Recommendations for the Gray's Reef National Marine Sanctuary Advisory Council from the Advisory Council Marine Research Area Concept Working Group

June, 2005
Savannah, GA

This document consists of the recommendations and working materials of the Research Area Working Group of the Gray's Reef National Marine Sanctuary Advisory Council.

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1.0 Introduction

In order to better understand the naturally occurring changes within an ecosystem and better discriminate natural from human induced change in the sanctuary environment, a baseline set of measurements of the ecosystem must be determined and followed over time. Developing an understanding of the interactions and interdependence of living marine resources in a natural environment is key to effective management. Also, such understanding is critical to development of rapid and appropriate responses to both natural and human induced events.

As with the protection of any natural resource, information on the status and natural variability of resource components, species, and systems is essential for the informed management of an area as extensive as Gray's Reef National Marine Sanctuary (GRNMS.) In order to adequately differentiate between anthropogenic and natural changes and to further determine how those changes might affect other components of the ecosystem, a baseline set of ecosystem measurements should be established and monitored over subsequent years. As this data is gathered and analyzed, scientists and managers can determine with greater confidence how much variability is natural in the system and how much may be the result of anthropogenic influence. With a better understanding of those factors that influence ecosystem health and function, managers can better protect the resource and respond rapidly and appropriately to natural or human-induced events.

In order to determine the changes in or responses of key resources to human influence within Gray's Reef, it has been suggested that an area needs to be established that serves as a control (that is, it is not impacted by extractive or disruptive activities). By comparing changes in key resources in the absence of human activity in a control area to other areas of the sanctuary where extractive activity is allowed, Gray's Reef management would have better information to balance the needs of research, protection and constituent use of the resources. As stated in the National Marine Sanctuary Act, sanctuary management must address the following goals:

- support, promote and coordinate scientific research on and monitoring of, the resources of these areas;
- enhance public awareness, understanding, appreciation and wise use of the marine environment;
- facilitate, to the extent compatible with the primary objective of resource protection, all public and private uses of the resources;
- maintain, restore and enhance living resources by providing places for species that depend upon these marine areas to survive and propagate.

The concept of a Marine Research Area in Gray's Reef National Marine Sanctuary was developed through comments obtained in public scoping for the GRNMS Draft Management Plan, subsequent resource and research workshops and through a recommendation from the Gray's Reef Sanctuary Advisory Council (see Appendix I - Gray's Reef Research Area Concept Timeline). The need for an investigation into the conceptual approach to the design of such an area was adopted as a strategy for the Research and Monitoring Action Plan of the Draft Management Plan (see Appendix J - Gray's Reef National Marine Sanctuary Draft Management Plan/Draft Environmental Impact Statement, Strategy RM-2). In January of 2004, the Sanctuary Advisory Council formally recommended establishing a working group to explore the "research area concept." At the first meeting of the Research Area Working Group (03 May, 2004) constituents from science, regional management, recreational and commercial fishing, conservation, law enforcement, education and recreational diving came together to explore the concept in detail.

In consideration of what questions might be addressed by establishing a marine research area, a list of questions for which GRNMS currently does not have answers was considered:

- What would benthic communities look like in the absence of human activity?
- What impacts do extractive activities have on the reef and living marine resources?
- What would the fish populations look like in the absence of fishing impacts?
- What impacts would the removal of targeted species have on the more "resident" fishes of Gray's Reef?
- How do we scientifically contrast community structure between "natural" reefs and reefs that have been influenced by human activities?
- How does one determine what impact human activities are having on the benthic invertebrates?
- What are the spatial and temporal dynamics of fish communities in a natural, unfished population?
- What variability is inherent in these natural systems and what changes may be the result of human influence?
- How well is NOAA conserving the resources of Gray's Reef National Marine Sanctuary?

2.0 Process

The Research Area Working Group (RAWG) of the Gray's Reef Sanctuary Advisory Council developed a facilitated, consensus driven process to address the concept. All participants discussed issues, considerations, and concerns for each step at length. Prioritization efforts were arrived at by consensus and comments were captured and appended to this document, as were general comments on the pros and cons of the establishment of a research area (Appendices F-H).

The RAWG process consisted of two main topics: Priority Research Questions, which were evaluated to determine IF a research area would be of value in GRNMS, and Siting Considerations, which included input on HOW a research area site should be determined. The process is described below.

It was necessary to determine if there were research questions that: 1) were important to the sanctuary and its resources and 2) required a research area to answer. If not, then siting considerations need not be discussed.

First, the context for the RAWG existence and process were presented by GRNMS staff, as described in the Introduction above.

Next, the Natural Resources of the Sanctuary and potential influences or impacts on those resources (both natural and human) were identified by the RAWG (see Appendix A-Matrix 1a).

By consensus, the resources and potential impacts of highest priority were determined. The evaluation process is summarized in Appendix A-Table A.1. Those resources and impacts were compared to one another and those that were considered to have medium or high likelihood of interaction were moved forward for further evaluation (see Appendix A-Matrix 1b).

Potential research questions were developed for activities considered to have medium or high impact on sanctuary resources. These questions were evaluated by asking the questions: "Would a research area provide significant information on this question?" and "Is a research area necessary to answer this question?" (see Appendix B-Matrix 2). Those research questions that received a "yes" to both questions were moved forward for further evaluation.

Next, in order to ensure that the priority questions were amenable to study, several issues had to be considered (e.g., could an area of adequate size be established within the 56 sq. km. boundaries of GRNMS, would it be enforceable, what would it cost, how long would it take). Between meetings, each participant was asked to fill out a Study Requirements matrix. The individual responses and a summary of those responses are included in Appendix C.

At the next meeting, the summary Requirements matrix was discussed by the group and input for each research question and their requirements were agreed upon by the group (see Appendix D).

Once the group agreed which important research questions required a research area, it was necessary to identify consideration for placement of such an area within GRNMS.

After general thoughts regarding the pros and cons of a research area were discussed and captured, potential siting criteria were identified by the group (Appendices F-H). The

first determination was to include as much high-relief hard bottom as possible in a research area, since this habitat type was considered by all to be the most relevant to the questions posed. Also, the working group decided that inclusion of as many previously used research sites as possible would be beneficial for comparative purposes. Thirdly, the group decided that it was important to try to minimize impact on the public, which, at GRNMS it was agreed, includes primarily recreational fishermen. Existing geo-referenced boat count data was used as a proxy for heavily fished areas (Appendices F-H).

A GIS-based site evaluation tool was developed by Matt Kendall, NOAA Biogeography Team, to develop a method for the evaluation of sites of various sizes that reflected the criteria agreed upon by the group. Once developed, the siting criteria were discussed again at length and it was decided that the GIS-based site evaluation tool was excellent, but the criteria needed to be refined before it could be used for siting. Specifically, in the initial analysis, previous research sites seemed to "drive" the results and discussion centered on the idea that not all previous research sites were of equal importance as reference sites. Additionally, there was discussion about whether or not the geo-referenced boat position data used in the analysis, gathered largely during King Mackerel tournaments, was representative of the areas targeted by bottom fishermen was discussed.

3.0 Recommendations

Recommendation 1

Significant research questions exist at Gray's Reef National Marine Sanctuary that can only be addressed by establishing a control (research) area. Therefore, it is the finding of this working group of the Sanctuary Advisory Council to NOAA that the research area concept should be further explored through a public review process.

Recommendation 2

The Working Group recommends that a GIS-based site evaluation tool, very much like the one developed by Matt Kendall, be used, with proper siting criteria, if a research area is to be established within the boundaries of Gray's Reef National Marine Sanctuary. Further, it is recommended that the inclusion of high relief habitat be the primary criterion for siting and that certain previous research areas (e.g., the ongoing monitoring station) be included in any area designated as a secondary consideration.

Recommendation 3

Minimizing impact on fisherman should be a priority, with the use of non-bottom impinging trolling gear being allowed within a research area. It will be necessary to gather data from bottom-fishermen on where they fish and it is recommended that the impact to these fishermen be minimized to the extent practicable.

