# North Pacific Fishery Management Council
# Five-Year Research Priorities, 2010-2014
# Adopted October 2009

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.

## Immediate Concerns

I. Fisheries

A. Fish and Fisheries Monitoring

1. Non-recovering stocks. A pressing issue is why stocks have declined and failed to recover as anticipated (e.g., Kodiak red king crab, 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. Continue efforts to design and implement an improved observer delivery program that allows accurate and precise estimation of the catch by season and sector, including expansion of the program to previously unobserved vessels. (Also see Strategic Priority II.A.1).
3. Improvements are needed in in-season catch accounting for crab in non-directed fisheries with high incidental catch rates.
4. Improve species identification in catches by both processors and observers for priority species within species complexes. Methods that quantify and correct for misidentifications are desired.

B. Stock Assessment

1. Develop a size-based stock assessment model of Tanner crab in order to provide appropriate scenarios for evaluating and selecting a rebuilding strategy.
2. Improve handling mortality rate estimates. 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. For example, assess discard mortality rates of Tanner crab by size, month, sex, and fishery type.

C. Fishery Management

1. Analyses are needed of the ability of pollock harvesters to adapt their behavior to avoid Chinook and other salmon bycatch under various economic and environmental conditions and incentive mechanisms.
2. 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.

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

II. Fisheries Interactions

A. Protected species

1. There is a need for studies of localized fishery-protected species 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.

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

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

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

B. Baseline Habitat Assessment

1. Dynamic ecosystem and environmental changes, on a pace not observed in recorded time, are occurring in the northern Bering Sea and Arctic. Given the potential for fishery expansion into the northern Bering Sea, as well as considerations associated with establishment of the 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 of critical importance.

**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. 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, including GOA POP stocks.
5. Studies are needed to evaluate the effects of 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 biannual groundfish surveys.
7. 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.
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. Refine methods to incorporate uncertainty into harvest strategies for groundfish, crab, and scallops for ACL estimation.
2. 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.
3. 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.
4. Studies are needed to validate and improve age determination methods for Pacific cod and spiny dogfish.
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 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).
7. 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).
8. 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 and rougheye rockfish, 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.
9. 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.

10. Continue whale depredation studies to improve the quality of longline survey estimates.

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. 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.
3. 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.
4. Analyze current determinants of exvessel, wholesale, international, and retail demands for principal seafood products from the GOA and BSAI;
5. 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.
6. Conduct prospective analyses of the robustness and resilience of alternative management strategies under varying environmental and ecological conditions.
7. 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).
8. 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.

II. Fisheries Interactions

A. Catch Estimation Issues

1. Improve estimation of catch of and other fishery interactions with marine mammals (e.g., state-managed gillnet fisheries), seabirds, non-target groundfish (e.g., sharks, skates) and crab, 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).

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. Expanded Ecosystem Studies

1. Environmental influences on ecosystem processes
   a) Climate variability: Changes in ocean temperature may affect managed species, upper level predators, and lower trophic levels.
      (1) 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.
      (2) 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.
      (3) 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.

(4) 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.

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

b) Ocean acidification: changes in pH may affect managed species, upper level predators, and lower trophic levels.

2. 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).

# September 2010 Joint Groundfish Plan Team Recommendations to North Pacific Fishery Management Council Five-Year Research Priorities, 2011-2015 Adopted October 2009

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## Immediate Concerns

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A. Fish and Fisheries Monitoring

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2. Continue efforts to design and implement an improved observer delivery program that allows accurate and precise estimation of the catch by season and sector, including expansion of the program to previously unobserved vessels. (Also see Strategic Priority II.A.1).
3. Improvements are needed in in-season catch accounting for crab in non-directed fisheries with high incidental catch rates.
4. Improve species identification in catches by both processors and observers for priority species within species complexes. Methods that quantify and correct for misidentifications are desired.Develop methods for reliable estimation of total removals (e.g., surveys, poorly observed fisheries) to meet requirements of total removals under ACLs.

B. Stock Assessment

1. Develop a size-based stock assessment model of Tanner crab in order to provide appropriate scenarios for evaluating and selecting a rebuilding strategy.
2. 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 used in the determination of total annual catch used to evaluate overfishing and in stock assessment and projection modeling. For example, assess discard mortality rates of Tanner crab by size, month, sex, and fishery type.
3. Refine methods to incorporate uncertainty into harvest strategies for groundfish, crab, and scallops for ACL estimation.

C. Fishery Management

1. Analyses are needed of the ability of pollock harvesters to adapt their behavior to avoid Chinook and other salmon bycatch under various economic and environmental conditions and incentive mechanisms.

