North Pacific Fishery Management Council

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Certified:_____
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SCIENTIFIC AND STATISTICAL COMMITTEE
to the
NORTH PACIFIC FISHERY MANAGEMENT COUNCIL
October 4-6, 2010

The SSC met during October 4-6, 2010 at the Captain Cooke Hotel, Anchorage, Alaska. Members present were:

Pat Livingston, Chair
NOAA Fisheries—AFSC
Farron Wallace, Vice Chair
Washington Depart. of Fish and Wildlife
Robert Clark
Alaska Department of Fish and Game
Keith Criddle
University of Alaska Fairbanks
Susan Hilber
Oregon Department of Fish and Wildlife
Anne Hollowed
NOAA Fisheries—AFSC
George Hunt
University of Washington
Gordon Kruse
University of Alaska Fairbanks
Franz Mueter
University of Alaska Fairbanks
Lew Queirolo
NOAA Fisheries—Alaska Region
Terry Quinn
University of Alaska Fairbanks
Ray Webster
International Halibut Commisson
Doug Woodby
Alaska Department of Fish and Game

Members absent were:

Kathy Kuletz
US Fish and Wildlife Service
Seth Macinko
University of Rhode Island

B-1 Plan Team Nominations

The SSC approves the nomination of Ms. Kristin Green to serve on the GOA Groundfish Plan Team, to fill the position vacated by Cleo Brylinsky.

C-2 Crab SAFE and OFLs

Diana Stram (NPFMC) and Forrest Bowers (ADF&G) presented the Crab Plan Team Report and SAFE. The SSC reviewed Tables 3 and 4 of the Final Crab SAFE that contain the OFLs and stock status of each crab stock and confirms that these follow the SSC recommendations for calculation provided in June 2010. The SSC previously approved the OFLs for Norton Sound Red King Crab, Aleutian Islands Golden King Crab, Pribilof Islands Golden King Crab, and Adak Red King Crab in June 2010. Aside from recommending that next year's Norton Sound red king crab assessment consider the 2010 northern Bering Sea trawl survey results, the SSC has no additional comments on these assessments.

The CPT asked the SSC to comment on the approach used to determine a total catch OFL. In this approach, a mature male OFL is determined using the Tier formulae and mature male biomass. Discards

of females are then added to obtain the total catch OFL. The total catch including all discard mortality from all fisheries is compared to this total catch OFL, and if greater, indicates that overfishing is occurring. This calculation is thought to be required under the Magnuson-Stevens Act, which mandates consideration of all removals due to fishing.

Like the CPT, the SSC is reluctant to endorse this procedure at this time due to three concerns. First, mature male biomass is the current default "currency" and it seems that overfishing should be evaluated using this metric. The second concern is that the basis for adding in discard mortality is unclear. Is the intent to allow for bycatch in other fisheries that may not be able to be regulated? Third, this approach still does not make a full accounting of total fishing mortality. Why isn't the bycatch of immature males added in to the total catch OFL? The SSC requests that the CPT prepare a white paper that addresses this issue and explores alternative ways of calculating OFL.

Another SSC concern is the current practice of preparing two SAFEs each year, one in May and one in September with new summer survey information. In some assessments (like Bristol Bay red king crab), the newer chapter is a major modification of the earlier one, in which model selection results have been removed and the chapter is extensively rewritten. Not only does this substantially increase the assessment burden on the authors, it also makes it difficult to follow the evolution of the assessment over time. One solution might be for the authors to write the May document as completely as it would be in September, but simply leave the updated abundance and OFL blank.

Snow crab model

The SSC received a presentation from Jack Turnock (NMFS-AFSC) on the updated snow crab assessment. The SSC reviewed and endorsed a snow crab model in June 2010 that was similar to the 2009 model but estimated natural mortality for males and growth for males and females within the model, modeled maturity as a smooth function of size, estimated separate selectivities and catchabilities for males and females, and fixed the weights on the NMFS survey data. For the final assessment, data sources were updated to include the revised NMFS survey estimates (using estimated net widths), survey length-frequencies through 2010, BSFRF data in "the study area" for animals of 40mm and larger for 2009, as well as catch, fishery length-frequency data, and groundfish bycatch data through the 2009/10 season.

The SSC appreciates the author's efforts in advancing the snow crab model. We refer to our June 2010 minutes for specific suggestions to further develop the model during the next assessment cycle and offer the following additional comments:

- The SSC supports all of the September CPT recommendations with regard to the snow crab assessment.
- The SSC continues to encourage the development of a spatial model for snow crab.
- We recommend including a map of the distribution of snow crab throughout the Bering Sea including results from the 2010 northern Bering Sea survey.
- We encourage the continued exploration of stage-based mortality (by sex)
- We ask the authors to further examine female mortality (including estimating female M in the model as a free parameter) and its influence on total mature biomass (as in Figure 4), which is a reference point that enters into the State harvest policy. We also ask that the authors examine the model fit to female discards (as in Figure 46).

Bristol Bay Red King Crab

The revised SAFE presents results from Model 3, selected in May/June as the best model and updated with the summer survey data. For the most part, the authors have been responsive in considering CPT (May) and SSC (June) comments, although many of the comments will not be fully addressed until May 2011. The SSC is still puzzled by one result in the previous SAFE. Namely, Model 5, which set additional mortality for females to 0, had a higher likelihood than Model 3. This should not be possible, because

Model 5 had one less parameter. The authors restated that Model 5 had the lowest likelihood but did not explain why this could be the case. The SSC would appreciate receiving an explanation for this result.