APPENDICES

APPENDIX A

- Table A.1: Summary of Possible Interactions between GRNMS Natural Resources and Natural Processes and Human Activities
- Matrix 1a: Possible Interactions between GRNMS Natural Resources and Natural Processes and Human Activities
- Matrix 1b: Prioritized Interactions between GRNMS Natural Resources and Human Activities

Table A.1: Summary of Possible Interactions between GRNMS Natural Resources and Natural Processes and Human Activities

Addressing the Main Issues of Concern to be Studied in the Marine Research Area

		DISCUSSED	INCLUDED IN FINAL MATRIX	NOT INCLUDED IN FINAL MATRIX	Comments
NATURAL RESOURCES	HABITAT	Water Column		♦	Gray's Reef too small to effectively note change
		Subsurface (Ground water)		♦	Gray's Reef too small to effectively note change
		Artificial Structure		♦	N/A
		Biogenic		♦	Topics included in studies of invertebrates
		Rippled Sand		♦	Any research area targeting High Relief HB would include this habitat
		Flat Sand		♦	Any research area targeting High Relief HB would include this habitat
		High Relief HB	●		
		Low Relief HB		♦	Any research area targeting High Relief HB would include this habitat
	LIVING RESOURCES	Plankton		♦	Gray's Reef too small to effectively note change
		Microbial Communities		♦	Doubtful that extractive activities have significant effect
		Benthic Algae		♦	Doubtful that extractive activities have significant effect
		Infauna		♦	Doubtful that extractive activities have significant effect
		Sessile Inverts	●		
		Mobile Inverts	●		
		Bottom Fish	●		
		Bait Fish	●		
		Pelagic Fish	●		
		Marine Mammals		♦	Doubtful that extractive activities have significant effect
		Turtles		♦	Doubtful that extractive activities have significant effect
		Seabirds		♦	Doubtful that extractive activities have significant effect

	NON LIVING RESOURCE	Fossils		♦	Doubtful that extractive activities have significant effect
POTENTIAL INFLUENCES	NATURAL PROCESSES	Production (fecundity, recruitment, growth, and immigration)		♦	Topics included in studies of invertebrates and fishes
		Hydrodynamics		♦	Gray's Reef too small to effectively note change
		Meteorology		♦	Gray's Reef too small to effectively note change
		Climate Change		♦	Gray's Reef too small to effectively note change
		Loss (disturbance, competition, predation, disease, emigration)		♦	Topics included in studies of invertebrates and fishes
	ANTHROPOGENIC INFLUENCES	Contaminants and Nutrients		♦	Does not require research to study
		Marine Debris	●		
		Pathogens		♦	Does not require research to study
		Pelagic Fishing	●		
		Bottom Fishing	●		
		Spearfishing	●		
		Management (Indirect Effects)		♦	Does not require research to study
		Research		♦	Does not require research to study
		Diving	●		
		Boating		♦	Not tractable
		Exotics and Invasives		♦	Does not require research to study
		Harassments/Disturbances		♦	Does not require research to study

*These comments represent consensus of the working group and help to clarify why certain issues and concerns were not brought forward in the final analysis of Matrix 1.

Matrix 1a: Possible Interactions between GRNMS Natural Resources and Natural Processes and Human Activities

Potential Influences on Resources	**Production** *(fecundity, recruitment, growth, immigration)*	**Hydrodynamics**	**Meteorology**	**Climate Change**	*competition, predation, disease, emigration)*	**Contaminants and Nutrients**	**Marine Debris**	**Pathogens**	**Pelagic Fishing**	**Bottom Fishing**	**Spearfishing**	**Management (Indirect Effects)**	**Research**	**Diving**	**Boating (e.g. discharges, noise, anchoring)**	**Exotics and Invasives**	**Harassment/ Disturbance**
Natural Resources																	
Habitat																	
Water Column																	
Subsurface (Ground water)																	
Artificial structure																	
Biogenic																	
Rippled Sand																	
Flat Sand																	
High Relief HB																	
Low Relief HB																	
Living Resources																	
Plankton																	
Microbial Communities																	
Benthic Algae																	
Infauna																	
Sessile Inverts																	
Mobile Inverts																	
Bottom Fish																	
Bait Fish																	
Pelagic Fish																	
Marine Mammals																	
Turtles																	
Seabirds																	
Non-living resources																	
Fossils																	

Matrix 1b: Prioritized Interactions between GRNMS Natural Resources and Human Activities

	Human Activities				
Natural Resources	**Marine Debris**	**Pelagic Fishing**	**Bottom Fishing**	**Spearfishing**	**Diving**
High Relief HB	**M**	**L**	**M**	**L**	**L**
Sessile Inverts	**M**	**L**	**H**	**M**	**M**
Mobile Inverts	**L**	**L**	**M**	**M**	**L**
Bottom Fish	**L**	**M**	**H**	**H**	**M**
Bait Fish	**L**	**M**	**M**	**L**	**L**
Pelagic Fish	**L**	**H**	**M**	**M**	**L**

APPENDIX B

- Table B.1: Summary of Considerations for the Value of a Research Area
- Matrix 2: Considerations for the Value of a Research Area

Table B.1: Summary of Considerations for the Value of a Research Area

Defining Management Priorities Requiring the Implementation of a Research Area

	Research Topics to Support Management Priorities:	Could a Research Area Provide Significant Information to Address Management Concerns? Is a Research Area Necessary?
INCLUDED IN MATRIX 3	*Sessile Inv/Bottom Fishing:*	
	Fishing Gear Effects	Yes/Yes
	Recovery Rates	Yes/Yes
	Indirect Effects	Yes/Yes
	Mobile Inv/Bottom Fishing:	
	Effect of Predator Removal	Yes/Yes
	Bottom Fish/Bottom Fishing:	
	Direct Effects	Yes/Yes
	Recovery Rates	Yes/Yes
	Spearfishing vs. Angling	Yes/Yes
	Spearfish Effects on Fish Behavior	Yes/Yes
NOT INCLUDED IN MATRIX 3	*Bait Fish/Pelagic Fishing:*	
	Effect of Pelagic Take on Bait Populations and Reef Structure	No/No
	Effect of Removal of Bottom Fish on Bait Populations and Reef Structure	No/No
	Bait Fish:	
	% of Bait Fish activity outside GR vs. inside GR	No/No
	Pelagic Fish/Pelagic Fishing:	
	Direct Effects	Unknown/No
	Effects on Migratory behavior	No/No

Matrix 2 - Considerations for the Value of a Research Area

Research questions to support management priorities	Could a Research Area provide significant information to address Management concerns?	Is a Research Area necessary?	Why would or why wouldn't the research area address the concerns?	What should be the characteristics of the area? (e.g. physical properties, activities)	What are the issues of concern? (e.g. user concerns, cons, costs, scientific process)	What are some additional information needs or requirements prior to establishment of area?
SESSILE INV/ BOTTOM FISHING fishing gear effects	Yes	Yes b/c trad studies such as caging would not be adequate	*Provide a control site	*Representative/ matched to treatment area *Eliminate bottom fishing gear effects *Could be a small area *Should not exclude other activities *Replication is necessary *Identifiable to public	*Enforcement/ Physical Marking *Cost and Commitment *Public Acceptance and Compliance *Displacement of Bottom Fishing *Education *Identification of the area *Size of area selection *Requires long-term study *Regional Oceanography/ Climatology	*Size options **a priori* distrib of fished area *Bottom type *spp comp inverts *Literature review *Experimental design *Usage data/ overflights *Info on removals at GR
SESSILE INV/ BOTTOM FISHING recovery rates	Yes	Yes b/c trad studies such as caging would not be adequate	*Provide a control site	*Representative/ matched to treatment area *Eliminate bottom fishing gear effects *Could be a small area *Should not exclude other activities *Replication is necessary *Identifiable to public	*Enforcement/ Physical Marking *Cost and Commitment *Public Acceptance and Compliance *Displacement of Bottom Fishing *Education *Identification of the area *Size of area selection *Requires long-term study *Regional Oceanography/ Climatology	*Size options *a priori distrib of fished area *Bottom type *spp comp inverts *Literature review *Experimental design *Usage data/ overflights *Info on removals at GR *Biology and growth rates of spp of concern

Research questions to support management priorities	Could a Research Area provide significant information to address Management concerns?	Is a Research Area necessary?	Why would or why wouldn't the research area address the concerns?	What should be the characteristics of the area? (e.g. physical properties, activities)	What are the issues of concern? (e.g. user concerns, cons, costs, scientific process)	What are some additional information needs or requirements prior to establishment of area?
SESSILE INV/BOTTOM indirect effects	Yes	Yes b/c trad studies such as caging would not be adequate	*Provide a control site	*Representative/ matched to treatment area *Eliminate bottom fishing gear effects *Could be a small area *Should not exclude other activities *Replication is necessary *Identifiable to public *Possibly a larger area is required to capture indirect effects	*Enforcement/ Physical Marking *Cost and Commitment *Public Acceptance and Compliance *Displacement of Bottom Fishing *Education *Identification of the area *Size of area selection *Requires long-term study *Regional Oceanography/ Climatology *Additional studies are required to investigate the details of indirect effects	*Size options *a priori distrib of fished area *Bottom type *spp comp inverts *Literature review *Experimental design *Usage data/ overflights *Info on removals at GR
MOBILE INV/ BOTTOM FISHING effect of predator removal	Yes	Yes b/c trad studies such as caging would not be adequate	*Provide a control site	Larger area to capture mobility - enough individuals captured	*Enforcement/ Physical Marking *Cost and Commitment *Public Acceptance and Compliance *Displacement of Bottom Fishing *Education *Identification of the area *Size of area selection *Requires long-term study *Regional Oceanography/ Climatology *Longer "before" study to capture periodicity of baseline pop.	*Size options *a priori distrib of fished area *Bottom type *spp comp inverts *Literature review *Experimental design *Usage data/ overflights *Info on removals at GR *Longer "before" study to capture periodicity of baseline pop.