II. Fisheries Interactions

A. Protected species

1. There is a need for studies of localized fishery-protected species 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.
2. Further research is needed on gear modifications and fishing practices for reducing bycatch, particularly of PSC species (e.g., salmon, crab).
3. Investigate interactions between whales and surveys and fisheries and develop population estimates of major whale species.

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 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, on a pace not observed in recorded time, are occurring in the northern Bering Sea and Arctic. Given the potential for fishery expansion into the northern Bering Sea, as well as considerations associated with establishment of the 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 of critical importance.

**Ongoing Needs**

I. Fisheries

A. Fish and Fishery Monitoring

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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 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 the effects of 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 biennialgroundfish surveys.
7. 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.
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. Improve 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. 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.

2. Improved estimates of natural mortality (M). Estimates of M (obtained independently from models) are needed 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. 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.

5. .

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

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 and rougheye rockfish, and Atka mackerel (see element 5 in Expanded Ecosystem Studies below). 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.

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. 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.

3. 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.
4. Analyze current determinants of exvessel, wholesale, international, and retail demands for principal seafood products from the GOA and BSAI.
5. 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.
6. Conduct prospective analyses of the robustness and resilience of alternative management strategies under varying environmental and ecological conditions.
7. 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).
8. 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.
9. 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 probable consequences of Gulf rationalization, research should be designed to use Kodiak in addition to other Gulf communities as a case study in prospective analyses of the potential effects of Gulf rationalization options on fishing behavior, participation, and economic impacts

II. Fisheries Interactions

A. Catch Estimation Issues

1. Improve estimation of catch of and other fishery interactions with marine mammals (e.g., state-managed gillnet fisheries), seabirds, non-target groundfish (e.g., sharks, skates) and crab, 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).

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. Expanded Ecosystem Studies

1. Ecosystem indicator development and maintenance: existing ecosystem indicators need to be routinely updated and maintained. These include, but are not limited to

a) Climate and physical time series (EBS cold pool volume, etc)

b) Low trophic level community production data

(1) Primary production time series appropriate to the scale of managed areas (EBS, AI, GOA) need to be developed

(2) Zooplankton production and biomass time series for the EBS need to be maintained. Series for the AI and GOA need to be developed that are appropriate to regional groundfish management scales

(3) Zooplankton community composition time series should be maintained and refined in the EBS and developed for the AI and GOA

(4) Benthic community composition, production, and biomass time series need to be developed for all managed areas. This could interface with habitat work.

c) Developing basic research needs below into indicator series for single species and ecosystem SAFEs

2. Ecosystem indicator synthesis research (combined indicators, thresholds, management objectives)

3. Basic research on environmental influences on ecosystem processes

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

(1) Maintain moorings: 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.

(2) Measure and monitor 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.

(3) NMFS and BSIERP scientists should evaluate EBS survey data 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.

(4) Measure and monitor 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.

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

Conduct research on ocean acidification: assess whether changes in pH would affect managed species, upper level predators, and lower trophic levels.

4. Basic research on trophic interactions.

a) 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.

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

**Crab Research Priorities** ***(excerpted from September 2010 Crab Plan Team report)***
The CPT discussed research needs and identified the following items (in order of priority) in conjunction with this annual review:

1. Refine estimates of survey catchability coefficients
2. Improve estimated handling mortality rates for discarded crab caught in the targeted and non-targeted fisheries including groundfish trawl and fixed gear fisheries
3. Develop quantitative female reproductive indices to incorporate into stock assessment process particularity with respect to EBS snow and Tanner crab and Bristol Bay RKC
4. Identify and assess production periods that may represent recruitment shifts across BSAI crab stocks
5. Improve estimates of growth, particularly for opilio, with the intent to evaluate spatial and inter-annual variability
6. Investigate current natural mortality estimators and develop longevity-based estimators based on maximum age or using tag-recapture methods
7. Explore the basis for setting the $\gamma$ parameter particularly with respect to calculating $F_{OFL}$ for Tier 4 crab stocks
8. Identify life history bottlenecks with respect to depleted stocks and lack of recovery despite rebuilding plans
9. Improve in-season catch accounting for crab in non-directed fisheries to incorporate crab bycatch into the assessment models
10. Identify as well as assess productivity trends which may impact crab stock recruitment

**Scallop Research Priorities** ***(excerpted from the September 2010 SPT report):***

The team discussed research priorities, both in general and those specific to the EFH agenda item. ADF&G also noted that with the camera sled project they have a great deal of habitat data available and would cooperate with NMFS in their EFH research.

