

Caribbean Fishery Management Council Five-year Research Priorities under the MSRA

Preface: In no uncertain terms, we have included recommendations that represent the need for improved basic data collection. We feel that these are minimal requirements for more comprehensive management of US Caribbean fisheries, and these recommendations are indicated by *). In a classic sense, a ‘research plan’ should represent studies and/or priorities which complement existing programs/fill gaps. Standard data collection programs (for example, catch reports submitted by fishers, port sampling) should be providing the basic information, while smaller scale process oriented ‘research’ studies should be directed to improve interpretation of these data.

Rank	I. STOCK STATUS
x	<p><i>Investigate alternative management approaches to ACL’s.</i></p> <p>“Flexibility in application of NS1 guidelines. There are limited circumstances that may not fit the standard approaches to specification of reference points and management measures set forth in these guidelines.....Councils may propose alternative approaches for satisfying the NS1 requirements of the Magnuson-Stevens Act than those set forth in these guidelines....”</p>
x	<p><i>Improved Landings Data*</i></p> <ul style="list-style-type: none"> • Study to determine reporting rates of fishers • Validation of self-reported landings - via TIP data, monitoring fishing vessels, etc. • Methods to improve timeliness—in season reporting/monthly
x	<p><i>Increased TIP Sampling program given SEFSC guidance on appropriate sampling design. Length Structure (effort, bycatch, ...)*—</i></p> <ul style="list-style-type: none"> • Biological Samples – maturity, hard parts (otoliths). Ideally from fishery-independent but fishery-dependent can be used with appropriate caution.
x	<i>Studies to determine bycatch rates.</i>
x	<i>Age, growth, maturity (prioritize list of species to assess – see 2009 SSC report.</i>
x	<i>Investigate alternate methods for assessing status of stocks- e.g. acoustic, density surveys.</i>
x	<i>Designation of indicator species in FMUs.</i>
x	<i>Stock structure, especially for bottom fish populations: Genetics, stable isotope data,</i>

	<i>Tagging – Will facilitate Island-based management of shared (?) stocks.</i>
x	<i>Integration/linking/coordination of multiple fishery-independent data collection efforts (e.g. visual census, SEAMAP, MRIP/MRFSS, mesophotic habitat studies)</i> <i>.See ecosystem discussion; fishery independent workshop (Miami Sept 2014)</i>
x	<i>Determination of MSYs within an Ecosystem context, especially accounting for extensive changes in community structure (predator/prey levels) and the necessities of coral reef ecosystem health.</i>
	OTHER THOUGHTS Effort Movements—Tagging Corals, habitats
Rank	II. ASSESSMENT OF THE EFFECTS OF CURRENT FEDERAL MANAGEMENT REGULATIONS
x	<i>Status of the fish populations subject to year-round harvest prohibitions (e.g. Nassau grouper) in the US Caribbean.</i> <i>Research questions:</i> <ul style="list-style-type: none"> • <i>What are the trends in the abundance and size/age structure of these species?</i> • <i>Have they achieved the rebuilding plan goals?</i> • <i>What level of harvest would be allowed (sustainable), after recovery?</i> <p>Status: In the USVI, Nemeth is monitoring one spawning area for Nassau grouper. The information being collected includes estimates in numbers and size range, as well as changes of these numbers over time. Passive acoustic work is underway in Mona Island and Bajo de Sico to estimate abundance and timing at spawning sites (Scharer et al).</p>
x	<i>Status of the parrotfish species for which harvest is prohibited in the EEZ only (midnight, blue and rainbow parrotfish).</i> <i>Research questions:</i> <ul style="list-style-type: none"> • <i>What are the trends in the abundance and size/age structure of these species?</i> • <i>How do we define recovery?</i> • <i>How do we monitor them to define when they have recovered?</i> • <i>What is their impact on habitat/coral reef recovery (see ecosystem recommendations)?</i> • <i>What would be the level of harvest after their recovery?</i> <p>Status: There is a need to assess the managed species but their take is prohibited. Surveys of known areas where they used to occur needs to be done. As far as we know,</p>

