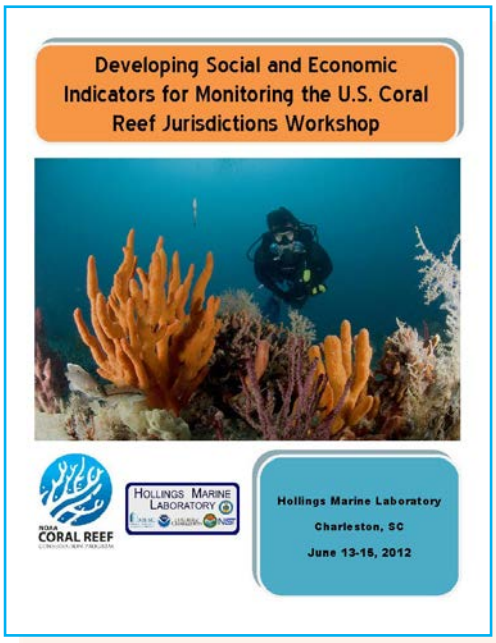
Developing Social and Economic Indicators for Monitoring the U.S. Coral Reef Jurisdictions

Report from a Scientific Workshop to Support the National Coral Reef Monitoring Program

Hollings Marine Laboratory June 13-15, 2012



To support the development of indicators, methods and measures for the National Coral Reef Monitoring Plan, the NOAA Coral Reef Conservation Program sponsored a workshop for scientists to review the socioeconomic plan, validate and refine the indicators and develop secondary data measures. Held at the National Centers for Coastal Ocean Science Hollings Marine Laboratory June 13-15, 2012, the workshop produced outputs that will be used along with the previously developed plan and survey questions in monitoring seven inhabited U.S. Coral Reef jurisdictions. The group prioritized thirteen indicators and provided valuable details on measurement and methods. This workshop provided an opportunity for expanded review of the National Coral Reef Monitoring Plan social science indicators and monitoring plan to ensure optimal design of this important program. Many of the participants are interested in continuing to advise the socioeconomic monitoring team as National Coral Reef Monitoring Plan implementation begins in FY 13, leading to the national status and trends report card.

National Coral Reef Monitoring Plan

Established by the Coral Reef Conservation Act in 2000, the National Oceanic and Atmospheric Administration's Coral Reef Conservation Program (CRCP) brings together expertise from many NOAA offices for a multidisciplinary approach to understand coral reef ecosystems and to develop tools that help solve key coral management issues. As a result of a 2007 external review, a series of partner workshops and an external evaluation of the program in June 2010, the CRCP Program Manager assembled a Working Group of NOAA scientists and managers with expertise on coral reef ecosystems from different offices or

science centers from US Pacific and Atlantic/Caribbean regions to develop a national plan for monitoring the status and trends of coral reef ecosystems.

The Working Group developed the National Coral Reef Monitoring Plan (NCRMP) which is a roadmap to guide the coordination of monitoring efforts for clear and efficient communication to national and territorial policy makers and resource managers. In addition to benthic communities, reef-associated fish communities and climate and ocean acidification monitoring the plan calls for the socioeconomic monitoring of jurisdictions. Although a draft plan has been established for the critical socioeconomic monitoring component, there was an identified need to enhance the plan by bringing together scientists with additional expertise in long term socioeconomic monitoring and indicators.

Table 1. Geographic Scope for Socioeconomic Monitoring

Jurisdiction	Geographic scope
American Samoa	Islands of Tutuila, Ta'u, Olosega, Ofu, and Aunu'u
CNMI	Islands of Saipan, Tinian and Rota only
Guam	Entire island of Guam
Hawai'i	Main Hawai'ian Islands only
Florida	Counties: Martin, Palm Beach, Broward, Miami-Dade, and Monroe
Puerto Rico	Puerto Rico, Vieques, Culebra, Desecheo, Mona Islands
USVI	St. Croix, St. Thomas, and St. John

The Socioeconomic Component

The NCRMP Plan provides an overview of each of the components through a description of the geographic scope, timing, and methods. Socioeconomic monitoring is planned to occur every 3-4 years for each jurisdiction. This will allow all inhabited U.S. Coral Reef Jurisdictions to be surveyed in time to coincide with the national-level status and trends report to be produced by the CRCP every four years. The purpose of the socioeconomic monitoring plan is to answer the questions: *What is the status of human knowledge, attitudes, and perceptions regarding coral reefs? And, how are human uses of, interactions with, and coral dependence on coral reefs changing over time?* While adequate funds are not available to get at the causes of problems, the monitoring effort will identify research areas that need further work; these projects can then be funded through other programs.