The SSC agrees with CPT recommendations about items to be addressed by May 2011. First, the authors have not addressed reviewer comments from the June 2009 CIE review. CPT informed the SSC that the author will present a response to the CIE comments during a proposed modeling workshop during February 15-18, 2011. The SSC looks forward to seeing the assessment author's response and plan team recommendations at the April 2011 Council meeting.

Second, the CPT recommended that the standard survey should be used for the male abundance index and the re-tow survey be used for females, because the standard survey is the baseline and the re-tow survey is intended to address the problem of delayed female molt timing. However, the SSC would be interested to see an evaluation of model results using the standard survey only versus standard plus re-tow survey results for males for reasons similar to the rationale to include BSFRF survey data in the snow crab assessment. For instance, the selection of the best data to be used in the assessment could involve a sensitivity analysis in which model fit statistics are examined. This could evaluate datasets are most consistent with model projections from one year to the next. In any case, it is important to determine the dataset(s) to be used in the assessment *a priori*, not *post hoc*. Third, further sensitivity analysis should be done with respect to data weighting, catchability parameters, and mortality parameters. Also, rationale for model choices should be enhanced. Finally, the extent of expansion of the population northward should be examined. In that light, consideration should be given as to whether a tagging study in the north would be useful to estimate movement probability.

Eastern Bering Sea Tanner Crab

The authors were responsive to SSC comments from June 2010. Lacking a stock assessment model, the authors continue to base stock status determination for Tanner crab on results from the annual summer trawl survey. This year, the revised survey estimates were corrected based on survey net width for the first time and included the 2010 summer survey. The latest results confirm that estimated Tanner crab abundance has fallen below the MSST, which will require a rebuilding plan to be developed by October 1, 2012. The SSC noted a sharp one-year decline in the estimated abundance of mature females. Here, and in similar instances, the SSC would like the authors to report whether such declines are statistically significant.

A stock assessment model is under development, but is not yet ready for review. It is imperative that the model be completed for use as a projection model in the rebuilding analysis. A workshop on crab model development, to be held in February 2011, will be helpful in this regard. As noted in the June 2010 SSC report, the SSC would like the authors to develop a model capable of handling two different minimum size limits in the eastern and western areas, because the Alaska Board of Fisheries may take such an action at their next meeting on BSAI crabs. Also, the SSC looks forward to a model that considers recent results on gear selectivity.

As indicated in the SSC's June 2010 report, the SSC concurs with the CPT that the years used for status determination should be further investigated with respect to potential changes in productivity, and a rationale provided for the selected choice. In addition, the issue of Tanner/snow crab hybrids should be examined. Apparently, the hybrids are allocated to one species or the other based on eye color and mouth shape in the landings, but are identified as hybrids in the surveys and not counted toward the survey estimates for Tanner and snow crab. While in practice this could be a conservative approach, it would be useful to know how the current practice affects species-specific catches relative to the specified harvest strategy and whether some species-specific accounting needs to be better reconciled between stock assessments and catch reporting.

Pribilof Islands Red King Crab
The OFL method and tier determination were approved by the SSC for this stock in June. The SSC appreciates the concise nature of the stock assessment chapter. Based on the CPT's recommendation, we suggest that the author examine an average of recent survey biomasses when computing the OFL and look forward to a presentation of this in June 2011. The SSC continues to look forward to the implementation of a catch-survey analysis for this stock.

Pribilof Islands Blue King Crab
The OFL method and tier determination were approved by the SSC for this stock in June 2010. As with the similar red king crab assessment for the Pribilof Islands, the SSC appreciates the concise nature of the document. The SSC agrees with the CPT that an average of recent survey biomasses be examined when computing the OFL. The SSC continues to look forward to the implementation of a catch-survey analysis for this stock.

St. Matthew Island Blue King Crab
St. Matthew blue king crabs are assessed with a four-stage catch-survey analysis of males only and managed under a Tier 4 designation. The authors have been responsive in addressing previous SSC comments. The SSC looks forward to the results of the author's ongoing efforts to reconcile discrepancies in recruits estimated by the model and those indicated by pot surveys (see SSC's comments in June 2010). The SSC endorses the Crab Plan Team's recommendations for the May 2011 assessment.

Ecosystem appendix
Bob Foy (NMFS-AFSC) presented the work being done on this section of the Crab SAFE. The SSC commends the authors on advancing this section and has some recommendations for future consideration. The current section includes data through 2008-2009. It would be useful to add more current data, to the extent practicable. The SSC also continues to encourage crab stock assessment authors to use the information within their individual stock assessments. Finally, there would be value in re-examining the prey used at all age classes of crab. In the vicinity of the Pribilof Islands, there should be a concentrated effort to determine prey use by potential predators of crab, in particular PIBKC, to see if predation might be a contributor to the failure of this stock to meet rebuilding targets, particularly given the spatial changes in flatfish predators that may have occurred.

In discussing recent trends in crab and the Bering Sea ecosystem, authors should recognize that the period 2000-2010 is comprised of two very different pentades: a warm one from 2001-2005 and a cold one from 2007-2010, with 2006 intermediate in conditions. Averaging over 2000-2010 for many aspects of the marine environment may prove misleading.

