# North Pacific Fishery Management Council

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**Certified:_____**
**Date:_____**

**REPORT**
**of the**
**SCIENTIFIC AND STATISTICAL COMMITTEE**
**to the**
**NORTH PACIFIC FISHERY MANAGEMENT COUNCIL**
**June 6th – June 8th, 2011**

The SSC met from June 6th through June 8th, 2011 at Pioneer Hall, Igloo number 1, Nome Alaska.

Members present were:

| | | |
|---|---|---|
| Pat Livingston, Chair | Farron Wallace, Vice Chair | Jennifer Burns |
| *NOAA Fisheries—AFSC* | *Wash. Dept. of Fish and Wildlife* | *University of Alaska Anchorage* |
| Robert Clark | Susan Hilber | Anne Hollowed |
| *Alaska Department of Fish and Game* | *Oregon Dept. of Fish and Wildlife* | *NOAA Fisheries—AFSC* |
| Gordon Kruse | Kathy Kuletz | George Hunt |
| *University of Alaska Fairbanks* | *US Fish and Wildlife Service* | *University of Washington* |
| Seth Macinko | Jim Murphy | Franz Mueter |
| *University of Rhode Island* | *University of Alaska Anchorage* | *University of Alaska Fairbanks* |
| Lew Queirolo | Kate Reedy-Maschner | Ray Webster |
| *NOAA Fisheries—Alaska Region* | *Idaho State University, Pocatello* | *International Halibut Commisson* |
| Terry Quinn | Doug Woodby | |
| *University of Alaska Fairbanks* | *Alaska Department of Fish and Game* | |

**B-1 Plan Team Nomination**

In a previous meeting, the SSC discussed the lack of Crab Plan Team (CPT) members with quantitative stock assessment experience and recommended that the Council consider adding an additional member to the CPT to fill this void. The SSC appreciates that this request has been fulfilled with the nomination of Steve Martell, University of British Columbia. Steve has extensive experience with length-based stock assessments and recently chaired the crab modeling workshop and is well-qualified in this regard. **The SSC recommends that the Council approve his appointment to the Crab Plan Team.**

**C-1 Halibut Catch sharing plan**

Rachel Baker (NMFS-AKR) and Jane DiCosimo (NPFMC) provided background information and context for the agenda item. Scott Meyer (ADFG) presented a description of three proposed algorithms for selecting the maximum size limit for the halibut charter fishery in Regulatory Areas 2C and 3A. Susie Daniels, a charter owner from Gustavus, gave public testimony.

Previously, two methods labeled A and B had been examined, and Scott introduced a third, hybrid approach (Method C). This method calculates a maximum size limit using creel survey length frequency data from the previous year, with all lengths above a potential limit replaced with lengths equal to that potential limit, as a surrogate for the length frequency distribution. Given a specified maximum catch limit in weight, and the standard length-weight relationship, the maximum size limit to achieve this maximum catch can be found. **The SSC views hybrid Method C as an improvement for selecting the maximum size limit.** We agree with the analyst that this approach is somewhat conservative, without being exceedingly so for large size limits, as is the case with Method B.

The SSC also recommends continued investigation of the usefulness of IPHC setline survey data for when there are gaps in the length frequency data from ADFG creel surveys. We also suggest a sensitivity analysis be conducted to determine the effect on the size limit of unsampled catch having larger or smaller lengths than fish from sampled catch.

There was some discussion regarding the fixing of size limits for a few years so that data on changes in the length distribution in response to management could be collected, and to provide stability for the charter industry. Council staff explained that the Catch Sharing Plan does not give the Council the flexibility to do this, as that would require an annual action which the plan seeks to avoid. The SSC cautions that the present approach, even given the improved hybrid option, is likely to be highly destabilizing to the charter industry because of the uncertainty it imposes on their business operations. The SSC views the current approach as just one of many alternatives that could be considered and there may be other approaches to charter management that would offer more stability in regulations on the industry.

**C-2 BSAI Crab Draft SAFE report**

At this meeting, the SSC is providing the OFL/ABC recommendations for four crab stocks (Table 1) and modeling advice for all stocks. Diana Stram (NPFMC) and Jack Turnock (AFSC) presented Crab Plan Team (CPT) recommendations for these four stocks and information for all stocks discussed during the May CPT meeting.

Norton Sound Red King Crab
Eric Osborn (Commercial Fisher) and Charlie Lean (Norton Sound Economic Development Corporation) provided public testimony.

The SSC reviewed the 2011 stock assessment, which was an updated version of the length-based model presented in the 2010 SAFE. The assessment included new information from the 2011 winter pot survey, the 2010 summer commercial fishery, the 2010/11 winter commercial and subsistence catches and 2010 abundance and size class proportions from the 2010 NOAA trawl survey. The SSC noted that the 2010 NMFS survey used a 20x20 nmi2 grid rather than the 10x10 nmi2 used in all other surveys. The SSC requests that the author examines the potential impact of this shift in grid size on the 2010 abundance estimate.

**The SSC agrees with the CPT and the author's recommendations that the assessment model (Model 6) output should be used as the basis for estimating biological reference points for the 2011/12 season.** The biomass trends have been increasing in recent years, and recruitment has been modest in recent years.

In response to previous SSC comments, the authors provided a rationale for why larger (>123 mm) crab would have a higher natural mortality rate. The authors reported that the assumption was included to

improve the fit to the summer trawl survey length frequency data. It was noted that the mechanisms for the accelerated decline in large crab are unknown. Given that the processes underlying the drop in large crab remain uncertain, the SSC continues to recommend, for purposes of estimating the OFL that an M of 0.18 continue to be used as a proxy for FOFL. The BMSY proxy was based on average model-estimated legal male biomass for the period 1983-2011. **The author estimated the OFL to be 0.655 million lbs and the SSC accepts this estimate for 2011/12.** The SSC recognizes that this advice is conservative because the proxy for BMSY is based on legal male biomass rather than mature male biomass, and an FOFL of 0.18 is lower than the average value of natural mortality, because the model assumes a higher natural mortality rate for larger crabs. This conservatism is justified given the uncertainty in model parameterization.

Retrospective analysis showed that since 1989, the model over-estimated biomass. This is a warning flag that the assumed processes in the model are not stationary. The presence and implications of a retrospective pattern is a source of uncertainty in the assessment. The CPT attempted to correct for this pattern of retrospective bias by calculating the linear relationship between the retrospective predicted estimate 2000 through 2008 and the hindcast estimate during the same period. The SSC did not accept this ad-hoc adjustment for the retrospective pattern, because opinions differ within the scientific community on whether correcting for retrospective bias is appropriate and if a correction is applied, what methods should be used. Clearly there is a need to develop guidance on when and how assessment authors should account for retrospective bias in assessment models. Instead the authors should look for the cause of the retrospective pattern, which may be due to time variation in certain population parameters (e.g., natural mortality, selectivity)

The SSC recognizes that under the Council's recommended P* of 0.49 and no adjustment to max ABC for the term sigma-b for other sources of uncertainty, that the maximum permissible ABC (0.65 million lbs.) would be nearly identical to the OFL (0.66 million lbs.). We caution that this estimate does not reflect the scientific uncertainty in model parameterization evidenced by the strong retrospective pattern or the issues regarding natural mortality for large crabs. This assessment is an example where the SSC would have preferred to incorporate a sigma-b adjustment to quantify additional uncertainty or apply a buffer between ABC and OFL. To avoid this situation in the future, the SSC requests that the authors include estimates of ABC under different levels of sigma-b or using buffers for data poor stocks (e.g., 10% as for Tier 5 under the Crab FMP or 25% under Tiers 5 and 6 for groundfish) to better justify the rational for selecting an ABC below the maximum.

**For 2011/12, the SSC recommends an ABC of 0.59 million lbs. This ABC is based on a buffer of 10% to account for scientific uncertainty in the assessment.** The SSC continues to encourage the authors to work on the assessment model with a long-term goal of moving this stock to Tier 3. We agree with the CPT recommendation that this stock assessment would be a good candidate for a review during the modeling workshop planned for January 2012.

Adak Red King Crab

The SSC reviewed the 2011 draft SAFE chapter for Adak red king crab. There is no assessment model for this stock. The fishery has had limited openings since 1995/96 and was closed for the 2010/11 season. The CPT recommended and the SSC agrees that this stock should be managed as a Tier 5 stock. The SSC agrees that the OFL should be estimated as average total catch, using the same base period recommended last year (1995/96-2007/08). Based on this designation, the SSC recommends that the OFL for 2011/12 be set at 123,867 lbs (OFL = 120,000 lbs.).