Research questions to support management priorities	Could a Research Area provide significant information to address Management concerns?	Is a Research Area necessary?	Why would or why wouldn't the research area address the concerns?	What should be the characteristics of the area? (e.g. physical properties, activities)	What are the issues of concern? (e.g. user concerns, cons, costs, scientific process)	What are some additional information needs or requirements prior to establishment of area?
BOTTOM FISH/ BOTTOM FISHING direct effects	Yes	Yes	*Provide a control site	*Representative/ matched to treatment area *Eliminate bottom fishing gear effects *Could be a small area *Should not exclude other activities *Replication is necessary *Identifiable to public *Intermediate size *Non-destructive sampling *Long-tem measured in generation time of spp of concern *Requires comparative site within GR	*Enforcement/ Physical Marking *Cost and Commitment *Public Acceptance and Compliance *Displacement of Bottom Fishing *Education *Identification of the area *Size of area selection *Requires long-term study *Regional Oceanography/ Climatology *Size to capture edge/halo effect	*Fish movement *Need regional population estimate supplemented by estimates of removal rates at GR
BOTTOM FISH/ BOTTOM FISHING recovery rates	Yes	Yes	*Provide a control site	*Representative/ matched to treatment area *Eliminate bottom fishing gear effects *Could be a small area *Should not exclude other activities *Replication is necessary *Identifiable to public *Intermediate size *Non-destructive sampling *Long-tem measured in generation time of spp of concern *Requires comparative site within GR	*Enforcement/ Physical Marking *Cost and Commitment *Public Acceptance and Compliance *Displacement of Bottom Fishing *Education *Identification of the area *Size of area selection *Requires long-term study *Regional Oceanography/ Climatology *Size to capture edge/halo effect *More frequent sampling *Recruitment rates *Fish growth rates *Mortality rates *Life history *Production (secondary)	*Size options *a priori distrib of fished area *Bottom type *spp comp inverts *Literature review *Experimental design *Usage data/ overflights *Info on removals at GR *Fish movement *Need regional population estimate supplemented by estimates of removal rates at GR *Baseline fish population data

Research questions to support management priorities	Could a Research Area provide significant information to address Management concerns?	Is a Research Area necessary?	Why would or why wouldn't the research area address the concerns?	What should be the characteristics of the area? (e.g. physical properties, activities)	What are the issues of concern? (e.g. user concerns, cons, costs, scientific process)	What are some additional information needs or requirements prior to establishment of area?
BOTTOM FISH/ BOTTOM FISHING **spearfishing v angling**	Yes	Yes	*Treatments	*Representative/ matched to treatment area *Eliminate bottom fishing gear effects *Could be a small area *Should not exclude other activities *Replication is necessary *Identifiable to public *Intermediate size *Non-destructive sampling *Long-tem measured in generation time of spp of concern *Requires comparative site within GR *Two treatment areas plus control - one closed to spearfishing, one to bottom fishing	*Interaction between treatment areas *Unrealistic public compliance *Vastly more complicated (e.g. permits) *Feasibility of experimental design	
BOTTOM FISH/ BOTTOM FISHING **spearfishing effects on fish behavior**	Yes	Yes	*Provide a control site	*Representative/ matched to treatment area *Eliminate bottom fishing gear effects *Could be a small area *Should not exclude other activities *Replication is necessary *Identifiable to public *Intermediate size *Non-destructive sampling *Requires comparative site within GR	*Difficult to distinguish behavior vs take (i.e. why aren't fish there) *Behavior of fish could affect other studies	

Research questions to support management priorities	Could a Research Area provide significant information to address Management concerns?	Is a Research Area necessary?	Why would or why wouldn't the research area address the concerns?	What should be the characteristics of the area? (e.g. physical properties, activities)	What are the issues of concern? (e.g. user concerns, cons, costs, scientific process)	What are some additional information needs or requirements prior to establishment of area?
BAIT FISH / PELAGIC FISHING **effect of pelagic take on bait pops and reef structure**	No	No				
BAIT FISH / BOTTOM FISHING **effect of removal of bottom fish on bait pops and reef structure**	No	No				
BAIT FISH **% of bait fish activity outside GR vs inside GR**	No	No				
PELAGIC FISH/ PELAGIC FISHING **direct effects (e.g. structure, pops.)**	Unknown	No				*Need regional population estimate supplemented by estimates of removal rates at GR
PELAGIC FISH/ PELAGIC FISHING **Effects on migratory behavior**	No	No				

APPENDIX C

- Matrix 3a: Study Requirements Matrix to Be Completed by Participants of Research Area Working Group (Blank)
- Matrix 3b: Summary of Study Requirements Matrix Completed by Participants of Research Area Working Group
- Matrix 3c: Individual Study Requirements Matrices Completed by Participants of Research Area Working Group

MATRIX 3a: Study Requirements Matrix to Be Completed by Participants of Research Area Working Group (Blank)

	Study							
	Sessile Invertebrates/Bottom Fishing			Mobile Invertebrates/ Bottom Fishing	Bottom Fish/Bottom Fishing			
Requirements	**Fishing Gear Effects**	**Recovery Rates**	**Indirect Effects**	**Effect of Predators**	**Direct Effects**	**Recovery Rates**	**Spearfishing v angling**	**Spearfishing effects on fish behavior**
Objective	Evaluate the impacts of bottom fishing gear on benthic invertebrate populations (priority organisms include sponges and corals). Can be expanded to look outside.	Determine the rate of recovery of populations of sessile inverts following various levels of disturbance by bottom fishing gear	Determine the nature and extent of indirect effects (e.g., changes in benthic food webs) caused by changes in benthic communities due to bottom fishing	Characterize the mobile invert communities in the absence of fishing	Determine the level to which benthic fish populations are reduced by bottom fishing effort	Determine the rate of recovery for species targeted by bottom fishing	Ascertain differences in the level of impact on benthic fish populations caused by spearfishing and angling	Determine what aspects of fish behavior (e.g., schooling, feeding, mating, predation, symbioses) are affected, the extent of effects (temporary or long-term), and impacts of changes caused by spearfishing
Research/ Sampling Requirements								
Habitat Type/Specific Place								
Size								
Number of Research Areas								
Design Option								
Duration								
Marking								
Enforcement								
Outreach								
Displacement/ Prohibited Activities								
Ancillary Data Requirements								
Research Costs								
Notes								

Matrix 3b: Summary of Study Requirements Matrix Completed by Participants of Research Area Working Group

	Study							
	Sessile Invertebrates/Bottom Fishing			Mobile Invertebrates/ Bottom Fishing	Bottom Fish/Bottom Fishing			
Requirements	**Fishing Gear Effects**	**Recovery Rates**	**Indirect Effects**	**Effect of Predator Removal**	**Direct Effects**	**Recovery Rates**	**Spearfishing v angling**	**Spearfishing effects on fish behavior**
Objective	Evaluate the impacts of bottom fishing gear on benthic invertebrate populations (priority organisms include sponges and corals). Can be expanded to look outside.	Determine the rate of recovery of populations of sessile inverts following various levels of disturbance by bottom fishing gear	Determine the nature and extent of indirect effects (e.g., changes in benthic food webs) caused by changes in benthic communities due to bottom fishing	Determine the impacts to benthic prey communities caused by removal of predators due to fishing (priority species include lobster, crabs, urchins etc.)	Determine the level to which benthic fish populations are reduced by bottom fishing effort	Determine the rate of recovery for species targeted by bottom fishing	Ascertain differences in the level of impact on benthic fish populations caused by spearfishing and angling	Determine what aspects of fish behavior (e.g., schooling, feeding, mating, predation, symbioses) are affected, the extent of effects (temporary or long-term), and impacts of changes caused by spearfishing
Habitat Type/Specific Place	Densely and Sparsely colonized Live Bottom	Densely and Sparsely colonized Live Bottom	Densely and Sparsely colonized Live Bottom	from All habitats to Live Bottom	Live Bottom	Live Bottom	Live Bottom with target species of both activities (e.g. black sea bass are bottom-fished, not spearfished)	Live Bottom with high density of target species
Size	VS	VS	VS	VS, S, M, VL	M-L	M-L	VS - M	VS - M
Number of Research Areas	3 VS or 1 M-L (to accommodate plots)	3 VS or 1 M-L (to accommodate plots)	3 VS or 1 M-L (to accommodate plots)	2 to 12	2 to 6	2 to 6	2 to 12	2 to 12
Design Option	A or B (C or BC if outside)	A or B (C or BC if outside)	A or B (C or BC if outside)	All but D, E	All but D, E	All but D, E	All but D	All but D
Duration	2 - 5 years	5 -10 years	3 - 10 years	3 - many years (10 or more)	2 - many years (up to 20yrs)	2 - many years (up to 20yrs)	4 - 10 years	18 months - many years (up to 20yrs)
Research/ Sampling Requirements	Document incidences of injury only (simple counts) vs. more detailed benthic characterizations including injuries	Lower end - follow recovery of documented injury in Fishing Gear Effects study - Compare recruitment, abundance, condition and growth in closed vs reference areas or manipulative experiment	High end - trophic structure studies (i.e. gut contents, predator-prey, energy flow models)					

Matrix 3b: Summary of Study Requirements Matrix Completed by Participants of Research Area Working Group