CRCP staff began planning for the socioeconomic monitoring through development of indicators and survey questions. Eleven indicators were developed to best monitor the human communities in relation to changes in the bio-physical ecosystems (Figure 1, numbers 1-11). Survey questions were developed to address indicators numbers 1-8. As these are intended for measurement, at least in part, through surveys, the survey question bank and an overview

of survey methods was submitted to and approved by the Office of Management and Budget. An OMB request for modification must be submitted before conducting each survey. Although these questions are dynamic in development, the intention is to formulate a long term monitoring plan that provides consistency in its collection.

Indicators numbers 9-11 were to be measured using secondary data. Further refinement and development of these indicators was the initial driving force behind the workshop. The total list of indicators is intended to contribute to an understanding of the socioeconomic state of a jurisdiction, including information about the population, individual knowledge, attitudes, and perceptions, the social and economic structure, the impacts of society on coral reefs, and the impacts of coral health on communities.

Socioeconomic Workshop

To fine tune the original monitoring plan and develop the methods for secondary data collection, a workshop was sponsored by NCRMP and organized by social scientists at the National Centers for Coastal Ocean Science Hollings Marine Laboratory. Participants were invited for their theoretical and methodological expertise in indicator development, and experience in both coral jurisdictions and the sociological dimensions of natural resources. (For a complete list of participants, see Appendix I.) The objectives of the workshop were to first educate the participants on the current status of the monitoring program then lead them through a series of exercises that would focus the work of the CRCP Socioeconomic Monitoring team. The workshop addressed measurement issues, data availability, and comparability of measures and data across jurisdictions in order to ensure that the socioeconomic component of NCRMP would be well positioned to document the social and economic health and vitality of coral reef-dependent communities using primary and secondary data.

Figure 1. Draft NCRMP Socioeconomic Indicators

1. Participation in reef activities
2. Knowledge of reef rules & regulations
3. Perceived compliance with rules & regulations
4. Perceived resource condition
5. Knowledge of threats
6. Attitudes towards reef management
7. Participation in behaviors that improve coral health
8. Cultural importance
9. Human population trends
10. Economic impact of coral reef fishing
11. Economic impact of dive/snorkel tourism

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12. Physical Infrastructure
13. Community well-being
14. Governance
15. Ecological Footprint

Workshop Objectives

1. Workshop participants are informed about the National Coral Reef Monitoring Program.
2. Workshop participants are informed about the indicator and monitoring work being conducted by others in order to identify linkages.

3. Workshop participants will identify and describe a common set of accurate, accessible and efficient measures for the indicators and data sources for the social and economic monitoring of the U.S. coral jurisdictions.
    - Demographics (identify secondary data)
    - Social Domain (identify secondary data, review of question bank for primary collections)
    - Economic Domain (identify secondary data, review of question bank for primary collections)
    - Use (identify secondary data, review of question bank for primary collections)
    - Knowledge, attitudes and perceptions (review of question bank, consider integration with other domains)
4. Workshop participants will draft monitoring and implementation methods for indicator collection and analysis as well as review and refine the socioeconomic components of the NCRMP.
5. Participants will discuss use of other data collection methods including participatory workshops to examine spatial use patterns and methods adapted for tourism.

Structure and Content

The structure of the workshop was a combination of presentations, small and large group discussions, and conceptual activities. Assignment to small groups was designed to combine differing expertise in the breakout sessions. This workshop structure was designed to meet the needs of NCRMP investigators and managers, as well as to supply useful outputs for the research community.

Once the workshop was convened, the organizers provided an overview of the workshop agenda, including the goals, objectives, and expectations. Workshop participants agreed on ground rules for interaction as well as working definitions of common terminology to be used for the duration of the workshop. Jeff King, Deputy Director of Hollings Marine Laboratory provided a welcome and invitation to the group to use the facility to best achieve their needs. NOAA Coral Reef Conservation Program Director, John Christensen provided an overview of CRCP and NCRMP and charged the group with the needs of the program. Christy Loper, Arielle Levine and Maria Dillard presented aspects of the NCRMP and an overview of social monitoring. Prior to the event, five participants, Bob Leeworthy, Gary Green, Stewart Allen, Mike Jepson and Susan Lovelace were asked by organizers to prepare and provide a presentation of present their current work with indicator/index development as it might inform the NCRMP.

During the second half of the first day, participants working in small and large group settings reviewed the list of indicators initially proposed by the NCRMP program (Figure 1, numbers 1-11), as well as a straw man of indicators and measures developed by the workshop organizers. *The participants evaluated the indicators* using the following criteria:

- Simple
- Few
- Easily collected
- Understandable
- Comparable
- Responsive to change
- Past data is available
- Measureable
- Able to identify change

Each group discussed additions or changes to the list. The large group refined and prioritized the most appropriate indicators from the combined list. They proposed the addition of indicators including: (1) Built infrastructure such as access, sewage treatment, development, oil and gas development, (2) Community well-being to include poverty, education, health, social conflict, (3) Perceived threats and perceived importance of the reefs, (4) Lifestyle, (5) Attitudes towards reef management/enforcement, (6) Ecological footprint, and (7) Knowledge and use of reefs. After discussing how each of these fit together with the original indicators, the group ultimately added physical infrastructure, community well-being, governance/institutions and ecological footprint to the list (Figure 1, numbers 12-15) then voted on a prioritized list for further work (see Figure 2).