	no one is currently doing any research in this topic. Need to have survey designs specific to these species.
x	<p><i>Status of the queen conch population, a prohibited species in the EEZ of the subzones of St. Thomas/St. John and Puerto Rico.</i></p> <p><i>Research questions:</i></p> <ul style="list-style-type: none"> • <i>What are the trends in the abundance and size/age structure of this species in the EEZ and throughout its range within St. Thomas/St. John and Puerto Rico?</i> • <i>Have they achieved the rebuilding plan goals?</i> • <i>What level of harvest would be allowed (sustainable), if any?</i> • <i>Are they providing recruits for the shallow water population?</i> • <i>Is the EEZ a population refugia?</i> <p>Status: Garcia-Sais (in review) assessed the populations of queen conch in the seasonally closed areas off the West coast of Puerto Rico. The CFMC contracted with Dr. Aldana to determine the viability of the deepwater conch gonads and the presence or absence of parasites in the gut of conch (might impact spawning).</p>
x	<p><i>Status of the species subject to seasonally closed areas to protect spawning aggregations (Mutton Snapper Closed area on St. Croix, red hind spawning aggregations on Lang Bank (St. Croix), Bajo de Sico, etc.)</i></p>
x	<p><i>Status of species subject to seasonal closures in the EEZ only and in the EEZ and territorial waters (queen conch, deepwater snapper, mutton and lane snapper, grouper unit 4 – yellowfin, tiger, etc.).</i></p> <p><i>Status of species within the no take areas such as the Hind Bank MCD – no take area in the EEZ, and within the state waters such as the monuments in St. Croix, EEMP in St. Croix, the NE Corridor, Tres Palmas, Luis Pena and others.</i></p>
x	<p><i>Shifts in fishing practices owing to implementation of regulations, e.g. gear changes from nets and traps to divers, change in fishing effort, escape vents. Gear changes result in changes to the species caught, the relative numbers of these species, size selectivity of the species being targeted and our ability to manage. Also, shifts in fishing grounds.....</i></p> <p><i>Research questions:</i></p> <ul style="list-style-type: none"> • <i>How do these changes impact the fish community and associated habitats?</i>
x	<p><i>Status of the yellowtail snapper populations – EEZ size limit is 12”TL; Puerto Rico has a size limit of 10.5”FL; there is no size limit in the USVI.</i></p> <p><i>Research questions:</i></p> <ul style="list-style-type: none"> • <i>What is the status of the yellowtail snapper population under these varying regulatory regimes?</i>

	<ul style="list-style-type: none"> • <i>Is there compliance with the regulations?</i>
x	<p><i>Status of queen conch population in St. Croix given the current management regime, which allows harvest of queen conch in the St. Croix EEZ (Lang Bank).</i></p> <p><i>Research questions:</i></p> <ul style="list-style-type: none"> • <i>What are the trends in the level of density and the size/age structure of queen conch?</i> • <i>What proportion of the legal sized population of queen conch is being harvested?</i>
x	<p><i>Status of the spiny lobster and queen conch populations, both have catch restrictions, but there is no information on the compliance of the recreational sector.</i></p> <p><i>Research questions:</i></p> <ul style="list-style-type: none"> • <i>What is the compliance with respect to the size limit for both species and retention of females with eggs for spiny lobster?</i> • <i>What do recreational fishers do with the regulatory discards?</i> • <i>What are the impacts of recreational fishing on the health of the spiny lobster and queen conch populations?</i>
x	<p><i>Recreational bag limits for all fish were imposed for federal waters in 2011.</i></p> <p><i>Research questions:</i></p> <ul style="list-style-type: none"> • <i>How is compliance?</i> • <i>What do recreational fishers do when they exceed the bag limits (regulatory discards)?</i> • <i>What are the impacts of bag limits on the health of the fish populations?</i> • <i>Should we have bag limits or is this a waste of time?</i>
<p>III. ECOSYSTEM BASED RESEARCH: WATERSHED APPROACH, LARGE SPATIAL AND TEMPORAL SCALE STUDIES</p>	
x	<p><i>Relationships between watershed specific material loading contributions, complexity of benthic subsystem components and historical fishery landing trends of pelagic and demersal fish populations.</i></p> <p><i>Research questions:</i></p> <ol style="list-style-type: none"> 1. <i>How do <u>changes</u> (historical, climatic, recent) in watershed systems of Puerto Rico and the Virgin Islands affect reef fish complexity and fisheries landings.</i> 2. <i>How do <u>differences</u> among (e.g. PR vs. USVI) watershed characteristics affect fish species composition, production and landings?</i> 3. <i>What is the importance of "<u>outwelling</u>" from coastal lagoons on reef fish production?</i> <p><i>STATUS:</i> <i>There is a significant amount of information (historical and recent) available for different watersheds in PR and the USVI from the USGS since 1900. Changes in</i></p>

