

Top	Research ID	Title	Description	Research Status	Crab Plan Team Priority	Notes
TT	147	Life history research on data poor or non-recovering crab stocks	Why certain stocks have declined and failed to recover as anticipated is a pressing issue (e.g., Pribilof Island blue king crab, Adak red king crab). Research into all life history components, including predation by groundfish on juvenile crab in nearshore areas, is needed to identify population bottlenecks, an aspect that is critically needed to develop and implement rebuilding plans.	Partially underway	2_Urgent	Combine with 171? And include language about non-recovering stocks
TT	225	Develop projection models to evaluate management strategies under varying climate, ecological, and economic conditions and evaluate impacts to managed resources and coastal communities.	There is a need to develop projection models that evaluate the robustness and resilience of different management strategies under varying climate, ecological, and economic conditions. Projection models should forecast seasonal and climate related shifts in the spatial distribution and abundance of commercial fish and shellfish, and impacts to communities.	Partially underway	2_Urgent	General need for MSEs here. Isn't question where they are needed?
TT	592	Maturity estimates for Bering Sea and Aleutian Island crab stocks	Application of Tier 3 control rules for crab requires reliable estimates of maturity to determine mature biomass. Maturity estimates of BSAI crab stocks are, in many cases, based on old studies using outdated methods. New studies to estimate both male and female maturity curves are needed for several stocks, with Aleutian Islands golden king crab considered a priority.	No action	2_Urgent	- Redundant with other life hx priorities - Initiate matrix of basic life hx data needs across crab stocks?
TT	148	Spatial distribution and movement of crabs relative to life history events and fishing	There is a need to characterize the spatial distribution and movement of crab stocks. For example, information is needed to understand the distribution of male/female snow crab at time of mating, a better understanding of spatial stock dynamics and population connectivity for Tanner Crab east and west of 166, and to understand the distribution and movement of golden king crab in the Aleutian Islands in areas historically fished and not fished. There is a need to characterize the spatial distribution of male snow crab at time of mating relative to reproductive output of females in the middle domain of the EBS shelf. Additionally there is a need to investigate spatial stock dynamics and population connectivity for Tanner Crab (2 stocks).	Partially underway	2_Urgent	
TT	New	Studies on physiological responses to climate stressors	Investigate how observed environmental changes (temperature, OA, etc.) affect physiological condition & survival of multiple life stages and reproductive output. Consider interactions among multiple stressors			

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	187	Continue to develop and improve the use of indicator-based ecosystem assessments throughout the range of the Council's managed resources for EBS.	Maintain indicator-based ecosystem assessment for EBS.	Underway	1_Critical	Change title to: Continue to develop and improve the use of indicator-based ecosystem assessments throughout the range of the Council's managed resources for EBS.
	241	Develop bottom and water column temperature database and indices	Develop bottom and water column temperature database and indices for use in EBS, GOA, and AI stock assessments.	Partially underway	1_Critical	Is this still "partially" underway? Lots of other temp data that need to be housed in common database
	196	Genetics, population dynamics, and management implications of hybridization between Tanner and snow crab in the Bering Sea.	The presence of hybrids complicates the assessment and management of EBS snow and Tanner crab stocks. Genetics research is needed to better understand the abundance of hybrids relative to pure snow and Tanner crabs. Other needed research includes assessing temporal shifts in hybrid crab spatial distribution, the geospatial overlap with snow and Tanner crabs, the directionality of hybrid mating dynamics, and the extent of first generation crosses and backcrosses. To evaluate management implications, a two-species spatial population model should be developed that captures the essential features of the population dynamics, including hybridization. Alternative management approaches should be evaluated.	Partially underway	2_Urgent	Very specific - definitely falls into the category of a time-limited project Remove from top ten
	150	Maintain the core biological and oceanographic data (e.g., biophysical moorings, stomach data, zooplankton, age 0 surveys, benthic production) necessary to support integrated ecosystem assessment	Maintain the core data and process studies needed to support integrated ecosystem assessments. Core data include inputs for single- or multi-species management strategy evaluations, food web, and coupled biophysical end-to-end ecosystem models (e.g. biophysical moorings, stomach data, zooplankton, age 0 surveys (i.e. BASIS surveys), benthic production). Develop and maintain indices of sea ice formation, sea ice retreat, and timing/extent of the spring bloom for the EBS. For this, maintenance of moorings, especially M-2, is essential. If recent changes in ice cover and temperatures in the Bering Sea persist, these may have profound effects on marine communities.	Underway	2_Urgent	
	167	Alternative approaches to acquire fishery-independent abundance data for unsurveyed crab stocks.	Explore alternative approaches to acquire fishery-independent abundance data on stock distribution and recruitment of unsurveyed crab stocks (e.g., Aleutian Islands golden king crab, cooperative research efforts with Industry).	Partially underway	2_Urgent	