C-3 Crab ACL

Diana Stram (NPFMC) presented the final Environmental Assessment for proposed Amendments 38 and 39 to the Fishery Management Plan for the BSAI King and Tanner Crabs to comply with Annual Catch Limit requirements and to revise the rebuilding plan for EBS snow crab. The SSC reviewed the initial review draft in June 2010 and provided extensive comments at that point. The SSC commends the authors for extensive clarifications and additions to the document, which clearly lays out the issues and provides detailed guidance to the public and to the Council for choosing among the Alternatives. Public testimony was provided by Edward Poulsen (Alaska Bering Sea Crabbers) and Arni Thomson (PNCIAC and Alaska Crab Coalition).

The SSC provides the following comments and recommendations to inform the Council in its decision:

1. Choice of alternatives for establishing ACLs. The SSC has generally favored and previously recommended the P* approach for determining appropriate buffers between ACL and OFL where possible. Because of the difficulty in quantifying uncertainty in OFL for stocks in the lowest tier, **we support a blended approach using P* for Tiers 1-3 and constant buffers for Tier 5 and possibly for Tier 4 stocks.** For Tier 5 stocks, the distribution of OFL (and therefore the probability that ABC exceeds OFL) cannot be reliably estimated and is likely to be highly variable. Therefore, a constant buffer would provide for greater stability over time. For Tier 4 stocks, the SSC notes that a constant buffer may need to vary across stocks because of different levels of uncertainty, whereas a P* approach would implicitly account for different levels of uncertainty. In June 2010, the Council selected the status quo as the Preliminary Preferred Alternative and the revised EA now includes more details on this alternative.

2. Process for determining the appropriate level for "additional" uncertainty in the estimates of OFL. One of the key features of setting Annual Catch Limits is the consideration of the amount of scientific uncertainty in the point estimate of OFL to provide for an appropriate buffer between the ACL and the OFL that takes into account uncertainty in the OFL. Sources of uncertainty include both within-assessment uncertainty (σ_w), which can be directly quantified, and any additional sources of uncertainty (σ_b) that are much more difficult to quantify. The SSC recognizes that values for σ_b currently have relatively weak quantifiable scientific support. However, the EA provides context for the magnitude of additional uncertainty in other fisheries and the CPT has developed reasonable criteria for classifying stocks into those with low, intermediate, and high levels of additional uncertainty. An alternative approach whereby the determination of σ_b would be deferred to the State was discussed, but no details were given nor was written analysis available to evaluate this process.

The SSC has previously discussed concerns that the default values for additional uncertainty in OFL might become fixed values that would be difficult to change. **The SSC recommends that the initial default values be evaluated annually by the assessment authors, CPT, and SSC and that the CPT further develop a process and criteria for how to determine the most appropriate levels for σ_b.** This process should draw on State and federal expertise in evaluating different sources of scientific uncertainty to ensure that the best available information is used.

Both the CPT and the public expressed concerns about "double" buffering or excessive levels of precaution that could result from a poorly designed process. For example, if assessment authors or the plan team are conservative in estimating the OFL, this would duplicate considerations of uncertainty if the same sources of uncertainty are also included in determining σ_b. To avoid this duplication, the OFL should always be set at the "best" (risk-neutral) point estimate and not at some conservative level. Consideration of scientific uncertainty in the level of OFL is appropriately applied through the specification of σ_w and σ_b. **The SSC feels that the public process established by the Council for reviewing stock assessments through the plan teams and the SSC provides the best forum for determining the appropriate level of scientific uncertainty in OFL for the purposes of establishing Annual Catch Limits.**

3. Skewed OFL distributions. The SSC notes that there is inconsistency in the use of the mean versus the median as the "best" estimate of OFL across stocks. This can have large implications for buffer sizes and P* values in the case of those stocks that have a skewed OFL distribution, as shown in the EA. The SSC suggests that in future assessment cycles, the authors and CPT clearly state whether the mean or median is used in a given assessment and that some justification be provided for the choice.

4. Timing of SSC recommendations: Several options are included in the document to ensure that the SSC recommendations for ABCs can be made prior to setting TACs. The SSC in June 2010 requested an analysis of the possible consequences of Option 4, which would have the SSC set ABC levels annually in June. The EA includes some analyses of the relative errors between using a one-year-ahead projection and using updated assessment results after all the survey data for the current year are included. The results

clearly show that relative errors can be substantial and the SSC recommends against Option 4 because it does not make use of the best-available scientific information.

5. Snow crab rebuilding: The document has changed little since the initial draft. The SSC received information that a revised rebuilding plan might not be required because the current stock assessment model indicates that the stock never dropped below MSST in the past. However, the Council may choose to proceed with revising the rebuilding plan or accept status quo. The SSC suggested that the current rebuilding plan is adequate to meet rebuilding targets. The SSC previously recommended that a revised rebuilding plan consider a one-year time-frame of being above the B_{MSY} threshold to declare the snow crab stock rebuilt and suggests that this could still be a consideration for a revised rebuilding plan or FMP amendment. More generally, the SSC recommends that stocks that have an assessment model and are under a rebuilding plan should be considered rebuilt if biomass exceeds B_{MSY} for one year. The rationale is that model-based biomass estimates are less variable than survey biomass estimates.

