition matrix, perhaps this can be explored in the modeling framework.

4. The selectivities were constrained so that they do not exceed 1.0, but the tables of log-transformed parameter estimates do not indicate that this upper bound was approached. This should be clarified.
5. It would be helpful to include a table of NMFS trawl survey CPUE by crab stage, just as was provided for the ADF&G pot survey (Table 1).
6. Page 10 refers to a table of observed and estimated sample size, but no such table was provided.
7. As with the 2015 model, GMACS consistently overestimates trawl survey estimates of male biomass in the last decade, whereas GMACS tends to underestimate the last couple of pot survey estimates (Figure 9, 12). This is also reflected in patterns in residuals, and the proportions of stage-3 crab tend to be overestimated in recent years (Figure 14). These patterns should be discussed in the assessment.
8. The report contains very little description and interpretation of results. Moreover, not all figures are cited in the document. The document should highlight the major features of the results and offer some explanation, as well.
9. A brief explanation was provided about the future outlook (page 12) that indicated a declining stock. However, stock trends shown in Figure 24 generally suggest population growth since 1993. Closer examination of Tables 9-11 suggest that trends depend somewhat on model run and life stage. Statements about future outlook should be qualified and refer to figures and tables and explain any differences in outcomes.
10. The SSC discussed the possibility that these patterns could be indicative of spatial patterns in stock distribution. The trawl survey covers a much larger geographic distribution than the pot survey (Figure 4). Crab distribution may vary with sex (females tend to be found close to shore) and life stage. Thus, the trawl and pot surveys may sample the crab stock differentially. Moreover, the geographic distributions of these stages may vary with stock density and temperature. It could be informative to conduct some spatial analyses, which could include: (1) estimation of survey catchability as a function of temperature, (2) a stock assessment model run that includes pot surveys and only those trawl stations that fall within the pot survey distribution as a comparison the runs that include the full trawl survey data, and (3) analysis of the spatial distribution of surveyed crabs by stage at high and low biomass and during warm and cold years.
11. The CPT offered many insightful comments including recommendations on general code development for GMACS and the SMBKC application. The SSC appreciates and endorses the CPT recommendations.

Bristol Bay Red King Crab

Dr. Foy provided an overview of an analysis into alternative ways to incorporate surveys conducted by the Bering Sea Fisheries Research Foundation (BSFRF) into the Bristol Bay red king crab (BBRKC) assessment. A written report was authored by Drs. Jie Zheng and M.S.M. Siddeek. There was no public testimony.

The BSFRF conducts surveys using a Nephrops trawl, which has been purported to catch a greater fraction of crabs in the trawl path than the NMFS trawl. Thus Nephrops trawl catches may provide insights into the catchability of the NMFS trawl when towed in side-by-side comparisons. Seven scenarios for including BSFRF survey data in the BBRKC assessment were explored. Whether or not to include these data, and the best procedure for doing so, remain open questions. For instance, estimated capture probabilities from the NMFS surveys based on side-by-side comparisons vary greatly by sex and year.

The SSC supports the CPT recommendation to bring forward three scenarios for the stock assessment in fall 2016: (1) scenario 1, which is the status quo (2015) using BSFRF data from 2007 ad 2008 in which the two surveys are treated as independent surveys and survey selectivities are estimated separately and directly in the model; (2) scenario 1n, which is the same as scenario 1 but also includes the 2013-2015 BSFRF survey data, and (3) scenario 2, which is the same as scenario 1n but assumes that the BSFRF survey has capture probabilities of 1.0 for all length groups.

When these scenarios are presented, the terms "capture probabilities" and "selectivity" should be clearly defined. In the report, their descriptions seemed somewhat confusing and contradictory. For instance, Figure 6 implies catchabilities at small sizes in the BSFRF survey that are less than 1.0 for all scenarios, but from the text, this should not be the case. It is important that the definitions and procedures are clearly described.

Bristol Bay Red King Crab – Ecosystem Report Card
Dr. Foy provided an example of a pilot ecosystem report card for Bristol Bay red king crab. The SSC supports the development of species-specific indicators that can be provided to stock assessment authors to encourage the incorporation of ecosystem considerations and indicators in the assessment. We provide the following recommendations on developing report cards for crab stocks in general and for this specific pilot report card.

- The SSC encourages the report card authors to coordinate with Dr. Kalei Shotwell who is developing a template for stock assessment authors to include ecosystem considerations into groundfish assessments.
- The ecosystem indicators included two temperature measures capturing mean bottom temperature and the spatial extent of the cold pool. While these were chosen to reflect different impacts on red king crab, these indices are, not surprisingly, almost perfectly negatively correlated and therefore largely redundant.
- The indices for competitor biomass, benthic forager biomass, and pelagic forager biomass should be carefully reviewed based on available information on overlap in diets with competitors and the diet composition of potential predators on the relevant crab size classes. For example, small-mouthed flatfish (e.g., northern rock sole, yellowfin sole) have high diet overlap with red king crab and Tanner crab and might be more important to include in competitor biomass than as benthic foragers, because king crab rarely occur in their stomachs. Pacific halibut should be considered for inclusion as a benthic forager based on some stomach analyses. Also, it is not clear about the intent of including pelagic foragers, because some of the species listed are not known to be significant predator of crab larvae. Analyses of the climate regime shift in the GOA in the late 1970s suggest that there are positive associations between forage fish and king crab, not negative associations that one would expect as predator and prey. The SSC recommends consideration of two other indices. A climate index, such as PDO or NPI or ALPI may be useful to include, as correlative studies by Zheng and Kruse indicated a possible association with these indices and the probability of strong or weak crab recruitment. Also, an advection index could be a useful addition, given the apparent role of ocean currents on larval advection and retention.
- The SSC encourages the CPT to consider the merits of species-specific report cards for crabs or a more generic crab report card as done for groundfish.