The following research items were noted (in order of prioritization):

1. Stock structure:
    a. Sources and sinks of scallop larvae unknown to verify to what extent it is a single statewide stock. Need for better understanding of larval movements in scallops.
    b. Additional genetic studies are needed for more information related to stock structure. Current genetic study shows that stocks appear to be connected with limited degree of separation (Stew Grant paper in press indicates limited genetic variability).
2. Stock Assessment:
    a. Vessel of opportunity research to tow camera sleds. Additional camera sled survey information on areas closed to scallop fishing with known scallop beds. Habitat-based assessment approach possibility for pooling camera sled research and broadscale assessment statewide for statewide biomass estimate.
    b. Mark-recapture-tagging studies to look at mortality, intact discards, scallop movement, growth
    c. Fishery-independent stock assessment in Yakutat

3. Continue research on weak meats and scallop quality. Environmental parameters should be studied coincident with determining cause of weak meats.

North Pacific Fishery Management Council
National Marine Fisheries Service, Alaska Region

# EXCERPT from:

## Essential Fish Habitat (EFH) 5-year Review for 2010 FINAL Summary Report, April 2010

## 13 Research and information needs

[...]

***Recommendations arising from the 5-year review:***

In their December 2009 review, the Ecosystem Committee recommended that habitat research should look at species diversity in areas that are now closed to trawling, in addition to species recovery rates (a priority in NMFS' current EFH proposal funding).

The GOA Plan Team also recommended that EFH research funding should encourage further studies of habitat impacts and the linkages of habitat to species productivity. The Crab Plan Team identified that research over the next five years should be directed to allow a better definition of "essential" habitat for crab species.

The SSC identified some specific priorities that would aid the evaluation of EFH:

- There is a continuing need to validate the LEI model and to improve estimates of recovery rates, particularly for the more sensitive habitats, including coral and sponge habitats in the Aleutian Islands region, possibly addressed through comparisons of benthic communities in trawled and untrawled areas.
- There is also a continuing need to obtain high resolution mapping of benthic habitats, particularly in the on-shelf regions of the Aleutian Islands.
- Time series of maturity at age should be collected to facilitate the assessment of whether habitat conditions are suitable for growth to maturity.
- In the case of red king crab spawning habitat in southern Bristol Bay, research is needed on the current impacts of trawling on habitat in spawning areas and the relationship of female crab distribution with respect to bottom temperature.

[...]

### 13.3 EFH research priorities identified by species

Table 16 through Table 20 identify research priorities that were highlighted in the individual species reviews, by FMP. These research needs could be used by the SSC and the Council in refining the Council's research priorities which are disseminated to NPRB, NMFS, and other agencies. Additionally, these research needs will also likely be used by NMFS in developing research priorities for the 2012-2016 funding cycle.