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	178	Develop a framework and collect economic information	Develop a framework for the 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.	Partially underway	2_Urgent	
	179	Conduct pre- and post-implementation studies of the benefits and costs, and their distribution, associated with dedicated access privileges	Conduct pre- and post-implementation studies of the benefits and costs, and their distribution, associated with changes in management regimes (e.g., changes in product markets, characteristics of quota share markets, changes in distribution of ownership, changes in crew compensation) as a consequence of the introduction of dedicated access privileges in the halibut/sablefish, AFA pollock, and crab fisheries. Benefits and costs include both economic and social dimensions.	Partially underway	2_Urgent	
	174	Develop spatially explicit stock assessment models	Develop spatially explicit stock assessment models. High priority species for spatially explicit models include: walleye pollock, snow and Tanner crab, Pacific cod, sablefish, yellowfin sole, rock sole, arrowtooth flounder, Pacific ocean perch, black spotted rockfish, rougheye rockfish, and Atka mackerel.	Partially underway	3_Important	Priority matrix? Remove from top ten
	164	Effects of trawling on female red king crab and benthic communities subsequent recruitment	Research is needed on the effects of trawling on the distribution of breeding and ovigerous female red king crab and subsequent recruitment. Relevant studies include 1) assessing the efficacy of the current Red King Crab Savings Area Boundaries, and 2) assessing effects of potential habitat modifications on the distribution of females, particularly in nearshore areas of southwest Bristol Bay, and environmental effects (e.g., trawling overlap in warm vs. cold years), 3) quantification of unobserved mortality (e.g. pelagic trawl gear contacting bottom). Retrospective studies, the identification of larval release locations, and larval advection using Regional Ocean Modeling System would help address this need.	Underway	3_Important	Modify to make more general and applicable to all crab stocks
	208	Explore factors that contribute to year class strength for managed resources	New information and data are needed that would inform our understanding of the stock- recruit relationship for groundfish, Pacific halibut, and crab to project year-class strength.	Underway	3_Important	Research on stock-recruit relationships Explore factors that contribute to year class strength for managed resources