The SSC appreciates this initial effort to construct an ecosystem report card for Bristol Bay red king crab and looks forward to future iterations.

EBS Snow Crab
Jack Turnock (NMFS-AFSC) provided an informational update on his length-based model. The SSC noted that Jack was very responsive to previous CPT and SSC comments. The 27 scenarios investigated provided an acceptable range to evaluate model performance and the SSC agreed with the CPT's recommendation to bring forward 4 scenarios in September. The SSC made no additional recommendations.

Tanner Crab
Bob Foy provided an informational update on the length-based model developed by Buck Stockhausen (NMFS-AFSC). The SSC noted that the 13 scenarios investigated provided an acceptable range to evaluate

model performance and agreed with the CPT's recommendation to bring forward 6 scenarios in September for final evaluation. The SSC made no additional recommendations.

**C-3 BSAI Crab 10-year Review**

The SSC received a presentation of the BSAI Crab Rationalization 10-year program review from Sarah Marrinan (NPFMC) and Brian Garber-Yonts (NMFS-AFSC) and of the Social Impact Assessment appendices by Mike Downs and Stev Weidlich (Northern Economics). Public testimony was received from Matteo Paz Soldán and Simeon Swetzof (City of St Paul), Stephen Taufen (Groundswell Fisheries Movement) and Sean Dochtermann (Bering Sea Crab Crewmen's Association).

The SSC commends the analysts on the considerable scope of the data they were able to summarize in the document. In particular, the analysts directly responded to many of the comments provided by the SSC in April 2015, including: 1) identifying quota holders; presenting trends in crew compensation, the division of rents between crew and quota vessel owners, fleet efficiency, and entry opportunities; 2) a description of how the markets for various forms of quota and product affect the flow of rents from the fishery; 3) detailed descriptions and index-driven analyses of community trends; and 4) information on the processing sector. The discussion was sensitive to baselines and elucidated heterogeneity in the fleet, and usefully combined qualitative and quantitative information to provide a complete picture of the state of the program. **The SSC finds the document to be a satisfactory, broad and comprehensive review of the crab rationalization program.** The document presents the best data available on a broad range of measures affected by crab rationalization, and is summarized in a fashion that is useful for identifying "red flags" in program performance.

However, the SSC believes the 10-year program review falls well short of what was originally intended by the Council at the time the crab rationalization program was created. When the Council adopted the program, then Chairman David Benton wrote to the US Congress presenting the program for Congressional approval. In his letter, Chairman Benton noted the expected benefits of the program: "Rationalization will improve economic conditions substantially, for all sectors of the industry. Community concerns and the need to provide for economic protections for hired crew will be addressed. Safety in the fisheries will be enhanced. Biological benefits will also be realized." The Chairman's letter to Congress then noted that the Council specifically designed a periodic review mandate as one of several safeguards built into the program: "The novelty of the program has compelled the Council to include several safeguards into the program, including… review programs to assess the success of the rationalization program." Attached to the Chairman's letter to Congress was a summary of the Council's rationalization program, the Executive Summary of which listed nine "primary elements" of the program. One of these nine primary elements was the call for: "Comprehensive data collection and program review to assess the success of the rationalization program."

The Council provided Congress with a description of what was expected from the review mandate in a section of the summary entitled "Program Review":

> "Given the novelty of the program, the Council is acutely sensitive to the need for monitoring the program's success. Under the program… [there would be] a preliminary report on the program at three years. A full review of the program would be undertaken at the first Council meeting in the fifth year after implementation of the program. This fifth year review would be intended to objectively measure the success of the program in addressing the concerns and achieving the goals and objectives specified in the Council's problem statement and the Magnuson-Stevens Act standards. Impacts of the program on vessel owners, captains, crew, processors, and communities would be examined. The review would include an assessment of options to mitigate negative impacts of the program. Additional reviews would be conducted every five years."

Thus, from the beginning, a formal program evaluation was envisioned as an essential element of the program, whereby formal hypotheses regarding the effects of the program are tested, with adequate controls to isolate the effects of the program from broader trends, or relative to what conditions would have been in the absence of the program.

The SSC is on record noting that the 18-month, 3-year, and 5-year reviews have all fallen short of the kind of review necessary to meet the original intent of the review component of the program. Commenting on the 5-year review document at their December, 2010 meeting, the SSC incorporated some of the comments on earlier efforts:

"In October, 2008, in reference to the 3-year review, the SSC remarked (emphasis in the original):
> **"Without quantitative estimates of these changes, it is not possible to determine if implementation of crab rationalization has resulted in improvements or losses of net benefits to the Nation or if it has resulted in changes in the distribution of net benefits that have resulted in unintended harm to particular regions, communities, or segments of the fishery.** Certainly by the time the Council's 5-year program review is prepared, the SSC anticipates that rigorous quantitative estimates of these outcomes will be available. At that time, analyses that compare the impacts predicted in the Crab Rationalization EIS to actual impacts would be very useful."

"The SSC notes that the 5-year review does not materially address our criticism of the 3-year review. While we find that the 5-year review document and appendices provide useful information, we view the lack of formal quantitative modeling and statistical analysis as a missed opportunity to better understand the causal effects of design features included in the crab rationalization program. Better understanding of these consequences would help inform the analysis of future catch share programs that might be contemplated by the Council, as well as the likely consequences of possible modifications to the existing crab rationalization program."

The current effort (the 10-year review document) is an almanac of relevant data that provides a broad and comprehensive review of the program. While such summaries of existing data and trends are useful for identifying items of concern that require further analysis, it is only the first step in the program evaluation process.  Therefore, the **SSC determined that the framework and format for this document falls short of the scientific standard for analysis that is mandated for a ten-year review.** This review did not identify program impacts separate from other causes and trends, or evaluate them against the goals and objectives laid out in the Council's problem statement.