Additional SSC comments:
In June 2010, the SSC recommended that "the relative economic performance of the competing alternatives, as projected in the model, be characterized as percentage changes, rather than gross discounted present value estimates of foregone revenue." The document has been changed in response to this recommendation. In addition, the author's presentation of long-term nominal economic projections has been supplemented with the requested caveats and relative performance measures, expressed in 'percent change' from status quo–baseline information. The SSC appreciates the analysts' responsiveness to our concerns. The SSC also had a number of minor and editorial suggestions that will be communicated to the authors.

C-4 Scallop ACL

Diana Stram (NPFMC) presented a report to the SSC on the public review draft of the Environmental Assessment (EA) for the proposed amendment to the Fishery Management Plan for the Scallop Fishery off Alaska to comply with Annual Catch Limit (ACL) requirements. Public testimony was provided by Jim Stone (Alaska Scallop Association). The SSC most recently reviewed the Initial Review Draft of the EA at the June 2010 Council meeting.

This draft of the EA provides a good description of the alternatives and options to address the need for compliance for scallop ACLs. Alternatives include Alternative 1 (Status Quo), Alternative 2 (ACL = OFL), Alternative 3 (ACL = 90% OFL), and Alternative 4 (ACL = 75% OFL). For Alternatives 2 through 4, sub-alternative "a" applies the ACL determination on a statewide basis, whereas sub-alternative "b" applies the ACL determination on a regional basis. The EA also analyzes three options for dealing with non-target stocks: (1) remove non-weathervane scallops from FMP, (2) move non-target scallops to ecosystem component (EC), and (3) set ACLs for non-target scallop species. Previous SSC comments have been adequately addressed, and the SSC finds that the public review draft provides sufficient information for an informed decision by the Council.

As noted by the SSC in June 2010, Alternative 2a and 2b result in a P*=0.5, but national ACL guidelines specify that the probability of overfishing must be less than 50%. Therefore, Alternatives 2a and 2b do not seem to comply with NS 1 Guidelines, which state that "If a Council recommends an ACL which equals ABC, and the ABC is equal to OFL, the Secretary may presume that the proposal would not prevent overfishing, in the absence of sufficient analysis and justification for the approach."

Of the viable alternatives, Alternative 3a (ABCs = 90% OFL) results in a P*=0.285, and Alternative 3b results in a P* between 0.252 and 0.418, whereas Alternative 4a (ABCs = 75% OFL) results in a P*=0.091, and Alternative 4b results in P* values between 0.063 and 0.304. As pointed out in staff testimony, the Council is not rigidly constrained by the alternatives and the Council may select a

management option with alternative buffer sizes other than 10% (Alternative 3a, 3b) and 25% (Alternative 4a, 4b)

Management uncertainty for this stock is low. Table 4-3 shows that annual catches have been just 23% to 69% of the statewide OFL (Alternative 2a), whereas Table 4-3 shows that annual realized catches are generally <100% of regional OFLs, with a few exceptions (Alternative 2b). As noted in the SSC's June 2010 report, quota management since fishery rationalization has been extremely precise for the scallop fishery, and this unusually high level of precision indicates that management uncertainty for this stock is low. Also, there are very small amounts of scallop bycatch in non-target fisheries, further reducing uncertainty in estimates of total fishing mortality.

Regarding scientific uncertainty, the SSC notes that the MSY estimate of 1.24 M lbs may be conservative, because it does not consider potential sustained yields from extensive areas that are closed to scallop fishing, owing to deference to subsistence preference (Southeast Alaska) or concerns about crab bycatch (large areas around Kodiak Island, along portions of the Alaska Peninsula and Aleutian Islands, and into the eastern Bering Sea). However, current assessments rely on catch rates and techniques for obtaining reliable biomass estimates are currently under development.

Another facet of the Council decision is the choice of the spatial scale over which to apply ACLs. The Scallop Plan team recommends against regional ACL application because the registration areas are not primarily biologically based; for instance, some registration areas bisect scallop beds (e.g., near Cape Douglas, and north of Yakutat near Kayak Island). A genetic study using allozyme, microsatellite, and single nucleotide polymorphism found genetic homogeneity among weathervane scallops sampled over 2,500 km from the eastern GOA to the BS (Gaffney et al., in press). Such a finding would be generally consistent with stock structure of the related Atlantic sea scallop, which exists as a metapopulation on the U.S. east coast – that is, spatially separated aggregations that are separated by geography but linked by larval dispersal. For these reasons, the SSC supports the estimation of ACLs at a statewide level. However, because there remains some level of uncertainty about stock structure, the SSC recommends future research into the stock question.

The options for handling non-target scallop species are well described. Option 1 (removal of non-weathervane scallops from the FMP) poses some, albeit small, risk of another "Mr. Big" incident in which a vessel may choose to not register with the state and nevertheless fish unregulated in the EEZ for non-weathervane scallops. Option 3 requires calculation of ACLs for non-weathervane scallop species. The SSC notes that, if the Council chooses option 3, these ACL calculations would likely need to be made prior to final action. Calculation of ACLs for these non-target scallop species is rather problematic owing to very sparse data on the abundance, distribution, and life history attributes of these non-weathervane scallop species. Option 2 (place non-weathervane scallop species into Ecosystem Component, EC) is somewhat debatable, because there is reportedly some low, but non-quantified, level of personal use and occasional commercial landings, whereas the EC designation states that such species are "Not generally retained for sale or personal use." However, reasonable interpretation of "generally" appears to allow for the EC designation. The Scallop Plan Team recommends Option 2, which appears to be a prudent choice that balances the difficulties with Options 1 and 3.