Before moving back to small groups, participants broadly discussed major considerations such as comparability of data across geographic, cultural, institutional, temporal and practical scales. Many of the temporal issues are overridden by the need to develop a cost-effective regular interval report card of U.S. coral reef jurisdiction conditions for Congress and the American public. A four year data collection period for the initial report will allow for systematic collection in each jurisdiction. Geographic scales may vary. It will be helpful to collect data at the same scale of biological data when possible. Communications and understanding of different NCRMP efforts are an important reason for all teams to match in scale, when possible. This session culminated in a discussion of standardized data collection within and across jurisdictions. Primary data may be collected differently between jurisdictions while secondary data may be available at different scales with differing reliability between

jurisdictions. The group came to an informal consensus that there should be a set of indicators that are comparable across jurisdictions, but this does not preclude additional indicators from being used in a particular jurisdiction.

Another important discussion identified the need to target tourists/visitors and/or the businesses they support. Visitors are a large percentage of coral reef-related users in many of the jurisdictions. The current NCRMP has budgeted only for resident surveys missing this important group. At the end of this discussion, participants recommended that the NCRMP consider measuring similar indicators that are appropriate to visitors and businesses. During this discussion participants also considered a national survey and whether it is an appropriate tool for measuring meaningful information. One suggestion was to determine where tourists to specific jurisdictions are coming from then survey those states. This also leads to issues of nationality. Although we may sample citizens of the U.S., visitor use in some jurisdictions comes largely from other countries. It was suggested that a national survey be deferred until a solid strategy and funding can be considered. In the meantime, measuring the knowledge, use and values of visitors to coral reef jurisdictions can contribute to a fuller picture of human use and value.

During the second afternoon, the groups were asked to identify measures that could directly or indirectly quantify the indicator. Each group received an assigned group of indicators and was asked to begin work on those of highest priority. The groups were also asked to record information describing peer-reviewed support, current uses of indicators and measures, and potential data sources for measures.

The discussions and outputs of this small group activity are summarized below (see Appendix IV).

On the final day of the workshop, participants engaged in a discussion to identify potential linkages between ongoing or proposed projects and the socioeconomic component of NCRMP. As many of the participants were from different NOAA office and programs, a number of likely connections were established. Resources and potential partnerships were also discussed.

Figure 2. Prioritized list of NCRMP Socioeconomic Indicators

Priority	Indicator	Description	Examples
1	Participation in reef activities	Includes frequency and location of use, as well as access to activities; may encompass activities that are indirectly tied to reefs such as snorkeling, surfing reef breaks, diving, fishing, harvesting	revenues from recreational and tourist activities
2	Perceived resource condition	Perceptions of trends based on personal experience(to be reported alongside actual resource condition)	# visits to parks, # fishing and collection licenses, # scuba trips

