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IMPROVING APPLICATIONS OF SCIENCE IN MPA DESIGN AND MANAGEMENT: WORKSHOP REPORT

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INTRODUCTION

This workshop was convened as part of the Symposium on Caribbean Marine Protected Areas: Practical Approaches to Achieve Economic and Conservation Goals, held at the 54th Annual Meeting of the Gulf and Caribbean Fisheries Institute, Providenciales, Turks and Caicos Islands, 12–17 November 2001. The workshop used the scientific theme of the MPA Symposium, "Connectivity at Multiple Spatial Scales", as a starting point to identify existing and underutilized tools that can improve the application of science to MPA management. The spatial themes of the earlier session, cross-shelf habitat connectivity among demersal life stages and oceanic connectivity among larval stages, were applied to corresponding administrative themes within several sub-discussions. Efforts to unify often distinct technical or administrative challenges were encouraged, with an eye on practical recommendations.

Over thirty attendees from ten countries and a wide range of institutions examined issues at the interface of scientific research and practical MPA management. Participants were asked to identify positive and negative trends in our scientific knowledge and its application to the design, implementation, and assessment of MPAs. Priority areas for filling gaps were also identified. Ultimately, we combined the Negatives section with the Gaps to be Filled section, since the topics arising within each were often directly connected. The group agreed upfront to focus primarily on no-take areas (= marine fishery reserves), although, discussions of reserves within the context of larger, multi-use zoned MPAs often arose.

POSITIVES—EXISTING TRENDS WITH SUBSTANTIAL UTILITY

A list of existing and emerging trends was developed. The continued or enhanced application of these themes is inherently endorsed. Subsets of some of these themes also occur in the following section on Negatives-Gaps to be filled.

I. Identification of key population linkages: Adults and juveniles across the shelf

A. Habitat mapping—

- Resolution and precision at multiple-spatial scales is increasing with both remote and *in-situ* devices.
- Distribution of mapping products to managers and regulated interests is improving with greater availability of CDs and web-based products.
- Analytic capacities are increasing with the development of new generations of Geographic Information System (GIS) software, including query-driven platforms for managers.

B. Faunal surveys—

- Good resources for short term, small scale monitoring work exist and are being improved.
- Resources are under development for the long term, large scale monitoring needed to best assess MPA effectiveness.
- Key habitats or behaviors (e.g., spawning aggregation sites) are receiving increased research attention, and this information has been directly applied in some MPA initiatives.
- Biological information on early demersal life stages is continuing to build.
- Recent advances in statistical sampling theory are tractable for intensive *in-situ* monitoring with appropriate amounts of trained divers.

II. Identification of key population linkages: Oceanic advection and retention

- New classes of hybrid numerical oceanographic models are being directly applied to larval transport modeling.
- New information on larval behavior, indicating highly developed maneuvering skills, is

being integrated into the numeric models as possible.
- Advances in otolith microchemistry and genetics are being applied to better differentiate population structure at several scales.
- Efforts to use information on larval advection or retention in the design of marine reserve networks is increasing.

III. Outreach to obtain key information and defuse anti-science bias
- There have been increases in efforts to bring the information of knowledgeable fishermen into both research and management processes. Several notable examples involve the identification of threatened spawning aggregation sites.
- Use of fishers in building information bases also aids the application of science by proactively diluting the mistrust that many regulated interests feel towards both scientists and managers. Tangible examples of this now exist in MPA design and should be fundamental to all MPA design exercises.

IV. Involvement of researchers in management processes
- Direct involvement of researchers in management processes has increased substantially.
- Concerns about applied research are being diluted as the literature continues to demonstrate that objectivity need not be sacrificed for the sake of real-world application.
- Scientists are gaining skills in translating research into layperson terms, but have a long way to go.

NEGATIVES—GAPS TO BE FILLED

Many of these issues follow from the common absence of clear goal-setting and subsequent hypothesis-testing to determine long-term MPA effectiveness. Many issues also follow from the extreme complexity of predictively understanding these systems in the face of natural variation, much less the variations induced by the many anthropogenic stressors and management interdictions.

I. Establish explicit and realistic protocols for measuring effectiveness

A. *Identify measurable goals and metrics to determine effectiveness (MPAs are experiments)*—
- Managers need to provide explicit goals. Scientists need to work with managers to develop measurable attributes of the key goals.
- Testable hypotheses are needed for the optimal evaluation of primary attributes of effectiveness.
- A broad array of metrics, familiar to both scientists and managers, needs to be identified and considered in terms of multiple working hypotheses.
- A subset of key science-management metrics need to be explicitly identified as critical and monitored over appropriate time scales.