The assessment author estimated the maximum permissible ABC based on the 10% tier-5 buffer ((1-0.1)* 123,867 lbs) to be 0.111 million lbs. The CPT recommended that the directed fishery remain closed and that the ABC should be set at the maximum level of bycatch observed during the reference period 1995/96-2007/08. The CPT based their recommendation on the following findings: (1) the stock declined

to low stock sizes in the mid 1970s and has remained at a low level, (2) the last ADF&G Industry Survey was in 2002 and it provided no evidence of populations of sufficient size to support a directed fishery, (3) in 2006 a pot survey was conducted and it provided no evidence of recruitment, (4) in 2009 the trawl survey of Petrel Bank found a small aging population with no expected recruitment, and (5) ADF&G approved a test fishery in 2009 and this yielded a single mature male crab. Collectively, these data suggest that the stock is well below historical levels and remains at a very low stock size. The SSC also noted that the Adak RKC stock is distributed around islands in isolated pockets. Only a few genetic samples have been collected, so information about potential interchange between subareas is unknown.

The SSC agrees that the directed fishery should remain closed. The SSC did not accept the CPT's rationale for addressing bycatch needs in other crab and groundfish fisheries. The SSC agrees that the Council should include an allowance for incidental capture of Adak RKC in non-directed fisheries. Review of the time series of bycatch shows an allowance based on the mean bycatch for the period 1995/96-2007/08 should be sufficient. **Therefore, the SSC recommends an ABC of 270,000 lbs. in 2011/12.**
The SSC continues to be concerned about the paucity of data for the Adak red king crab stock. A survey to confirm stock status, sex ratios and size frequencies is needed for this stock.

Aleutian Islands Golden King Crab
There are no biomass estimates available for this stock, as there is no accepted stock assessment model or comprehensive annual surveys. Triennial surveys cover only a small portion of this stock. A stock assessment model is under development and the Crab Plan Team reviewed the current status of this model at their May 2011 meeting. The SSC was provided a summary of the team's comments and recommendations for further model improvements. Although the SSC did not receive a presentation of the model during its June meeting, the team's comments seem reasonable. Their comments included considerations of apparent data conflicts, dome-shaped selectivity, and the desire to simplify the model. The Crab Plan Team is scheduled to review the next version of the model at its September 2011 meeting. The SSC requests a presentation on the assessment model at its October meeting. **Given the importance Aleutian Islands golden king crab fishery, the development of an accepted stock assessment model is a high priority.**

Given the absence of biomass estimates, the Aleutian Islands golden king crab fishery is managed as a tier 5 stock. In 2010, the SSC recommended an approach to estimate OFL based on the average annual ratio of bycatch mortality to retained catch during 1990/91-2008/09 (excluding 1993/94-1994/95 owing to insufficient data), average annual retained catch over 1985/86-1995/96, and average annual rate of bycatch mortality in groundfish fisheries over 1993/94-2008/09. For the current stock assessment, the assessment author recommends using this same approach, but using updated data, including data on historical bycatch that were not available for last year's assessment. The ABC is calculated using a 10% buffer on OFL.

**Based on this approach, the SSC recommends following the advice of the assessment author and Crab Plan Team to manage this fishery with a total catch OFL of 11.40 million pounds and ABC of 10.26 million pounds for 2011/2012.**

Pribilof Islands Golden King Crab
Historically, the Pribilof Islands golden king crab fishery has supported small and sporadic fisheries. There was no fishing effort between 2006 and 2009 and only one vessel fished in 2010, as well as in 2011 to date. Biomass estimates are not available, so this stock is managed using tier 5. In last year's assessment, the total catch OFL was estimated by a simple conversion equation based on retained catch. This year, the author updated data on catch and bycatch, corrected data errors, and added data on bycatch in non-directed crab fisheries. These additions allowed the author to apply an approach analogous to that used for Aleutian Islands golden king crab. Specifically, the author recommended calculating OFL using

the average annual ratio of bycatch mortality to retained catch between 2001 and 2010, average annual retained catch from 1993 through 1998, average annual bycatch mortality in non-directed crab fisheries during 1994-1998, and the average annual rate of bycatch mortality in groundfish fisheries over 1992/93-1998/99.

**Based on this approach, the SSC recommends following the advice of the assessment author and Crab Plan Team to manage this fishery with a total catch OFL of 0.20 million pounds and ABC (using the 10% buffer for tier-5 stocks) of 180,000 lbs for 2011/2012.**

In making this recommendation, the SSC notes that 6 years of data are very few years upon which to base these catch specifications. Therefore, the SSC encourages the assessment author to explore alternative approaches to estimate OFL. Outer continental shelf surveys have been conducted in 2002, 2004, and 2008. In September 2010, the Crab Plan Team encouraged including this slope survey into an assessment for possible upgrade to Tier 4. In this year's assessment, the author indicates that the survey data should be explored for their utility to provide reliable estimates of biomass for the Pribilof District. Considerations include the distribution of the survey with respect to stock distribution, as well as estimation of survey catchability by sex and size. The SSC looks forward to results of this examination in the future.

St. Matthew Island Blue King Crab

The St. Matthew Island blue king crab fishery has been managed under tier 4 based on a stock assessment using a four-stage catch-survey analysis (CSA). In June 2010, the SSC discussed difficulties of the model to duplicate the large proportion of recruits in the pot surveys. Other issues with the model have since emerged and were discussed during the crab modeling workshop held in Seattle in February 2011. In their report, the Crab Plan Team provided additional guidance to the author. The model and its code are currently being revised to address these problems, and a simpler three-stage version is also being developed as an alternative. As a precaution against the possibility that the Crab Plan Team does not approve the CSA model for use this year, in the SSC's March 2011 meeting report the author was advised to estimate biological reference points based on survey biomass or some other index of abundance. The April 2011 draft assessment for St. Matthew Island blue king crab contains such a proposed fall-back procedures for use in managing the fishery in 2012. Given the issues with the assessment model, the SSC wishes to receive a presentation on modeling efforts for St. Matthew Island blue king crab at the October 2011 meeting at which time OFL and ABC recommendations will be made.

Pribilof Island Red and Blue king crab

**The SSC endorses the Crab Plan Team recommendation to use a 3 year moving average to estimate mature male biomass in the current year.** We continue to look forward to seeing stock assessment models for these stocks, once the models are sufficiently developed for our review.

**With respect to PIBKC rebuilding, the SSC requests a presentation at our next meeting on the proposed use of bycatch data sources.**

Bristol Bay Red King Crab

Jie Zheng and Shareef Siddeek (ADF&G) developed 11 model scenarios this year. The issues examined included estimating initial year proportions, use of re-tow data, sample size for size composition, estimating catchability for the NMFS survey, inclusion of the BSFRF data, time-varying M, and time-varying molt probabilities.

The Plan Team made several suggestions to improve document clarity and recommended reevaluating the treatment of the BSFRF data by including length data and data for females. The Team also requested two additional scenarios: (1) a scenario combining (1a) with (7), and (2) a scenario combining (1c) with (7).

The Team also developed 4 possible time periods for the baseline for calculating reference biomass. The SSC concurs with these recommendations.

EBS Snow crab

The SSC received an update on the current status of the snow crab model, which has undergone substantial changes since September 2010. Four models were explored including the September 2010 model that estimates mature male mortality, models estimating immature M with either a logistic or smooth selectivity function, and a model keeping all mortality rates (immature, mature males, mature females) constant at M=0.23 and fixed growth parameters. All other models estimated growth within the model as in September 2010, which greatly improved residual patterns. The SSC agrees that model formulations, which estimate growth within the model is most appropriate. All models also incorporate the BSFRF data and estimate survey selectivity within the model as endorsed by the SSC in April 2011. While the SSC noted some concern that there is still considerable discrepancy between the selectivity curve estimated by Somerton, as presented to the SSC in December 2010, and the model-based estimates of selectivity, the model takes into account both the 2009 and 2010 survey and the estimated selectivity may reflect a trade-off between somewhat conflicting trends in the 2009 and 2010 data.

The CPT requested six models for the September 2011 assessment that focus on exploring two selectivity options (logistic and smooth selectivities) and three mortality scenarios in a factorial design. **The SSC concurs with these recommendations and encourages the authors to clearly lay out the consequences of incremental changes to the base model in the September 2011 assessment.**

The SSC re-iterates requests from previous minutes for the authors and the plan team, and other survey specialists to consider for future assessments:

- Development of a spatial model for snow crab
- Evaluation of the weights that are used for different likelihood components and the effective sample size for the multinomial likelihood to increase consistency with how likelihood components are weighted in other assessments (both crab and groundfish) and to provide a better rationale for the values used.
- Development of a logical scheme to combine data from the 2009 and 2010 trawl experiments to better understand the factors affecting selectivity.

EBS Tanner Crab

Authors Lou Rugolo (AFSC) and Jack Turnock (AFSC) developed a draft assessment (presented by Turnock) in which they attempted to respond to changes suggested by the Crab Plan Team and SSC during 2010, as well as from the February 2011 Crab Workshop and the April 2011 SSC meeting. The Plan Team was encouraged by the changes and felt that progress was being made, although the model is not yet ready for use in the stock assessment (the strategy is to continue making improvements and evaluate it for assessment purposes in May 2012). Following a recommendation from the crab workshop, the years 1969 through 1974 were not used for data quality reasons. This means that the period 1974 through 1980 is now the period used for determining reference biomass; given the shortness of this period, the SSC recommends strongly that this time period be evaluated, which the authors intend to do.