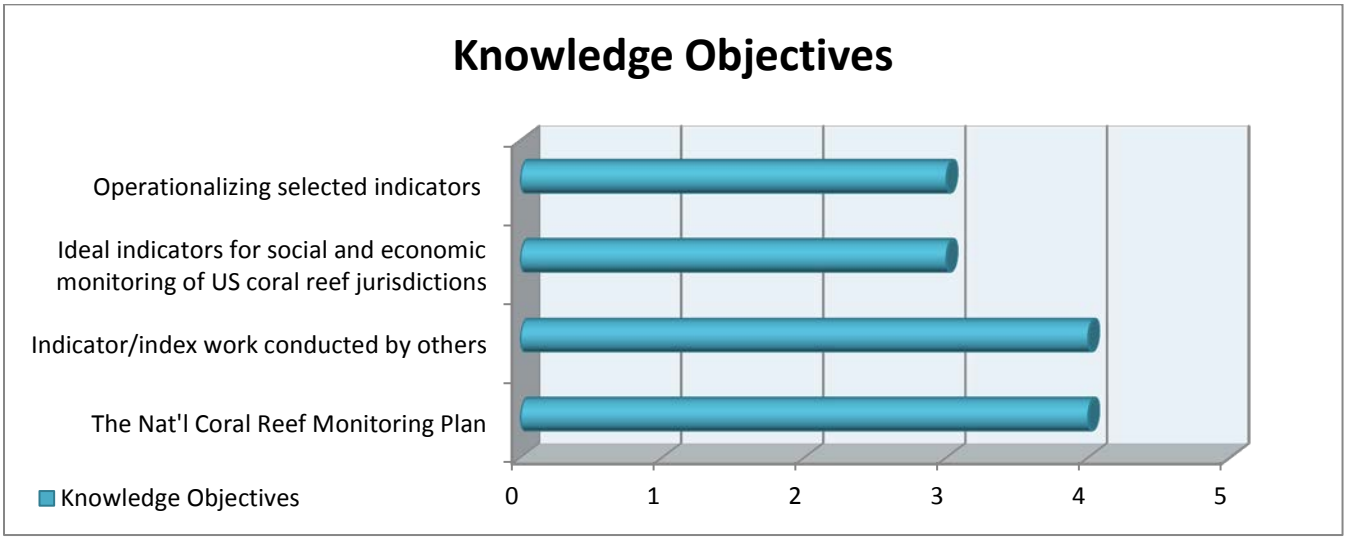
Priority	Indicator	Description	Examples
3	Attitudes towards coral reef management strategies and enforcement	Includes both perceptions of management activities as well as measures of participation in management	# citations, participation in advisory councils
4	Awareness and knowledge of coral reefs	Includes sources of information on coral reefs and awareness of threats to coral reefs, including climate change	# community centers, # environmental nonprofits registered
5	Human population trends (change) near coral reefs	Includes demographics, density, lifestyle (at individual level), and visitor counts	population, diversity of population by age, sex, race, ethnicity
6	Economic impact of coral reef fishing to jurisdiction	Economic distribution as a proxy for impact	income from fishing, e.g. charter boat fishing, number of "ocean jobs", fisheries landings per year, seafood sales, unemployment rates
7	Economic impact of dive/snorkel tourism to jurisdiction	Economic distribution as a proxy for impact	# of establishments, jobs, revenue, income, income from tourism industry, e.g. dive shops
8	Community Well-being	Includes health, basic needs, and economic security	disabled population, infant mortality rate, mental health, number of severe weather events, poverty rates, number of people on public assistance, access to medical care, job diversity, # registered voters, cultural centers, land cover, # parks
9	Cultural importance of reefs	Cultural norms, cultural and spiritual practices (individual and community levels), importance of reefs to well-being and quality of life, multigenerational knowledge	revenues from recreational and tourist activities, cultural symbols of coral reefs, fish, etc. present in publications, monuments, art
10	Participation in behaviors that may improve coral reef health	Includes activities such as beach cleanups, sustainable seafood choices, activities to reduce climate impacts (e.g. energy reduction strategies), waste reduction (e.g. recycling), reducing LBSP	# of beach cleanups, # of participants

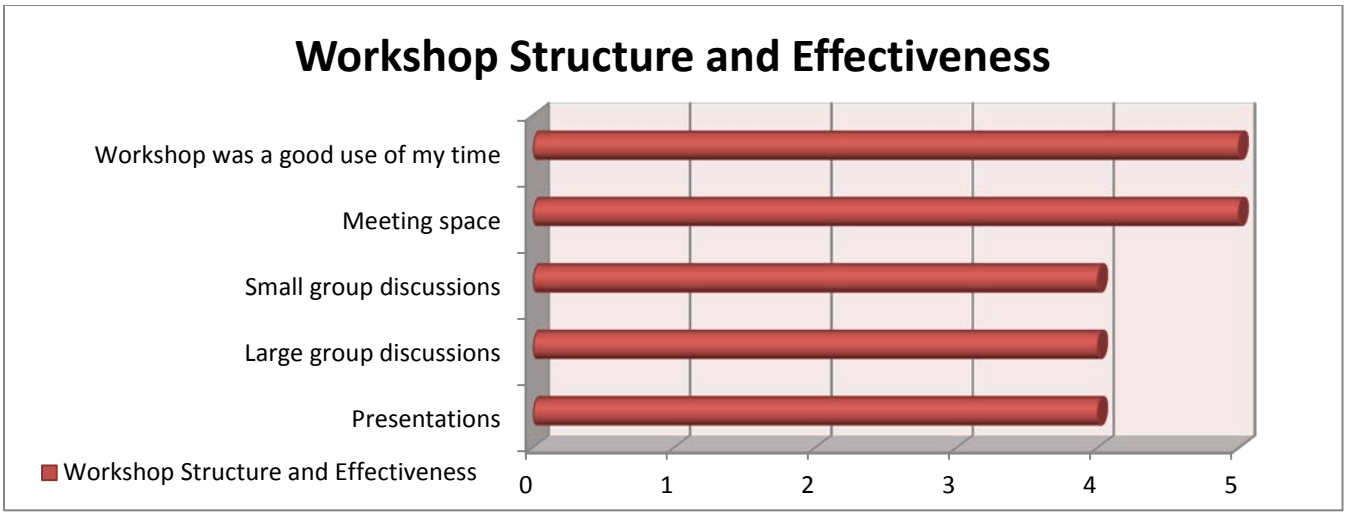
Priority	Indicator	Description	Examples
11	Physical Infrastructure	Includes development, energy infrastructure, physical access to coastal resources, EPA registered facilities, waste management, and water supply	# building permits issued per year, percent impervious surface, # beach access points
12	Awareness of coral reef rules and regulations	Includes behaviors, norms, etiquette, customary rules	# citations, # license holders
13	Governance	Current status of reef related governance	local institutions involved in coral reef conservation, management strategies enacted, % of coral reef area under protection

Workshop Evaluation

Workshop participants were engaged and eager to participate throughout the process which is always a good sign of success. As a final activity, participants were asked to provide their feedback to improve future workshops. Key results of this feedback are presented below (see Figures 3a, 3b).