The SSC has also supplied to the author a number of suggested edits and elaborations pertaining to the RIR analysis, for consideration.

C-5 GOA Tanner Crab Bycatch

Staff presentation was provided by Diana Evans (NPFMC), John Olson (NMFS AKR), and Nick Sagalkin (ADF&G). Public testimony was offered by Alexus Kwachica (Kodiak Crab Alliance Co-op), Dorothy

Childers (Alaska Marine Conservation Council), Stephen Taufen (for F/V Stormbird and F/V North Point), and Julie Bonney (Alaska Groundfish Databank).

The authors have made substantive changes to the document in response to SSC comments provided during our April 2010 review. In particular changes were made to clarify or expand on describing what is known about Tanner crab abundance and movements in the proposed closure areas as well as magnitude and size composition of Tanner crab bycatch. The EA portion of the document is reasonably complete in describing what is known about Tanner crab and the various groundfish fisheries that operate in and near the proposed closure areas despite acknowledged deficiencies in the available data.

However, the SSC notes that, among other purposes, the problem statement indicates that "*Specific protection measures should be advanced to facilitate stock rebuilding.*" Relative to this portion of the problem statement, the analysis lacks projections of Tanner crab stock trajectories under the status quo or action alternatives. Consequently there is no information to suggest the likely magnitude or timing of Tanner crab stock increases under either action alternative, let alone the magnitude or economic value of any such increase at the scale of the options or suboptions under the alternatives. Without a stock dynamics model for GOA Tanner crab, it is difficult to determine what, if any, incremental increase in Tanner crab populations might arise from either action alternative relative to the no action alternative. The SSC notes that, in addition to possible stock benefits associated with the proposed action, there is an allocative dimension that could have been provided as a basis for evaluating possible benefits. For example, current Tanner crab bycatch mortality could have been used as a basis for determining the numbers of legal crab that could be taken in subsequent directed crab fisheries. This latter approach treats the proposed amendment as a choice about allocating harvestable surpluses of Tanner crab between a directed crab fishery and a groundfish fishery that entails Tanner crab bycatch mortality. An advantage of such an approach is that it does not rely on presumptions that reduced bycatch would translate into increased future abundance. The SSC realizes that there is substantial uncertainty to predicting crab stock changes as a result of management actions. For instance, a combination of reduced harvest rates, crab bycatch caps, and trawl area closures implemented in the mid 1990s seem to have resulted in steady stock rebuilding of Bristol Bay red king crab over the ensuing 10 years. However, a similar suite of management actions with respect to Kodiak red king crab in the mid 1980s resulted in no measureable improvements in the status of that stock to date.

In addition, the SSC notes that the analysis does not provide sufficient basis to draw the conclusion (page 99) that "some net benefits may accrue to the Nation through continued rebuilding of Tanner crab stocks." Specifically, the net benefits section concludes that there will likely be no net loss in groundfish catches, implying that the opportunity costs for groundfish vessels to redeploy from areas where they have fished into areas where they have not fished "may" increase. In terms of potential benefits of the action alternatives, the analysis does not provide estimates of crab savings or rebuilding trajectories that allow a conclusion to be drawn that the benefits outweigh the costs. The fundamental issue here is one of allocating benefits and costs between a crab fishery and a groundfish fishery. This document does not provide adequate basis for understanding the relative magnitude of benefits or costs associated with the action alternatives.

C-7 Five-Year Research Priorities: 2011-2015

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 activities that must be addressed to satisfy federal requirements and to address pressing fishery management and ecosystem issues related to fishery management. 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 bycatch, 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 constitute 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.

The research priorities are listed in Appendix A to this report.

D-1(b) Discussion paper Economic data collection

Mark Fina (NPFMC) provided an overview of the discussion paper. The motivation for preparation of this paper was a request from the Council to Council staff. While the presentation focuses principally upon the data concerns, needs, and applications within the context of the Council fisheries management process, there are other legitimate data needs not articulated within the paper. Among these are scientific research, application to non-fishery management resource issues (e.g., ESA, MMPA), and emerging demands at the national-level for comprehensive and standardized economic data collection methodologies.

As noted by staff, the discussion paper lacks a purpose and need statement; development of a clear purpose and need statement is a crucial next step. The current draft analysis does not include any description of the criteria used to determine data quality. There does not appear to be any statistical basis for this determination. The SSC reiterates that it is incumbent on NMFS and the Council to ensure collection of data needed to support analysis of the actual and anticipated economic benefits and costs, distributional impacts, and net National benefit estimates of competing alternative management actions. The SSC suggests that it might be useful to convene a CIE or NRC panel to review the EDR and similar data collection programs.