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	223	Develop and evaluate global climate change models (GCM) or downscaled climate variability scenarios to assess impacts to recruitment, growth, and spatial distributions.	Quantify the effects of historical climate variability and climate change on recruitment, growth, spatial distribution, benthic productivity . Develop standard environmental scenarios (e.g., from GCMs) for present and future variability based on observed patterns. This is important for fisheries that target benthic species such as crab for which management may be structured on an assumption of stable stock distribution.	Partially underway	3_Important	Combine with 671??
	235	Investigate gear modifications and changes in fishing practices to reduce	Gear modifications and changes in fishing practices to reduce bycatch and PSC are needed.	Partially underway	3_Important	Very much an ongoing need that is unlikely to ever be "completed"
	240	Develop a multivariate index of the climate forcing of the Bering Sea shelf	Develop a multivariate index of the climate forcing of the Bering Sea shelf . Three biologically significant avenues for climate index predictions include advection, setup for primary production, and partitioning of habitat with oceanographic fronts and temperature preferences.	Partially underway	3_Important	Step 1 develop. Step 2 maintain This is step 1. Is it still partially underway?
	251	Modeling studies of ecosystem productivity	Modeling studies of ecosystem productivity in different regions (EBS, GOA, and AI). For example, studies could evaluate the appropriateness of the 2 million t OY cap.	Underway	3_Important	Intent is on "evaluate the appropriateness of the 2.0 million mt OY cap" So, not a crab priority.
	671	Understanding benthic production expectations with climate change	Investigations are needed to address the impacts of global climate change on spatial patterns of benthic productivity. This is important for fisheries that target benthic species such as crab for which management may be structured on an assumption of stable stock distribution.	No action	3_Important	Add description: Investigations are needed to address the impacts of global climate change on spatial patterns of benthic productivity. This is important for fisheries that target benthic species such as crab for which management may be structured on an assumption of stable stock distribution.
	163	Conduct routine fish, crab, and oceanographic surveys in the Arctic Ocean	Dynamic ecosystem and environmental changes in the Arctic Ocean are occurring. Assessment of the current baseline conditions and trophic interactions is important. This effort should not supplant the regular surveys in the BSAI and GOA, which are of critical importance to science and management.	Partially underway	3_Important	
	169	Studies on factors that affect catchability particularly for King, Snow, and Tanner crab	For groundfish and crabs, studies are needed on factors that affect catchability, as they directly bear on estimates of the stock assessment. Research to refine the estimates of survey catchability, q, used to infer absolute, rather than relative, abundance would substantially improve the quality of management advice. Particular emphasis should be placed on Tanner crab and Red King Crab because of recent trends in stock status, and on fishery and for Aleutian Island golden king crab to improve the stock assessment model.	Underway	3_Important	

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	170	Quantitative reproductive index for the BSAI crab stocks	Advance research towards developing a quantitative reproductive index for BSAI crab stocks. Research on mating, fecundity, fertilization rates, and, for snow and Tanner crab, sperm reserves and biennial spawning, is needed to develop annual indices of fertilized egg production that can be incorporated into the stock assessment process and to model the effects of sex ratios, stock distribution, and environmental change on stock productivity. Priority stocks for study are eastern Bering Sea snow and Tanner crab and Bristol Bay red king crab.	Underway	3_Important	
	172	Develop and validate aging methods for crabs.	Develop and validate aging methods for crabs to improve estimates of M for stock assessments.	Underway	3_Important	
	173	Expand studies to identify stock and management boundaries	To identify and refine stock boundaries and understand source/sink dynamics (e.g., scallop metapopulations). Conduct studies to evaluate all crab stock boundaries relative to management boundaries (e.g. Bristol Bay red king crab, Adak red king crab, Aleutian Island golden king crab, EBS Tanner crab, Pribilof blue king crab). Expanded studies are needed in the areas of genetics, mark-recapture, reproductive biology, larval distribution, and advection. Such boundaries are to be evaluated so that the risks and consequences of management actions are clear.	Partially underway	3_Important	
	177	Conduct prospective and retrospective analyses of changes in the spatial and temporal distribution of fishing effort in response to management and environmental changes	Conduct prospective and retrospective analyses of changes in the spatial and temporal distribution of fishing effort, in response to management actions (e.g., time/area closures, marine reserves, PSC and other bycatch restrictions, co-ops, IFQs, multi-target crab fisheries) and environmental changes.	Partially underway	3_Important	
	183	Research the role of habitat in population dynamics and ecosystem processes	Research is needed on the role of habitat in population dynamics and ecosystem processes. Specifically, studies are needed to evaluate how habitat-forming species (e.g., corals) influence life history parameters (e.g., mortality, growth, movement) of FMP species and their preferred prey. Such research will identify key habitats (including essential fish habitat and habitat areas of particular concern), improve the design and management of marine protected areas, and ultimately improve stock assessments and restoration efforts.	Partially underway	3_Important	