The main issues that have arisen in past reviews were discussed:

1. Hybrids: Previous reviews were concerned that misidentification of hybrids might have degraded data quality. However only 1 hybrid has been seen in the survey in the last 8 years, probably because of their size. Therefore, the authors did not think this is a big issue in recent years.
2. Early bycatch data in groundfish fishery. Specifically, why is bycatch estimated to be so high in 1973/74 and 1974/75? Concerns were raised about mis-identification of snow crabs in previous SSC comments. This is being looked into.
3. Patterns in survey length frequency. See model scenarios below.
4. Lack of fit to survey biomass between 1983 and 1987. See model scenarios below.

The following model scenarios were decided at the Crab Plan Team meeting:

1. Estimate survey catchability, Q, to see if this improves survey biomass fit in mid 1980s.
2. Include the underbag data.
3. Estimate growth and natural mortality with priors (especially important since growth data is borrowed from Kodiak)
4. Try different selectivity periods based on fishery changes.
5. Try dynamic initial biomass estimation.

The SSC agrees with this plan of action.

The Crab Plan Team would like to use the Tanner crab model for population projections despite its lack of approval of the model as an assessment model. The SSC urges caution in proceeding in this direction. It is usually more appropriate that a model is accepted for assessment and then used for the projection (unless an alternative approach was used for projection, such as time series modeling). The Team requested the authors to go ahead with the rebuilding model for evaluation in September, if it can be used to produce plausible results. Rebuilding scenarios would include no catch, bycatch only, different percentages of $F_{35\%}$, and the ADF&G GHL rule. Recruitment scenarios could include random, a spawner-recruit (SR) model, an SR model with autocorrelation, an SR model with periodic behavior, and others. The SSC will review these scenarios and the performance of the model in September, 2011.

Crab Modeling Workshop

The Crab Plan Team reported that they recommended conducting a 5-day workshop on crab modeling, tentatively scheduled for January 9-13, 2012. The team prioritized Aleutian Islands golden king crab and eastern Bering Sea Tanner crab model review for this workshop. They also proposed that, if the Tanner crab model is near completion in September, then Norton Sound red king crab should be the next highest priority. The SSC agrees with this prioritization, but also recommends that consideration be given to St. Matthew blue king crab. The SSC notes that there is some possibility that the Aleutian Islands golden king crab model may be much farther developed by September and also that development of two other assessment models, Pribilof Island red and blue king crab, are on hold pending completion of the model for St. Matthew blue king crab.

Straw proposal for establishing criteria in estimating Bref

The SSC appreciates the CPTs response to our request for establishing criteria for estimating BREF. The SSC acknowledges that the data available to conduct the analysis will differ between stocks. The SSC notes that the desire is to establish similar criteria across stocks with common data knowing that the criteria may result in the selection of different time periods between stocks.

The SSC agrees that the timing of a 'regime shift' may differ from a 'productivity shift' because of delays in shifts in key processes (such as predation) resulting from a change in the environment. The SSC agrees that most of the metrics proposed could be used to assess shifts in BMSY. However, the proposal to attempt to reconstruct the stock size for Tier 4 stocks by estimating the biomass if fishing had been set at FMSY, is not correct. The observed survey biomass is a realization of a fished population, thus, the reconstructed stock size under FMSY would be an underestimate of the stock size.

Table 1. SSC OFL and ABC recommendations for four crab stocks June 8th, 2011. Bold indicates where SSC recommendations differ from Crab Plan Team recommendations. (Note diagonal fill indicated parameters not applicable for that tier level while shaded sections are to be filled out for the final SAFE in September 2011)

| Chapter | Stock | Tier | Status (a,b,c) | $F_{OFL}$ | $B_{MSY}$ or $B_{MSYproxy}$ | Years[1] (biomass or catch) | 2011[2] [3] MMB | 2011 MMB / $MMB_{MSY}$ | γ | Mortality (M) | 2011/12 OFL mill lb | 2011/12 ABC mill lb |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | EBS snow crab | 3 | | | | | | | | | | |
| 2 | BB red king crab | 3 | | | | | | | | | | |
| 3 | EBS Tanner crab | 4 | | | | | | | | | | |
| 4 | Pribilof Islands red king crab | 4 | | | | | | | | | | |
| 5 | Pribilof Islands blue king crab | 4 | | | | | | | | | | |
| 6 | St. Matthew Island blue king crab | 4 | | | | | | | | | | |
| 7 | Norton Sound red king crab | 4 | a | 0.18 | 2.49 | 1983-current [model estimate] | 4.70 | 1.9 | 1.0 | 0.18 | 0.66 | **0.59** |
| 8 | AI golden king crab | 5 | | | | See intro chapter | | | | | 11.40 | 10.26 |
| 9 | Pribilof Island golden king crab | 5 | | | | See intro chapter | | | | | 0.20 | 0.18 |
| 10 | Adak red king crab | 5 | | | | 1995/96–2007/08 | | | | | 0.12 | **0.03** |

[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 2/15/2012 at time of mating.
[3] Model mature biomass on 7/1/2011

**C-3 (b) Northern Bering Sea Research Plan report**

The Northern Bering Sea Research Area (NBSRA) Report was presented by Diana Evans (NPFMC) and Cynthia Yeong (NMFS-AFSC). Public testimony was presented by Charles Degnan (resident of Unalakleet), Dorothy Childers (Alaska Marine Conservation Council), Fred Phillip (member, Bering Sea Elders Group), Muriel Morse (Alaska Marine Conservation Council and member, Bering Sea Elders Group), John Gauvin (Alaska Seafood Cooperative), and Eric Osborne (fisherman, resident of Nome).

The SSC was provided with an oral presentation and written report. An excellent oral presentation provided a brief background to the NBSRA, overview of a northern Bering Sea survey conducted in 2010 including mapped distributions of key groundfish and crab species, geographic distributions of some fish and crab species relative to the cold pool, very brief review of chronic versus acute approaches to studying trawling effects, and an overview of the proposed paired design of a before-after-control-impact (BACI) study proposed to be conducted in the northern Bering Sea. The written document mainly focused on the proposed BACI study with the addition of a brief description of chronic and acute trawl impact studies conducted by the AFSC's TRAWLEX project in the southeastern Bering Sea.

The SSC last reviewed the NBSRA Research Plan in June 2009. At that time, the document was a draft outline and the SSC made several recommendations, including the following: (1) "Areas utilized by marine mammals, seabirds, crab, listed species, and subsistence resources and users should be mapped. These data should be compiled and integrated, either as part of component 1 of the new research plan, or as a new separate mapping and retrospective analysis component"; (2) "… the plan should more fully explain how it will integrate linkages to upper trophic levels, including eiders, whales, walrus, and subsistence resources. In addition, the impetus for the NBSRA study plan is the potential redistribution of fisheries due to climate change…"

The stated goal of the research plan is to investigate the effects of bottom trawling on bottom habitats and provide information to the Council in protecting crabs, marine mammals, endangered species, and subsistence needs. However, the plan only focuses on the first part of this goal (bottom trawling effects) and fails to provide information on crabs, marine mammals, endangered species and subsistence. Rather than being a comprehensive research plan to address the stated goal, the document is a narrowly focused trawl impact experiment. In addition, the description of the trawling effects study lacks sufficient scientific and technical detail to be evaluated. When the SSC first reviewed the NBSRA Research Plan in June 2009, it was noted that the document was at the early stage of development in draft outline form. This current version is still largely in outline form and still focuses on the trawling effects study. Given the vague description of the trawling effects study and the lack of important information on other important parts of the overall research plan, the current schedule is extremely ambitious. The Council is scheduled to review the plan in December 2011 and the plan is scheduled to be finalized in April 2012.

The SSC had many questions and discussions about the research plan. Owing to many concerns and unresolved issues, it was difficult for the SSC to provide technical scientific review of this incomplete document. On this basis, the SSC offers the following advice.