Figures 3a, 3b. Workshop Evaluation Results (Modal Responses Reported)





As a result of the workshop, most participants answered that they know significantly more about NCRMP and the indicator/index work conducted by others. Post-workshop, most participants reported that they are somewhat more knowledgeable about ideal indicators for monitoring US coral reef jurisdictions and operationalizing selected indicators. The group found the overall structure and process of the workshop to be effective in all areas surveyed. Additionally, the participants decisively rated the workshop as an extremely good use of their time. In answering the open-ended question, nearly 80% of participants stated interest and willingness to participate in an advisory group for the social and economic components of the NCRMP. All but one participant had a federal affiliation and most participants were social scientists representing a broad variety of disciplines. Some participants wished the discussion was more focused and tasks more narrowly defined. However, a majority of participants liked best the small groups and the interaction with other participants from different fields.

Next Steps

Following the workshop, the NCRMP Socioeconomic Team went to work drafting the implementation plan for FY 13-16. The next phase for the socioeconomic component of NCRMP is to finalize the research design using the expert input from the workshop. The team will then work on developing a database for processing and storing data, identifying potential contractors for administering jurisdictional surveys, and analyzing survey pilot tests to determine if any changes to the survey bank questions are needed. Prior to implementation in the first jurisdictions and the development of the jurisdiction specific survey modules, the team will finalize the core modules for residents and tourism business operators to apply across all jurisdictions. Although surveys have been tested in several areas, it will be necessary to obtain Office of Management and Budget approval for the modifications and methods of each jurisdictional survey. After FY 13 funds are engaged, the plan will be implemented.

Acknowledgements

The workshop organizers would like to thank the workshop participants for giving their time to the preparation, travel and meeting required for a successful workshop. Their continued

engagement is vital to the endeavor. Also, we appreciate the facilitation, lead note taking, travel support and hosting duties of the leadership and staff at Hollings Marine Laboratory. Lastly, graduate students from the College of Charleston were responsible for coordinating key aspects of the workshop and note taking for the breakout groups. Their volunteer effort was invaluable.

Socioeconomic Monitoring Team

Christy Loper, Ocean and Coastal Resource Management, CRCP Social Science Coordinator (prior to 8/1/2012)
Peter Edwards, Ocean and Coastal Resource Management, CRCP Social Science Coordinator (beginning 8/16/2012)
Arielle Levine, National Marine Fisheries, Pacific Islands Regional Office
Maria Dillard*, National Center for Coastal Ocean Science, Hollings Marine Laboratory
Susan Lovelace*, National Center for Coastal Ocean Science, Hollings Marine Laboratory

* *denotes conveners*

Appendices

I.	List of Participants
II.	Conference Agenda
III.	NCRMP Monitoring Themes and Tiered Metrics
IV.	Breakout Group Output of Indicators, Measures, Sources and Methods
V.	Bibliography of References Provided by Workshop Participants

Developing Social and Economic Indicators for Monitoring the U.S. Coral Reef Jurisdictions Workshop – Participants

1. **Stewart Allen**, National Marine Fisheries, Pacific Islands Fisheries Science Center
2. **John Christensen**, National Ocean Service, Office of Ocean and Coastal Resource Management, Coral Reef Conservation Program
3. **Scott Crosson**, National Marine Fisheries, Southeast Fisheries Science Center
4. **Maria Dillard**, National Ocean Service, National Centers for Coastal Ocean Science
5. **Peter Edwards**, National Marine Fisheries, Office of Habitat Conservation, Restoration Center
6. **Theresa Goedeke**, National Ocean Service, National Centers for Coastal Ocean Science, Center for Coastal Monitoring and Assessment
7. **Gary Green**, University of Georgia Warnell School of Forestry and Natural Resources, Natural Resources, Recreation, and Tourism
8. **Susie Holst**, National Ocean Service, Office of Ocean and Coastal Resource Management, Coral Reef Conservation Program
9. **Michael Jepson**, National Marine Fisheries, Sustainable Fisheries/Social Science Branch
10. **Bob Leeworthy**, National Ocean Service, Office of National Marine Sanctuaries
11. **Arielle Levine**, National Marine Fisheries, Pacific Islands Regional Office (also San Diego State University, Department of Geography)
12. **Christy Loper**, National Ocean Service, Office of Ocean and Coastal Resource Management, Coral Reef Conservation Program
13. **Susan Lovelace**, National Ocean Service, National Centers for Coastal Ocean Science
14. **Linwood Pendleton**, NOAA Chief Economist
15. **Greg Piniak**, National Ocean Service, National Centers for Coastal Ocean Science, Center for Coastal Monitoring and Assessment
16. **Gabe Sataloff**, National Ocean Service, Coastal Services Center, Human Dimensions Program
17. **Steven Thur**, National Ocean Service, Office of Ocean and Coastal Resource Management, Coral Reef Conservation Program