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	184	Evaluate efficacy of habitat closure areas and habitat recovery	Establish a scientific research and monitoring program to understand the degree to which impacts on habitat, benthic infauna, etc., have been reduced within habitat closure areas, and to understand how benthic habitat recovery of key species is occurring (e.g., Red King Crab Savings Area efficacy and Pribilof Island Habitat Conservation Area). (This is an objective of EFH research approach for the Council FMPs).	Partially underway	3_Important	
	191	Assess whether changes in pH and temperature would affect managed species, upper level predators, and lower trophic levels.	Assess whether changes in pH and temperature would affect managed species, upper level predators, and lower trophic levels. Laboratory studies are needed to assess the synergistic effects of ocean acidification and changes in temperature on productivity of marine species.	Partially underway	3_Important	
	197	Develop methodologies to monitor for new/emerging diseases and/or parasites among exploited species and higher	Develop methodologies to monitor for new/emerging diseases and/or parasites among exploited species and higher trophic levels.	Partially underway	3_Important	
	217	Impact of fisheries on benthic habitat and trophic interactions	Conduct studies to assess the impact of bottom trawl fisheries on invertebrate abundance and species composition in benthic habitats. This is especially relevant to direct impacts on Bristol Bay red king crab. Indirect impacts are important to the foraging ecology of walrus (candidate species for listing under ESA), bearded seals, and gray whales.	Underway	3_Important	
	220	Research on survey analysis techniques for species that exhibit patchy distributions	Continue research on the design and implementation of appropriate survey analysis techniques, to aid the Council in assessing species (e.g., Pribilof Island king crabs and rockfish) that exhibit patchy distributions and, thus, may not be adequately represented (either over- or under-estimated) in the annual or biennial groundfish surveys.	Underway	3_Important	
	431	Develop tools for analyzing coastal community vulnerability to fisheries management changes	Develop tools for for assessing and predicting coastal community vulnerability to fisheries management changes. Assess changes in community vulnerability over time by FMP and individual catch share fishery.	Underway	3_Important	
	554	Molt and mate timing for Norton Sound red king crab	Within the assessment, there are conflicting observations about molt timing in April/May versus August/September. Moreover these observations suggest the potential for biennial mating. These issues could have important consequences on the assessment model.	Partially underway	3_Important	

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	613	Maintain and update coupled biophysical projections for the North Pacific	Coupled model projection systems are needed to support the NPFMC's strategic initiatives related to the Bering Sea Regional Action Plan, the Bering Sea Fisheries Ecosystem Plan and the Alaska Climate Integrated Modeling activity. Research is needed on methods to dynamically downscale physics and bio-geo-chemical information derived from global models and earth systems models to regional ocean models (ROMs) as well as methods for coupling nutrient-phytoplankton-zooplankton (NPZ) into ROMs. Likewise continued research on methods for coupling biological models (including the response of fishers) to projected environmental change will be an ongoing strategic activity. Projected environmental conditions from the ROMS/NPZ model is the foundation for management strategy evaluations needed to provide climate informed harvest strategies for the future. Support for continued update and refinement of the ROM/NPZ coupled models will be an ongoing strategic research need for the NPFMC.	Partially underway	3_Important	
	614	Expansion of catch in areas database to include BSAI and GOA crab and scallop fishing.	The NOAA Catch in Areas database incorporates VMS and Observer data and is used to characterize the distribution of fishing activity by target. This information is required for assessment of fishing effects on EFH and calculating fisheries bottom contact and spatial overlap. The database does not currently include crab or scallop fishing activity. Both VMS and observer data are available for these fisheries and work is needed to add it to the CIA database.	No action	3_Important	
	158	Research ecosystem indicators and their thresholds for inclusion in ecosystem-level management strategy evaluation.	Initiate/continue research on the synthesis of ecosystem indicators, developing and evaluating thresholds for ecosystem indicators, and ecosystem-level management strategy evaluation.	Partially underway	4_Strategic	Expand and consolidate with other indicator / ESP priorities?
	186	Collect and maintain zooplankton and meroplankton biomass and community composition time series	Collect and maintain zooplankton and meroplankton biomass and community composition time series in the eastern Bering Sea. Develop, collect and maintain time series of zooplankton biomass and community composition for the GOA, AI, Arctic.	Partially underway	4_Strategic	Maintain strategic. Not developed for crab assessments
	224	Climate and oceanographic information covering a wider range of seasons	There is a need for climate and oceanographic information that covers a wider range of seasons than is presently available.	Partially underway	4_Strategic	Is this still "partially" underway?
	242	Collect and maintain primary production time series	Collect and maintain primary production time series in the EBS, AI, GOA, and Arctic; particularly in relationship to key climate and oceanographic variables.	Partially underway	4_Strategic	Can we combine with the zooplankton priority (186)?