**Table 16 Research priorities identified in the individual species reviews – BSAI Groundfish**

| BSAI Groundfish Species | Recommendation |
|---|---|
| pollock | none |
| Pacific cod | The early life history stages of Pacific cod are poorly understood, as noted in several recent articles. Most of the recent work has focused on the Gulf of Alaska stock of Pacific cod. |
| sablefish | Little is known about the early juvenile stage distribution, habitat requirements, and interaction with other components of the ecosystem. They have been known to reside in habitat subject to potentially adverse fishing effects as indicated by high LEI values for living structure (table B.3-3 of Final EFH EIS). Research is needed on the effect of fishing on the habitat in this area, the role of habitat features on prey, predator, and competitor species in the area, and the role of these species on the growth and survival of sablefish. |
| yellowfin sole | Distribution of eggs, larvae and early juvenile stages is mostly unknown (undocumented). |
| greenland turbot | Distribution of early juvenile stages is mostly unknown (undocumented). |
| arrowtooth flounder | Distribution of larvae and early juvenile stages is mostly unknown (undocumented). |
| northern rock sole | Distribution of eggs, larvae and early juvenile stages is mostly unknown (undocumented) |
| flathead sole | Little to no information exists regarding early juvenile distribution and EFH requirements. |
| alaska plaice | Distribution of larvae and early juvenile stages is mostly unknown (undocumented). |
| rex sole | Distribution of early juvenile stages is mostly unknown (undocumented). |
| dover sole | none |
| Pacific ocean perch | Little information currently exists on the habitat use of various life stages of POP. The studies above are addressing this issue, but field studies are often limited to small geographical areas relative to the POP distribution in Alaska. This field work should be continued and expanded in order to better understand how stock productivity is related to habitat.<br>Also, efforts should be made to estimate population abundance in "trawlable" and "untrawlable" habitats, and their relative trends over time. A concern with our trawl surveys is that we implicitly assume the trawlable habitats (where we have data) are equivalent to the untrawlable habitats. |
| northern rockfish | Little information currently exists on the habitat use of various life stages of rockfish. The studies above are addressing this issue, but field studies are often limited to small geographical areas. This field work should be continued and expanded in order to better understand how stock productivity is related to habitat.<br>Also, efforts should be made to estimate population abundance in "trawlable" and "untrawlable" habitats, and their relative trends over time. A concern with our trawl surveys is that we implicitly assume the trawlable habitats (where we have data) are equivalent to the untrawlable habitats. |
| shortraker rockfish | Little information currently exists on the habitat use of various life stages of shortraker rockfish in the BSAI. Information on the distribution and habitat use of the various life-history stages would improve our knowledge of stock productivity and population dynamics.<br>Also, efforts should be made to estimate population abundance in "trawlable" and "untrawlable" habitats, and their relative trends over time. A concern with our trawl surveys is that we implicitly assume the trawlable habitats (where we have data) are equivalent to the untrawlable habitats. |
| blackspotted/ rougheye rockfish | Little information currently exists on the habitat use of various life stages of either blackspotted or rougheye rockfish in the BSAI. A study examining fine-scale habitat partitioning would help address the question of how speciation could occur and be maintained with organisms that appear to occupy similar large-scale habitats. Also, efforts should be made to estimate population abundance in "trawlable" and "untrawlable" habitats, and their relative trends over time. A concern with our trawl surveys is that we implicitly assume the trawlable habitats (where we have data) are equivalent to the untrawlable habitats. |
| dusky rockfish | It is assumed that the bycatch of dusky in targeted fisheries in the Bering Sea is minimal and does not adversely impact the population or their habitat. |
| thornyhead rockfish | It is assumed that the bycatch of shortspine thornyheads in targeted fisheries in the Bering Sea is minimal and does not adversely impact the population or their habitat. |

| BSAI Groundfish Species | Recommendation |
|---|---|
| atka mackerel | o Studies to determine whether there have been any changes in life history parameters over time (e.g. maturity-at-age, fecundity, weight- and length-at-age)<br>o Studies to determine the impacts of environmental indicators such as temperature regime on Atka mackerel<br>o Information on Atka mackerel habitat preferences is needed to improve our understanding of Essential Fish Habitat (EFH), and improve our assessment of the impacts to habitat due to fishing<br>o Better habitat mapping of the Gulf of Alaska would provide information for survey stratification and the extent of trawlable and untrawlable habitat.<br>o Regional and seasonal food habits data for Gulf of Alaska Atka mackerel |
| squid | Squid in the BSAI are very poorly understood, so any information on distribution or habitat would be helpful. Perhaps the most important question is how the distribution of squids (and the habitat needs that drive it) overlap with seabird and marine mammal predators. This would be really useful for looking at the potential impact of squid removals on other parts of the ecosystem. |
| octopus | 1) Life history: Because octopuses are semelparous, a better understanding of reproductive seasons and habits is needed to determine the best strategies for protecting reproductive output. Reproductive seasons and spawning habitat of E dofleini need to be identified for Alaskan waters. Life histories of other species need more information.<br>2) Seasonal movement: E. dofleini in Japan and off the US west coast reportedly undergo seasonal movements, but the timing and extent of migrations in Alaska is unknown. While many octopus move into shallower coastal waters for egg-laying, it is probable that at least some octopus reproduction occurs within federal waters.<br>3) State/Federal: The distribution of octopus biomass and extent of movement between federal and state waters is unknown and could become important if a directed state fishery develops. Tagging studies to determine seasonal and reproductive movements of octopus in Alaska would add greatly to our ability to appropriately manage commercial harvest.<br>4) Biomass Estimation: Fishery-independent methods for assessing biomass of the harvested size group of octopus are feasible, but would be species-specific and could not be carried out as part of existing multi-species surveys. Pot surveys are effective both for collecting biological and distribution data and as an index of abundance; mark-recapture methods have been used with octopus both to document seasonal movements and to estimate biomass and mortality rates. These methods would require either extensive industry cooperation or funding for directed field research. Factors determining year-to year patterns in octopus abundance are poorly understood. Octopus abundance is probably controlled primarily by survival at the larval stage; substantial year-to-year variations in abundance due to climate and oceanographic factors are expected. The high variability in trawl survey estimates of octopus biomass make it difficult to depend on these estimates for time-series trends; trends in CPUE from observed cod fisheries may be more useful.<br>5) Natural Mortality: Estimates of natural mortality rates for octopus would require species and region-specific field studies. Any stock assessment calculations would need to be based on natural mortality rates for adult octopus prior to spawning. Development of octopus-specific survey gear or tagging would be needed to perform such studies.<br>6) Growth: Field and laboratory studies to determine growth rates, age at maturity, and fecundity. |
| sharks | Estimates of bycatch from unobserved fisheries, including halibut IFQ and salmon.<br>Identification of nursery areas and juvenile habitat use.<br>Investigation of fishing effects on the species, such as fecundity and survival. |
| sculpins | there is a need for research on sculpin habitat utilization throughout their life history. This basic information is not known. It is also not known whether bottom trawling negatively impacts the habitat of adult sculpins. It would be first priority to find out what types of habitat are utilized by sculpins throughout their life history and then determine whether fishing activities negatively impact those habitats. |
| skates | 1) Location and habitat features of skate nurseries. While some of these have been identified, further research is needed to fully characterize these areas.<br>2) Age-related movement and distribution of skates, particularly the Alaska skate. |
| forage fish complex | Basic information on distribution, seasonal movements, and habitat associations |