<u>Correspondent and logistics coordinator</u>:
Bob Crimian, HML/CofC

<u>Note- takers:</u>
Stacey Thompson, HML
Jason Wong, NOAA
Catherine Bridges, CofC
Leslie Wickes, CofC

Developing Social and Economic Indicators for Monitoring the U.S. Coral Reef Jurisdictions

~Agenda~

Wednesday June 13 - Friday June 15, 2012

~ GOAL ~

The two and a half day workshop will assess and refine socioeconomic indicators and measures that can be monitored to develop an understanding of the state of a U. S. coral jurisdiction including information about the population, the social and economic structure of communities, the impacts of society on coral reefs, and the impacts of coral health on communities. Indicators for the program will include both primary and secondary collections. A question bank has been previously developed and approved by OMB for primary collections. These will be reviewed for integration into indicator measurement.

~ OBJECTIVES~

1. Workshop participants are informed about the National Coral Reef Monitoring Program.
2. Workshop participants are informed about the indicator and monitoring work being conducted by others in order to identify linkages.
3. Workshop participants will identify and describe a common set of accurate, accessible and efficient measures for the indicators and data sources for the social and economic monitoring of the U.S. coral jurisdictions.
    - Demographics (identify secondary data,)
    - Social Domain (identify secondary data, review of question bank for primary collections)
    - Economic Domain (identify secondary data, review of question bank for primary collections)
    - Use (identify secondary data, review of question bank for primary collections)
    - Knowledge, attitudes and perceptions (review of question bank, consider integration with other domains)

4. Workshop participants will draft monitoring and implementation methods for indicator collection and analysis as well as review and refine the socioeconomic components of the NCRMP.
5. Participants will discuss use of other data collection methods including participatory workshops to examine spatial use patterns and methods adapted for tourism.

Tuesday Evening—informal meet and greet

Appendix II. Participant Workshop Agenda

Wednesday	***ACTIVITIES and OBJECTIVES***
8:00	Wednesday June 13, 2011 Please meet in lobby of Fulton Lane Inn to split into available vehicles. Travel to HML
8:00 - 8:30	1. ***Check-in, Coffee & Tea***- Participants get caffeinated ☺
8:30 - 10:00	2. ***Welcome and Purpose of Workshop*** Welcome and overview of workshop. Participants share information and research. • Welcome and Introduction • Jeff King, Deputy Director, Hollings Marine Laboratory • John Christensen, Manager, NOAA Coral Reef Conservation Program
10:00 – 10:15	BREAK
10:15 - 12:15	3. ***Overview of CRCP and NCRMP*** • Christy Loper • Arielle Levine • Maria Dillard **Objective:** Workshop participants are informed about the National Coral Reef Monitoring Program.
12:15 – 1:15	LUNCH – Catered On-Site
1:15 – 2:30	4. ***Socioeconomic Monitoring Presentations*** • Bob Leeworthy, • Gary Green, • Stewart Allen, • Mike Jepson, • Susan Lovelace **Objective:** Workshop participants are informed about the indicator and monitoring work being conducted by others in order to identify linkages.
2:30 – 2:45	BREAK
2:45 – 4:30	5. ***Indicators, Large Group***

	5.5 Breakout Groups: • Review of Current Indicators • Addition of Indicators **Outcomes:** Comprehensive brainstorm of appropriate indicators.
4:30 – 4:40	SHORT BREAK
4:40 - 5:30	***6. Planning and tour of coral culture lab***
5:30 7:00	Return Downtown Meet for Social Hour *Dinner is self-assembled. Restaurant recommendations will be provided.*
Thursday	***ACTIVITIES and OBJECTIVES***
8:00	Thursday June 14, 2011 Please meet in lobby of Fulton Lane Inn to split into available vehicles. Travel to HML
8:00 - 8:30	***7. Check-in, Coffee & Tea-*** Participants get caffeinated ☺
8:30 - 10:00	***8. Breakout Groups: Indicators*** Review and refine work from Day 1 ***8.5 Large Group: Indicators*** **Outcomes:** Refined list of appropriate indicators.
10:00 – 10:15	BREAK
10:15 - 12:15	***9. Large Group: Measurement*** • Key considerations for next small group discussions • Key questions still to be answered.
12:15 – 1:15	LUNCH – Catered On-Site

