AGENDA D-2(d)
OCTOBER 2009

MEMORANDUM

TO: Council, SSC and AP Members

FROM: Chris Oliver
Executive Director

DATE: September 23, 2009

SUBJECT: Research Priorities

ESTIMATED TIME
4 HOURS
All D-2 Items

ACTION REQUIRED

Adopt five year research priorities.

BACKGROUND

The Magnuson-Stevens Act requires the Council to adopt a five-year plan each year. The Council adopted its first five-year research plan in October 2008 (Item D-2(d)(1)), based on recommendations from its four Plan Teams, the Scientific and Statistical Committee, and the Advisory Panel. At this meeting, the Council will update its five-year research plan. The recommendations from the Scallop Plan Team (Item D-2(d)(2)), Crab Plan Team (Item D-2(d)(3)), and Joint BSAI and GOA Groundfish Plan Teams (Item D-2(d)(4)), are attached.

North Pacific Fishery Management Council
Five-Year Research Priorities, 2009-2013
Adopted October 2008

Based on recommendations from its scientific committees, the Council has identified priorities for research in the next one to five years as those activities that are the most important for the conservation and management of fisheries in the Gulf of Alaska, Aleutian Islands and the eastern Bering Sea. This listing of priorities is intended for 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.

I. Fisheries

A. Fish and Fisheries Monitoring

- 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.

- Design and implement an improved observer delivery program that allows accurate estimation of the catch by season and sector (Also see Priority II.A.1)

- Improvements are needed in in-season catch accounting for crab in non-directed fisheries with high incidental catch rates.

- 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.

- 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 movements of fish and shellfish for use in studies of species interactions in spatially explicit stock assessments.

- 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, including GOA POP stocks.

- 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 biannual groundfish surveys.

- Identification and recovery of archived data (e.g., historical agency groundfish and shellfish surveys) should be pursued.

- There are needs 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.

- Continue and expand existing efforts to collect maturity scans during fisheries that target spawning fish.

B. Stock Assessment

- Improve species identification in catches by both processors and observers for priority species within species complexes to avoid misidentifications, and to reduce the large numbers of unidentified individuals.

- Assess discard mortality rates of Tanner crab by size, month, sex, and fishery type.

- Improve information (specifically, natural mortality, size at maturity, and other basic indicators of stock production/productivity) for "other species" and data-poor stocks of crab to allow application of Tier 5 or Tier 4 assessment criteria. Two possibilities that would require dedicated research for development are: (1) directly estimate fishing mortalities through large-scale tagging programs; and (2) 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.

- Collect data to improve natural mortality (M) estimates. Estimates of M (obtained independently from models) are needed for several stocks, including Pacific cod and BSAI crab stocks.

- Quantify the effects of climate variability and climate change on recruitment and growth by developing standard environmental scenarios for 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.

- There is a need for the development of advanced stock assessment modeling techniques. Specifically, there is a pressing need to develop techniques for linking uncertainty into stock assessments, including both scientific uncertainty (measurement error, process error or model misspecification) and implementation error (enforcement and catch monitoring).

- 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 (see Strategic Priority IV.A.1.a "Climate variability" below for more detail).

- 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, and Atka mackerel (see element 5 in Expanded Ecosystem Studies below). Specific issues include: a) an evaluation of the location of potential boundaries for an AI – EBS split that would be needed to assess the implications of the creation of a separate Aleutian Island management area, and b) stock delineation for estimation of adult equivalence to appropriately account for the impact of incidental catches of salmon in pollock fisheries on salmon populations.

- There is a need to investigate whether scallop beds coincide with retention zones, as determined by circulation patterns, and how this relates to stock structure. There is also a need to investigate movement of scallops within beds to determine whether scallops can and do fill in areas that have been previously harvested.

C. Fishery Management

- 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).

- 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.

- An evaluation is needed of economic effects from the recently adopted crab rationalization program on Gulf of Alaska coastal communities, including Kodiak. This includes understanding the economic impacts (both direct and indirect impacts) and how the impacts are distributed among communities and economic sectors, conducting qualitative research to assess changes in community participation and effort in fisheries, and estimating net economic benefits.