The SSC acknowledges that a formal program evaluation demands significant resources and data, and therefore requires identifying a narrower scope and specific performance metrics for careful evaluation. Further, the SSC recognizes that the role of program evaluation spans multiple Council programs that require periodic review.  The SSC is concerned that the current process for reviewing management programs does not include systematic refinement and improvement of data and analyses like that used for stock assessments. As a result, significant information gaps arise and are allowed to persist without a clear plan to address the issue before gathering data for the ensuing five-year review. Given the persistent problems in producing reviews that meet the expectations for evaluating management programs, **the SSC recommends that the Council consider an alternative process for program monitoring and evaluation,** possibly establishing a "social science plan team" that could meet once or twice a year to discuss program evaluation strategies, refinements in data collection, and analytical methods.  This could be specific to crab rationalization or span multiple programs.  The SSC and AFSC social scientists have an upcoming workshop in June to discuss the development of a Human Dimensions SAFE, and will discuss how a social science plan team could contribute to the Council's process for conducting program evaluations.

Going forward with the monitoring and evaluation of the crab rationalization program, the SSC identifies the following specific issues raised by this review:

- There is a need to reinstate fieldwork funds for the social impact assessment (SIA) in the next program review. While the current SIA is a remarkably comprehensive document, there are many limitations of the data used by the analysts because they were not provided adequate resources for conducting fieldwork.
- There is a need for a description of active participation by quota holders.
- Given the importance of accessibility to the crab fisheries, there is a need to develop methods to characterize how access and upward mobility has changed. In particular, there is a need to characterize accessibility under the LLP.
- Analysis is required to identify the extent to which crew pay is changing as a result of being charged for quota royalties.
- Data and analysis are required to capture how the change in the length of the season has altered the nature of crab jobs for participants, and the ability to dovetail working in the crab fishery with other occupations.
- Data and analysis are required to evaluate the effects of implementing measures to prevent excessive consolidation of quota in the harvesting and processing sectors. For example, the combination of IPQ caps and the consolidation of Tanner crab processing onto a couple of processing facilities currently prevents the Tanner crab TAC from being fully prosecuted, and could be indicative of a larger problem in the design of the crab rationalization program.
- Integrating analyses between economic and social impacts is required to link changes in job structure to changes in community structures and lifestyles.
- Questions of entry and access are central to monitoring catch share programs and have motivated recent Council actions; however, the data are not able to answer the basic question of how much quota is held by new entrants. For example, Table 10-1 reports that approximately 20% of quota is held by entity names that did not receive initial allocations, but an unknown portion of this is reclassification of ownership entities involving the same individuals.
- The data in the community profiles have not been maintained well enough to track community effects, and the SIA lacks a way to characterize how the change in the structure of harvesting jobs affects participants' engagement and vulnerability to changes in the status of the fishery.

The 10-year review document, in its current form, would be more useful with the following adjustments in presentation:

- Extend the Summary and Conclusion section, which identifies the pieces of evidence for (or against) achieving each implicit program objective, to highlight major questions that remain unanswered, performance indicators whose status is currently unknown, and data/information deficiencies that preclude assessing whether program objectives have been met. Extending the Summary and Conclusion section in such a way could serve as a useful starting point for initiating more in-depth analyses of particular items of concern.
- Conduct additional analysis to establish whether differences in ex-vessel prices among share types (e.g., Table 9-10) persist after controlling for the vessels and processors involved, etc.
- In the SIA, major shifts in the geography of quota are driven by CDQ groups with business addresses in Anchorage or Wasilla. Since this benefit is clearly linked to the CDQ region, this should be distinguished from non-CDQ owned quota in presentation of this information.
- The SSC is excited to see the AFSC's new market profiles, and looks forward to reviewing them in a future meeting, but this document is probably not the best venue for them.
- The document would be enhanced by a discussion of what was learned in the process of designing and implementing the data collection for monitoring and evaluating the crab rationalization program, and how it led to discontinuities that limit its current value.

- The community engagement indices in Appendix B could be enhanced by further decomposing the observed trends into different components. For example, are the observed trends in community engagement due to community-specific factors that affect engagement in all fisheries, or are the observed trends specific to engagement in the crab fisheries? Extending the analysis to include engagement in other fisheries and/or using some form of shift-share analysis to further decompose the trends could be useful in this regard.
- Appendix A stands alone from the main document, and would be more relevant if both sections drew on the data presented between them to provide greater context for change. The SSC felt the SIA lacked a full assessment of impacts beyond quantitative shifts in vessels, quota, quota holders, for example, but recognizes that ethnographic fieldwork is the only way to responsibly characterize impacts.
- Qualifying words such as "only" should be removed from the community-by-community summaries. For example, statements such as "there are only two vessels" or "only 4 crew jobs" are not contextualized for the role those small numbers represent, and that the losses of those may adversely affect communities.

**C-6 Squid to Ecosystem Component**
The SSC received a presentation from Diana Stram and John McCracken (NPFMC).  Public testimony was provided by Brent Paine (United Catcher Boats).

The SSC appreciates the care and dedication of the Council Staff in the preparation of this EA/RIR/IRFA. **Nevertheless, the SSC recommends that the document not yet be released for public review for the following reasons:**

1. The description of the Alternatives and Options as described are somewhat confusing.  There are a large number of permutations and combinations of options, with important implications if one option, but not another, is chosen.  All of the possible combinations need to be evaluated with similar care, with their potential for both positive and negative impacts discussed. These evaluations should include comparisons with the status quo, and the RIR should provide more detail about whether moving squids to the EC will change Net Benefits to the Nation due to the redistribution of total allowable catch to other fisheries.