	<p>rainfall affect sedimentation, nonpoint-source contaminants, nutrients and other components which affect or modify benthic and pelagic community characteristics. Some MPAs strongly influenced by watersheds (e.g. JOBANEER) have long-term collection programs on water chemistry and on physical parameters (salinity, turbidity, SST, and other) throughout various stations in Jobos Bay. Outwelling of nutrients and detrital matter from lagoons have been documented in the west coast of Puerto Rico and may affect reef associated fisheries (Owen, 1985??).</p>
x	<p>Historical and regional differences of reef fish feeding habits and energy pathways within and across ecosystem food webs sustaining (demersal and pelagic) fisheries.</p> <p>Research questions:</p> <ol style="list-style-type: none"> 1. Have reef fish feeding habits changed as a function of historical and recent changes in reef benthic community structure? 2. Are there differences in feeding habit behavior associated with regional differences in watershed conditions? <p>STATUS: There is extensive information documenting changes or <u>degradation</u> in coral reef community structure which may be associated with climatic or regional changes in water quality conditions. There is existing historical studies on the feeding habits of reef fish (e.g. Randall, 1967) in Puerto Rico and the US Virgin Islands when Caribbean reef ecosystems were under “<u>pristine</u>” or under baseline conditions. Since, there has been fish feeding habit studies conducted on the field (citations). Stable isotopes ratios studies (e.g. C13/C12) have been performed to determine energy pathways within ecosystems (e.g. Joyuda Lagoon citation) as well as across ecosystem food webs sustaining (demersal and pelagic) fisheries (citations).</p>
x	<p>Evaluate the influence of reef benthic habitat complexity, and particularly live coral cover on fish species diversity across an insular shelf distance gradient.</p> <p>Research questions:</p> <ol style="list-style-type: none"> 1- How changes in live coral affect the overall complexity of reef benthic habitats? 2- Amongst benthic habitat complexity components, which are more important as regulators of fish community structure? 3- Can artificial reef structures play an important role as reef restoration tools? <p>Status: Multivariate analyzes of fish assemblages from natural reserves in Puerto Rico (Esteves and Garcia, in prep) suggest that distance from shore, rugosity, live coral cover and depth are key shapers of coral reef fish community structure, as defined by the absolute and relative abundance of its taxonomic components. Thus, temporal variations/shifts of benthic habitat complexity, as influenced by climate change and other causes may drive variations of fish community structure and affect the status of commercially exploited top demersal and pelagic reef fish populations.</p>
x	<p>Establish the role of physical connectivity (distance) between juvenile and adult</p>