**Table 17 Research priorities identified in the individual species reviews – GOA Groundfish**

| GOA Groundfish Species | Recommendation |
|---|---|
| pollock | Additional research is needed on impacts of trawling using midwater nets. |
| pacific cod | The early life history stages of Pacific cod are poorly understood, as noted in several recent articles. Most of the recent work has focused on the Gulf of Alaska stock of Pacific cod. |
| sablefish | Little is known about the early juvenile stage distribution, habitat requirements, and interaction with other components of the ecosystem. They have been known to reside in habitat subject to potentially adverse fishing effects as indicated by high LEI values for living structure (table B.3-3 of Final EFH EIS). Research is needed on the effect of fishing on the habitat in this area, the role of habitat features on prey, predator, and competitor species in the area, and the role of these species on the growth and survival of sablefish. |
| yellowfin sole | Distribution of eggs, larvae and early juvenile stages is mostly unknown (undocumented) |
| Northern rock sole | Diet information differentiated between the two rock sole forms needs to be documented. This information may already exist in the AFSC database. |
| Southern rock sole | Diet information differentiated between the two rock sole forms needs to be documented. This information may already exist in the AFSC database. |
| Alaska plaice | Any spawning information such as type (batch or broadcast?) and documentation of spawning location. |
| dover sole | The level of information for the early juvenile life stage is inadequate to change the current level from "Unknown" to "Level 1". |
| rex sole | The level of information for the early juvenile life stage is inadequate to change the current level from "Unknown" to "Level 1". |
| arrowtooth flounder | It would be desirable to know if arrowtooth flounders are broadcast or batch spawners. It would also be informative to know there role, if any, in the pelagic zone. |
| flathead sole | While more information exists regarding early juvenile distribution and EFH requirements in the GOA than in the BSAI, it does not seem complete enough to change the level of information for this life stage from "Unknown" to "Level 1". |
| Pacific ocean perch | There is little information on larval, post-larval, or early juvenile stages slope rockfish. Habitat requirements for these stages are mostly unknown. Habitat requirements for later stage juvenile and adult fish are anecdotal or conjectural. Research needs to be done on the bottom habitat of the major fishing grounds, on what HAPC biota are found on these grounds, and on what impact bottom trawling has on these biota. Additionally, Pacific ocean perch are undersampled by the current survey design. The stock assessment would benefit from additional survey effort on the continental slope. Further research on trawl catchability and trawlable/ untrawlable grounds would be very useful. |
| northern rockfish | Except for adults, there is almost no information on life history or habitat of northern rockfish in the GOA. At this time, identification of northern rockfish larvae and post-larvae is not possible, even using genetic methods. Additional genetic studies are needed to determine genetic markers that will positively identify northern rockfish to species. Few small juvenile northern rockfish have been caught in either the fishery or by surveys; studies are needed to locate and sample these young fish before their habitat requirements can be determined. Manned submersible studies on the outer shelf and upper slope have observed small red rockfish associated with corals and sponges. New studies need to be done to identify these fish to species and determine if they include northern rockfish. Although much more is known about adult fish, even their habitat requirements remain largely conjectural or based on circumstantial evidence. Research needs to be done on the bottom habitat of the major fishing grounds, on what HAPC biota are found on these grounds, and on what impact bottom trawling has on these biota. |