D-2 BSAI and GOA Groundfish Specifications and Plan Team Reports

The SSC received a presentation from Grant Thompson (NMFS-AFSC) on the GPT's proposed ABC and OFL specifications for 2011 and 2012 and provided an overview of GPT's recommendations and discussions of various studies and analyses reviewed at the September meeting. The SSC notes that 2010 several survey results did not reveal a conservation concern. The SSC agrees with the GOA and BSAI GPTs that proposed specifications should be based on a roll over of the 2011 harvest specifications. The SSC also agreed with the plan team's proposal with respect to the 2011/2012 specifications to: 1) split Kamchatka flounder from the Arrowtooth flounder complex in the BSAI, 2) split the ABC for blackspotted/rougheye rockfish complex into AI and EBS components, and 3) specify ABCs and OFLs for sharks, skates, sculpins, and octopus in the BSAI, and 4) specify ABCs and OFLs for sharks, squid, octopus and sculpin in the GOA. The SSC will consider in December the three alternatives described by the BSAI plan team for splitting the blackspotted/rougheye rockfish complex.

Stock Structure

The SSC received an overview of GPTs' discussions and recommendations on stock structure. The SSC recognizes the valuable contribution of the Stock Structure Working Group report to the development of consistent framework guidelines for evaluating all sources of information to aid in defining stock

structure for managed species. The SSC requests that a problem statement be developed that focuses on the question of stock structure.

The report correctly articulates that the interpretation of scientific information on stock structure should be an objective, scientific process, whereas the application of the precautionary approach under uncertainty should be reserved for management and policy decisions. The report correctly notes that compiling the available scientific information is the first step, which should be followed by an evaluation of the risks associated with status-quo and alternative management strategies. Although the report could indicate that there may be reasons for spatial management on scales smaller than identified stock boundaries, this should not become the focus of the report.

The guidelines are intended to inform the GPT's and SSC when determining spatial management units for exploited Alaskan groundfish species. Spatial management determinations will be based on a case by case basis during the annual specification setting process. The SSC notes that considerations of stock structure is an integral part of a good stock assessment, and endorses efforts to fully consider scientific information on stock structure for those assessments where this has not already been done. Uncertainties in this regard are usually brought forward in the annual process to determine research priorities.

The GPT's were presented with three case studies using the framework guidelines, including Atka mackerel, Pacific cod and blackspotted/rougheye rockfish. The SSC appreciates the use of examples to demonstrate the process by which scientific information is considered. The plan teams provided recommendations for splitting the Black-spotted/rougheye rockfish complex ABC into AI and BS components and recommended the author provide another alternative where the ABC would be split at the mid-range of the complex's spatial distribution. The SSC agrees with both recommendations.

The working group proposed that the ABCs for all GOA and BSAI stocks should be subdivided into subsets of NMFS areas as a precautionary measure. The plan teams endorsed this with a modification "to the extent practicable." The SSC does not support this recommendation as a blanket approach. The need and degree for finer spatial management is a function of life histories, which vary on a species by species basis. Proposals for subdivision of ABCs within a stock, along with supporting scientific and fishery information, should be considered on a case by case basis in the annual stock assessment process.

Pacific cod model

The SSC reviewed recent developments of the Pacific cod models for the BSAI and GOA and was pleased to see that the process for vetting suggested model changes through the GPTs appeared to be very effective in selecting a manageable number of reasonable models for the analysts to consider. The SSC was encouraged to see that the analyst was able to fit several models that do not include any age data and that results from these models were broadly consistent with results from other models that include the age data. The SSC has the following recommendations for the analyst with regard to decision points:

- The SSC agrees with the GPTs recommendations to bring forward models 2 and 4 in November, but to modify the models to include constant growth over time. However, the SSC requests that the authors include results from the previously approved Model 1 (last year's model) for comparison. Models 5 and 6 appear to either overfit the data and/or resulted in unreasonable estimates of the standard deviation of length-at-age.
- The SSC agreed with the use of the 1 cm bin structure, but had concerns about possible artifacts arising from the large number of length bin / year / season combinations and the likely presence of a large number of zero entries. Therefore, we recommend that the authors explore an intermediate bin size in next year's assessment that results in fewer zeros and faster run times.

- With respect to iterative estimation of input standard deviations (for "deviation vectors") and other quantities, the SSC recommends that the author use his judgment in determining a reasonable approach for setting these quantities.
- The SSCs recommends that an examination of maturity-at-length (instead of maturity-at-age) in the "age-free" models, as suggested in public comments, would be appropriate but should be deferred to next year.

GOA Rock Sole Model Review

The SSC is pleased to see this first attempt to develop a statistical age-structured model for northern and southern rock sole in the GOA. A few questions follow:

- On page 3, please clarify whether recruitment means recruitment to the survey gear or recruitment to the fishery. The SSC assumes the former was intended. Please justify the assumption of a 1:1 sex ratio at recruitment. For instance, are the size distributions of males and females similar at this stage?
- The SSC noted that the model seems to fit empirical age-frequency distributions reasonably well. However, length-at-age frequencies are not fitted well for some years for females (see p. 38-39). Do these discrepancies indicate evidence of shift in growth rates that should be specified in the model or do they indicate some other problem, such as a sampling issue? Also, the SSC noted some discrepancies between model and empirical length-frequency distributions (p. 44, 46, 47). Some of those discrepancies appear to be related to very small sample sizes in some years. A full assessment should consider the extent to which data weighting by sample size may address such issues. A full assessment should carefully consider and discuss such model fit diagnostics.
- In the full assessment, consider adding a statement about the method used to age rock sole and whether those ages have been validated. Last, the SSC requests a description of the basis for stock definition in the full assessment following the guidelines developed by the stock structure working group.