	<p><i>recruitment habitats in determining reef fish community structure and the relative abundance of top demersal predators.</i></p> <p><i>Research questions:</i></p> <ol style="list-style-type: none"> 1- <i>Is the availability of juvenile recruitment habitats limiting density and replenishment of commercially important reef fish and shellfish populations?</i> 2- <i>What are the mechanisms that allow these populations to thrive in small numbers at oceanic sites?</i> 3- <i>Is overfishing a factor regulating the status of snapper, hogfish and queen conch populations at oceanic/mesophotic sites?</i> <p>Status: Recent fishery independent surveys of commercially exploited fish and shellfish populations from mesophotic habitats within the PR EEZ (Abrir la Sierra -ALS, Desecheo-DES and Bajo de Sico-BDS) noted sharp density differences of large snappers (Cubera, dog, mutton), hogfish, and queen conch between the oceanic sites at DES and BDS, relative to ALS. The lower densities of the aforementioned populations from oceanic sites have been attributed to the lack of physical connectivity between juvenile and adult recruitment habitats. Larger sample sizes are critically needed to support these preliminary observations. A monitoring program of fishery independent surveys, expanded to include insular shelf habitats should be considered.</p>
x	<p><i>Identify reef fish larval sources, dispersal dynamics and taxonomically specific geographical ranges for population replenishment requirements.</i></p> <p><i>Research questions:</i></p> <ol style="list-style-type: none"> 1- <i>What are the main larval sources replenishing nursery habitats of PR and the USVI?</i> 2- <i>What are the main recruitment habitats for post-larval stages of commercially important species of fishes and shellfishes in PR and the USVI?</i> 3- <i>What is the dispersion and survival fate of grouper/snapper larvae originating from spawning aggregations in PR and the USVI?</i> <p>Status: Reef fish larval taxonomy and distribution studies in the Caribbean have been performed by Ramirez and Garcia, 2002 (PR) and by a research group from the SEFC on USVI waters. Additional, more comprehensive work needs to be performed at oceanic island passages, particularly Windward, Mona and Anegada to analyze the flux and developmental stages of commercially important reef fish larvae across these oceanic barriers.</p>
x	<p><i>Develop ecosystem modeling applications based on water quality, benthic habitat complexity, distance between juvenile and adult recruitment habitats and larval availability as controlling variables.</i></p> <p><i>Research questions:</i></p> <ol style="list-style-type: none"> 1- <i>Can watershed restoration efforts have measurable changes on the community structure of marine sub-systems, and particularly on the health of coral reefs?</i> 2- <i>What changes/translocations of energy flow and food webs interactions can be</i>

	<p><i>expected as a result of watershed restoration initiatives?</i></p> <p>3- <i>What are the implications of such restoration measures for the ecosystem related fishery resource?</i></p> <p>Status: Large scale man-made modifications of some of the largest watersheds in PR associated with agricultural, domestic/urban and/or industrial development have been performed over the last 50-60 years without the provision of quantitative baseline or monitoring studies evaluating effects on marine ecosystems, with its corresponding fishery implications. At present, a multi-agency federal and state initiative to restore the Guanica watershed is in progress. Application of multivariate models to predict energy flow through different food webs with the concomitant variations of community structure may be possible departing from the regulation of water quality, as influenced by material loadings from the watershed. It is uncertain at this point if sufficient baseline information of ecosystem conditions previous to restoration were in place for application of such models in the Guanica watershed case. Provision for applications of such models should be in place for additional watershed restoration initiatives.</p>
Rank	IV. FISHERY ASSOCIATED HUMAN COMMUNITIES
<p>x</p>	<p><i>Basic information/community profiles: demographics, ethnicities, unemployment, income sources, employment opportunities etc. including information from household surveys:</i> Constructing community profiles will allow science-based consideration of the potential impacts of conservation or management measures prior to their recommendation, approval or implementation.</p> <p>Possible research questions:</p> <ol style="list-style-type: none"> 1. What are the economic and social contributions of recreational and commercial fishing activities? 2. What are the impacts of fisheries regulations on commercial and recreational sectors? 3. What is the size and importance of recreational fishing? <p>Status: <i>information about commercial fishing communities can be found on some ethnographic studies. The Anthropology and Sociology department at the University of Rhode Island is undertaking a study in which socio-economic data of fishing communities of Southeastern Puerto Rico's is being collected. http://www.anthropology-news.org/index.php/2012/03/01/investigating-coastal-resource-use-quality-of-life-and-well-being-in-southeastern-puerto-rico</i></p> <p>Note: <i>Knowledge about recreational fisheries is very limited.</i></p>
<p>x</p>	<p><i>Community structures, identities, networks, and resiliency:</i> Documenting the structures, identities, social networks, and resiliency of fishing communities will allow to better understand the fishing industry. Also, efforts towards understanding these dynamics will allow science-based consideration of the potential impacts of conservation or management measures prior to their recommendation, approval or implementation.</p>