	Study							
	Sessile Invertebrates/Bottom Fishing			Mobile Invertebrates/ Bottom Fishing	Bottom Fish/Bottom Fishing			
Requirements	**Fishing Gear Effects**	**Recovery Rates**	**Indirect Effects**	**Effect of Predator Removal**	**Direct Effects**	**Recovery Rates**	**Spearfishing v angling**	**Spearfishing effects on fish behavior**
Marking	Yes, buoys for closed area	Yes, buoys for closed area	Yes, buoys for closed area	Yes, buoys for closed area	Yes, buoys for closed area	Yes, buoys for closed area	Yes, buoys for closed area (would be challenging)	Yes, buoys for closed area
Enforcement	Yes, Onsite and/or remote - requires outreach and education	Yes, Onsite and/or remote - requires outreach and education	Yes, Onsite and/or remote - requires outreach and education	from None to Onsite and/or remote	from None to Onsite and/or remote	from random inspections to onsite and/or remote	from random inspections to onsite and/or remote (would be challenging)	from random inspections to onsite and/or remote
Outreach	Yes, what, why and for how long - seminars, flyers, print, news, web, visualization techniques, media, marking on charts, buoy labeling, notices to mariners, etc.	Yes, what, why and for how long - seminars, flyers, print, news, web, visualization techniques, media, marking on charts, buoy labeling, notices to mariners, etc.	Yes, what, why and for how long - seminars, flyers, print, news, web, visualization techniques, media, marking on charts, buoy labeling, notices to mariners, etc.	Yes, what, why and for how long - seminars, flyers, print, news media, marking on charts, buoy labeling, etc.	Yes, from announcements to results published to "why, how, who"	Yes, from announcements to results published to "why, how, who" (would need a lot)	Yes, from announcements to results published to "why, how, who" (need would be greater presumably due to complicated nature of study)	Yes, from announcements to results published to "why, how, who"
Displacement/ Prohibited Activities	Bottom Fishing, Spearfishing, Bottom-impinging trolling,	Bottom Fishing, Spearfishing, Bottom-impinging trolling,	Bottom Fishing, Spearfishing, Bottom-impinging trolling,	From No Entry to no take to no bottom fishing to no bottom or spearfishing	From No Entry to no take to no bottom fishing to no bottom or spearfishing	From No Entry to no take to no bottom fishing to no bottom or spearfishing	From No Entry to no take to no bottom fishing to no bottom or spearfishing to no spearfishing	From No Entry to no take to no bottom fishing to no bottom or spearfishing
Ancillary Data Requirements	Fishing Effort by gear type, compliance, Physical measurements including episodic events	Fishing Effort by gear type, compliance, Physical measurements including episodic events, Lit Review (e.g., growth rates)	Fishing Effort by gear type, compliance, Physical measurements including episodic events, Lit Review (e.g., population and community ecology)	Boat Counts (effort?), Physical measurements, Lit Review, who eats what?	Effort (Boat Counts, tournaments, catch data), Physical measurements, Lit Review	Boat Counts, Physical measurements, Extensive Lit Review (info on life histories, ecosystem, regional oceanography /climatology, edge effect, movement, regional estimate of population size, growth rates, mortality rates, life history, recruitment rates)	Effort for all activities, Boat Counts, Physical measurements, Extensive Lit Review (info on life histories, ecosystem, regional oceanography/ climatology, edge effect, movement, regional estimate of population size, growth rates, mortality rates, life history, recruitment rates)	Need to know number and behavior of spearfishermen, Boat Counts, Physical measurements, Lit Review (info on life histories, movement)

Matrix 3b: Summary of Study Requirements Matrix Completed by Participants of Research Area Working Group

	Study							
	Sessile Invertebrates/Bottom Fishing			Mobile Invertebrates/ Bottom Fishing	Bottom Fish/Bottom Fishing			
Requirements	**Fishing Gear Effects**	**Recovery Rates**	**Indirect Effects**	**Effect of Predator Removal**	**Direct Effects**	**Recovery Rates**	**Spearfishing v angling**	**Spearfishing effects on fish behavior**
Research Costs	$15K to $200K/yr above and beyond GRNMS logistical support (would include grant funds)		>$300K	For this project - "Minimal" to $300K total For all projects - $350K to $1M/year	For this project - "Minimal" to $500K total For all projects - $350K to $1M/year	For this project - - "Minimal" to $500K total For all projects - - $350K to $1M/year	For this project - "Minimal" to $500K total For all projects - $350K to $1M/year	For this project - "Minimal" to $150K total For all projects - $350K to $1M/year
Notes	Assuming no anchoring, unclear about the effects of bottom-impinging trolling, also practicality of enforcement might be easier to close the area to all fishing, if GRNMS staff had time to participate the research costs would be substantially reduced, more buoys = increased cost and more hassle			Formulation of specific questions and feasibility of study depend on results from fishing gear effects and recovery rate studies.				

Matrix 3c: Individual Study Requirements Matrices Completed by Participants of Research Area Working Group

Lad Akins	**Study**							
	Sessile Invertebrates/Bottom Fishing			Mobile Invertebrates/Bottom Fishing	Bottom Fish/Bottom Fishing			
Requirements	Fishing Gear Effects	Recovery Rates	Indirect Effects	Effect of Predator Removal	Direct Effects	Recovery Rates	Spearfishing v angling	Spearfishing effects on fish behavior
Objective	Evaluate the impacts of bottom fishing gear on benthic invertebrate populations (priority organisms include sponges and corals)	Determine the rate of recovery of benthic populations following various levels of disturbance by bottom fishing gear	Determine the nature and extent of indirect effects (e.g., changes in benthic food webs) caused by changes in benthic communities due to bottom fishing	Determine the impacts to benthic prey communities caused by removal of predators due to fishing (priority species include lobster, crabs, urchins etc.)	Determine the level to which benthic fish populations are reduced by bottom fishing effort	Determine the rate of recovery for species targeted by bottom fishing	Ascertain differences in the level of impact on benthic fish populations caused by spearfishing and angling	Determine what aspects of fish behavior (e.g., schooling, feeding, mating, predation, symbioses) are affected, the extent of effects (temporary or long-term), and impacts of changes caused by spearfishing
Habitat Type/Specific Place	Ledges (Densely/moderately colonized) and other charted sites/GR site 20, other marked ledges	same	same	same				
Size								
Number	6 (3 in, 3 out)	same	same	same				
Design Option	BC	Same	Same	Same	Same	Same	Same	same
Time	3- 5 years	same	same	same				
Research/Sampling Requirements	Biological inventories incl. density and size, gear debris inventories/ bi-annual sampling	Same	same plus tagging to determine movement between sites	same plus tagging to determine movement between sites	same plus tagging to determine movement between sites	same plus tagging to determine movement between sites	same plus tagging to determine movement between sites	same plus tagging to determine movement between sites, video to determine behavior
Marking	Buoys, notice to mariners, charts, flyers	Same	Same	Same	Same	Same	Same	Same
Enforcement	USCG, DNR, NMS, Volunteers?	Same	Same	Same	Same	Same	Same plus dive operators	Same plus dive operators
Displacement/Prohibited Activities	Any removal activities	Same	Same	Same	Same	Same	Same	Same
Education/Outreach	Seminars, flyers, talks at club meetings, print and news media	Same	Same	Same	Same	Same	Same	Same
Ancillary Data Requirements	Usage (boats/fishing/diving/spear fishing effort incl tournaments), episodic events (storms, upwellings)	Same	Same	Same	Same	Same	Same	Same
Cost								

Matrix 3c: Individual Study Requirements Matrices Completed by Participants of Research Area Working Group

Henry Ansley	**Study**							
	Sessile Invertebrates/Bottom Fishing			Mobile Invertebrates/Bottom Fishing	Bottom Fish/Bottom Fishing			
Requirements	Fishing Gear Effects	Recovery Rates	Indirect Effects	Effect of Predator Removal	Direct Effects	Recovery Rates	Spearfishing v angling	Spearfishing effects on fish behavior
Objective	Evaluate the impacts of bottom fishing gear on benthic invertebrate populations (priority organisms include sponges and corals)	Determine the rate of recovery of benthic populations following various levels of disturbance by bottom fishing gear	Determine the nature and extent of indirect effects (e.g., changes in benthic food webs) caused by changes in benthic communities due to bottom fishing	Determine the impacts to benthic prey communities caused by removal of predators due to fishing (priority species include lobster, crabs, urchins etc.)	Determine the level to which benthic fish populations are reduced by bottom fishing effort	Determine the rate of recovery for species targeted by bottom fishing	Ascertain differences in the level of impact on benthic fish populations caused by spearfishing and angling	Determine what aspects of fish behavior (e.g., schooling, feeding, mating, predation, symbioses) are affected, the extent of effects (temporary or long-term), and impacts of changes caused by spearfishing
Habitat Type/Specific Place	Habitat should be representative of where the gear is used.	Habitat should be representative of where the gear is used.	Habitat should be representative of where the gear is used.	Habitat should be representative of where the gear is used/supports targeted species. Isolated bottom needed/required.	Habitat should be representative of where the gear is used/supports targeted species.	Habitat should be representative of where the gear is used/supports targeted species.	Habitat should be representative of where both gears are used. Habitat should support species targeted by both groups. E.g., spearfishers typically don't target black sea bass, but go for larger fish.	Habitat should support species targeted by spearfishing.
Size	Dictated by existing habitat distribution, extent, & how many habitat types targeted by studies. Overall, it seems the exact study site(s) for hook & line could (would have to be) be relatively small. Could be one larger area that encompasses all habitat types targeted. Or it could be several smaller areas with different habitat types. Needs to be large enough to allow for replicates and controls. Also affected by available funding and program resources.	Would be same site(s) where initial treatment was done. See corresponding comments under "Fishing Gear Effects"	Would be same site(s) where initial treatment was done. See corresponding comments under "Fishing Gear Effects"	See corresponding comments under "Fishing Gear Effects"	See corresponding comments under "Fishing Gear Effects"	See corresponding comments under "Fishing Gear Effects".	Not sure. Needs to take into consideration the movement of prey and large enough to allow adequate sampling and treatments reflective of typical spearfishing & angling practices.	See corresponding comments under "Spearfishing vs Angling".