1:15 – 2:45	***10. Large Group: Measurement Charge*** ***10.5 Small Groups*** **Outcomes:** Refined list of Indicators, Measures and Data sources
2:45 – 3:15	BREAK
3:15 – 4:45	***11. Large Group: Report out and monitoring*** **Outcomes:** List of Report Card ideas
4:45 - 5:00	***12. Large Group: Wrap Up*** Day 2 check-in on progress- objectives being met; Topics for Friday
5:15 7:00	Return Downtown *Dinner is self-assembled. Restaurant recommendations will be provided.*
Friday	***ACTIVITIES and OBJECTIVES***
8:30	Friday June 15, 2011 Please meet in lobby of Fulton Lane Inn to split into available vehicles. Travel to HML.
9:00 - 9:30	***13. Check-in, Coffee & Tea***- Participants get caffeinated ☺
9:30 - 10:30	***14. Large Group Discussion- Monitoring*** **Outcome:** List of other topics that should be addressed in long-term monitoring. List of coastal management needs beyond monitoring.
10:30 – 10:45	Break
10:45 - 12:00	***15. Large Group: Continued Discussion - Integration and Planning*** **Outcome:** Notes on how the NCRMP fits with other NOAA collections as well as suggestion next steps. 15 complete workshop evaluations!
	~Adjourn, Thank-You for Participating!~

Appendix III. NCRMP Themes and Indicators by Prioritized Tiers

	Tier 1 – critical	Tier 2 – important	Tier 3 - informative
BENTHOS /CORAL	Percent cover of benthic organisms/substrate Coral condition (*e.g.*, bleaching, disease) Abundance and size structure Rugosity Benthic diversity Key species	Growth rate Bioerosion rates	Reproduction Recruitment Mortality Metabolic performance Microbial communities Non-indigenous species Protected species
FISH	Abundance and size structure Diversity Key species		Reproduction Population fecundity Recruitment Distribution Trophic structure Non-indigenous species Protected species
CLIMATE	Temperature/thermal stress Vertical thermal structure Carbonate chemistry	Insolation Wave energy Hydrodynamics	Nutrients/productivity Meteorology Impacts of global change
PEOPLE	Participation in coral reef activities Knowledge, attitudes, and perceptions of coral reefs and management strategies Population changes and distribution Economic dependence on coral reefs	Land use Land cover	Economic value

Appendix IV. Breakout Group Output- Indicators, Measures, Sources and Methods. Compiled from 6/14 Breakout Session

	Indicator	Measures	Sources	Methods
1	Participation in reef activities • Snorkeling • Diving • Non-deep sea fishing • Surfing reef break • Harvesting • Kayaking • Stand-up paddle boarding • Jet ski • Glass bottom boat • Viewing/learning • Photography • Watching • Scientific Research	-types of activities -frequency of participation -length of participation - group size, repeat visit for a site, specialization (general travel purpose or specific - reasons/motivation for participation (important for fishing- type of fishing, etc.)	- primary Exit interviews Observations Surveys -Secondary PADI NMFS, CREEL NSRE FWS Outdoor Foundation American Recreational Association, Outdoor Recreation Coalition License/permit data	-surveys of residents - Piggy back on existing data from recreational groups, sites, organizations, memberships Note: Consider these sources for national surveys and jurisdictional
		-visitor activities -person days	-visitors themselves	-survey of visitors -interview of tourism operators
		-use counts -location of use	-satellite data -pre-existing data	-over-flights
		-facilities and providers	-visitor bureaus -local governments -existing datasets -facilities and providers	-mining secondary source data (where available across jurisdictions)
2	Perceived resource condition	See question bank (inadequate? But eliminate some?) Location, proportion of good/bad, outlook and past status	Question bank	Primary collection Drop off survey Phone survey Internet survey (mapping?) Face to face combination with… Pile sorting

Appendix IV. Breakout Group Output- Indicators, Measures, Sources and Methods. Compiled from 6/14 Breakout Session

	Indicator	Measures	Sources	Methods
				Cultural mapping
3	Attitudes towards coral mgmt strategies	Cognitive Hierarchy Actual compliance Perceived compliance Literature review, record review Attitudes towards mgmt	Primary, survey (phone, mail, in person) - survey of constituents Secondary (institutional/agency) Actual infractions recorded, citations issued Observation; survey Primary – survey of constituents; willingness to comply/scenario based Grad students Public meetings records and comments, participation and representation; membership in organizations (environmental, religious, club) Citations before/after public meetings Volunteerism – jurisdiction or NGO based	Jurisdictional; temporal frequency? 3-4 years interval; periodicity and seasonality should be considered by jurisdictional characteristics/contexts (e.g. peak, non-peak, hot/cold, wet-dry, am/pm) Constituent group: demographic, user groups, ethnicity, purpose of stay/use, business status/group, generation, managers Different strategy for different jurisdictions – stratification sensible in larger areas and not as much in small islands Contracting flexibility? meta-analysis
4	Knowledge of reefs	-perception/ understanding of threats to reefs	-primary collections -previously collected	-jurisdictional, national, visitor surveys