	<p><i>Possible research questions:</i></p> <ol style="list-style-type: none"> 1. <i>How do we define commercial and recreational fishermen?</i> 2. <i>Are our typologies about commercial and recreational fishermen in tune with the social and economic reality?</i> 3. <i>What sort of social arrangements and networks do recreational and commercial fishermen show? Is there overlapping?</i> 4. <i>What kind of strategies do fishermen implement to cope with social and economic uncertainty?</i> <p>Status: <i>as in the previous topic</i></p>
x	<p>Patterns of resource utilization and dependence, including sources, uses and distribution of fish in fishing communities: <i>Analyzing and documenting how fishing communities obtain, utilize and distribute fish will allow science-based consideration of the potential impacts of conservation or management measures prior to their recommendation, approval or implementation. It will also assist in the allocation of ACLs should this become necessary or desirable.</i></p> <p><i>Possible research questions:</i></p> <ol style="list-style-type: none"> 1. <i>What fishing technologies are favored today?</i> 2. <i>Is there a shift from traditional ways of fishing (e.g. nasas or fish traps) to other techniques like diving?</i> 3. <i>How are fishing harvests being distributed? Are the fish houses a pivotal node within the distribution network or are there alternative ways of distributing and selling fish. harvests?</i> <p>Status:</p>
x	<p>Community perceptions regarding marine ecosystem status, and the reasons (e.g. environmental, cultural, social, and economic) for those perceptions: <i>Understanding of community perceptions is necessary to predict expected levels of voluntary compliance with conservation or management measures.</i></p> <p><i>Possible research questions:</i></p> <ol style="list-style-type: none"> 1. <i>What is the perception of primary stakeholders about the marine resource status?</i> 2. <i>Are there common grounds between how managers and resource users understand the resource?</i> <p>Status: A few studies regarding commercial fishermen knowledge and perceptions about marine ecosystems are available. For example:</p> <p>García-Quijano, Carlos G. 2007. "Fishers' Knowledge of Marine Species Assemblages: Bridging Between Local and Scientific Knowledge in Southeastern Puerto Rico" <i>American Anthropologist</i> 109:3, 529-536.</p>
x	<p>Potential impacts on marine ecosystems from economic downturns on fishing</p>