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	535	Development and evaluation of data poor and data moderate methods	Several methods are currently in use around the country for setting harvest specifications for data-poor and data-moderate stocks (corresponding, respectively, to Tiers 6 and 4-5 of the BSAI and GOA groundfish harvest control rules), several others are currently under development, and still others could be developed in the future. There is a need to continue development of such methods and to conduct comparative performance tests of the methods.	Underway	4_Strategic	Also a fishery management (theme) priority
	149	Improve handling mortality rate estimates for crab	Continue to improve estimate of discarded crab handling mortality rate for crab species. Empirical data exist for snow and Tanner so new handling mortality data are needed for king crab by size, sex, and fishery type with consideration of temperature. This will require improving understanding of 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. The magnitude of post-release mortality is an essential parameter in the determination of the overfishing level used to evaluate overfishing in stock assessment and projection modeling. Current priorities are to assess handling mortality in long-line fisheries and for long term mortality studies.	Partially underway	4_Strategic	
	194	Identification and integration of archived data	Identification and recovery of archived data (e.g., historical agency groundfish and shellfish surveys, and fishery data) should be pursued. Investigate integrating these data into stock and ecosystem assessments. Some archival acoustic data have been cataloged, and most trawl surveys have been included in databases. Some one-time research surveys remain neglected.	Partially underway	4_Strategic	
	233	Develop an ongoing database of product inventories	Development of an ongoing database of product inventories (and trade volume and prices) for principal shellfish, groundfish, Pacific halibut, and salmon harvested by U.S. fisheries in the North Pacific and eastern Bering Sea.	No action	4_Strategic	
	234	Analyze current determinants of demand for principal seafood products	Analyze current determinants of ex vessel, wholesale, international, and retail demand for principal seafood products from the GOA and BSAI.	Partially underway	4_Strategic	
	237	Improved habitat maps	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 in the GOA, BS, and Aleutian Islands.	Underway	4_Strategic	

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	238	Develop a GIS relational database for habitat, to include a historical time series of the spatial intensity of interactions between commercial fisheries and habitat.	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. Such time series are needed to evaluate the impacts of changes in fishing effort and type on EFH.	Underway	4_Strategic	
	250	Conduct ecosystem structure studies	Studies are needed to evaluate the effects of global warming, ocean acidification, and selective fishing on food webs. 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).	Partially underway	4_Strategic	
	176	Refine methods to incorporate uncertainty into harvest strategies for groundfish	Refine P* and decision theoretic methods to incorporate uncertainty into harvest strategies for groundfish for ACL estimation. Continue existing management strategy evaluations at the stock level.	Underway	2_Urgent	Refine methods to incorporate uncertainty into harvest strategies for managed resources groundfish
	182	Evaluate the effectiveness of current and alternative Council PSC/bycatch reduction initiatives	Analyze the effects of recent Council actions on PSC and bycatch, including the interaction among PSC and bycatch reduction initiatives (e.g., halibut, salmon, crab). Attention should be given to different incentives that have the potential to cost-effectively reduce PSC.	Partially underway	3_Important	Evaluate the effectiveness of current and alternative Council PSC/bycatch reduction initiatives
	202	Improve estimation of total removals	Develop methods for reliable estimation of total removals (e.g., surveys, poorly observed fisheries) to meet requirements of total removals under ACLs. Catch Accounting System now provides total removals annually. Improved reporting on some data such as subsistence catches and Pacific cod bait in crab fisheries is needed. Improvements are needed for in-season catch accounting by sex and size for crab in non-directed fisheries with high bycatch or PSC rates, particularly for blue king crab in the Pacific cod pot fishery in the Pribilof Islands.	Partially underway	2_Urgent	Improve estimation of total removals
	216	Assess whether Bering Sea canyons are 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 and above the canyon areas, including a comparison of mid-level and apex predators to neighboring shelf/slope ecosystems.	Partially underway	3_Important	Assess whether Bering Sea canyons are habitats of particular concern for managed resources
	244	Collect and maintain time-series data on the community composition, production and biomass of benthic invertebrate and	Collect and maintain time-series data on the community composition, production and biomass of benthic invertebrate and vertebrate fauna.	Partially underway	4_Strategic	Combine with 671??
	189	Develop stock-specific ecosystem indicators and incorporate into stock	Develop stock-specific ecosystem indicators and incorporate into stock assessments. (in progress)	Partially underway	2_Urgent	