- As Kodiak is likely to be at the center of controversy over the likely consequences of Gulf rationalization, research should be designed to use Kodiak in addition to other Gulf communities as case studies in prospective analyses of the potential effects of Gulf rationalization options on fishing behavior, participation, and economic impacts.

- Development of an ongoing database of product inventories (and trade volume and prices) for principal shellfish, groundfish, and salmon harvested by U.S. fisheries in the North Pacific and Eastern Bering Sea.

- Analyze current determinants of exvessel, wholesale, international, and retail demands for principal seafood products from the GOA and BSAI;

- 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, pollock, and crab fisheries). "Benefits and costs" include both economic and social dimensions. For example, analyses are needed of the magnitude and distribution of

economic effects of salmon bycatch measures for the Bering Sea pollock fishery. In this case, it is important to understand the ability of pollock harvesters to adapt their behavior to avoid salmon bycatch under various economic and environmental conditions and incentive mechanisms.

- Conduct prospective analyses of the robustness and resilience of alternative management strategies under varying environmental and ecological conditions.

- 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, bycatch restrictions, co-ops, IFQs).

- Develop a framework for collection of economic information on commercial, recreational, charter fishing, and fish processing to meet the requirements of the MSFCMA sections 303(a)(5, 9, 13), 303(b)(6), and 303A.

II. Fisheries Interactions

A. Bycatch and Observer Issues

- Improve estimation of total bycatch for marine mammals, seabirds, non-target groundfish and crab, and protected species. At present, it is clear that observer coverage in some fisheries is insufficient for estimation of total bycatch. Further, observer coverage must be analyzed to compare, to the extent possible, the total catch, bycatch, and fishing behavior between observed and unobserved fishing vessels. Examples include the CV trawl fisheries, sablefish longline fishery, Pacific cod pot and longline fisheries, halibut longline fishery, and guided recreational fisheries. Improved accuracy of identifications and enumerations of bycatch species is necessary. The current program results in imprecise bycatch (mortality) estimates for species such as skates, sharks, yelloweye rockfish, and sablefish in halibut longline fisheries, and discards in sport fisheries. 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

- 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.

- There is a need for studies of local fishery interactions. Whereas global fishery control rules may generally prevent overfishing on a broad regional basis, non-random patterns of fishing may cause high rates of removals in local areas important to apex predators such as Steller sea lions, ice seals, northern fur seals, spectacled eider, Steller's eider, and short-tailed albatross. More studies are needed to fully evaluate potential local effects of fishing on other components of the ecosystem (e.g., marine mammals, seabirds, and the impact on benthic habitat and fauna by bottom contact gear).

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

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

III. Habitat

A. Habitat Mapping

- 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.

- 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.

- Assess the extent of the distribution of Primnoa corals in the GOA.

B. Function of Habitat

- Evaluate relationships between, and functional importance of, habitat-forming living substrates to commercially important species, including juveniles.

- 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.

- 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. Recent example include slope HAPCs designated in the western Gulf of Alaska.

C. Evaluate habitats of particular concern:

- 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 the canyon areas, including mid-level and apex predators (such as short-tailed albatrosses) to neighboring shelf/slope ecosystems.

- Assess the extent, distribution, and abundance of important skate nursery areas in the EBS to evaluate the need for designation of new HAPCs.

D. Arctic baseline habitat assessment

- Dynamic ecosystem and environmental changes, on a pace not observed in recorded time, are occurring in the Arctic (among other regions). Given the establishment of a new FMP for the Arctic, assessment of the current baseline conditions is imperative. This effort should not supplant the regular surveys in the BSAI and GOA, which are the most important.

IV. Other areas of Research Necessary for Management

A. Expanded Ecosystem Studies

- Environmental influences on ecosystem processes

a) Climate variability: Changes in ocean temperature may affect managed species, upper level predators, and lower trophic levels.

- Sea ice: If recent changes in ice cover and temperatures in the Bering Sea persist, they may have profound effects on marine communities. 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.

- Zooplankton production: Apparent declines in zooplankton wet weight over the shelf, measured by the Oshoro Maru, could imply the loss of critical copepod and euphausiid prey of important commercial species, such as pollock, as well as the ESA listed North Pacific right whale.