The SSC endorses the Groundfish Plan Team recommendations, including consideration of sex- and stock-specific M, and examination of northern and southern rock sole geographic distributions in the survey dataset. Evidence of spatial patterns in species mixtures could assist in classification of "unknown" rock sole in historical data to allow the assessment to be extended to earlier years. At first examination, it appears that this assessment will meet Tier 3 criteria.

BSAI Flatfish: Incorporation of Time-varying Selectivity

The SSC received a very brief report on the need to consider time-varying selectivity in the BSAI yellowfin sole and northern rock sole stock assessments. The SSC supports the GPT's recommendation to explore the utility of this time-varying selectivity in the next assessment. The current (base) model should also be retained in the assessment to facilitate evaluation of the alternative model incorporating time-varying selectivity.

Other Species Specifications

The SSC received a report by Grant Thompson (NMFS-AFSC) and Jane DiCosimo (NPFMC) summarizing discussions and recommendations by stock assessment authors and the groundfish plan teams regarding splitting "other species" management groups for the BSAI and GOA into constituent stock complexes. Written reports were provided for SSC review on shark, octopus, sculpin, squid, and skate complexes in the BSAI and GOA. Public testimony was provided by Kenny Down (Freezer Longline Coalition) specifically related to the shark complex.

For the BSAI skate complex, the plan team recommended not changing the current method of assessment (combining Tier 3 and Tier 5 methods). The SSC agrees, and notes that we will entertain separate Tier 3

management for Alaska skates if additional information is provided. GOA skates are already separated out of the current "other species" complex in the Gulf, and no changes are recommended.

Sculpins in both the BSAI and GOA are now treated as Tier 5 species. The GPT highlighted the disparate approach to treatment of natural mortality estimates, in which the estimate of M for each species in the BSAI is chosen as the best among available estimates, whereas the most conservative single estimate of M is used in the GOA. The stock assessment author will be investigating improved estimates for M in the Gulf and the SSC looks forward to seeing this in the future. The SSC notes that although we have previously endorsed the conservative approach to selecting M for GOA sculpins, objective estimates will be required with adoption of amendments implementing ACLs.

Squid are currently estimated with a Tier 6 approach in both the BSAI and the GOA. However, squid are already split out as a separate complex in the BSAI, but not in the GOA. The SSC agrees with the GPT recommendations to continue with the Tier 6 approach in both regions. We recommend the exploration of a percentile approach for the GOA and ask to see an examination of this in the assessment next year. The SSC does not endorse a "minimum" biomass estimate in a Tier 5 approach. We would welcome a full analysis of a minimum biomass approach under Tier 6 for consideration in the future.

Sharks are currently assessed as Tier 6 complexes in both regions. The GPT was presented with 6 alternative methods for assessment by the stock assessment authors, where 5 of the methods are variants of the Tier 6 approach and one method was a blend of Tier 5 and 6 methods. The SSC recommends against the percent of maximum catch approaches, and instead recommends consideration of a percentile approach. The proposed method 4 ("tier 5.5") has a number of fundamental problems (combining biomass and catch values, inclusion of uncertainty into the point estimate of OFL) and the SSC recommends against pursuing this.

The stock assessment author proposed a percentile method for assessing octopus in each region. The SSC encourages further development of this approach with accompanying rationale for our review in December, 2010. The SSC disagrees with the GPT recommendation to set ABC at the average catch; instead, we recommend using the default formula of ABC = 0.75 x OFL.

Tier 6 Workshop

On July 8, 2010, a group of SSC members, GOA and BSAI plan team members, assessment analysts, Council staff, and the public met via videoconference to respond to a request by the Council to explore alternative methods of determining ABC and OFL for Tier 6 stocks. The Council is concerned that the present use of average historical catch may unduly constrain catches in other fisheries. Several case studies were presented and a number of alternatives were entertained and discussed, as summarized in the workshop report. The workshop has spurred analysts to propose alternatives to average catch in some cases in this assessment cycle.

Rockfish Maturity

The SSC reviewed the report prepared by Rodgveller et al. on estimating rockfish maturity and the GOA GPT recommendations for future evaluations of maturity in stock assessments. The SSC agrees that when possible, the analysts should consider including maturity data and parameter selection in the stock assessment to incorporate the uncertainty associated with maturity schedules into the assessment. While the standardization of procedures is an appealing approach, the SSC concludes that the stock assessment author should have the discretion to select the approach that makes the best use of the available information.

Economic Status Report

The Economic SAFE has dropped several time series of economic data (Tables 52-60). This is appropriate as these time series are either discontinued or readily available from primary data sources

referenced in the report. The SSC looks forward to seeing analyses of market conditions in the final draft SAFE Economics Status Report in December.

Ecosystem Chapter
The new Ecosystems Considerations Chapter of the Groundfish SAFE reflects adoption of many of the changes suggested by the SSC in 2009, and has the potential to be of considerable value. A significant deficiency of the current draft is the absence of updates on most of the marine mammal and seabird issues. Of the sections listed, two were last updated in 2009, two in 2008, three in 2007 and five were last updated in 2006. Many of these involve endangered species (SSL last updated in 2007; seabird bycatch in 2006, reported in 2008, and declines in marine mammals in 2006). The lack of this information on seabirds and marine mammals is a serious deficiency. This information is critical to managers and industry because interactions between fisheries and these species could result in the shutdown of a segment or segments of the fishery.