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	192	Collect, analyze, and monitor diet information	Collect, analyze, and monitor diet information (species, biomass, energetics), 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.	Underway	1_Critical	
	198	Initiate and expand non-market valuation research of habitat, ecosystem services, and passive use considerations	Initiate and expand non-market valuation research of habitat, ecosystem services, and passive use considerations.	No action	4_Strategic	
	200	Monitor contaminant flux and loads in lower and higher trophic levels, and assess potential for impact on vital rates.	Monitor contaminant flux and loads in lower and higher trophic levels, and assess potential for impact on vital rates. Laboratory studies are needed to assess the effects of oil dispersants on the productivity of marine species.	No action	4_Strategic	
	230	Examine social and economic interactions between coastal communities and commercial and recreational fisheries	Examine social and economic interactions between coastal communities and commercial and recreational fisheries (e.g. subsistence-commercial linkages, adaptations to changes in resource use, economic opportunities for coastal communities).	Underway	3_Important	
	247	Assess the relative importance of non-commercially exploited species to human communities	Assess the relative importance of non-commercially exploited species (invertebrates, fish, marine mammals, and seabirds) to human communities, particularly in Arctic.	Partially underway	4_Strategic	
	366	Continue to investigate time variation and the shape of fishery and survey selectivity models	There is considerable controversy about (1) whether selectivity should be dome-shaped or asymptotic, and (2) whether selectivity should be time-varying by default. Using a dome-shaped curve can create a large increase in biomass which may not be real. Treating selectivity as time-varying increases the number of model parameters greatly, which may lead to confounding among parameters. Better scientific guidance through research studies is needed to address these two problems.	Partially underway	2_Urgent	

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	533	Explore optimal sampling strategies and geospatial approaches for time series of survey data	The Stock Assessment Improvement Plan seeks to ensure that NMFS conducts its surveys in the most effective and efficient manner possible. Statistical analysis of the optimal number of survey stations needed to accurately assess the status and trends of groundfish and crab stocks is required to achieve this goal. An extension of this activity would be to explore alternative abundance estimation methods. For example exploring Thorson's geostatistical model as an alternative to the designed-based estimates for abundance indices used in stock assessments is a potentially useful analysis. Extensions would include an assessment of whether there are certain life history characteristics or levels of aggregation when geospatial models are used.	Underway	2_Urgent	
	536	Evaluate incorporation of climate change impacts into stock assessments	Climate change impacts are becoming an increasingly important consideration for long term planning and should be included in projections of exploitable fish stocks and associated ecosystem components. Incorporation of climate-based parameters into fish stock assessments will allow for exploration of harvest scenarios in the context of evolving climate conditions. Research is needed to explore how these parameters can be integrated into fishery stock assessments.	Underway	4_Strategic	
		Explicit ocean acidification priority?				