The research plan lacks a set of hypotheses to be tested. In addition, the plan fails to provide background information on the northern Bering Sea ecosystem including the importance of benthic energy flow in this

region, literature review of the biota living in the area and their habitats (e.g., sediments) including life history of species potentially affected by trawling impacts and their ability to recover from disturbance (i.e., are these slow-growing, long-lived species that are very vulnerable to long-term effects?), and a review of previous trawling effects studies. The background should address what birds and marine mammals are present in the areas under consideration, and what components of their food base may be compromised by trawling. Many previous studies and reviews (e.g., NRC 2002 cited in the plan) have found common effects of trawling on habitat complexity, species diversity, and species' biomass. This background information is critical, not only to the design of a trawling effects study, but also to assess the risks associated with bottom trawling in this area. The literature cited in the document on trawling effects is very limited and Alaska centric. Among many others, the SSC calls the following study to the attention of the authors: Collie, J.S., S.J. Hall, M.J. Kaiser, and I.R. Poiner. 2000. A quantitative analysis of fishing impacts on shelf-sea benthos. J. Anim. Ecol. 69(5): 785–798. This meta-analysis provides insights into the magnitude of mean effects of trawling with respect to such things as gear type and taxa and recovery rates by sediment type. Coupled to distributional maps of biota and sediments, these expected effects may provide information on areas most sensitive to trawling in the area of consideration. Of note, mud sediments, which occur in the NBSRA, are among the most sensitive to disturbance by bottom trawls. In mud habitats, subtle features (ripples, worm tubes) provide oxygenation of upper sediments needed to support aerobic infauna communities and suspension and re-settlement of sediments are additional effects to evaluate in a trawl impact study.

There is no evidence in the plan of incorporation of information collected during the community and science workshops, aside from the brief minutes of the science workshop that appear as an appendix. Residents of coastal communities have critical knowledge to be incorporated into the research plan. The SSC received a draft report, titled "The Northern Bering Sea: Our Way of Life", prepared by the Bering Sea Elders Advisory Group. Though still in draft, this document contains extremely useful information including detailed maps of important areas for walrus, seals, whales, subsistence uses, etc.

On page 8 of the document (note, page numbers need to be fixed), it is stated that "It is very important to identify the species of particular interest at the beginning of the experimental design effort." However, the current plan makes no consideration of the species of particular interest or their geographic distribution. Given the benthic dependencies of the focal species, the benthic invertebrate (and fish) prey of walrus, seals, whales, seabirds, crabs, and other focal species must be considered in the design of trawling effects studies. In this regard, the SSC's previous request for mapping is critical.

The plan states "study design needs to account for seasonal and decadal signals", but it is not clear from the document how this will be done. Yet, without such considerations, conclusions from the study could be irrelevant or incorrect as the system changes in the future. The research plan must address all aspects in the Council's stated goal. In addition to an investigation of the effects of bottom trawling on bottom habitats, the plan needs to provide information to the Council in protecting crabs, marine mammals, endangered species, and subsistence needs.

The experimental design of the proposed trawl impact study must address the stated hypotheses. Once the groundwork is completed to identify the focal species (prey in common with crabs, mammals, and birds), the experimental design parameters must be specified in much more detail. The statistical methods to test the hypotheses must be provided. The design must articulate the metrics (biomass, abundance, body size,

habitat forming invertebrates, etc.) to be measured. Many other technical details need attention. For example, the plan indicates that van Veen grabs will be used to sample infauna, yet the January workshop report indicates that the prey of walrus dwell at depths too deep to be sampled by this gear. The utility of low-impact sampling methods, such as submersible or ROVs, should be considered and discussed (this was also recommended in the June 2009 SSC review). Other researchers in the region (e.g., Jim Lovvorn) have used low impact gears with success. Such methods would reduce the environmental impacts of the research.

The design should include the specific sites and species to be studied and the basis for their selection. The draft plan indicates that sites critical to managed species and subsistence will be considered for inclusion, but these will be excluded if harmful to the subjects. Such a statement provides no guidance on site selection. The document also indicates that established benthic research stations from scientific programs will be avoided, if possible. It would be tragic if long-term monitoring sites, such as those studied by Jackie Grebmeier, were compromised by the proposed research.

The study should evaluate both the direct and indirect effects of trawling. Indirect effects may include effects of re-suspended sediments on filter feeders, altered predator-prey relationships (e.g., does trawling promote feeding opportunities by predators?), and others. Ecosystem-level impacts are the crux of the issue concerning potential bottom trawling in the northern Bering Sea. However, the document makes mention of ecologic studies in only one sentence. The plan, as outlined, appears to only address some of the short-term direct effects and fails to address their interpretation and significance to the ecosystem. While the current document focuses on a 'doable' task (trawl impact study), the ecosystem considerations, such as impacts on the food web and protected species, are too critical in this region to defer to some unfunded, follow-up study. Study of these impacts must be built into the overall plan. Success in this regard will depend on collaboration with partners, such as USFWS, NPRB, NSF, UAF, UW, etc. The plan fails to articulate a monitoring plan to document recovery rates. Recovery rates are shorter in well-sorted, sandy sediments and longer in low-energy, muddy bottoms.

The SSC has fundamental questions about the ability to draw correct conclusions about the effects of a prospective trawl fishery from a small-scale, one-time research experiment. A good example of this problem appears in the draft plan itself. An acute trawl impact study was reported for the southeastern Bering Sea in which four passes of a research trawl in six pairs of experimental and control corridors were evaluated and virtually no statistically significant effects were found. However, a chronic effects study in the same area, which took advantage of areas closed to trawling and adjacent high trawling areas, revealed that the benthos in the highly trawled area was less diverse, dominated by sea stars (in some systems, sea stars are keystone species that restructure ecosystems), had less emergent epifauna, less biogenic substrate, and reduced structural complexity. Results from this chronic trawling effects study are consistent with many other trawling effects studies worldwide. Given this, the SSC is very concerned to read on page 7 of the plan that, "If no statistically significant effects are detected, it concluded that bottom trawling did not cause detectable changes in the benthic-invertebrate community within the time scale of the study. As such, it is unlikely that bottom trawling will impact animals and subsistence activities that are dependent on this type of benthic habitat." Such a conclusion would not only go well beyond the time and spatial scales of such a limited study, it is also inconsistent with hundreds of studies on trawling effects worldwide.

Many coastal communities and residents oppose any trawling, including research trawling, in the northern Bering Sea owing to their strong dependence on the health of fish, invertebrate, seabird and marine mammal resources in the region. Given that the Council recommended opening the Modified Gear Trawl Zone in the southern portion of the region and testimony that this area remains lightly fished, consideration should be given to conducting experiments in this southern area that is already open to fishing. Also, this area is one that is more likely to be relevant to commercial trawling interests in the near future.

**C-5 Initial review BSAI chum salmon bycatch analysis**

Diana Stram (NPFMC), Jim Ianelli (NMFS-AFSC), Alan Haynie (NMFS-AFSC), and Scott Miller (NMFS-AFSC) presented details from the initial review draft Environmental Assessment (EA) and Regulatory Impact Review (RIR) concerning analysis of alternatives and assessment of potential impacts of addressing chum salmon bycatch (PSC) in the BSAI groundfish fisheries. Topics discussed in the EA were the background and rationale for the action, a description of the affected fisheries (including state-managed salmon fisheries), the range of management alternatives considered, analytical techniques for assessing the implications of chum salmon PSC in western Alaska, and evaluating the impacts of the alternatives. Public testimony was given by Michael Sloan (Nome Eskimo Community), Tim Andrew (Association of Village Council Presidents), Charlie Lean (Norton Sound Economic Development Corporation), Tim Smith (Nome Fisherman's Association), and John Starkey (Association of Village Council Presidents).

Alternatives discussed in the EA include: 1) status quo, with the current system of area closures along with exemption to these closures by pollock vessels participating in the Voluntary Rolling Hotspot inter-cooperative agreement (VRHS ICA); 2) a hard cap on chum salmon bycatch, with options for sector splits, sector transfers, and cooperative provisions; and 3) chum salmon bycatch triggered closures, with options for sector splits, sector transfers, cooperative provisions, and area and timing considerations; and, 4) chum salmon triggered closures with an intercooperative exemption.

The SSC commends the authors for the impressive amount of analytical work completed on the EA to date. The analysts did a good job of addressing all of the comments made during the SSC's February 2011 review of the preliminary review draft of the EA:

- Inclusion of a concise problem statement.
- Removal of a rolling hotspot system from alternative 3 and creating a new alternative (4) that includes a rolling hotspot with an intercooperative exemption
- Use of published sources for recent genetic analyses rather than relying on unpublished draft documents.
- Resolving differences in temporal stratification of genetic and bycatch data and developing methods of weighting these data to produce AEQ estimates by stock grouping.
- Analyzing and adjusting AEQ data for a year effect and applying uncertainty from this effect into years without genetic sampling.
- Developing a table of impacts of bycatch on appropriate stock grouping by year in western Alaska.

- Including a thorough analysis of the current rolling hotspot system in the EA.

**The analysis does a good job of quantifying the effect of proposed actions on number of chum salmon potentially saved and potentially foregone in the pollock harvest, given the range of alternatives. However, a parallel treatment of the impacts on commercial salmon fisheries, subsistence use, and sustainability of chum salmon runs should be added.** Methods used to make these estimates should be included in Chapter 3 and the description of the impacts should appear in Section 5.4.