2. As pointed out by the analysts, under Alternative 2, if Option 2 is not selected, then the Council would need to define what is considered to be directed fishing, as an EC determination requires that a species is not targeted. Analysis of this scenario cannot be conducted, since directed fishing is undefined. It is likely not a minor issue to re-define directed fishing, and any such definition would need to be evaluated for its impacts. This is a major deficiency in the analysis.

3. Squid retention and sale by the BSAI pollock fleet appear not to be "insignificant" under the present NS1 rules for designating a species as EC. The BSAI pollock fleet retains squid, which is subsequently sold. Annual mean retention rates are 31-71% in the BSAI and 13-92% in the GOA. Is there a biomass or a monetary threshold for determining whether the retention and sale of squid is significant? Do the limitations on retention and sale apply to conditions before a species is moved into the EC, or only when it is an EC? Public testimony indicated that the pollock fleet would be willing to stop selling retained squid if squid were designated as EC. The proposed rule for revised NS1 guidelines was published January 20, 2015 and the Final Rule is to be published in the near future. The analysis should briefly indicate whether this revision is expected to impact the analytical conclusions.  The Council may need to revisit the Purpose and Need Statement because of the amount of squid retained in the BSAI pollock fishery.

4. Given the concerns raised above, it is unclear whether the proposed actions will have no significant impacts, either beneficial or adverse. In some places the document states that: "There are no significant (beneficial or adverse) impacts on squid stocks, salmon PSC, or significant (beneficial or adverse) socio-economic impacts on the groundfish fisheries." (Page 1, last sentence of Abstract). Yet, on page 10, bottom, it states "Alternative 2, moving squid to EC, has the potential to reduce the adverse impact on chum and Chinook salmon…". And on page 52 it is stated that Alternative 1 "… has an adverse impact on salmon." Since PSC of salmon is considered a significant problem, it seems that Alternative 2 would potentially have a significant beneficial impact. Likewise, the release of the pollock fishery from the need to avoid squid bycatch, and the resultant ability to continue fishing in areas of high pollock CPUE despite high bycatch of squid, would seem to be a significant economic advantage, especially as this ability to remain in high squid bycatch regions may allow the fleet to avoid salmon PSC. The possibility of localized depletion is also discussed. Given these statements, it is hard to reconcile them with the conclusion that the impacts of this action are "…not sufficient to require the preparation of an EIS…" (Page 26. bottom of 3$^{rd}$ paragraph). What is the threshold of "sufficient"?

The SSC also had the following comments on the document:

The proposed actions, to move squid to EC was proposed because of the difficulty to assess squid stocks, and the management problems associated with constraining squid catch in the BSAI. The SSC requests that the history of the issues be more fully described: i.e., the issues in setting specifications for squid, what alternate methods have been considered, and why they were deemed unworkable. Such documentation is important to fully evaluate whether some option could render Alternative 1 more viable. It would seem that methods could include: 1) redefining the time period over which catches are averaged, 2) biomass estimation using ecosystem models, 3) biomass estimation using hydroacoustic surveys such as shown in the BSAI squid SAFE for 2016, and 4) methods used in a recent analysis of global increases in cephalopods using survey and fishery data (Doubleday et al. 2016; Current Biology 26(10):R406-R407).

Throughout the document, terms used should be carefully defined in the context of the proposed action. Also care is needed to maintain a clear differentiation of what is known (data-based), what is assumed, and what may happen.

The SSC requests additional information describing issues pertaining to Maximum Retainable Amount (MRA) regulations, including descriptions of "directed fishing' and "prohibited status", and a very general description of how MRA's are calculated. Specifically, are MRAs determined on a haul-by-haul basis or on a trip-by-trip basis? Haul-specific estimation of the proportion of squid may be possible in the factory trawlers, but it is not clear how a haul-specific squid bycatch could be determined on catcher vessels with no at-sea sorting. This difference suggests a need to examine the ramifications of the proposed action on both the catcher fleet and on the catcher-processor fleet.

The analysis correctly points out that Alternative 2 may facilitate the pollock fishery to avoid salmon PSC. The document presently examines only the impacts on chum salmon PSC. There should be a similar evaluation of impacts on Chinook salmon and herring PSC.

Consider whether lessons can be learned from examining the actions with grenadiers in the NPFMC, and with squid in the PFMC? What will be the impact on other sources of bait if bycaught squid cannot be retained and sold?

There is some apparent contradiction as to the potential for localized depletion of squid. The figures show that most of the BSAI catch of squid occurs in the vicinity of Bering Canyon and the northwest corner of Unimak Pass over a very short time period (although it is unclear if the short window is due to the subsequent squid closure, or changes in squid behavior). Where possible, it would be good to report squid

catches to species. It is not clear if localized depletions are sufficient to be of concern. While the conclusion of no depletion may well be correct, the lack of evidence in this case is not the same as a lack of effect.

How does the amount of squid caught by the fishery relate to the amount of squid present in the BSAI? To evaluate the potential for depletion, it would be useful to know more about the species composition of the squid being removed from the area of Bering Canyon by the fishery.

It is not clear whether catch accounting of squid bycatch will be performed under all of the proposed alternatives. On page 18, bottom, it states "Absent selection of Option 1, no catch monitoring of squids (sic) species in either FMP would occur and no stock assessment would occur." In the paragraph above, it states "The catch of EC species is required to be reported for monitoring purposes and directed fishing for EC species is prohibited." These statements seem to be in contradiction. As acknowledged in the middle of page 24, the SSC minutes of October 2015 are quoted as stating: "…it will be important to continue tracking squid catch, retaining tools to limit squid catch if necessary…". The SSC reaffirms their opinion on this issue.