	<p>pressure/effort: <i>Historically, economic downturns have been observed to affect fishing pressure/effort. On the one hand, as displaced workers seek to feed their families they may look into fishing industry as an economic option. On the other hand, shrinking economies may also affect the fresh fish market. Understanding the likely extent of such dynamics will allow fishery managers to develop, recommend, approve and implement appropriate regulatory responses in a timely manner.</i></p> <p><i>Possible research questions:</i></p> <ol style="list-style-type: none"> 1. <i>Has the prevailing economic recession increased or decreased the fishing pressure?</i> 2. <i>Is the number of commercial fishermen increasing due to the lack of job opportunities? Or on the other hand, are commercial fishermen fishing less due to costs and a lower demand for fresh but more expensive fish?</i> 3. <i>Is the number of recreational fishing trips lower due to the economy and high fuel costs?</i> <p>Status: Some studies shed light on the effects that economic fluctuations -and employment opportunities- in fishing communities and its possible effect on resource use. Griffith, David and Manuel Valdes Pizzini. 2002. Fishers at Work, Workers at Sea. Perez, Ricardo. 2005. The State and Small-Scale Fisheries.</p>
x	<p>Direct and indirect impacts of coastal development (e.g. residential, touristic, and marina development and operation) on marine resources, beach and fishing access: It is pertinent to address the impact of coastal development not only on fisheries resource but also its impacts on fishing-dependent communities.</p> <p><i>Possible research questions:</i></p> <ol style="list-style-type: none"> 1. <i>How does recreational use of the resource affect the commercial sector, and vice versa?</i> 2. <i>Is there a real conflict between play and work? And if so which are them? How they have been addressed?</i> 3. <i>Are fishing communities suffering gentrification processes?</i> <p>Status: There is a good deal of literature about the gentrification topic. Studies about conflicts between different coastal uses are also available.</p>
x	<p>Impacts of global climate change, ocean acidification and sea level rises on island communities: <i>Understanding the likely and actual impacts of these pressures will allow fishery managers to develop, recommend, approve and implement appropriate regulatory responses in a timely manner. In addition, conveying this information to fishery participants and communities will allow them to appropriately plan their fishing (and non-fishing) investments and activities.</i></p> <p><i>Possible research questions:</i></p> <ol style="list-style-type: none"> 1. <i>What is the impact of global climate change on fish stocks of commercial value</i>

	<p><i>and therefore on fishing-dependent communities?</i></p> <p>2. <i>What is the impact of global climate change on fish stocks of recreational value and on the recreational sector?</i></p> <p>Status:</p>
V. NEW AND ALTERNATIVE SAMPLING TECHNIQUES	
x	<p><i>Status of spawning aggregations.</i></p> <p><i>Research questions:</i></p> <ul style="list-style-type: none"> • <i>What species are using the aggregations sites?</i> • <i>What are the fish densities, size frequency distributions and sex ratios at these sites?</i> • <i>What are the habitats, the characteristics of these aggregation sites?</i> • <i>How can these aggregations be monitored? (e.g., passive acoustics, ROVs, AUVs)</i> • <i>How much are these aggregations contributing to the population?</i> <p>Status: Monitoring of spawning aggregations is to date not only sporadic in most areas in the EEZ except for the hind bank (MCD), the not take zone off St. Thomas. These should be continuously monitored to assess the status of the fish populations. Technologies such as rebreathers for transects, acoustics, and ROVs and AUVs are essential tools for determining the status of spawning aggregations in the US Caribbean.</p>
x	<p><i>Distribution and mapping of mesophotic reefs and baseline description of habitat and fish and invertebrate populations</i></p> <p><i>Research questions:</i></p> <ul style="list-style-type: none"> • <i>What are the predominant habitats in the EEZ? How are they distributed by depth?</i> • <i>What areas where they might occur have not been charted?</i> <p>Status: About 40% of the US Caribbean between the shoreline and the 100 m isobaths are areas between 30 and 100 m. Five of the seasonally closed areas to protect spawning aggregations and 2 additional mesophotic reefs have been characterized to date through the Coral Reef Conservation Program. These were possible because of the high resolution bathymetry that NOS collects during the R/V Nancy Foster missions to the Caribbean. The 30 to 50 m reefs are located mostly in the EEZ and are highly productive fishery areas. These as well might serve as refugia for shallow water replenishing; a hypothesis that needs to be tested.</p>
x	<p><i>Characterization of deepwater snapper ecosystem.</i></p> <p><i>Research questions:</i></p> <ul style="list-style-type: none"> • <i>What habitats are found at the depths of the deepwater snappers?</i> • <i>What is EFH for each life stage of these snappers?</i>

- *What are the trophic levels at these depths?*

Status: The Snapper Unit 1 (including silk) and Snapper Unit 2 (queen snapper) are highly valuable fisheries in the US Caribbean. These fisheries occur in deep water, at depths where new technologies such as autonomous underwater vehicles (AUV), remote operated vehicles (ROV) are required to for example describe essential fish habitat (EFH) as required by the MSA. A diverse community exists beyond diving depths and in the EEZ that need to be described and assessed.

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