Matrix 3c: Individual Study Requirements Matrices Completed by Participants of Research Area Working Group

Henry Ansley	**Study**							
	Sessile Invertebrates/Bottom Fishing			Mobile Invertebrates/Bottom Fishing	Bottom Fish/Bottom Fishing			
Requirements	Fishing Gear Effects	Recovery Rates	Indirect Effects	Effect of Predator Removal	Direct Effects	Recovery Rates	Spearfishing v angling	Spearfishing effects on fish behavior
Number	Dictated by existing habitat distribution, extent, & how many habitat types targeted by studies. 2-4 sites (treatments & controls) sites either within one overall area that incorporates all habitat types normally targeted by the gear and is large enough to provide needed replicates. More than one site may be required if the habitat types are widely dispersed. If different habitat types are studied sequentially (not all at once), the number of sites could be reduced. Also affected by available funding and program resources.	Would be same site(s) where initial treatment was done. As applied to this objective, see corresponding comments under "Fishing Gear Effects"	Would be same site(s) where initial treatment was done. As applied to this objective, see corresponding comments under "Fishing Gear Effects"	As applied to this objective, see corresponding comments under "Fishing Gear Effects".	As applied to this objective, see corresponding comments under "Fishing Gear Effects".	As applied to this objective, see corresponding comments under "Fishing Gear Effects".	As applied to this objective, see corresponding comments under "Fishing Gear Effects". Likely at least four separate sites, incl. controls.	As applied to this objective, see corresponding comments under "Fishing Gear Effects". Likely at least four separate sites, incl. controls...
Design Option	E (immediate, short-term impacts 3 yrs). C or BC for long-term (depending on study objectives & resources).	C or BC (depending on study objectives & resources).	C or BC (depending on study objectives & resources).	C or BC (depending on study objectives & resources).	C or BC	C or BC	E	E

Matrix 3c: Individual Study Requirements Matrices Completed by Participants of Research Area Working Group

Henry Ansley	**Study**							
	Sessile Invertebrates/Bottom Fishing			Mobile Invertebrates/Bottom Fishing	Bottom Fish/Bottom Fishing			
Requirements	Fishing Gear Effects	Recovery Rates	Indirect Effects	Effect of Predator Removal	Direct Effects	Recovery Rates	Spearfishing v angling	Spearfishing effects on fish behavior
Time	2-3 years (looking at immediate impacts only).	10+ years, including site baseline studies for several years. Depends on how long you want to look at recovery full-term or get just an idea on rates. If there is any information about growth rates of the invertebrates or similar species, that may give you a rough idea of how long to monitor. If area baselines have already been established, required time could be reduced.	10+ years. As applied to this objective, see applicable corresponding comments under "Recovery Rates".	Dependent on study design/detail, 5-10 years. As applied to this objective, see corresponding comments under "Recovery Rates"	10-20 years, depending on species & size classes targeted. Consider longevity of species such as grouper, black sea bass, etc. Permanent for ongoing comparisons. As applicable to this objective, see corresponding comments under "Recovery Rates"	10-20 years depending on species & size classes targeted. Consider longevity of species such as grouper, black sea bass, etc. Permanent for ongoing monitoring until it is decided that "recovery" is reached (not known). As applicable to this objective, see corresponding comments under "Recovery Rates"	10 years, including site baseline studies. If area baselines have already been established, required time could be reduced.	5 years
Research/Sampling Requirements	Counts, ids, measurements, labeling & photographs/videos within a measured sample area. Determine area makeup of sites before (baseline). Identify species to be targeted. Apply treatment (fishing). Repeat measurements. Long-term - annually. Also need to determine initially if compared sample sites are similar & representative. Need to consider available & future resources/funding during design & prior to implementation of studies. Can it be carried to completion?	Ongoing annual counts, presence/absence, photographs, growth measurements, etc. Other ways to measure recovery/health? e.g., metabolic levels, efficiency, etc.?? Need to consider available & future resources/funding during design & prior to implementation of studies. Can it be carried to completion?	Detailed baseline info. on targeted systems especially needed prior to treatment... Then similar to previous two studies. Again, need to consider available & future resources/funding during design & prior to implementation of studies. Can it be carried to completion?	Identify/define predator-prey interactions to be studied. Counts, ids, measurements, & photographs/videos over time. Need ongoing information on angler effort in area. Initial baseline survey of study site(s), including closed site... Allow. predator populations to build in closed area(s). Survey /monitor as community develops. Repeat surveys semi-annually. Could eventually open closed area. Continue surveys & monitoring to monitor effects. Need to consider available & future resources/funding during design & prior to implementation of studies. Can it be carried to completion?	Identify targeted species. Counts, ids, measurements, & photographs/videos over time. Initial baseline survey of study site(s), including closed site(s). Need to have ongoing information on fishing effort in area. Tagging studies to determine natural movement patterns & emigration. Survey/monitor all sites at least annually. Need to consider available & future resources/funding during design & prior to implementation of studies. Can it be carried to completion and any ongoing monitoring continued?	Similar to corresponding section under "Direct Effects"	Identify targeted species. Counts, ids, measurements, & photographs/videos over time. Initial baseline survey of study site(s), incl. closed site(s). Allow populations to build in closed area(s). Repeat survey. Open separate closed area(s) to angling or spearing. Need to control or know angling/spearing effort. Continue surveys/monitoring. Need to consider available & future resources/funding during design & prior to implementation of studies. Can it be carried to completion?	Identify targeted species. Observations & videos over time. Establish behavioral parameters to monitor. Monitor/video behavior, including reaction to divers... Open area(s) to controlled spearing efforts. Monitor/video behavior during & post/pre-spearing, including reactions to divers (not spearing). Need to consider available & future resources/funding during design & prior to implementation of studies. Can it be carried to completion?

Matrix 3c: Individual Study Requirements Matrices Completed by Participants of Research Area Working Group

Henry Ansley	**Study**							
	Sessile Invertebrates/Bottom Fishing			Mobile Invertebrates/Bottom Fishing	Bottom Fish/Bottom Fishing			
Requirements	Fishing Gear Effects	Recovery Rates	Indirect Effects	Effect of Predator Removal	Direct Effects	Recovery Rates	Spearfishing v angling	Spearfishing effects on fish behavior
Marking	Presuming that the sites would be closed to user groups: If required to make a case or if helpful for law enforcement, permanent corner markers should be placed for duration of study. If the sample area is very large, buoys should be placed at intervals along the boundaries or larger ones should be used at the corners. Limiting the number of separated sites would help reduce buoying costs. Studying one habitat type at a time would help reduce buoying costs. If buoying does not affect enforcement effectiveness, then might consider only no buoys and simply issue GPS coordinates. If want to facilitate compliance (and compromising studies), then put out a few reference buoys.	See comments under "Fishing Gear Effects"	See comments under "Fishing Gear Effects"	See comments under "Fishing Gear Effects"	See comments under "Fishing Gear Effects"	See comments under "Fishing Gear Effects"	See comments under "Fishing Gear Effects"	See comments under "Fishing Gear Effects"
Enforcement	Mandatory. Must be effective. Both on-site and remote. Avoiding popular areas would likely get better user buy-in & compliance. If the study was done outside the Sanctuary, enforcement would be spread thin. Too, getting the authority to close (presuming that is needed) an area outside the Sanctuary might be difficult administratively and politically.	See comments under "Fishing Gear Effects"	See comments under "Fishing Gear Effects"	See comments under "Fishing Gear Effects"	See comments under "Fishing Gear Effects"	See comments under "Fishing Gear Effects"	See comments under "Fishing Gear Effects"	See comments under "Fishing Gear Effects"

Matrix 3c: Individual Study Requirements Matrices Completed by Participants of Research Area Working Group

Henry Ansley	**Study**							
	Sessile Invertebrates/Bottom Fishing			Mobile Invertebrates/Bottom Fishing	Bottom Fish/Bottom Fishing			
Requirements	Fishing Gear Effects	Recovery Rates	Indirect Effects	Effect of Predator Removal	Direct Effects	Recovery Rates	Spearfishing v angling	Spearfishing effects on fish behavior
Displacement/Prohibited Activities	Try to avoid conflicts by staying away from heavily used areas. Finding a small, isolated piece of bottom would be great. If the study site is a small area, may be just as easy to close to all (not discriminating against anyone, easier to enforce). If large area, then you might want to do a preliminary, "quick & dirty" investigation to determine if other user activities (e.g., trolling, diving) might impact study results. Doing the study outside of the Sanctuary would not displace Sanctuary users, but it might displace other offshore users (again, try to stay away from popular areas). Finally, if the "return" for study results is only minimal if other user group activities are restricted, then consider allowing them. The buy-in might be more important to study results than restricting them.	See comments under "Fishing Gear Effects"	See comments under "Fishing Gear Effects"	See comments under "Fishing Gear Effects"	See comments under "Fishing Gear Effects"	See comments under "Fishing Gear Effects"	See comments under "Fishing Gear Effects"	See comments under "Fishing Gear Effects"
Education/Outreach	Users must be told why, what, and for how long! Periodic updates. Needless to say, wide distribution of coordinates. If any way to get users involved/buy-in on study, then do it. As mentioned above, the quick-&-dirty preliminary investigation mentioned above would go a long way in determining and showing users whether an activity has to be prohibited in the study area. If the Sanctuary decides to try to do a study outside its boundaries and intends to close the study site, GRNMS needs to consider feasibility within existing administrative & political climate, as well as potential public reaction to closing (?) another area outside of the Sanctuary. On the other hand, the users that target GRNMS might be happy to see closures/restrictions occur outside of the Sanctuary	See comments under "Fishing Gear Effects"	See comments under "Fishing Gear Effects"	See comments under "Fishing Gear Effects"	See comments under "Fishing Gear Effects"	See comments under "Fishing Gear Effects"	See comments under "Fishing Gear Effects". Potential opportunity to involve user groups in study...	See comments under "Fishing Gear Effects". Potential opportunity to involve user group in study.