It would be of value in assessing the potential impact of the proposed actions to know which species of predators consume squid, and the proportion of the predators' diets that are squid when they are foraging in the Bering Canyon region. The prey database can be queried for fish diet data by area and time of year. There are also some data on the predator diets (Aydin et al., 2002) and on squid as prey used by seabirds and fur seals (Sinclair et al.). Many of the fur seal data were collected from animals along the shelf slope between the Pribilofs and Unimak Pass. It would be useful, when looking at dietary habits, to be specific as to the species of squid involved, where possible.

**D-1 Research Priorities**
Jim Armstrong (NPFMC) presented a summary of the proposed changes and additions to the Council's research priorities database submitted by the scallop, crab and groundfish Plan Teams. Matthew Baker (NPRB) provided public testimony. Dr. Baker noted that in response to comments provided during a recent external review, the North Pacific Research Board is considering a revision to the research categories used for annual requests for proposals. Six new NPRB research themes were proposed: Monitoring, Habitat, Ecosystems, Population assessment, Fisheries management, and Protected species. These new categories were designed to encourage interdisciplinary research that would be highly relevant to the NPFMC.

The SSC noted that several improvements to the database are needed to address issues related to the accessibility and visualization of information contained in the NPFMC research priorities database. Additional options for improved data display are needed. These will not only provide improved utility of the database by all users, but will also facilitate review of priorities during Plan Team and SSC meetings.

The SSC considered the new research themes proposed by NPRB and Council Staff. The SSC agrees that the addition of overarching research themes such as those proposed by NPRB would provide a very useful way to consolidate research projects under a common theme and facilitate matching Council research priorities directly to NPRB research themes. It was noted that some cross-cutting studies may be responsive to multiple themes. The SSC reiterates its request to have an option to see SSC proposed prioritization ranks because the current configuration of the database only allows visualization of the Council's prioritization scores.

The SSC reviewed the current list of research priorities and noted that there does not seem to be a clear mechanism for retiring a research priority. This is especially important for short-term "Urgent" or "Important" projects which should have a clear start and end date. The SSC recommends that meta-data on the research project(s) that are responsive to NPFMC research priorities is added to the database. This information might include the PI(s), contact information for the PI(s), the title of the research project, an

abstract of the research project, project start and end years, a list of publications derived from the project, and current status of the project (no action, pending, partially under way, under way, completed).  Ideally PIs on an active research project would be contacted annually to obtain a brief progress report.  It was noted that links of the NPRB database through a distributed network might expedite the addition of project meta-data into the NPFMC database

The SSC recognizes the importance of clearly stating the NPFMC's research priorities using the standardized method for ranking research priorities.  The SSC reviewed discrepancies between past SSC and Council research ranks.  There appears to be some confusion between the interpretation of Urgent and Critical Ongoing Monitoring.  The SSC continues to rank priorities in the Critical On-Going Monitoring if they are critical surveys without a specific end date. The SSC continues to rank research that is urgent and can be complete in one or two years in the Urgent category.

The SSC recognized that research priorities for some ecosystem components (e.g., seabirds, essential fish habitat, and marine mammals) may not be considered by the Plan Teams.  Therefore there is some risk that high priority research projects might be orphaned.  Mechanisms should be considered to ensure that these research priorities remain current.  One mechanism would be for the ecosystem committee to provide input on research priorities prior to the June SSC meeting.

The SSC reviewed the nine new research priorities submitted by the Plan Teams and provided ranks for each project. The SSC also reviewed research priorities discussed during SSC meetings in 2015/16.  Six new projects were identified by the SSC.  The SSC recommends that a project narrative is developed and that these new priorities are ranked as follows:

1. Meta-population of scallops, SSC rank – Important
2. Development of a statewide survey program to address catchability in different geographic areas. SSC rank = Urgent, no action
3. Implementation of a statewide scallop survey. SSC rank = Critical ongoing monitoring,
4. Resolve conflicting information on seasonal molt and mate timing for Norton Sound Red King Crab. SSC rank = Important; no action
5. Expand research on Pacific herring genetics to assess overwintering and spawning grounds SSC rank = Important; no action
6. Estimates of herring PSC from commercial trawl landings to address efficacy of current herring closure areas. SSC rank = Urgent; no action

Because there is no column in the database with SSC priorities, the SSC was not able to fully evaluate Plan Team suggested changes to existing priorities this year. Within the review that was possible, the SSC noticed a number of cases where Plan Teams ranked surveys as Strategic, whereas SSC ranked surveys as Critical Ongoing Monitoring. The SSC noted that the addition of a new classification, "Important – Ongoing Monitoring", is needed.   This added classification would allow the Council and its advisory bodies to distinguish between critical ongoing monitoring that is needed to assess the status and trends of communities, industry and living marine resources and important ongoing ecosystem monitoring. The SSC agrees with the CPT's recommendation that when research topics are consolidated under a general research category (e.g., project 147), that an additional column be added to the database to indicate some of the high priority species that might be candidates for targeted research under a consolidated research theme.

**D-2 Review EM Analysis**
The SSC received presentations from Diana Evans (NPFMC) and Jennifer Mondragon (NMFS-AKRO) on the fixed gear Electronic Monitoring Work Group's (EMWG) progress as described in three documents: *Analysis to Integrate Electronic Monitoring into the North Pacific Observer Program*, *Catch Estimation Process for Electronic Monitoring*, and Pacific States Marine Fisheries Commission (PSMFC) fieldwork

reports from 2015 and early 2016. The SSC was asked to comment on the integration plan and proposed catch estimation methods. There was no public testimony.

*Analysis to Integrate Electronic Monitoring into North Pacific Observer Program Discussion Paper*
The Council intends to integrate electronic monitoring (EM) tools into the North Pacific Groundfish and Halibut Observer Program (Observer Program) for vessels using fixed gear. As such, staff began preparing an analysis to integrate EM as a tool in the Observer Program. The discussion paper includes the Council's adopted purpose and need statement and alternatives, as well as a preliminary description of the components of an EM program, and was developed and refined by the EMWG. Further, the document highlights some questions that will be evaluated in the EM integration analysis, and provides the proposed timeline for this amendment action.