| GOA Groundfish Species | Recommendation |
|---|---|
| shortraker rockfish[1] | There is very little information on larval, post-larval, or juvenile shortraker rockfish, especially juveniles, which are rarely caught in any sampling gear. Studies are needed to locate and sample these young fish before their habitat requirements can be determined. Although more is known about adult fish, the specifics of their habitat requirements need further research. For example, does a relationship exist between adult shortraker rockfish and Primnoa coral, and if so, how important is this relationship? Research needs to be done on the bottom habitat of the major fishing grounds, on what HAPC biota are found on these grounds, and on what impact bottom trawling has on these biota. |
| blackspotted/ rougheye rockfish | There is little information on larval, post-larval, or early juvenile stages of rougheye and blackspotted rockfish. Habitat requirements for these stages are mostly unknown. Habitat requirements for later stage juvenile and adult fish are anecdotal or conjectural. Research needs to be done on the bottom habitat of the major fishing grounds, on what HAPC biota are found on these grounds, and on what impact bottom trawling has on these biota. Additionally, the current NMFS trawl survey design should extend into deeper waters (>300 m) to cover the range of primary habitat for rougheye and blackspotted rockfish. Further research on trawl and longline catchability, trawlable/untrawlable grounds, and natural mortality would be very useful. |
| dusky rockfish | There is little information on larval, post-larval, or early juvenile stages slope rockfish. Habitat requirements for these stages are mostly unknown. Habitat requirements for later stage juvenile and adult fish are anecdotal or conjectural. Research needs to be done on the bottom habitat of the major fishing grounds, on what HAPC biota are found on these grounds, and on what impact bottom trawling has on these biota. Additionally, dusky rockfish are undersampled by the current survey design. The stock assessment would benefit from additional survey effort on the continental slope. Further research on trawl catchability and trawlable/untrawlable grounds would be very useful. |
| yelloweye rockfish | adult and juvenile fish associations with living habitats and also more can be done to identify larvae and their locations, do DSR larvae ever use eel grass beds like some other rockfish species do? |
| thornyhead rockfish | age and growth studies |
| atka mackerel | o Studies to determine whether there have been any changes in life history parameters over time (e.g. maturity-at-age, fecundity, weight- and length-at-age)<br>o Studies to determine the impacts of environmental indicators such as temperature regime on Atka mackerel<br>o Information on Atka mackerel habitat preferences is needed to improve our understanding of Essential Fish Habitat (EFH), and improve our assessment of the impacts to habitat due to fishing<br>o Better habitat mapping of the Gulf of Alaska would provide information for survey stratification and the extent of trawlable and untrawlable habitat.<br>o Regional and seasonal food habits data for Gulf of Alaska Atka mackerel |
| skates | Habitat needs for GOA skates have not been studied. In particular, it would be valuable to know whether there are nursery sites (where egg cases are deposited) similar to those that have been found in the BSAI. Also, we know nothing about movement of skates throughout the GOA. |

[1] EFH is currently described for shortraker/ rougheye rockfish, not shortraker rockfish and blackspotted/ rougheye rockfish, as assessed in the SAFE report, and recommended by this review

| GOA Groundfish Species | Recommendation |
|---|---|
| octopus | 1) Life history: Because octopuses are semelparous, a better understanding of reproductive seasons and habits is needed to determine the best strategies for protecting reproductive output. Reproductive seasons and spawning habitat of E dofleini need to be identified for Alaskan waters. Life histories of other species need more information.<br>2) Seasonal movement: E. dofleini in Japan and off the US west coast reportedly undergo seasonal movements, but the timing and extent of migrations in Alaska is unknown. While many octopus move into shallower coastal waters for egg-laying, it is probable that at least some octopus reproduction occurs within federal waters.<br>3) State/Federal: The distribution of octopus biomass and extent of movement between federal and state waters is unknown and could become important if a directed state fishery develops. Tagging studies to determine seasonal and reproductive movements of octopus in Alaska would add greatly to our ability to appropriately manage commercial harvest.<br>4) Biomass Estimation: Fishery-independent methods for assessing biomass of the harvested size group of octopus are feasible, but would be species-specific and could not be carried out as part of existing multi-species surveys. Pot surveys are effective both for collecting biological and distribution data and as an index of abundance; mark-recapture methods have been used with octopus both to document seasonal movements and to estimate biomass and mortality rates. These methods would require either extensive industry cooperation or funding for directed field research. Factors determining year-to year patterns in octopus abundance are poorly understood. Octopus abundance is probably controlled primarily by survival at the larval stage; substantial year-to-year variations in abundance due to climate and oceanographic factors are expected. The high variability in trawl survey estimates of octopus biomass make it difficult to depend on these estimates for time-series trends; trends in CPUE from observed cod fisheries may be more useful.<br>5) Natural Mortality: Estimates of natural mortality rates for octopus would require species and region-specific field studies. Any stock assessment calculations would need to be based on natural mortality rates for adult octopus prior to spawning. Development of octopus-specific survey gear or tagging would be needed to perform such studies.<br>6) Growth: Field and laboratory studies to determine growth rates, age at maturity, and fecundity. |
| sharks | Estimates of bycatch from unobserved fisheries, including halibut IFQ and salmon; Identification of nursery areas and juvenile habitat use; Investigation of fishing effects on the species, such as fecundity and survival. |
| sculpins | sculpin habitat utilization throughout their life history. This basic information is not known. It is also not known whether bottom trawling negatively impacts the habitat of adult sculpins. It would be first priority to find out what types of habitat are utilized by sculpins throughout their life history and then determine whether fishing activities negatively impact those habitats. |
| squid | Squid in the GOA are very poorly understood, so any information on distribution or habitat would be helpful. Perhaps the most important question is how the distribution of squids (and the habitat needs that drive it) overlap with seabird and marine mammal predators. This would be really useful for looking at the potential impact of squid removals on other parts of the ecosystem. |
| forage fish complex | There are lots of little bits of information on GOA forage fishes; what is needed is a comprehensive understanding of distribution, habitat, and movement gulfwide. Hopefully the GOA IERP will yield some of this |