Matrix 3c: Individual Study Requirements Matrices Completed by Participants of Research Area Working Group

Henry Ansley	**Study**							
	Sessile Invertebrates/Bottom Fishing			Mobile Invertebrates/Bottom Fishing	Bottom Fish/Bottom Fishing			
Requirements	Fishing Gear Effects	Recovery Rates	Indirect Effects	Effect of Predator Removal	Direct Effects	Recovery Rates	Spearfishing v angling	Spearfishing effects on fish behavior
Ancillary Data Requirements	Normal physical measurements.	Normal physical measurements.	Normal physical measurements.	Normal physical measurements.	Normal physical measurements	Normal physical measurements	Normal physical measurements	Normal physical measurements
Cost	Have no idea! Depends on exact objectives, treatment, and time.	Again, have no idea! Depends on exact objectives, treatment, and time.	Again, have no idea! Depends on exact objectives, treatment, and time.	Again, have no idea! Depends on exact objectives, treatment, and time.	Again, have no idea! Depends on exact objectives, treatment, and time	Again, have no idea! Depends on exact objectives, treatment, and time	Again, have no idea! Depends on exact objectives, treatment, and time	Again, have no idea! Depends on exact objectives, treatment, and time

Matrix 3c: Individual Study Requirements Matrices Completed by Participants of Research Area Working Group

John Duren / Jim Siler	**Study**							
	Sessile Invertebrates/Bottom Fishing			Mobile Invertebrates/Bottom Fishing	Bottom Fish/Bottom Fishing			
Requirements	Fishing Gear Effects	Recovery Rates	Indirect Effects	Effect of Predator Removal	Direct Effects	Recovery Rates	Spearfishing v angling	Spearfishing effects on fish behavior
Objective	Evaluate the impacts of bottom fishing gear on benthic invertebrate populations (priority organisms include sponges and corals)	Determine the rate of recovery of benthic populations following various levels of disturbance by bottom fishing gear	Determine the nature and extent of indirect effects (e.g., changes in benthic food webs) caused by changes in benthic communities due to bottom fishing	Determine the impacts to benthic prey communities caused by removal of predators due to fishing (priority species include lobster, crabs, urchins etc.)	Determine the level to which benthic fish populations are reduced by bottom fishing effort	Determine the rate of recovery for species targeted by bottom fishing	Ascertain differences in the level of impact on benthic fish populations caused by spearfishing and angling	Determine what aspects of fish behavior (e.g., schooling, feeding, mating, predation, symbioses) are affected, the extent of effects (temporary or long-term), and impacts of changes caused by spearfishing
Habitat Type/Specific Place	Live bottom	S	S	Live bottom	S	S		Live bottom
Size	small	A	A	medium	A	A		medium
Number	One (the control can be any part of the sanctuary not designated as research area.	M	M	Same as column one	M	M		One (see note in column one)
Design Option	One area inside sanctuary.	E	E	One area inside sanctuary	E	E	At least two research areas	One area in sanctuary
Time	5 years			5 years				5 years
Research/Sampling Requirements	Annual report			Annual report				Annual report
Marking	buoys			buoys			This would be challenging	buoys
Enforcement	Onsite at first. Perhaps remote monitoring later.			Onsite at first			This would be challenging	Onsite at first
Displacement/Prohibited Activities	Bottom fishing & spearfishing			Bottom fishing & spearfishing			It is assumed that "angling" means "bottom fishing with hook and line"	Objective would have to be better defined to determine displacement
Education/Outreach	Much is needed			Much			greater	" " "
Ancillary Data Requirements							greater	
Cost							greater	

Matrix 3c: Individual Study Requirements Matrices Completed by Participants of Research Area Working Group

Steve Gittings	**Study**							
	Sessile Invertebrates/Bottom Fishing			Mobile Invertebrates/Bottom Fishing	Bottom Fish/Bottom Fishing			
Requirements	Fishing Gear Effects	Recovery Rates	Indirect Effects	Effect of Predator Removal	Direct Effects	Recovery Rates	Spearfishing v angling	Spearfishing effects on fish behavior
Objective	Evaluate the impacts of bottom fishing gear on benthic invertebrate populations (priority organisms include sponges and corals)	Determine the rate of recovery of benthic populations following various levels of disturbance by bottom fishing gear	Determine the nature and extent of indirect effects (e.g., changes in benthic food webs) caused by changes in benthic communities due to bottom fishing	Determine the impacts to benthic prey communities caused by removal of predators due to fishing (priority species include lobster, crabs, urchins etc.)	Determine the level to which benthic fish populations are reduced by bottom fishing effort	Determine the rate of recovery for species targeted by bottom fishing	Ascertain differences in the level of impact on benthic fish populations caused by spearfishing and angling	Determine what aspects of fish behavior (e.g., schooling, feeding, mating, predation, symbioses) are affected, the extent of effects (temporary or long-term), and impacts of changes caused by spearfishing
Habitat Type/Specific Place	Densely-populated ledge	Densely-populated ledge	Densely-populated ledge	Densely-populated ledge	Densely-populated ledge	Densely-populated ledge	Densely-populated ledge	Densely-populated ledge
Size	500m x 500m	500m x 500m	500m x 500m	1 km^2	1 km^2	1 km^2	500m x 500m	500m x 500m
Number	4 (2 each) representative areas	4 (2 each) representative areas	4 (2 each) representative areas	2 representative areas	2 representative areas	4 (2 each) representative areas (same areas as used for Direct Effects Study)	2 with similar baseline abundance and size-frequency distribution	2 (areas used in Spearfishing v. Angling Study
Design Option	A or B - High v. low effort Ten 100m random x-sects in each, establish permanent stations at impacted sites	B – BARI[2] - High v. formerly fished, 40 randomly located repetitively visited stations in each, plus permanent sites	B – BARI[2] - High v. low using fish censuses in random location	A or B – BARI[2] - 30 min surveys for target spp. for abundance, 20 surveys/trip/site, random	A or B - High v. low effort	B – BARI[2] - closure of 1 site of each type after 2 yr baseline	Pair comparison - two different treatments (fishing methods)	Pair comparison - two different treatments (fishing methods)
Time	2 yr	5 yr	7 yrs (2 plus 5)	5 yrs (2 baseline plus 3)	2 yr	2 yr baselines and 5 yrs recovery	5 yr	5 yr
Research/Sampling Requirements	Document injury, fate, area of loss, gear/debris monthly during fishing season	Rate of change in newly closed area, recruitment, abundance, growth, once per year	Document fish, trophics (using biomass and stomach contents in selected spp.), baseline in first 2 yrs, then trends, once per year	Abundance following closure compared to reference site; semi-annual sampling	Boat counts, CPUE, surveys of fishers on water during 1 wk period each yr, fish counts for comparison to total populations	Rate of change in newly closed areas, quarterly spls, recruitment, size frequency of target spp.	Boat counts, CPUE surveys of fishers on water 1 wk each year, size frequency over time, injuries	Behavior obs in both fished areas (avoids influence of large predators, as in recovering area); counts of activities along swimming transects

[1] Cost estimates assume that non-GRNMS investigators are contracted to conduct the work
[2] BARI – Before/After/Reference/Impact

Matrix 3c: Individual Study Requirements Matrices Completed by Participants of Research Area Working Group

Brian Keller	**Study**							
	Sessile Invertebrates/Bottom Fishing			Mobile Invertebrates/Bottom Fishing	Bottom Fish/Bottom Fishing			
Requirements	Fishing Gear Effects	Recovery Rates	Indirect Effects	Effect of Predator Removal	Direct Effects	Recovery Rates	Spearfishing v angling	Spearfishing effects on fish behavior
Objective	Evaluate the impacts of bottom fishing gear on benthic invertebrate populations (priority organisms include sponges and corals)	Determine the rate of recovery of benthic populations following various levels of disturbance by bottom fishing gear	Determine the nature and extent of indirect effects (e.g., changes in benthic food webs) caused by changes in benthic communities due to bottom fishing	Determine the impacts to benthic prey communities caused by removal of predators due to fishing (priority species include lobster, crabs, urchins etc.)	Determine the level to which benthic fish populations are reduced by bottom fishing effort	Determine the rate of recovery for species targeted by bottom fishing	Ascertain differences in the level of impact on benthic fish populations caused by spearfishing and angling	Determine what aspects of fish behavior (e.g., schooling, feeding, mating, predation, symbioses) are affected, the extent of effects (temporary or long-term), and impacts of changes caused by spearfishing
Habitat Type/Specific Place	LB*	LB	LB	LB, SR**	c	LB	LB	LB
Size	1 ac (per existing)	1 ac	1 ac	1 ac	1 ac	1 ac	1 ac	1 ac
Number	6	6 (same)	6 (same)	12 (same 6 LB)	6 (same)	6 (same)	12 (same 6)	12 (same 6)
Design Option	B	B	B	BC	B	B	B	B
Time	Years	Years	Many years	Many years	Years	Years	Years	Year/years
Research/Sampling Requirements	Seasonal counts/% cover	Seasonal counts/% cover	Seasonal counts/% cover	Seasonal counts	Seasonal counts	Seasonal counts	Seasonal counts	Observations
Marking	Buoys	Buoys	Buoys	Buoys	Buoys	Buoys	Buoys & markers	Buoys & markers
Enforcement	On-site & remote	On-site & remote	On-site & remote	On-site & remote	On-site & remote	On-site & remote	On-site & remote	On-site & remote
Displacement/Prohibited Activities	3 no-take in GRNMS	3 no-take in GRNMS	3 no-take in GRNMS	6 no-take in GRNMS	3 no-take in GRNMS	3 no-take in GRNMS	3 no-take, 3 no-spear, & 3 no-angle in GRNMS	3 no-take, 3 no-spear, & 3 no-angle in GRNMS
Education/Outreach	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Ancillary Data Requirements	Full set	Full set	Full set	Full set	Full set	Full set	Full set	Full set
Cost	$300K/yr	+$0K	+$0K	+$100K/yr	+$0K	+$0K	+$100K/yr	+$0K