- NMFS and BSIERP scientists should evaluate EBS survey data collected in 2008 during the summer trawl survey, acoustic surveys, and the BASIS cruises to assess whether these surveys will provide reliable estimates of zooplankton species composition and abundance for the Eastern Bering Sea. Evaluate the potential of collaborative research with Japanese and Russian investigators to assess species composition and abundance in samples archived abroad.

- Fish composition: NMFS and BSIERP scientists should complete proposed analysis of 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.

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

- Trophic interactions.

a) Diet information, from seasons in addition to summer, is needed 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.

b) 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 selective removal of some components of the ecosystem (e.g., Pacific cod, pollock, and crab) relative to others (e.g., arrowtooth flounder).

Excerpts from Scallop Plan Team minutes on Research Priorities (February 2009 SPT meeting)

Research Priorities

Diana Stram reviewed the minutes from last year, which shows past research priorities, as well as the Council's SSC research priorities list. Scallop stock assessment is on the SSC list under item B6, and would also possibly fall under SSC item III, in general, on habitat mapping.

The team discussed the need to set a primary research priority in order to have a better chance for funding from a variety of sources. The consensus of the team is that our overarching goal is to identify stock structure so that we can move away from the statewide OFL definition. All other research priorities will remain on the list because research in those areas is still needed.

Ken Goldman stated that stock structure has very specific meaning, referring to the genetic structure of a population. He then stated that there are new genetics tools that may elucidate our understanding of weathervane scallop stock structure.

Gregg Rosenkrantz indicted that he would like someone in genetics to look into whether these techniques will help with management of the fishery? He noted that perhaps some oceanographic modeling and video plankton recording could be done. He questioned whether scallop genetics studies over a large time period are very applicable to management.

Ken reiterated that there are new techniques that should enable the stock structure connectivity between scallop beds could also be examined. He sated he will talk to a few geneticists who he works with on other projects in regards to their thoughts on this, but Ken felt that since they are doing this work on several species that it should be able to be done with scallops.

Doug Woodby, ADF&G staff in the audience, identified a genetic study that isn't published yet, but it indicates one stock with some genetic variation and suggests that sub area management might be warranted. Doug pointed out that there are also papers in molecular ecology notes on polymorphic microsatellites and another on SNPs on weathervane scallops. Thus, some of the genetics work has been done and there may be a baseline of data but we probably need a little more definitive study of it. There is also genetic work being done to separate localized stocks, mostly with Pacific Cod. There followed an audience discussion on non-genetic markers as well as on the limitations of genetics in management of the fishery. A theme of this discussion was that a research priority should be studies of advection of larvae between beds.

The team also discussed the need to indicate that we will notice EFH and NPRB on our research priorities. Matt Eagleton, NOAA Fisheries staff in the audience, also suggested that Essential Fish Habitat (EFH) Research Proposal funds could be available for scallop research. If we identify a priority item related to Scallop EFH and make this part of the EFH review, the priority could then be highlighted within the EFH proposal process. Matt will do this as part of the EFH process and pass along scallop research priorities.

ADF&G is developing a plan to assess GOA scallop stocks in primary fishing areas using a towed imaging system (ADF&G CamSled), and the SPT agree that continuation of research on stock assessment and scallop habitat mapping using CamSled is an important priority. However, the SPT noted that current definitions of MSY and OFL are based on a statewide stock, whereas current ADF&G management practices set GHLs for

Management Areas, Districts, and in some cases, statistical areas. If better scallop stock assessment surveys are to lead to more precise harvest control rules, then the SPT believe that an understanding of statewide scallop stock structure and how it affects scallop recruitment to major fishing areas will be essential.

This discussion led to the following definition of a Primary Research Priority:

Determine if discrete scallop beds along the GOA coast from Lituya Bay to Kodiak Island are reproductively isolated units or if upstream areas are a significant source of scallop recruitment via larval advection and subsequent settlement in downstream areas.

The SPT emphasizes that methods applied to this problem must address time scales relevant to the fishery management framework.

The team notes that work continues on many of the 2008 SPT Research Priorities; at this meeting, the team heard progress reports on CamSled research, a CamSled/dredge comparison, shell aging methodology, shell height modeling, and a pilot study on scallop meat quality and 'weak meats' in the eastern GOA.