Several additional issues remain in the EA:

- Include a summary on alternative hypotheses for the declines of chum salmon in Western stocks, and Nome area in particular. This issue should be carried through the document in sections 1.0, 5.1 and section 7.5.
- Include a discussion of the rationale for using a pooled age-length key for estimating age composition of chum salmon.
- In Chapter 8 section 8.1.9, the cumulative impacts section appears incomplete in that paragraph one indicates that an analysis of significance is forthcoming, whereas the final paragraph of the section indicates that there is no significant impacts.
- If available and significant, we recommend that the impact of the recent tsunami on Japanese hatchery production of chum salmon be noted in the analysis.

From the draft RIR/IRFA presented to the SSC, it is clear that the authors have sought to be responsive to the SSC's earlier request for greater examination of the post-PSC impacted uses and users. In our earlier review, we had expressed concern at the apparent lack of balance or proportionality in the level of detail, both descriptive and analytical, in the EA/RIR/IRFA. The result is an Initial Draft that includes numerous cut-and-paste descriptive materials from published secondary sources (e.g., ADF&G Fishery Outlooks, CDQ Annual Reports). The SSC appreciates author's attention to our request, but recommends that the narrative material be reduced substantially through summarization and editing of the material to provide greater clarity in the document.

In direct evaluations of the specific suite of proposed actions, there is explicit treatment of only a subset of the full set of alternatives and options under consideration by the Council. Analysis of Alternative 1 (the status quo or no action alternative), functionally defaults to the sweeping descriptive narrative, which makes characterization of the status quo outcome difficult. It is this status quo condition that serves as the empirical baseline, which is then employed to develop a back-cast simulation evaluating revenue-at-risk and catch foregone. Employing empirical catch, production, price, and PSC statistics for the GOA pollock fisheries, estimated "gross revenue" impacts, by sector and market-level, are offered, under a set of strictly limiting assumptions. While the pollock industry impact analysis qualitatively identifies the types of costs that may be involved, the quantitative analysis focuses exclusively on gross revenue impacts. Although this has become standard practice in many recent Council analyses, the SSC wishes to reiterate that using gross revenue impacts in this way is an inappropriate and misleading measure of net impacts. Resolution of this deficiency is, as we have emphasized repeatedly, fundamentally dependent upon acquiring comprehensive cost data. The EA/RIR/IRFA incorrectly, associates gross revenue impacts with industry costs, but this in no way reflects the actual costs to the pollock industry or to

pollock dependent communities. The appropriate measure is the impact on profits not gross revenue. There are other instances in which revenue impacts are incorrectly associated with costs to industry (e.g., EA page xxxiv). Both the EA and the RIR should be reviewed to correct this error.

**For Alternative 2, which contains very complex and potentially important policy considerations and precedence-setting implications, the analysis is incomplete.** Specifically, the draft analysis is completely silent on the costs and benefits attributable to the concepts of transfers and roll-overs of PSC amounts and their implications for understanding the economic, socio-economic, and cultural impacts of these PSC-redistributive options.

In general, the pollock revenue-at-risk (or revenue foregone, depending on interpretation of fishery outcomes) is characterized as the "pollock-side" of the benefit/cost evaluation. Assumed AEQ "savings" estimates, were projected as a proxy for the "non-Chinook" impacted users and uses benefit/cost impacts (see page 196). This approach inappropriately ignores the multi-dimensional nature of benefits deriving from non-Chinook salmon (e.g., cultural, subsistence, passive-use), they were treated in the abstract in the introductory narrative. This defeats efforts to comprehensively account for changes in chum salmon PSC on all concerned users and uses.

The same revenue-at-risk back-cast analytical strategy was stated to have been employed to examine aspects of Alternative 3, including options, although that analysis appears to be largely absent from the document, to the extent SSC reviewers could determine.

The draft RIR declares that there is no analytical treatment of Alternative 4, although we now understand from staff presentation that Alternative 4 was intended to be the de-facto status quo Alternative (i.e., no meaningful difference from Alternative 1).

**The asymmetrical treatment of benefits and costs in the context of the pollock fishery versus that of the subsistence communities is both striking and troubling.** The analytical work that has gone into modeling the potential impacts on the pollock fishery is impressive, particularly given the time available to the analysts. In contrast, the consideration of impacts on the salmon users and dependent communities is truncated at the production of the estimates of AEQ savings of chum salmon. The rationale given for not proceeding beyond the AEQ estimates to a fuller consideration of impacts on subsistence communities is that much needed data is missing and too many assumptions would be required to proceed beyond the AEQ estimates. The tradeoff between economic benefits in the pollock fishery and the relationship of salmon to life in rural Alaska is difficult for the Council to evaluate. The process may best be served by comprehensive analyses of all dimensions of the tradeoffs and potential impacts involved.

The descriptions of subsistence and salmon dependent communities are treated superficially. There are a number of sources that need to be researched and evaluated to make those sections of the document richer and more relevant. Testimony from the public pointed to internal studies conducted by the Association of Village Council Presidents (AVCP), Kawerak, Nome Eskimo Community, and other western Alaska entities that need to be included. These entities should be contacted for additional socio-cultural and economic data for its potential to be included in this analysis. ADF&G area manager James Magdanz is another valuable resource, and can contacted for other sources. These sources may allow for an exploration of changes in family structure, changing uses of fish camps, skill loss and outmigration, for

example, from the local perspective. The SSC realizes that new studies addressing these concerns are not possible for inclusion in the RIR, but a concerted effort to evaluate any and all existing data should be made.

The Environmental Justice section (Chapter 7) requires revision. Statements about relative importance of subsistence and suggesting dollar values for subsistence are unnecessary and should be excised. Subsistence importance should not be measured through quantity because of a myriad of constraints, for example closed seasons, gear, human resources, weather, freezer space, among others. Using less does not mean wild foods are less important. The authors should identify who "provides" (p. 263). There is also a suggestion that, because there is primarily formal economy data documented, that "poverty and income statistics should really be adjusted to reflect the monetary value of subsistence production to provide a relatively comparable measure of income." This is hugely problematic and should not be attempted. Subsistence requires financial resources, social capital, health, ability, skill, time, for example. Oftentimes, it is the highest wage earner who is also producing the most subsistence resources, and taking care of multiple households. Subsistence foods cannot be sold (there are some customary trade exceptions), but the Subsistence Division only provides dollar equivalents to subsistence when considering the costs of replacement during closures. Such estimates do not capture the full cost of the loss of access, but only the market-based expenditure to acquire and transport a substitute food source (e.g., beef, when caribou hunting is closed).

Descriptions about Akutan need to be revised (pages 265-266). The statement about village life from an earlier era should be excised as it places them outside the modern economy, and is erroneous since they are aggressively pursuing modern development (geothermal energy, for example). Support economies in coastal communities where the pollock fleet delivers its catch should not be dismissed. They are at a greatly reduced scale, but having a transient fleet and cannery personnel spend money in a small community can provide vital income. Akutan is distinct from the plant and the pollock fishery, but relies a great deal on both.

There are a number of factual errors. For example (P. 100), Port Heiden does not fish Area M. They fish Area T in Bristol Bay (Ugashik District), but the outer Port Heiden section is fished by Area M fishers. Port Heiden is a cultural boundary between Alutiiq and Aleut. Another example is found on the map on page 179. There is no processor in Cold Bay, Peter Pan Seafoods in Port Moller was missing, and Sand Point has Trident and Peter Pan Seafoods. There are likely other errors and the document should be carefully reviewed for accuracy.

In the Outreach Report, the primary concern coming from the communities is the theme of "waste." Some of the comments speak about recovering that waste through the food bank system. There is an assumption from these comments that these fish are coming to Alaska communities to relieve the need in rural fishing villages. The RIR is clear that SeaShare delivers these fish to Seattle area food banks, not Alaska. Staff should be aware that this misperception continues.

There are several missing references in the text and references cited section, such as Wolfe 2009, Andersen 1992, Andersen and Scott 2010, and the Langdon reference (p. 261). The document should be carefully checked for others. The SSC will provide to the analysts a detailed list of additional necessary edits, recommended changes, and desired clarifications.

Deficiencies in this draft document are important to correct in order to provide a useful understanding of the complete complex of proposed actions. **Thus, the SSC recommends that the draft should not be released for public review until corrected.**

**D-1 (a) Review Pacific cod assessment model**

Grant Thompson (NMFS-AFSC, and Pacific cod stock assessment main author) presented this topic to the SSC. A new process was inaugurated last year to narrow model scenarios considered to an attainable number prior to the Joint Groundfish Plan Team (JPT) September meeting. Kenny Down (AFLC) provided public testimony.