The SSC commends the EMWG for its efforts in developing an integration plan and putting forward a catch estimation process and notes that these both interact closely with the processes for the current Observer Program. The document provides an outline of steps to integrate EM into the Observer Program and the SSC looks forward to seeing additional detail in the initial review draft in October 2016.

Owing to the highly technical nature of EM and the associated requirements to develop, deploy and retrieve EM hardware, the integration process involves a suite of complex interactions between the agency, industry, and EM service providers. **The SSC is optimistic about the role of EM for catch estimation in the future but considers the EMWG's proposed implementation timeline to be extremely optimistic and is concerned that there may not be sufficient opportunity for review.**

Generally, the SSC notes that there are many suitable configurations that can lead to successful EM implementation and we encourage the EMWG to continue to consider the impacts of implementation approach on, 1) quality of scientific data products, 2) burden on vessels, and 3) impacts on the policy process. At this stage of development of the integration plan, it is clear that the EMWG is considering these things, but is still in the planning phase. We recommend that these aspects be addressed specifically in the future EM initial review.

No specific analyses of the alternatives were presented (only Alternative 2 was discussed). Moving forward for initial review, the SSC recommends that specific worked examples be used to demonstrate key decision points and associated impacts. Specifically, examples are needed that demonstrate the performance of a given level of sampling coverage and image quality on the quantification of frequently encountered and abundant species as well as rare and hard to identify species. This would provide a range of potential data products that bookend species of interest giving valuable perspective on associated processing time and costs.

The SSC reiterates the comments we made in February 2015 during our review of the Cooperative Research Plan for deploying EM systems on 13 vessels in the Gulf of Alaska. During that review, we acknowledged the importance of the Council's program goals and noted that EM technology appears to be capable of enumerating catches directly, but expected that a substantial amount of work would be required before a vetted EM catch accounting system would be operational. The SSC recommends that prior to implementation of EM, the Council clearly articulate quantifiable program goals for implementation such that appropriate EM coverage rates can be determined. Once quantifiable program goals are developed, the SSC recommended a time and motion study to assess efficiencies and inefficiencies of the program (e.g., estimate the time required to analyze the video and produce an estimate of catch and the associated uncertainty).

A key issue that needs to be addressed in the initial review analysis is ensuring that data are collected using reliable and verifiable methods. The overview in section 5 (Quality of monitoring data) provides metrics

for measuring data quality. However, this list is not inclusive of methods to verify information in the effort logbook, which is to be used for catch estimation. In situations where haul data is incomplete, video auditing of the effort logbook is likely required to verify the information needed for estimation at the haul-level under both a ratio and simple mean design-based scenarios. While the SSC looks forward to the evaluation of whether the length of the groundline is a reliable proxy for haul size, this approach likely has a number of problems as noted in the catch estimation analysis. **Unverifiable haul-size information poses a serious data quality issue for catch estimation.** Given that EM development is in the early stages, we encourage the EMWG to consider the development and use of a combined effort logbook and partial video audit method to validate the effort information.

The SSC finds the EM image analysis work to date by the PSMFC very informative (Alaska Track 1, 2015 and 2016). Importantly, the time-frame for the current workflow to produce catch estimates takes between 0.5 and 0.9 minutes of analysis time for each minute of observed fishing time, depending on the fishery being observed. Generally, halibut longline fishing review times were shorter and Pacific cod longline fishing review took longest. In addition, the 2015 Observer Annual Report stated that when image processing costs are included, the EM deployment and workflow costs as much as a human observer in the partial coverage category (Observer Program 2015 Annual Report, page 31). We also note that these costs did not appear to include the required image processing QA/QC costs. The SSC requests a thorough discussion of the costs of the program during the initial review analysis.

The SSC notes that previously the EM program was focused on vessels in the no-selection pool (<40ft, Jig), but in the Integration Analysis, emphasis is placed on >40 – 57 ft vessels. The SSC notes that EM may be an appropriate tool to gain some understanding of the catch and discards of this unobserved portion of the fixed gear fleet. The integration analysis emphasized 40-57.5 ft vessels and the analyst noted that they are bringing a few vessels <40 ft into the program. The initial review should explicitly consider this component of the fleet for future EM development and deployment given it is an important data gap.

*Catch Estimation Process for Electronic Monitoring*
In 2016, NMFS and the Council initiated pre-implementation of EM in the small boat (40-57.5 feet length overall) longline fleet, focusing on vessels that had trouble carrying an observer in the past. Along with the pre-implementation of EM onto vessels in 2016, NMFS is developing estimation methods so that data collected from those vessels can eventually be used in the NMFS Catch Accounting System (CAS) to generate catch, bycatch, and PSC estimates for the EM stratum.

The purpose of the Catch Estimation discussion paper was to describe the potential estimation methods and outline tradeoffs that NMFS is considering between the different estimation approaches. Once the estimation methods have been developed, the infrastructure needs to be put into place to move data from the video reviewers (currently occurring at PSMFC) to the Observer Program at the Alaska Fisheries Science Center and NMFS Alaska Region.

There are three sampling strata (small-vessel trip selection, large-vessel trip selection, and full coverage) in the sample design used by the Observer Program in 2015. Within each stratum, the sampling and associated catch, bycatch, and prohibited species catch (PSC) estimation are hierarchical. Catch, bycatch, and PSC estimation follows the sampling hierarchy by expanding sample data to the haul, haul data to the trip, and the trip data to the fishery within each stratum. Strata estimates are then combined to produce overall estimates. As with estimation based on observer data, the EM stratum methods will depend of the sample design used to collect the data and the estimation needs.