B. *Hypothesis testing must operate at appropriate scales (MPAs are not traditional experiments)*—
- More explicit recognition of the confounding effects of both natural and anthropogenic variables is needed. This task is further complicated as the political timelines (e.g., election cycles, sunset clauses) are commonly incompatible with biological response timelines needed to identify management results in the presence of so many confounding variables.
- Management effectiveness may not always be best measured by typical confidence levels, particularly in the face of 1) 500 years of prior marine anthropogenic impacts in the Caribbean and the many generations of shifting (= lowered) management baselines, and 2) extremely disconnected cause and effect responses from management actions over short time scales. For example, trend analyses may be more appropriate in some instances.
- Must realistically consider burdens of proof and available data. We have strong fundamental scientific knowledge touse alternative-based inferences (e.g., increases in abundance and spawning stock biomass will result in outmigration, larval dispersal) to build testable monitoring programs, and experimentation when feasible.
- Employ more examples of standards of "recovery" or principles of ecological risk assessment that help partition stressor/effect relationships across the system. Apply bet-hedging theory to MPAs in more detail.

II. Identification of key population linkages: Adults and juveniles across the shelf

A. *Basic biology—*

- Much basic biological information is still absent or limited (e.g., home ranges of adults and younger life stages; habitat dependency, opportunism, and shift timing with maturation across the shelf; growth variation correlates with fecundity; details of trophic patterns; and geographic variations within all of these attributes).

B. *Anthropogenic impacts—*

- Long term research is not present at most existing MPAs. These activities are limited by funding and a dearth of long-term monitoring plans.
- Commercial fisheries data are often unstandardized and, in many countries with multi-species fisheries, are not available at the species level. Impacts of commercial gear upon habitats are under-evaluated in the Gulf of Mexico and Caribbean.
- Recreational fishery impacts are often unassessed. For many stocks, existing recreational catch and effort databases, and relative impacts need to be assessed.
- Increase the available database on the effects of recreational scuba divers upon habitats.
- Many water quality issues are commonly unaddressed in MPA design and monitoring. These are critical as they can represent inputs from outside of the reserve.
- The effects upon nearshore systems of myriad coastal construction impacts are not receiving direct attention from the research community in many geographic areas. An increased analyses of coastal habitat loss, particularly cumulative impacts, is needed.

III. Identification of key population linkages: Oceanic advection and retention

- New numeric modeling predictions will require empirical validation, but much fundamental larval information is still unknown.
- Ichthyoplankton surveys are expensive and time-consuming to execute and post-process; ultimately, they are decreasing in frequency. Larval taxonomic expertise is limited. Direct empirical information on larval behavior is almost non-existent.

IV. Outreach to build the political insight needed to accommodate scientific time and spatial scales

- Provide adaptive management alternatives upfront, yet, educate managers that it is not a failure to modify these as new information becomes available.
- Better educate managers and fishers on cascade effects over multiple time- and spatial-scales, and the difficulties and delays in predicting outcomes (e.g., *Diadema* and coral health, Everglades canalization and Florida Bay sponge mortality).
- Bring commercial and recreational fishers more directly into the information gathering process.
- Once an MPA is established, fundamental follow-up tasks are often less marketable (e.g., research into effectiveness, baseline management funding for education and enforcement).
- Demonstrate that funding 1) for before-action research is particularly cost-effective since it is essential to measuring impacts, and 2) that all interests benefit from funding to support post-action research.
- Enforcement is so variable that determining effectiveness is frequently impossible within individual MPAs, and not comparable among MPAs.

SUMMARY

The high diversity of countries represented by both scientists and managers was of great value during this workshop and throughout the entire conference. The 54th annual meeting represented the fifth straight year of MPA sessions or workshops at GCFI, and also convened the largest symposium to date on Caribbean MPAs. The Caribbean has many examples of MPA management in addition to the several areas typically mentioned, and the transfer of practical experiences was increased as many institutions from outside of the Caribbean were also in attendance. The number of conferences and workshops related to MPAs has increased to a point where an idea-blizzard exists that can both aid and constrain the identification of key lessons and future actions. GCFI 's commitment to serve as a region-wide forum for the examination of fishery and habitat management tools from both research and administrative perspectives is ongoing and input is continuously solicited. Future conferences and other initiatives will work to

further superimpose marine science, socio-economic, and administrative objectives.

Attendees of this workshop included: Alejandro Acosta, Rich Appeldoorn (Co-moderator), Jim Beets, Georgina Bustamante, Jennifer Caselle, Kurt Cordice, Michael Crosby, Nancy Daves, Michael Domeier, Nick Drayton, Bob Glazer, Ron Hill, Brian Keller, Rich Langton, Ken Lindeman (Co-moderator), Stuart Ludsin, Lisa Max, Kathy Mills, John Munro, Francisco Pagan, Claire Paris, Shane Patterson, Joanna Pitt, Rob Power, Cheri Recchia, Martin Russell, Peter Sale, Kristian Teleki, and Jeremy Woodley.