This year the JPT, the combination of the GOA and BS Groundfish Plan Teams, met on 5/17/11 to accomplish this task. Following the April 2011 CIE Review, 3 sets of recommendations were received by the three reviewers. In addition, previous comments from the plan teams and SSC, and new comments from the public were considered. In all, there were 144 individual recommendations, of which 128 were from the CIE review, 1 from the GOA Plan Team, 10 from the SSC, and 5 from the public (all from Mark Maunder, who has been a frequent participant in public review of Pacific cod). Of these proposals, the stock assessment author was identified as the most appropriate person to address 99 of the proposals. In addition, 5 recommendations emerged from the JPT at their 5/17 meeting. Only 4 CIE Review comments were the same from all three reviewers: keep age composition data, drop fishery CPUE data, estimate aging error, and investigate survey variance. The JPT made three passes through the proposals, using predetermined and agreed-upon criteria for each pass. This resulted in six recommendations that could be compressed into 4 new models. Each of these models addresses at least some concerns by all groups. Model 1 is the status quo, last year's model. Model 2 is comprised of two unrelated changes: using splines for selectivity and dropping survey data prior to 1982. Model 3 attempts to estimate ageing bias within the model. Model 4 is the same as some that have been used in the past in eliminating most age data. Mode 5 is a reconfiguration of the time blocks for selectivity that should simplify the model and result in estimation of fewer parameters.

**The SSC is pleased that the process is working well.** The meeting was accomplished in one day and could be done by teleconference, saving people from having to travel to another meeting. The SSC notes that the process is responsive to the CIE review, the public, and the SSC, even though all recommendations could not be incorporated. **The SSC is satisfied with the model choices and does not propose any additional ones.**

**D-1(b) Discussion paper on groundfish uncertainty and total catch accounting**

The SSC reviewed a discussion paper and received an excellent presentation by Grant Thompson (NMFS-AFSC) on several issues relating to Annual Catch Limit (ACL) measures for groundfish in the GOA and BSAI under National Standard Guideline 1 (NSG1). He identified three particular issues of concern and presented some options of how these could be addressed in the future.

1. The first issue relates to the role of uncertainty in determining groundfish ACLs. Although recent amendments to the groundfish FMPs to implement ACLs bring these plans into compliance with the revised NSGs, improvements in accounting for uncertainty in setting ACLs can be made.

The author compared two options for incorporating uncertainty: the decision-theoretic (DT) approach and the P* approach and provided an example illustrating the advantages of the DT approach in one situation. The analysis also clarifies a previous concern about the DT approach arising from the crab ACL analyses.

In those analyses, the risk-averse and risk-neutral approaches resulted in very similar optimal fishing mortality rates in spite of large uncertainties. A simplified example in the discussion paper shows that under certain conditions a risk-averse manager will fish at a higher F than a risk-neutral manager to avoid bad outcomes (essentially selecting the best among the worst possible outcomes).

The SSC recommends a deliberative approach to improving the treatment of uncertainty in the groundfish FMPs and encourages the author and/or other analysts to further develop the document to (1) explore the advantages and disadvantages of the DT and $P^*$ approaches using more realistic scenarios and (2) determine how the approaches would be applied across different tiers (Tier 1-4). This will require continued research on developing appropriate models for understanding the interactions between fisheries in response to changes in harvest policy.

2. A second issue is that the current groundfish FMPs lack a specific value for "Minimum Stock Size Threshold" (MSST) as a reference value for determining whether a stock is overfished. This is because stock assessment authors determine overfished status based on projecting current biomass forward under certain assumptions, instead of comparing it to an MSST value. Although the SSC had some concerns about adding possible confusion by reporting another reference point in addition to those that are already being computed, providing such a value would greatly simplify current reporting requirements and may provide another useful benchmark for monitoring current biomass relative to MSST. The author proposed two options for future consideration. In addition to the options provided in the document (p. 21), the SSC offers two additional options for consideration and recommends that the Plan Teams and stock assessment authors review and evaluate all options before proceeding with plan amendments.

Option 3: MSST will be set as the greater of: a) ½ $B_{MSY}$, or b) the smallest *equilibrium* stock size at which the stock would be expected to rebuild to $B_{MSY}$ within 10 years if it were fished at $F_{OFL}$ in each year.
A stock would be declared overfished if the current stock size fell below the MSST unless the current age structure would be expected to rebuild to $B_{MSY}$ within 10 years when fished at $F_{OFL}$. Advantages include that the approach is fairly simple and provides a relatively stable reference point against which to measure current biomass. A disadvantage is that it might create confusion if current stock size falls below MSST, but the stock is not overfished. Moreover, it is unclear if this option is compatible with language on determining overfished status in NSG1.

Option 4: MSST will be set as the greater of: a) ½ $B_{MSY}$, or b) the smallest stock size at which the stock would be expected to rebuild to $B_{MSY}$ within 10 years if it were fished at $F_{OFL}$ in each year under the *current* age structure (proportions at age). The stock would be declared overfished if it drops below MSST. An advantage is that the approach is fairly simple and provides a reference point against which to measure current biomass. A disadvantage is that the MSST may vary considerably from year to year rather than providing a stable benchmark against which to evaluate current biomass.

3. The third issue is how to deal with removals from various sources for (A) computing various reference points and (B) counting them against harvesting specifications.

The SSC recommends that stock assessment authors and plan teams address this issue in the upcoming stock assessment cycle. Stock assessment authors should clearly lay out which sources of removals are currently included in the assessment, how removals from each source are estimated, and how they are being included in (A) and (B) above. To the extent possible, authors should discuss all known sources of mortality (including handling mortality, indirect mortality, subsistence, etc.) and which of these sources are considered in the assessment.

**D-1(d) Research priorities**

**Appendix A. Five-Year Research Priorities: 2012-2016**

The SSC has identified priorities for research in the next 1 to 5 years as those activities that are the most important for the conservation and management of fisheries in the Gulf of Alaska, Aleutian Islands, eastern Bering Sea, and the Arctic. This listing of priorities has two purposes: 1) to meet the requirements of the revised Magnuson-Stevens Act for the Councils to identify research that is needed in the next 5 years, and 2) to provide guidance on research priorities to the research community and to funding agencies.

The research priorities the SSC has identified are separated into two categories: **Immediate Concerns** and **Ongoing Needs**. **Immediate Concerns** include research activities that must be addressed to satisfy federal requirements and to address pressing fishery management and ecosystem issues related to fishery management. The SSC has indicated those Research Priorities for which Research is Underway. These are Research Priorities for which NPRB grants have been awarded or for which it is known to the SSC that one or more other agencies have undertaken the recommended research. These priorities will remain on the list until the recommended research is complete and evaluated in terms of the SSC Research Priority that was listed. **Ongoing Needs** include research to advance the Council's fisheries management goals as defined in the Groundfish PSEIS, other strategic documents of the Council (i.e., FMPs, AI FEP, and EFH, crab, salmon PSC, and other EISs) and NMFS. **Ongoing Needs** include efforts on which the assessment models depend for their annual updates. For example, without the survey information, the annual process of setting ABCs and OFLs for the managed stocks would be compromised. The SSC sees these efforts as needed on an ongoing basis, and constituting the time series on which management is based. It should be recognized that research in these categories is being conducted or may be conducted through Federal, State of Alaska, North Pacific Research Board, and other funding sources.

**Appendix A. Five-Year Research Priorities: 2011-2015**

**Immediate Concerns**

I. Fisheries

A. Fish and Fisheries Monitoring

1. Non-recovering stocks. A pressing issue is why certain stocks have declined and failed to recover as anticipated (e.g., Pribilof Island blue king crab, Adak red king crab). Research into all life history components, including predation by groundfish on juvenile crab in nearshore areas, is needed to identify population bottlenecks, an aspect that is critically needed to develop and implement rebuilding plans. (Students on the Pribilof Islands may be able to help collected and analyze stomach contents of halibut and cod for evidence of predation on juvenile king crab.)
2. Improve in-season catch accounting by sex and size for crab in non-directed fisheries with high bycatch rates, particularly for blue king crab in the Pacific cod pot fishery in the Pribilof Islands.
3. Develop methods for reliable estimation of total removals (e.g., surveys, poorly observed fisheries) to meet requirements of total removals under ACLs. Improve species identification, by both processors and observers, for priority species within species complexes in catches. Methods that quantify and correct for misidentifications are desired.
4. Characterize the spatial distribution of male snow crab relative to reproductive output of females in the middle domain of the EBS shelf (partially underway)

B. Stock Assessment

1. Improve handling mortality rate estimates for crab. Improved understanding on the post-release mortality rate of discarded crab from directed and non-directed crab pot fisheries and principal groundfish (trawl, pot, and hook and line) fisheries is required. The magnitude of post-release mortality is an essential parameter in the determination of total annual catch used to evaluate overfishing in stock assessment and projection modeling. For example, assess discard mortality rates of Tanner crab by size, month, sex, and fishery type. (partially underway: Chionoecetes RAMP study)
2. Refine methods to incorporate uncertainty into harvest strategies for groundfish for ACL estimation. (underway)
3. Develop biomass indices for Tier 6 species, such as sharks, and conduct net efficiency studies for spiny dogfish.
4. Conduct a tagging study of red king crab in the region north of Bristol Bay to assess the movement between this region and the Bristol Bay registration area.
5. Conduct winter surveys of groundfish in all three areas (EBS, GOA and AI) to create seasonal models of fish diet and biomass distribution relative to Steller sea lion critical habitat.
6. Conduct tagging studies of Pacific cod and Atka mackerel to create models of short-term movement of fish relative to critical habitat (tagging methods for pollock are in development).
7. Conduct tagging studies of Atka mackerel to estimate local abundance inside and outside critical habitat. (underway in Central Aleutian Islands; needed in Western Aleutian Islands)

C. Fishery Management

1. Develop a research program that will facilitate evaluation of salmon (both chinook and non-chinook) PSC mitigation measures in the BSAI and GOA. This includes updated estimates of the

amounts reasonably necessary for subsistence, and access to cost data for the commercial pollock and salmon industries so that impacts on profits (not revenues) can be calculated.