The SSC appreciates the analysts' efforts to explore and explain the term "design-based", which we recommend calling "simple random sampling" (SRS) estimator, and "ratio estimator". Put simply, the ratio estimator calculates the average per-haul rate of bycatch and PSC relative to total landed groundfish catch

and multiplies this by total catch over the trip to get estimate of trip-level bycatch and PSC. The SRS estimator takes the average bycatch and PSC per haul for a trip and multiplies this by the number of hauls on the trip to get trip-level bycatch and PSC. As the analysts correctly point out, these two approaches have different implicit assumptions and performances. The SRS estimator is unbiased if data are collected in an unbiased (e.g. randomized) fashion, but weights each sample unit (e.g. haul on a trip) equally such that each "haul" would contribute equally to the overall estimate, regardless of how much catch occurred. As such, estimates can suffer from higher variance than the ratio estimators. Ratio estimators take into account the size of the sample unit (hauls or trips) so that larger sample units (longer or larger hauls) contribute more to the overall estimate than smaller sample units. For example, the amount of discard per unit of haul-size (e.g. foot of groundline) is multiplied by the total size of the set (length of groundline). Ratio estimators can have lower variance if, 1) the size of hauls fished varies greatly, and 2) there is a relationship between the amount of discard and the size of the haul. However, in their scientific publication exploring these estimators (Cahalan et al. 2015) the analysts suggest the mean amount of catch per haul using the SRS estimator performed better in terms of bias and precision when scaling up haul level data to trips and/or fishery totals when a given species' catches were rare or at low percentages, as opposed to using the ratio estimator.

The SSC notes that the analysts had a clear preference for the ratio estimator, primarily due to the large variability in haul-level effort, and because currently the EM fleet is voluntary and as such does not provide a random sample of trips. The SSC pointed out that, while this makes sense statistically, the ratio estimator requires substantially more information than the SRS estimator, critical components of which may not be suitable to collection via EM. Specifically, catch estimates derived from EM observations need to be "weighted" by fishing effort (this assumes effort is correlated with catch) or by actual catch in weight. Attempts to determine effort (e.g. long line hooks, skate length) with EM imagery have not been successful to date, require substantially more image review time (increasing costs), and the degree to which these factors may be used to predict catch is poorly understood. In either situation, haul size must be recorded in a logbook. The analysts indicated they are conducting research to evaluate whether length of the groundline is a useful proxy for haul size. In addition, the analysts also pointed out that obtaining catch weight information at the haul-level requires using logbooks, which to date have not been validated. **The SSC recommends the analysts continue to explore these estimators and looks forward to further development and detail on their use and  tradeoffs in the upcoming initial review.**

For the following reasons the SSC suggests the analysts consider targeting data collection methods focused on validating logbook data as a requirement to developing data collection methods for implementing catch estimation. Consideration should be given to situations where audits would improve the catch estimation process, such as situations where statistical expansion is needed because EM captures only part of a haul. The SSC also notes having an electronic catcher vessel logbook would provide another source of verification on discards as well as some of the same information contained in the electronic effort logbook, without duplicating reporting requirements. This may also provide the necessary information to evaluate whether a ratio estimator using haul-specific catch total is appropriate.

Finally, the SSC noted the high failure rate of EM on the first trip. Further analysis evaluating methods to reduce this rate, how to address it in estimation, as well as the potential magnitude of the problem relative to the EM fleet should be included in the initial review document.

**D-3 Pacific cod Models**
We received a presentation from Grant Thompson (AFSC), who reviewed last year's assessment models, summarized recommendations from a recent CIE review of the EBS and AI Pacific cod assessments, and presented recommendations from the Joint Team Subcommittee (JTS).  As in previous years, the JTS met with the assessment author to recommend a suite of models to explore in this year's stock assessment. Public testimony was provided by Chad See and Gerry Merrigan (Freezer Longline Coalition).

The CIE review of EBS and AI Pacific cod assessments in spring 2016 resulted in a large number of specific recommendations from three reviewers, as summarized in Tables 1 and 2 in the JTS minutes. The JTS used a three-stage process to identify the highest priority recommendations for this year's Pacific cod stock assessments for the EBS and AI.

In addition to last year's base model, five model variants were recommended for further exploration in each of the two assessments. All of the proposed new models are versions of last year's model 15.6 for the EBS and model 15.7 for the AI. All of these models estimate catchability (Q) within the model rather than fixing it, which has been identified as a high priority by the Plan Team, the CIE reviewers, and the SSC. The author, Plan Team and the CIE reviewers selected these models (15.6 and 15.7) as the basis for further explorations in this year's assessment for the EBS and AI, respectively, and the SSC agrees with this choice.

Model 15.6 for the EBS is a variant of the alternative model (14.2) presented in December 2015 and had been under development by the author for several years to address a variety of issues. Major features that distinguish this model from the base model include (1) use of a greatly simplified fishery structure (a single fishery was defined instead of nine season-and-gear-specific fisheries), (2) use of a single season per year instead of 5, (3) internal estimation of natural mortality, (4) internal estimation of Q, and (5) a modified treatment of selectivity for the survey and the fishery, which are allowed to vary annually. In addition, the model includes a number of features deemed important by the author. Model 15.7 for the AI includes very similar features. To address CIE reviewer concerns, these models were simplified in several ways, including by not allowing time-varying selectivity and catchability.

Based on a strong CIE recommendation to use all available survey data, the JTS proposed three model variants that include Pacific cod data from the IPHC longline survey, from the NMFS longline survey, or from both surveys simultaneously. Other features of the proposed models included the use of empirical weight-at-age data, different data weightings and age-specific natural mortality in the EBS (e.g. Lorenzen formulation) and eliminating the earlier (pre-1994) time series data from the Aleutian Islands model.