Appendix IV. Breakout Group Output- Indicators, Measures, Sources and Methods. Compiled from 6/14 Breakout Session

	Indicator	Measures	Sources	Methods
		-level of basic knowledge -understanding of ecosystem services/ benefits	survey data (at national level)	
5	Human population trends (change) near coral reefs	See question bank Demographics, pop density, age, race, retirees, tenure, primary/secondary residents Lifestyle (see Gary's module for education and outreach). Link to #10 participation.	Question bank or census Social surveys done by jurisdiction	Primary and secondary: Secondary for jurisdiction Primary for individual
6	Economic impact, coral reef fishing	Regional economic impact Economic dependence on reefs	Primary level – asking people, subsistence Secondary level – NMFS; Sales, expenditures, employment, taxes, earnings; NASBLA; FWS survey; National Sporting Goods Association; ENOW-BLS; Census; Outdoor Foundation; American Recreational Coalition; Tourism Industry Association; import and export; spear fishing organization	Commercial vs. recreational Input-Output analysis Extent of industry specialization (economic diversity) By species Also consider live trade (of coral) Are there existing surveys from various organizations (e.g. recreation)?
7	Economic impact of non-extractive use	-direct (employment and revenue only) and indirect (if implan) jobs and income	-tourism operators -tourism boards -licensing agencies	-interviews of tourism operators -input/output analysis

Appendix IV. Breakout Group Output- Indicators, Measures, Sources and Methods. Compiled from 6/14 Breakout Session

	Indicator	Measures	Sources	Methods
8	Community wellbeing	Index Social conflict (divorce, bankruptcy, etc.) Poverty Vulnerability index Deepwater Horizon project See Jepson indices, etc.	Census Fisheries Health dept Other federal collections Realty websites (neighborhood indicators) NWS storm damage estimates Insurance companies FEMA	Secondary
9	Cultural importance *individual, community, spiritual	Measurement of monuments, museums, parks; retail shops (cultural emphasis); Cultural visitors Number of festivals, fishing events and participation Palolo, Atule/Akule – community fishing Reference and representation in literature and media (could be community-level knowledge)	Secondary – government statistics, past oral histories and studies, Chamber of Commerce, BLS, local tourism bureaus, NGOs, Park service, (education/exchange opportunities?) Primary- oral history	Take results from past oral histories and build from past data; compare generational oral histories Contextual analysis
10	Participation in behaviors that may improve coral reef health	-individual participation (types of activities) -memberships -participation in management activities	-primary -tweak questions in the bank	-survey
		-group/collective participation -number of groups -types of actions - total number of local	-primary -existing information	-interviews and observation

Appendix IV. Breakout Group Output- Indicators, Measures, Sources and Methods. Compiled from 6/14 Breakout Session

	Indicator	Measures	Sources	Methods
		members Note: may want to involve visitors to see what they are doing to improve coral reef health		
11	Physical infrastructure (ecological footprint)	Access EPA registered facilities Water access Sewage treatment Power source (i.e. oil, gas, nuclear) Development Land use and land cover Impervious surfaces Hotel beds available	USGS (impervious surfaces) GIS databases Remote sensing Census (economic census) EPA State CZMA programs Current business (survey of state level)	Secondary Capacity utilization method (link back to #1 participation in reef activities) Spatial analysis
12	Knowledge of rules and reg	Awareness	Primary – survey; jurisdictional Extent of signs and their distribution Secondary – how are rules and regulations exposed; outreach methods Public meetings records and comments, participation and representation; membership in organizations (environmental, religious, club)	Peripheral or cognitive; Max. likelihood Two-levels questions; awareness and source of awareness Depending on jurisdictions – where signs are distributed could be readily available in the municipal government level

Appendix IV. Breakout Group Output- Indicators, Measures, Sources and Methods. Compiled from 6/14 Breakout Session

	Indicator	Measures	Sources	Methods
			Volunteerism – jurisdiction or NGO based	
13	Governance	-percentage of coral reefs under protection by jurisdiction -investment of resources to protect the reef -capacity of local governments to address coral reef threats -MPA checklist scores	Coral Program: -pre-existing data -local, state, and federal agency spending in key areas/programs -existing contract -MPA checklist scores -coral action plans and strategies	-mining of existing data -interviews of key informants
14	14 Ecological footprint	Footprints on the Land-Cordell; lots of data sets on imprints, methodology easily applied – place to start	Many indices already available Existing college departments	Broad, easily available; but jurisdictional level? A by-product from portfolio of current designed data collection
		Biological/ecological capital and capacity Waste produced/released Extraction/use Population Import/export of impact of eco capacity		

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