2. Develop improved catch monitoring methods of fishery interactions, including direct and alternative options (e.g., electronic logbooks, video monitoring), particularly on smaller groundfish, halibut, and commercially guided recreational fishing vessels, including an assessment of feasibility for small vessels.
3. Improve the resolution of Chinook and chum salmon genetic stock identification methods (e.g., baseline development, marker development), and precision of salmon run size estimates in western Alaska, and initiate investigations of biotic and abiotic factors influencing natural mortality rate during ocean migration in the GOA and BSAI.

II. Fisheries Interactions

A. Protected species

1. Conduct studies of localized interactions between fisheries and protected species. Studies of interactions between Steller sea lions and commercial fisheries are needed in the Central and Western Aleutian Islands, with an emphasis on seasonal prey fields, diet, and movement of sea lions and their prey. These studies should be conducted at appropriate spatial and temporal scales.
2. Foraging ecology studies of SSL in the western and central Aleutians. Specifically, this research would include at-sea tracking of adult females and juveniles, and collecting SSL scat and spew. Supplemental research could include stable isotope analysis, fatty acid analysis, contaminant studies, monitoring of condition and health indices, and additional photogrammetric work. (partially underway)
3. Assess vital rates (i.e., reproduction and survival) of SSL in the western and central Aleutians. Specifically, this would require longitudinal studies (e.g., branding of pups) to determine rates of age- or size-class specific survival, as well as studies to help evaluate the reproductive performance of adult females and natality, including comparative surveys throughout the western Distinct Population Segments.
4. Investigate advancements in methods to estimate sea lion abundance, such as the use of unmanned aerial vehicles that would increase the probability of acquiring abundance estimates in remote areas. (underway)
5. Quantify killer whale predation of SSLs, particularly in the western and central Aleutian Islands.
6. Increase the frequency of Steller sea lion pup and non-pup surveys to a level sufficient to track population dynamics in the western DPS.

III. Habitats

A. Evaluate habitats of particular concern:

1. Assess whether Bering Sea canyons are habitats of particular concern, by assessing the distribution and prevalence of coral and sponge habitat, and comparing marine communities within and above the canyon areas, including mid-level and apex predators (such as short-tailed albatrosses) to neighboring shelf/slope ecosystems. (partially underway)

B. Baseline Habitat Assessment

1. Dynamic ecosystem and environmental changes in the northern Bering Sea and Arctic are occurring on a pace not observed in recorded time. In response to the new FMP for the Arctic,

assessment of the current baseline conditions is imperative. This effort, while of great scientific importance, should not supplant the regular surveys in the BSAI and GOA, which are of critical importance to science and management.

C. Fishing Effects on Habitat.

1. Conduct research on the effects of habitat modifications on spawning and breeding female red king crab, particularly in nearshore areas of southwest Bristol Bay.

**Ongoing Needs**

I. Fisheries

A. Fish and Fishery Monitoring

1. Continuation of State and Federal annual and biennial surveys in the GOA, AI, and EBS, including BASIS surveys and crab pot surveys, is a critical aspect of fishery management off Alaska. It is important to give priority to these surveys, in light of recent proposed federal budgets in which funding may not be sufficient to conduct these surveys. Recent substantial loss of funding for days at sea for NOAA ships jeopardizes these programs. These surveys provide baseline distribution, abundance, and life history data that form the foundation for stock assessments and the development of ecosystem approaches to management. These surveys are considered the highest priority research activity, contributing to assessment of commercial groundfish fisheries off Alaska.
2. Conduct routine surveys of subsistence use, fish, crab, and oceanographic parameters of the northern Bering Sea and Arctic Ocean. These surveys will become increasingly important under ongoing warming ocean temperatures because range expansions of harvested fishery resources are anticipated. If range expansions occur, data will be needed to adjust standard survey time series for availability.
3. Continue and expand cooperative research efforts to supplement existing surveys to provide seasonal or species-specific information for use in improved assessment and management. The SSC places a high priority on studies that provide data to assess seasonal diets and movements of fish and shellfish for use in studies of species interactions in spatially explicit stock assessments.
4. For groundfish in general, and rockfish in particular, continue and expand research on trawlable and untrawlable habitat to improve resource assessment surveys. For example, improved surveys, such as, hydro-acoustic surveys, are needed to better assess pelagic rockfish species that are found in untrawlable habitat or for semi-pelagic species such as northern and dusky rockfish.
5. Studies are needed to evaluate effects of the environment on survey catchability. For crabs, studies are needed on catchability, as it directly bears on estimates of the stock size for setting of catch quotas. Research to refine the estimates of survey catchability, $q$, used to infer absolute, rather than relative abundance, would substantially improve the quality of management advice. Particular emphasis should be placed on Tanner crab because of recent trends in stock status.
6. Continue research on the design and implementation of appropriate survey analysis techniques, to aid the Council in assessing species that exhibit patchy distributions and, thus, may not be adequately represented, either over or under estimated, in the annual or biennial groundfish surveys.
7. Improve biological data collection (e.g., age, size, maturity, and sex) of some bycatch species (e.g., sharks, skates, octopus, squid, sculpins, and grenadiers) to better quantify potential effects of bycatch on these stocks.

8. Advance research towards developing a quantitative female reproductive index for the surveyed BSAI crab stocks. The current stock-status assessment process for surveyed BSAI crab stocks uses the estimated mature male biomass at the presumed time of mating as the best available proxy for fertilized egg production. Research on mating, fecundity, fertilization rates, and, for snow and Tanner crab, sperm reserves and biennial spawning, is needed to develop annual indices of fertilized egg production that can be incorporated into the stock assessment process and to model the effects of sex ratios, stock distribution, and environmental change on stock productivity. Priority stocks for study are eastern Bering Sea snow and Tanner crab and Bristol Bay red king crab.
9. Continue and expand existing efforts to collect maturity scans (visual) during fisheries that target spawning fish.
10. Identification and recovery of archived data (e.g., historical agency groundfish and shellfish surveys) should be pursued. Investigate integrating these data into stock and ecosystem assessments.
11. Fishery independent survey of scallops (e.g., Yakutat area and other major GOA fishery locations).
12. Develop a long-term survey capability for forage fish (partially underway).

B. Stock Assessment

1. Acquire basic life history information (specifically, natural mortality, size at maturity, and other basic indicators of stock production/productivity) for sharks, skates, sculpins, octopus, and squid and data-poor stocks of crab, to allow application of Tier 5 or Tier 4 assessment criteria. There are two possibilities that would require dedicated research: (1) directly estimate fishing mortalities through large-scale tagging programs; and (2) develop habitat-based estimates of abundance based on local density estimates in combination with large-scale habitat maps. Little information is available, especially for sculpins, skates, octopuses, squids, grenadiers, and some sharks. (partially underway)
2. Improve estimates of natural mortality (M) for several stocks, including Pacific cod and BSAI crab stocks.
3. Validate and improve age determination methods for Pacific cod, Pacific sleeper sharks, and spiny dogfish. (partially underway)
4. Evaluate the assessment and management implications of hybridization of snow and Tanner crabs.
5. Quantify the effects of historical climate variability and climate change on recruitment and growth and develop standard environmental scenarios for present and future variability, based on observed patterns. There is also a clear need for information that covers a wider range of seasons than is presently available.
6. Develop projection models to evaluate the performance of different management strategies relative to the Council's goals for ecosystem approaches to management. Projection models are also needed to forecast seasonal and climate related shifts in the spatial distribution and abundance of commercial fish and shellfish. (partially underway)
7. To identify stock boundaries, expanded studies are needed in the areas of genetics, reproductive biology, larval distribution, and advection. Expanded tagging efforts are needed to support the development of spatially explicit assessments. High priority species for spatially explicit models include: walleye pollock, Pacific cod, sablefish, yellowfin sole, rock sole, arrowtooth flounder,

Pacific ocean perch, black spotted rockfish, rougheye rockfish, snow crab, and Atka mackerel. (partially underway)

8. Conduct genetic studies to provide information on sources and sinks for scallop larvae are needed to improve our understanding of the rate of larval exchange between scallop beds.
9. Develop age-structured models for scallop assessment.