Sablefish survey
The SSC was pleased to hear that a new survey index is being pursued. The SSC commented that there are some computational issues with the proposed analysis and recommended that analysts consider using data at the station level instead of at the skate/hachi level to reduce the size of the data set and the number of zero values.

Halibut fisheries working group report
The SSC notes that this work is still in progress, and that the report is a very brief summary of the work to date. As such, it is difficult for us to make specific comments at this stage. We look forward to seeing a more detailed description of the proposed analysis, including variance estimation, at a later date.

Pollock CIE Review
This assessment underwent a CIE review in June of this year and the SSC received a copy of the review and of the response by Jim Ianelli, the assessment's lead analyst. The reviewers' main concerns involved retrospective error, trying to estimate annual changes in selectivity, including ageing error in the model, concern over the high amount of ageing error, and omission of some model diagnostics.

All three CIE reviewers commented on possible ageing issues particularly for fish older than age 5. There appears to be marked differences in the level of agreement at the oldest ages between readers. At issue is the current practice of allowing readers to use one of three methods in preparing the otoliths for reading. It was recommended that ageing procedures and protocol be reviewed toward the goal of achieving greater consistency The SSC requests that the ageing unit of AFSC provide a written response to the comments on the amount of ageing error and that they evaluate whether current protocols need to be revised.

Regarding the assessment, Ianelli plans to address many of the remaining comments this year. First, ageing error and reducing variability in between-year age selectivity will be considered in the assessment; some work has already been done. Secondly, the error in one-year-ahead forecasts will be examined. Third, additional model diagnostics will be included. Finally, the robustness of the current harvest policy of setting directed catch to 0 at the B20% level will be explored.

The SSC supports the CIE reviewer recommendation that the assessment authors evaluate whether a plausible spawner-recruitment relationship, consistent with a Tier 1 designation, is still an appropriate basis for computing reference points in light of the apparent strong variation in recruitment related to the recent stanzas of warm and cold years

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 is needed to identify population bottlenecks, an aspect that is critically needed to develop and implement rebuilding plans.

2. Improvements are needed for in-season catch accounting by sex and size for crab in non-directed fisheries with high bycatch rates.

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.

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.

2. Refine methods to incorporate uncertainty into harvest strategies for groundfish for ACL estimation.

3. Develop biomass indices for Tier 6 species, such as sharks.

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.

C. Fishery Management

1. Develop a strategy to manage salmon bycatch in the BSAI and GOA.

II. Fisheries Interactions

A. Protected species

1. There is a need for studies of localized interactions between fisheries and protected species. Studies of interactions between Steller sea lions and commercial fishery 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. A short-tailed albatross monitoring program is needed to quickly record and communicate STAL encounters with commercial fishing operations.

3. More studies are needed to fully evaluate the possible linkages between fishery induced disturbances or local prey depletion for northern fur seal in the Pribilof Islands region.

4. Further research is needed on gear modifications and fishing practices for reducing bycatch, particularly of PSC species (e.g., salmon).

5. Conduct studies of whale depredation of catch in long-line fisheries and surveys to improve the quality of long-line abundance estimates.

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.

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.

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. 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. Continue to plan and implement routine surveys into the northern Bering Sea and conduct baseline surveys of the 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 are 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 snow and 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. There is a need to 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 Being Sea snow and Tanner crab and Bristol Bay red king crab.
9. Continue and expand existing efforts to collect maturity scans 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.

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.
2. Improve estimates of natural mortality (M) for several stocks, including Pacific cod and BSAI crab stocks.
3. Studies are needed to validate and improve age determination methods for Pacific cod, Pacific sleeper sharks, and spiny dogfish.
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. There is a need for the development of 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.

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.

8. Studies of sources and sinks for scallop larvae are needed to improve our understanding of the rate of larval exchange between scallop beds.

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.

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. Development of an ongoing 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 economic effects from recently adopted crab rationalization programs on the Gulf of Alaska coastal communities, including Kodiak. This includes understanding economic impacts (both direct and indirect) and how the impacts are distributed among communities and economic sectors.

II. Fisheries Interactions

A. Catch Estimation Issues

1. Improve estimation of fishery interactions (including catch) with marine mammals (e.g., state-managed gillnet fisheries), seabirds, non-target crab and groundfish (e.g., sharks, skates), and protected species. Improved methods should include direct and alternative monitoring options (e.g., electronic logbooks, video monitoring), particularly on smaller groundfish, halibut, and commercially guided recreational fishing vessels.

B. Protected Species Interactions

1. Population dynamics, life history, and assessment of protected species, particularly Steller sea lions and northern fur seals, are a high priority. In particular, investigation of factors contributing to changes in natality of Steller sea lions is an important area of research.

2. Economic, social, and cultural valuation research on protected species (i.e., non-market consumptive use, passive use, non-consumptive use).

3. 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

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.

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 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. A recent example includes slope HAPCs 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.

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

4. Ecosystem indicator synthesis research (thresholds, management objectives)

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.

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 and other 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.

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

C. Basic research on trophic interactions

1. Collect, analyze, and monitor diet information, from 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 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).