The SSC accepts the JTS recommendations for models to bring forward in the 2016 assessment and has the following additional recommendations:
- The SSC agrees with CIE recommendations to use all reasonable data sources that are available, although the use of the longline survey data in the model has been attempted in the past with little success. As the author noted, survey indices were generally negatively correlated with model-estimated biomass in past assessments. The use of 'extra SD' in the proposed models for both regions is a reasonable approach to deal with this issue.
- The SSC encourages the use of empirical weight-at-age data in some of the model variants, but notes that this requires precise aging data.
- The SSC encourages the author to conduct a retrospective analysis across historically used models in addition to the standard retrospective analysis using the current model.
- The SSC encourages further work (outside the model) to examine potential causes for the apparent dome-shaped selectivity in most models. Research on these older 'missing' fish could include analysis of existing northern Bering Sea survey data, as noted in last December's minutes, and an analysis of slope survey data to examine if older fish descend to deeper waters as suggested in public testimony.
- Regarding the process for model vetting, the SSC recommends that the JTS continue to meet in the spring to discuss and select Pacific cod models for the upcoming assessment cycle to help the author identify the highest priorities for model exploration. However, we see no compelling need for the SSC to continue to review the proposed suite of models selected by the JTS.

- The SSC shares the JTS concerns that the BSAI Team currently includes only two members who conduct age-structured stock assessments. At least one stock assessment scientist, Alan Hicks from the IPHC, will likely join the team, but the SSC agrees that additional assessment scientists need to be identified and invited to join the BSAI Plan Team.

In addition to these recommendations, the SSC had a general discussion applicable to all assessments about ways to better deal with model uncertainty. Clearly, the quest for one best model ignores much of the uncertainty in stock dynamics, as is readily apparent in the Pacific Cod assessments. Therefore, the SSC suggests that ensemble modeling approaches or model averaging should be explored to account for considerable model uncertainty in stock assessments. While the SSC has made similar recommendations in the past, there has been considerable research progress on this issue is recent years. Therefore, the time may be right for a workshop at our February 2017 meeting on how to select and weight models for ensemble modeling and how to use an ensemble approach with our current harvest control rules.

**NMFS Climate Science Strategy**
The SSC received an update from Anne Hollowed (NMFS-AFSC) on the Alaska Regional Action Plan for Southeastern Bering Sea Climate Science. The SSC provided input on an earlier version of the document in February. We appreciate the responsiveness of the writing team to these comments, which were addressed in detail throughout the document and in a separate section that summarized the response to each comment. The resulting document is much improved and more comprehensive in its treatment of ongoing and planned work relating to climate change.

The SSC offers a few additional suggestions that the writing team may consider before the document is finalized:
- *Human communities*: One aspect of the Action Plan that could benefit from some additional discussion is the evaluation of climate change impacts on human communities. The SSC realizes that weaknesses in the relevant sections largely reflects the relative lack of resources to address socio-economic considerations compared to bio-physical data collection and analytical capabilities.
  - With regard to research and data needs, we suggest that the document could highlight the need for a structure or framework that can position NOAA to better evaluate community impacts from climate change (as well as from any proposed regulatory changes as discussed elsewhere in our minutes). While there is some discussion of modeling needs to address these issues, there is no or little discussion of data collection and field research in the affected communities and of the resources needed to do so. It is not clear from the document if level funding includes data collection programs to support the proposed research and modeling (for example updating community profiles). The document includes a row in the summary table to "Expand research to understand climate change effects on human communities" but it lacks any specifics (p. 44).
  - With regard to Coordination and Communication the document highlights the need to 'Improve communication of the risks of climate change to fishing dependent communities'. However, the clear emphasis in this section is on disseminating information to stakeholders (a one-way street), rather than a dialogue between NOAA and fishery-dependent communities. It is not clear if and how NOAA Fisheries intends to invest in capacity to coordinate effectively with and to get meaningful input from coastal communities on research, harvest, and management responses to climate change. Moreover, the paragraph on training, education & outreach focuses on interdisciplinary training but does not extend to the need for training in the social sciences.
- *Mitigation*: The document includes a brief discussion (p. 15/16) on the potential for climate change to result in local extirpation of some species. We suggest that this section should distinguish between target species and non-target species. Mitigation measures for target species (e.g. snow crab) could be analyzed in the context of existing or modified harvest control rules, which may be sufficiently precautionary to ramp down F at low levels of abundance to slow down potential

declines. However, possible declines in non-target species such as forage fish will require other mitigation approaches.

- *Collaborations and partners:* The Climate Strategy document overall seems to downplay the importance of contributions and collaborations on climate research in the Bering Sea. While a section near the end lists many of the collaborators outside NOAA, it would be good to stress the importance of these collaborations throughout the document.
- *National context*: The presentation included some broader context for addressing climate change issues within NOAA fisheries, in particular the link to ecosystem-based management. It would be useful to provide the broader context within the document to clarify if and how this Action Plan is linked to national efforts and to climate change strategies in other regions.
- *Prioritization*: The SSC previously discussed the need for prioritization. The document acknowledges this need but does not yet provide a real strategy for balancing monitoring, process studies, laboratory studies and modeling. This will be challenging and perhaps the document could provide some guidance on how it could be accomplished.
- *Coordination of climate change efforts*: There are a large numbers of programs and people across the AFSC and PMEL who directly or indirectly deal with climate issues. This document is a great start to identifying an overall climate strategy for NOAA Fisheries, but there may also need to be some more centralized coordination and structure for these efforts to provide a strong voice for climate change issues in upper management to ensure that the program gets the resources it needs.
- *Management options*: Fisheries management in the Bering Sea has become fairly rigid as fisheries have become rationalized and bycatch is tightly regulated through PSC limits, MRAs, etc., which limits viable options for alternative approaches. The document could highlight the need to invest some resources into exploring reasonable alternatives to the current management paradigm in order to maintain greater flexibility in the face of climate change.