C. Fishery Management

1. Evaluate the effectiveness (e.g., potential for overharvest or unnecessarily limiting other fisheries) of setting ABC and OFL levels for data-poor stocks (Tier 5 and 6 for groundfish and Tiers 4 and 5 for crab, e.g., squid, octopus, shark, sculpins, other flatfish, other rockfish, skates, grenadier, and crab). Research is needed to refine the basis for setting gamma for Tier 4 crab stocks. (partially underway)
2. Conduct retrospective analyses to assess the impact of Chinook salmon bycatch measures on the BSAI pollock fishery. Analyses should include an evaluation of the magnitude and distribution of economic effects of salmon avoidance measures for the Bering Sea pollock fishery. In this case, it is important to understand how pollock harvesters have adapted their behavior to avoid bycatch of Chinook and "other" salmon, under various economic and environmental conditions and incentive mechanisms.
3. Develop forecasting tools that incorporate ecosystem indicators into single or multispecies stock assessments, to conduct management strategy evaluations under differing assumptions regarding climate and market demands. Standardization of "future scenarios" will help to promote comparability of model outputs.
4. Develop database of product inventories (and trade volume and prices) for principal shellfish, groundfish, Pacific halibut, and salmon harvested by U.S. fisheries in the North Pacific and eastern Bering Sea.
5. Analyze current determinants of ex vessel, wholesale, international, and retail demand for principal seafood products from the GOA and BSAI.
6. Conduct pre- and post-implementation studies of the benefits and costs, and their distribution, associated with changes in management regimes (e.g., changes in product markets, characteristics of quota share markets, changes in distribution of ownership, changes in crew compensation) as a consequence of the introduction of dedicated access privileges in the halibut/sablefish, AFA pollock, and crab fisheries. "Benefits and costs" include both economic and social dimensions.
7. Conduct prospective analyses of the robustness and resilience of alternative management strategies under varying environmental and ecological conditions.
8. Conduct prospective and retrospective analyses of changes in the spatial and temporal distribution of fishing effort, in response to management actions (e.g., time/area closures, marine reserves, PSC and other bycatch restrictions, co-ops, IFQs).
9. Develop a framework for collection of economic information on commercial, recreational, and charter fishing, as well as fish processing, to meet the requirements of the MSFCMA sections 303(a)(5, 9, 13), 303(b)(6), and 303A.
10. Continue to evaluate the socio-economic effects from crab rationalization programs on coastal communities. This includes understanding economic impacts (both direct and indirect) and how the impacts are distributed among communities and economic sectors.

11. Improve estimation of fishery interactions (including direct competition and bycatch) with marine mammals (e.g., state managed gillnet fisheries), seabirds, and non-target groundfish (e.g., sharks, skates), and protected species.

II. Fisheries Interactions

A. Protected Species Interactions

1. Economic, social, and cultural valuation research on protected species (i.e., non-market consumptive use, passive use, non-consumptive use).
2. There is a need for studies of localized fishery-protected species interactions. Studies of interactions between Steller sea lions and fisheries are needed in the Central GOA, with an emphasis on seasonal prey fields, diet, and movement of sea lions and their prey. These studies should be conducted at appropriate spatial and temporal scales
3. Foraging ecology studies of SSL in the Commander Islands. Research techniques would be similar to item #1.
4. Foraging ecology studies of SSL in the Gulf of Alaska. In addition to at-sea tracking of older animals, outside of the Kodiak area the primary information needed from this sub-region is updated information on diet composition of SSL throughout the sub-region.
5. Maintain assessment of SSL vital rates in the Russian Far East and Commander Islands. Research techniques would be similar to item #4 and include expansion to autumn and winter periods.
6. Aerial photogrammetric survey studies of rookeries and haul-outs in Russia. This survey methodology would provide abundance estimates for sea lions in Russia directly comparable to estimates for Alaska.
7. More studies are needed to fully evaluate the possible linkages between fishery induced disturbances or local prey depletion for northern fur seals in the Pribilof Islands region. (underway)
8. Continue research on gear modifications and fishing practices for reducing bycatch, particularly of PSC species (e.g., salmon). (underway for crab)
9. Conduct studies of whale depredation of catch in long-line fisheries and surveys to improve the quality of long-line abundance estimates. (underway)

III. Habitat

A. Habitat Mapping

1. Improved habitat maps (especially benthic habitats) are required to identify essential fish habitat and distributions of various substrates and habitat types, including habitat-forming biota, infauna, and epifauna. (partially underway)
2. Begin to develop a GIS relational database for habitat, including development of a historical time series of the spatial intensity of interactions between commercial fisheries and habitat, which will be needed to evaluate impacts of changes in EFH on the growth, reproduction, and distribution of fish and shellfish.
3. Assess the extent of the distribution of Primnoa corals and skate egg case concentration sites in the GOA.

B. Function of Habitat

1. Evaluate relationships between, and functional importance of, habitat-forming living substrates to commercially important species, including juveniles.
2. Develop a time series of the impact of fishing on GOA, AI, and EBS habitats that could be used to assess: a) the impact of changes in management on the rate of habitat disturbance, and b) the impact of habitat disturbance on the growth, distribution, and reproductive success of managed species.
3. Evaluate effects of fishing closures on benthic habitats and fish production. There are many closures that have been in effect for various periods of time, for which evaluations have not been conducted (e.g. slope HAPCs recently designated in the western Gulf of Alaska).

IV. Other Areas of Research Necessary for Management

A. Ecosystem indicator development and maintenance.

1. Climatic indicators

2. Lower trophic level community production data

a) Collect primary production time series

b) Collect and maintain zooplankton production and biomass time series in the EBS. Develop, collect and maintain time series of zooplankton production and biomass for the AI, GOA and Arctic.

c) Collect and maintain zooplankton community composition time series in the Bering Sea. Develop, collect and maintain time series of zooplankton community composition for the GOA, AI, Arctic.

d) Collect and maintain benthic community composition, production and biomass time series in all regions.

e) Evaluate over-wintering strategies for arctic copepods and the impact of these strategies on the timing of pelagic availability.

3. Develop methods for incorporating ecosystem indicators into stock assessments and ecosystem assessments.

4. Develop methods to synthesize and integrate ecosystem indicators to identify appropriate thresholds for meeting management objectives.

5. Continue and expand cooperative research efforts to supplement existing at-sea surveys that provide seasonal, species-specific information on upper trophic levels (seabirds and marine mammals). Updated surveys to monitor distribution and abundance of seabirds and marine mammals are needed to assess impacts of fisheries on apex predators, improve the usefulness of apex predators as ecosystem indicators, and to improve ecosystem management.

6. Initiate and expand non-market valuation research of habitat, ecosystem services, and passive use considerations.

B. Research on Environmental Influences on Ecosystem Processes

1. Climate variability: monitor and understand how changes in ocean conditions influence managed species.

a) Maintain moorings. Development and maintenance of indices of the timing and extent of the spring bloom is a high priority. For this, maintenance of moorings, especially M-2, is essential. (underway)

b) Monitor seasonal sea ice extent and thickness: If recent changes in ice cover and temperatures in the Bering Sea persist, these may have profound effects on marine communities.

c) Measure and monitor fish composition: Evaluate existing data sets (bottom trawl surveys, acoustic trawl surveys, and BASIS surveys) to quantify changes in relative species composition of commercial and non-commercial species, identify and map assemblages, and monitor changes in the distribution of individual species and assemblages. Additional monitoring may be necessary in the Aleutian Islands, northern Bering Sea, and areas of the Gulf of Alaska.

d) Assess the movement of fish to understand the spatial importance of predator-prey interactions in response to environmental variability.

2. Conduct Research on Ocean Acidification

a) Collect and maintain time series of ocean pH in the major water masses off Alaska. (partially underway)

b) Assess whether changes in pH would affect managed species, upper level predators, and lower trophic levels. (partially underway)

3. Species' responses to multiple environmental stressors

a) Laboratory studies are needed to assess the synergistic effects of ocean acidification, oil pollution, and changes in temperature on productivity of marine species.

C. Basic research on trophic interactions

1. Collect, analyze, and monitor diet information, from all seasons in addition to summer, to assess spatial and temporal changes in predator-prey interactions, including marine mammals and seabirds. The diet information should be collected on the appropriate spatial scales for key predators and prey to determine how food webs may be changing in response to shifts in the range of crab, forage fish and groundfish.

2. Ecosystem structure studies: Studies are needed on the implications of food web interactions of global warming, ocean acidification, and selective fishing. For instance, studies are needed to evaluate differential exploitation of some components of the ecosystem (e.g., Pacific cod, pollock, and crab) relative to others (e.g., arrowtooth flounder).

D. Ecosystem Modeling

1. Food habits collections and ecosystem modeling to quantify interactions between SSL groundfish prey and the food web effects of changes in fishing mortality.

2. Modeling and field studies of ecosystem productivity in different regions (EBS, GOA and AI).