Crab Plan Team Research Priorities:

Crab Plan Team discussed research needs and identified the following items as being of the highest priority for informing crab management.

I. Specific research needs for assessment purposes:

1. Catchability. Management advice for crab stocks relates directly to estimates of the size of the stocks concerned. 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.

2. Handling mortality rate. 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 used in the determination of total annual catch used to evaluate overfishing and in stock assessment and projection modeling.

3. 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 *Chionoecetes*, 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.

4. The Tier 4 OFL control rule for crab stocks involves basing F_{OFL} on the product of natural mortality and a parameter γ. Research to refine the basis for setting γ is needed, including: (a) simulation testing of methods to estimate γ based on only survey data, (b) calculation of $F_{35\%}/M$ and F_{MSY}/M for generic crab-related life histories, and (c) construction of the distribution for F_{MSY}/M using data for crab fisheries worldwide.

5. Bycatch. A synthesis is needed to estimate the cumulative impact of bycatch on all crab stocks.

6. Natural mortality. Explore life history and model based natural mortality estimators for BSAI crab stocks. This includes developing longevity-based estimators of natural mortality for BSAI crab by determining maximum age or maximum lifespan post terminal molt and tag-recapture and integrated modeling

II. Broad-based research concerns:

1. Non-recovering stocks. A pressing issue is why depleted stocks have failed to recover in the absence of fishing (e.g., Pribilof Island blue king crab and 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. Identify and assess production periods that may represent recruitment shifts across BSAI crab stocks.

Joint BSAI/GOA Groundfish Research Priority Recommendations

The Joint BSAI and GOA Groundfish Plan Teams discussed contributions to research priorities in 2009 and elected to highlight areas of particular research priority as it related to specific survey and assessment issues being discussed at the Joint Plan Teams meeting. These items are listed below by topic heading:

Stock structure Missing information for completing the stock structure framework (see Stock Structure Working Group report) for each assessment should be listed as *research priorities* for that stock.

Pacific Cod Questions remain about the cod age data, due to the mismatch between survey length modes and estimated mean length at age of younger fish in the Bering Sea, and by the difficulty of fitting the age compositions in the Gulf. The teams welcomed the work done by Tom Helser (and by Grant) on the estimates of mean length at age, but recommended more work be undertaken as a *research priority*. The teams were also impressed by the large influence of applying or not applying edge type criteria in determining age, first reported by Tom Helser at this meeting. This issue also is a *research priority*. Research priorities include:

- Continued research on edge-effect and other factors that may provide explanations regarding the observed inconsistencies between age composition and length data.
- Stock assessment model incorporating bias into the aging error matrix for ages 2-3 (AIC improved fit) could be employed in the short term to evaluate a process oriented approach to assessing inconsistency in these data sources.
- The AFSC in collaboration with the IPHC is planning a Pacific cod bomb radiocarbon 14C study using otolith specimens collected in 1962-1963 from the GOA. Pacific cod aging has not been scientifically validated and recovery of these samples would provide the first validation using bomb 14C, which is considered the gold standard of age validation. This is intended to be a study focused specifically on potential aging bias of ages 2-4 using these early samples, but will be augmented with AFSC collections to evaluate older ages.
- To factor out sampling artifacts, ages could be sampled randomly (as lengths) rather than using a length stratified sampling framework from hauls in 2010 survey. This would ensure spatial consistency of sample for these two types of data and allow direct comparison of size without effects caused by spatial variability in growth.
- Work will continue and efforts will be made to compare GOA and EBS Pacific cod age data.

Sablefish As *research priorities*, the Plan Teams recommend that the depredation research continue and that funding be found to update the sperm whale assessment with an updated abundance estimate. At this time there is no abundance estimate available, which means the potential biological removal for sperm whales can not be defined. This is important as there are apparent increases in sperm whale depredation/fishery interactions. Therefore, the Teams recommend a sperm whale abundance survey be conducted and included in the sablefish stock assessment also as a *research priority*.

Sharks Investigate the bias in extrapolated shark catch in the IPHC halibut longline survey due to stratified subsampling design currently employed.

Surveys The Teams encouraged continued evaluation of environmental effects on survey catchability.