Matrix 3c: Individual Study Requirements Matrices Completed by Participants of Research Area Working Group

Matt Kendall	**Study**							
	Sessile Invertebrates/Bottom Fishing			Mobile Invertebrates/Bottom Fishing	Bottom Fish/Bottom Fishing			
Requirements	Fishing Gear Effects	Recovery Rates		Effect of Predator Removal	Direct Effects	Recovery Rates	Spearfishing v angling	Spearfishing effects on fish behavior
Objective	Evaluate the impacts of bottom fishing gear on benthic invertebrate populations (priority organisms include sponges and corals)	Determine the rate of recovery of benthic populations following various levels of disturbance by bottom fishing gear	Determine the nature and extent of indirect effects (e.g., changes in benthic food webs) caused by changes in benthic communities due to bottom fishing	Determine the impacts to benthic prey communities caused by removal of predators due to fishing (priority species include lobster, crabs, urchins etc.)	Determine the level to which benthic fish populations are reduced by bottom fishing effort	Determine the rate of recovery for species targeted by bottom fishing	Ascertain differences in the level of impact on benthic fish populations caused by spearfishing and angling	Determine what aspects of fish behavior (e.g., schooling, feeding, mating, predation, symbioses) are affected, the extent of effects (temporary or long-term), and impacts of changes caused by spearfishing
Habitat Type/Specific Place	At a minimum, focus on a representative group of ledges. At a maximum, stratify by all the major habitat types (dense live bottom, sparse lb, and sand)	same as for gear effects	same as for gear effects	same as for gear effects	same as for gear effects	same as for gear effects	same as for gear effects	same as for gear effects
Size	Can be as small as a few representative ledges and some space around them.	Should be as large and square as possible (squares have a large amount of core area, reducing any edge effects but are the simplest shapes to mark, observe as a fisherman, and enforce.)	Same as for recovery rates	Same as for recovery rates	Same as for recovery rates	Same as for recovery rates	Same as for recovery rates	Same as for recovery rates
Number	One research area within the sanctuary that is large enough to allow replicate ledges and habitats to be selected within it. The rest of the sanctuary is the control.	Same as for gear effects	Same as for gear effects	Same as for gear effects	Same as for gear effects	Same as for gear effects	Same as for gear effects	Same as for gear effects
Design Option	See above.	See above.	See above.	See above.	See above.	See above.	See above.	See above.

Matrix 3c: Individual Study Requirements Matrices Completed by Participants of Research Area Working Group

Matt Kendall	**Study**							
	Sessile Invertebrates/Bottom Fishing			Mobile Invertebrates/Bottom Fishing	Bottom Fish/Bottom Fishing			
Requirements	Fishing Gear Effects	Recovery Rates	Indirect Effects	Effect of Predator Removal	Direct Effects	Recovery Rates	Spearfishing v angling	Spearfishing effects on fish behavior
Time	Depends on the growth rates of the organisms of interest and the extent of damage.	Depends on the growth rates of the organisms of interest and the extent of damage.	This is more on an annual long term monitoring issue (but it also depends on the specifics of the organisms under study)	Same as for indirect effects	Same as for indirect effects	Same as for indirect effects	Same as for indirect effects	Same as for indirect effects
Research/Sampling Requirements	See above	See above	See above	See above	See above	See above	See above	See above
Marking	Buoy mark the corners of the RA	Same as for gear effects	Same as for gear effects	Same as for gear effects	Same as for gear effects	Same as for gear effects	Same as for gear effects	Same as for gear effects
Enforcement	Definitely needed, education, marking charts, self policing, remote sensing to monitor, etc. should be considered as parts of a multi faceted approach	Same as for gear effects	Same as for gear effects	Same as for gear effects	Same as for gear effects	Same as for gear effects	Same as for gear effects	Same as for gear effects
Displacement/Prohibited Activities	No bottom fishing, spear fishing or anchoring. Probably shouldn't allow hook and line at at all, even trolling but that is asking a bit much of the fishermen)	Same as for gear effects	Same as for gear effects	Same as for gear effects	Same as for gear effects	Same as for gear effects	Same as for gear effects	Same as for gear effects
Education/Outreach	Definitely needed, marking on charts, as part of GRNMS tournaments, labeling on buoys etc. should all be considered as part of a multifaceted approach to education.	Same as for gear effects	Same as for gear effects	Same as for gear effects	Same as for gear effects	Same as for gear effects	Same as for gear effects	Same as for gear effects
Ancillary Data Requirements	Really depends on the specifics of each hypothesis. Definitely need to quantify the amount and types of fishing pressure.	Same as for gear effects	Same as for gear effects	Same as for gear effects	Same as for gear effects	Same as for gear effects	Same as for gear effects	Same as for gear effects
Cost	Totally depends on the specifics. Our office does a similar body of work in several places in the Caribbean. Rough ball park of the research component is $500K to $1mil annually. No idea what the enforcement/education/ other components would cost.	Lumped under gear effects	Lumped under gear effects	Lumped under gear effects	Lumped under gear effects	Lumped under gear effects	Lumped under gear effects	Lumped under gear effects

Matrix 3c: Individual Study Requirements Matrices Completed by Participants of Research Area Working Group

Joe Kimmel	**Study**							
	Sessile Invertebrates/Bottom Fishing			Mobile Invertebrates/Bottom Fishing	Bottom Fish/Bottom Fishing			
Requirements	Fishing Gear Effects	Recovery Rates	Indirect Effects	Effect of Predator Removal	Direct Effects	Recovery Rates	Spearfishing v angling	Spearfishing effects on fish behavior
Objective	Evaluate the impacts of bottom fishing gear on benthic invertebrate populations (priority organisms include sponges and corals)	Determine the rate of recovery of benthic populations following various levels of disturbance by bottom fishing gear	Determine the nature and extent of indirect effects (e.g., changes in benthic food webs) caused by changes in benthic communities due to bottom fishing	Determine the impacts to benthic prey communities caused by removal of predators due to fishing (priority species include lobster, crabs, urchins etc.)	Determine the level to which benthic fish populations are reduced by bottom fishing effort	Determine the rate of recovery for species targeted by bottom fishing	Ascertain differences in the level of impact on benthic fish populations caused by spearfishing and angling	Determine what aspects of fish behavior (e.g., schooling, feeding, mating, predation, symbioses) are affected, the extent of effects (temporary or long-term), and impacts of changes caused by spearfishing
Habitat Type/Specific Place	High relief/live bottom area(s)	High relief/live bottom area(s)	High relief/live bottom area(s)	High relief/live bottom area(s) where priority species (i.e., lobster, crabs, urchins etc.) occur	Several areas where fish can be caught	Several areas where fish can be caught	Several areas where fish can be caught	Several areas where fish can be caught
Size	As small as practicable	As small as practicable	As small as practicable	As small as practicable (for this experiment a very large area will be needed [especially if highly mobile prey are considered the priority species] to determine the best estimate of impact).	As small as practicable (for this experiment a very large area will be needed. The highly mobile nature of fishes demands that a large area be used to determine the best estimate of reductions in F).	As small as practicable (for this experiment a very large area will be needed. The highly mobile nature of fishes demands that a large area be used to determine the best estimate of recovery in terms of species composition, abundance (wt and number), and size	As small as practicable (for this experiment a very large area will be needed. The highly mobile nature of fishes demands that a large area be used to determine the best estimate of impacts of each gear in terms of species composition, abundance (wt and number), and size.	As small as practicable (for this experiment a very large area will be needed. The highly mobile nature of fishes demands that a large area be used to determine the best estimate of recovery in terms of species composition, abundance (wt and number), and size
Number	3 research sites with replicated sampling for a defined period	3 research sites with replicated sampling for a defined period	3 research sites with replicated sampling for a defined period	3 research sites with replicated sampling for a defined period	3 or more research sites with replicated sampling for a defined period	3 or more research sites with replicated sampling for a defined period	3 or more research sites with replicated sampling for a defined period	3 or more research sites with replicated sampling for a defined period
Design Option	ANOVA	ANOVA	ANOVA	ANOVA	ANOVA	ANOVA	ANOVA	ANOVA
Time	The longer term the better	The longer term the better	The longer term the better	The longer term the better	The longer term the better	The longer term the better	The longer term the better	Long term study (many years)