**Table 18 Research priorities identified in the individual species reviews – BSAI Crab**

| BSAI Crab FMP species | Recommendation |
|---|---|
| all species | Determine critical spawning grounds for all crab species. Information from this research could be used in future HAPC considerations. Research should look at substrate needs as well as pelagic habitat (e.g. the importance of oceanographic transport mechanisms) in determining critical spawning areas. |
| | Analyze temporal trends in spatial distribution of crab stocks to assess the current EFH descriptions. Include historical data and analyze shifts in distribution over time. |
| | Evaluate relationships between, and functional importance of, habitat-forming living substrates to juvenile and adult crab. |
| | Quantify crab habitat characteristics utilizing appropriate technology to allow increased precision of survey catch rate estimates. |

**Table 19 Research priorities identified in the individual species reviews – Scallop**

| Scallop FMP species | Recommendation |
|---|---|
| weathervane scallop | Research and better technological tools are needed to classify scallop distribution and bed areas. With this information, research will need better advances and tools to assess and disseminate the enormous influx of information expected. |
| | Additional camera sled survey information on areas closed to scallop fishing with known scallop beds. Habitat-based assessment approach possibility for pooling camera sled research and broadscale assessment statewide for statewide biomass estimate. |

**Table 20 Research priorities identified in the individual species reviews – Salmon**

| Salmon FMP Species | Recommendation |
|---|---|
| Chinook | Research is needed for stock origins and potential impacts of bycatch of Chinook salmon in certain GOA and BSAI groundfish fisheries. |
| coho | The ocean life history profile describing coho seasonal abundance is not complete in the EEZ of Alaska and beyond. Little information exists on the extent of ocean distribution of juveniles in late fall, and their ensuing distribution as adults from early winter to spring |
| chum | Recent research and management information is increasing the understanding of what defines the habitat needs of chum salmon especially in their ocean life stages. Work currently underway will augment the current knowledge base. |
| pink | More open ocean research, especially during the winter period, is a high priority need to better understand the causes of variable year class strength and high fluctuations in marine survival of pink salmon. Recent development of reasonably accurate forecasts on pink salmon run strength have been developed for southeast Alaska based on marine life period just prior to when juveniles enter the open ocean environment. This forecast model, however, does not account for how fluctuations in variable oceanic conditions affect juvenile pink salmon. [The need for similar oceanic research focused on a broad array of biophysical metrics [ecosystem approach] also applies to other salmon species.] |
| sockeye | (none offered) |

## 13.4 EFH research priorities identified for nonfishing impacts

Table 21 identifies research priorities that were highlighted in the individual species reviews. These research needs could be used by the SSC and the Council in refining the Council's research priorities which are disseminated to NPRB, NMFS, and other agencies. Additionally, these research needs will also likely be used by NMFS in developing research priorities for the 2012-2016 funding cycle.

**Table 21 Research priorities identified during the review of nonfishing impacts on EFH**

| EFH Activity | Research Need |
|---|---|
| Silviculture/Timber Harvest | Determine how culverts affect fish passage. |
| Silviculture/Timber Harvest | Determine how cost effective remediation measures are on fish passage. |
| Pesticide Application | Determine how copper, organophosphates, and the mixture of pesticides affect fish. |
| Commercial and Domestic Water Use | Determine cumulative effects of commercial and domestic water use at the watershed level. |
| Fill | Determine the cumulative effects of fill, especially in developed areas, on fish species. |
| Vessel Operations/ Transportation/ Navigation | Determine the cumulative effects of vessel operations and port expansion, especially in developed areas, on fish species. |

D6 Master

C-7
Oct 2010

10 Oct 2010
SSL Research needs: Response to request from NPFMC:

While the western population of Steller sea lion (SSL) has increased in abundance over the last ten years, the overall rate of recovery, as well as the pattern of recovery by sub-regions is not consistent with the existing guidelines for delisting criteria. Specifically, the numbers of SSL are in decline or stable in three of the seven sub-regions (i.e., western Aleutian Islands, central Aleutian Islands, and the central Gulf of Alaska).

Unfortunately, the only sub-region where SSL numbers are in a statistically significant decline is also the sub-region that has greatest information gaps regarding vital rates and foraging ecology. Current information on foraging ecology is also lacking for the other two sub-regions where sea lion numbers are not increasing at statistically significant rates (i.e., central Aleutians and central Gulf of Alaska). Also, because studies suggest sea lions on the Commander Islands are genetically more similar to those in Alaska than to other rookeries in Russia, additional research to close information gaps also includes studies within the Russian portion of the population.

Existing federal appropriations for the SSL research is insufficient to expand on-going population monitoring studies by NMFS and other research institutes. The NPFMC has requested NMFS provide the Council with a list of research projects that would address these information gaps. The following list is intended to be responsive to the request of the Council.

Finally, the Council is aware that the North Pacific Research Board intends to announce through the release of a Request for Proposals in the next 30 days, an opportunity for funding some of the research projects listed below.

~~Marine mammals~~: Protected Species

1. Foraging ecology studies of SSL in the western and central Aleutians. Specifically, this research would include at-sea tracking of adult females and juveniles, and collecting SSL scat and spew. Supplemental research could include stable isotope analyses, fatty acid analysis, contaminant studies, monitoring of condition and health indices, and additional photogrammetric work.
2. Foraging ecology studies of SSL in the Commander Islands. Research techniques would be similar to item #1.
3. Foraging ecology studies of SSL in the Gulf of Alaska. In addition to at-sea tracking of older animals, outside of the Kodiak area the primary information needed from this sub-region is updated information on diet composition of SSL throughout the sub-region.
4. Studies to assess vital rates (i.e., reproduction and survival) of SSL in the western and central Aleutians. Specifically, this would require longitudinal studies (e.g., branding of pups) to determine rates of age- or size-class specific survival, as well as studies to help evaluate the reproductive performance of adult females.

5. Maintain assessment of SSL vital rates in the Russian Far East and Commander Islands. Research techniques would be similar to item #4 and include expansion to autumn and winter periods.
6. Aerial photogrammetric survey studies of rookeries and haul-outs in Russia. This survey methodology would provide abundance estimates for sea lions in Russia directly comparable to estimates for Alaska.
7. Studies investigating advancements in methods to estimate sea lion abundance, such as the use of unmanned aerial vehicles, that would increase the probability of acquiring abundance estimates in remote areas.
8. Studies to improve understanding of killer whale predation of SSLs, particularly in the western and central Aleutian Islands.

Fish: 9. I Increased frequency of pup & non-pup surveys

1. Winter surveys of groundfish in all three areas (EBS, GOA and AI) to create seasonal models of fish biomass distribution relative to CH STOCK ASSESSMENT
2. Tagging studies of Pacific cod and Atka mackerel to create models of short-term movement of fish relative to CH (tagging methods for pollock are in development) STOCK ASSESSMENT
3. Tagging studies of Atka mackerel to estimate local abundance inside and outside CH STOCK ASSESSMENT
4. Food habits collections and ecosystem modeling to quantify interactions between SSL groundfish prey and the food web effects of changes in fishing mortality ECOSYSTEM
5. Modeling and field studies of ecosystem productivity in different regions (EBS, GOA and AI) ECOSYSTEM
6. Focal studies of SSL foraging behavior, SSL diet, fish abundance, fish movement, oceanography, ocean productivity and fisheries impacts in contrasting areas of SSL population trend in the Aleutian Islands (including the Commander Islands) and in areas where SSL forage. These studies would be conducted in summer and winter. Fish abundance estimates would be from trawling, acoustics, tagging, pots and/or camera surveys depending on the species and habitat. AFSC standard trawl surveys are not appropriate for assessing fish biomass distribution at local scales important to SSL. PROTECTED SPECIES

REPLACE #1

~~It is assumed that on-going research to monitor population trends (biennial surveys) and fish biomass, as well as on-going, long-term field camps would be continued with existing funding levels.~~

and natality rates, including comparative studies throughout WDPS

add w/ 1.