Matrix 3c: Individual Study Requirements Matrices Completed by Participants of Research Area Working Group

Joe Kimmel	Study							
	Sessile Invertebrates/Bottom Fishing			Mobile Invertebrates/Bottom Fishing	Bottom Fish/Bottom Fishing			
Requirements	Fishing Gear Effects	Recovery Rates	Indirect Effects	Effect of Predator Removal	Direct Effects	Recovery Rates	Spearfishing v angling	Spearfishing effects on fish behavior
Research/Sampling Requirements	To be decided	Periodic monitoring	Periodic monitoring coupled with sampling to look a gut contents	Periodic qualitative and quantitative monitoring of mobile inverts and their predators coupled with sampling of predators to look a gut contents	Periodic qualitative and quantitative monitoring of	Periodic qualitative and quantitative monitoring of	Periodic qualitative and quantitative monitoring of	Periodic qualitative and quantitative monitoring of
Marking	N/a	N/a	N/a	N/a	N/a	N/a	N/a	N/a
Enforcement	The research area needs to be kept free of any impacts other than that caused by the researchers	The research area needs to be kept free of any impacts other than that caused by the researchers	The research area needs to be kept free of any impacts other than that caused by the researchers	The research area needs to be kept free of any impacts other than that caused by the researchers	The research area needs to be kept free of any impacts other than that caused by the researchers	The research area needs to be kept free of any impacts other than that caused by the researchers	The research area needs to be kept free of any impacts other than that caused by the researchers	The research area needs to be kept free of any impacts other than that caused by the researchers
Displacement/Prohibited Activities	Ideally, research area is pristine	The research area needs to be kept free of any impacts other than that caused by the researchers	The research area needs to be kept free of any impacts other than that caused by the researchers	The research area needs to be kept free of any impacts other than that caused by the researchers	The research area needs to be kept free of any impacts other than that caused by the researchers	The research area needs to be kept free of any impacts other than that caused by the researchers	The research area needs to be kept free of any impacts other than that caused by the researchers	The research area needs to be kept free of any impacts other than that caused by the researchers
Education/Outreach	Results published	Results published	Results published	Results published	Results published	Results published	Results published	Results published
Ancillary Data Requirements	N/a	N/a	N/a	N/a	N/a	N/a	N/a	N/a
Cost	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal

Matrix 3c: Individual Study Requirements Matrices Completed by Participants of Research Area Working Group

Jack McGovern	**Study**							
	Sessile Invertebrates/Bottom Fishing			Mobile Invertebrates/Bottom Fishing	Bottom Fish/Bottom Fishing			
Requirements	Fishing Gear Effects	Recovery Rates	Indirect Effects	Effect of Predator Removal	Direct Effects	Recovery Rates	Spearfishing v angling	Spearfishing effects on fish behavior
Objective	Evaluate the impacts of bottom fishing gear on benthic invertebrate populations (priority organisms include sponges and corals)	Determine the rate of recovery of benthic populations following various levels of disturbance by bottom fishing gear	Determine the nature and extent of indirect effects (e.g., changes in benthic food webs) caused by changes in benthic communities due to bottom fishing	Determine the impacts to benthic prey communities caused by removal of predators due to fishing (priority species include lobster, crabs, urchins etc.)	Determine the level to which benthic fish populations are reduced by bottom fishing effort	Determine the rate of recovery for species targeted by bottom fishing	Ascertain differences in the level of impact on benthic fish populations caused by spearfishing and angling	Determine what aspects of fish behavior (e.g., schooling, feeding, mating, predation, symbioses) are affected, the extent of effects (temporary or long-term), and impacts of changes caused by spearfishing
Habitat Type/Specific Place	Low to High Relief Live Bottom	Low to High Relief Live Bottom	Low to High Relief Live Bottom	Low to High Relief Live Bottom	Low to High Relief Live Bottom	Low to High Relief Live Bottom	Low to High Relief Live Bottom	Low to High Relief Live Bottom
Size	Could be small	Could be small	Could be small	Large area to capture mobility.	Intermediate size.	Intermediate size	Intermediate size	Intermediate size
Number	At least 2 (control and treatment)	At least 2 (control and treatment)	At least 2 (control and treatment)	At least 2 (control and treatment)	At least 2 (control and treatment)	At least 2 (control and treatment)	Treatment areas	At least 2 (control and treatment)
Design Option	Need fished and unwished sites	Need fished and unwished sites	Need fished and unwished sites	Need fished and unwished sites	Need fished and unwished sites	Need fished and unwished sites	Need sites that are fished with different gear.	Need fished and unwished sites
Time	Long term study.	Enough years to allow for growth of sponge and corals. Long term study.	Long term study.	Long term study.	Long term study (generation time of affected species).	Long term study (generation time of affected species).	Long term study (generation time of affected species).	Long term study.
Research/Sampling Requirements	Closed and open areas must be similar. Replication needed.	Closed and open areas must be similar. Replication needed.	Closed and open areas must be similar. Replication needed.	Closed and open areas must be similar. Replication needed.	Closed and open areas must be similar. Replication needed.	Closed and open areas must be similar. Replication needed.	Treatment areas must be similar.	Closed and open areas must be similar. Replication needed.
Marking	Closed are needs to be marked.	Closed are needs to be marked.	Closed are needs to be marked.	Closed are needs to be marked.	Closed are needs to be marked.	Closed are needs to be marked.	Treatment areas need to be marked.	Closed are needs to be marked.
Enforcement	Enforcement would be needed for closed area.	Enforcement would be needed for closed area.	Enforcement would be needed for closed area.	Enforcement would be needed for closed area.	Enforcement would be needed for closed area.	Enforcement would be needed for closed area.	Enforcement would be needed.	Enforcement would be needed for closed area.
Displacement/Prohibited Activities	Bottom fishing closed in one or more areas.	Bottom fishing closed in one or more areas.	Bottom fishing closed in one or more areas.	Bottom fishing closed in one or more areas.	Bottom fishing closed in one or more areas.	Bottom fishing closed in one or more areas.	Bottom fishing or spear fishing in one or more areas.	Spearfishing closed in one or more areas.

Matrix 3c: Individual Study Requirements Matrices Completed by Participants of Research Area Working Group

George Sedberry	Study							
	Sessile Invertebrates/Bottom Fishing			Mobile Invertebrates/Bottom Fishing	Bottom Fish/Bottom Fishing			
Requirements	Fishing Gear Effects	Recovery Rates	Indirect Effects	Effect of Predator Removal	Direct Effects	Recovery Rates	Spearfishing v angling	Spearfishing effects on fish behavior
Objective	Evaluate the impacts of bottom fishing gear on benthic invertebrate populations (priority organisms include sponges and corals)	Determine the rate of recovery of benthic populations following various levels of disturbance by bottom fishing gear	Determine the nature and extent of indirect effects (e.g., changes in benthic food webs) caused by changes in benthic communities due to bottom fishing	Determine the impacts to benthic prey communities caused by removal of predators due to fishing (priority species include lobster, crabs, urchins etc.)	Determine the level to which benthic fish populations are reduced by bottom fishing effort	Determine the rate of recovery for species targeted by bottom fishing	Ascertain differences in the level of impact on benthic fish populations caused by spearfishing and angling	Determine what aspects of fish behavior (e.g., schooling, feeding, mating, predation, symbioses) are affected, the extent of effects (temporary or long-term), and impacts of changes caused by spearfishing
Habitat Type/Specific Place	High sponge/coral density area	Hard bottom with sponges/corals	All habitats	All habitats	High relief areas; high fishing areas vs low fishing areas	High fishing effort areas	Experimental site with target species (large snapper/grouper)	Sites with high density of target species (large snapper/grouper): also need control sites for all of these.
Size	Small replicate plots (100 x 100 ft) in larger no-fishing zone (100 yd x 100 yd)	Small replicate plots in larger no-fishing zone	Can use entire sanctuary as fished site; need smaller 1000 x 1000 yd unwished sites.	Small replicate plots in larger no-fishing zone	Need large (1 x 1 mile) unwished site, plus replicates (3 sites)	Large--at least 1 x 1 mile	Several large 1 x 1 mile sites subjected to fishing pressure from each gear type; plus control no-fishing sites.	Can be relatively small sites, as long as they contain the target species Need 6 sites (3 speared, 3 no access)
Number	6 minimum	6 minimum	6	6	6		6	6
Design Option	E	E	B	B	B	B	B	B
Time	24 months	24 months	36 months	36 months	48 months	38 month	48 month	18 month
Research/Sampling Requirements	quarterly	quarterly	quarterly	quarterly	semiannual	semiannual	semiannual	semimonthly
Marking	yes--mark large zone but not plots	mark area but not plots	mark area--these need to be much larger than actual study area to discourage vandals, intentional poaching (all marked areas should be larger than experimental site	mark area	mark area	mark area	mark	mark
Enforcement	yes remote	yes, remote	yes, remote	yes, remote	remote	remote	remote	remote
Displacement/Prohibited Activities	No entry	no entry	no entry	no entry	no entry	no entry	no entry	other uses allowed; no spearfishing

Matrix 3c: Individual Study Requirements Matrices Completed by Participants of Research Area Working Group

George Sedberry	Study							
	Sessile Invertebrates/Bottom Fishing			Mobile Invertebrates/Bottom Fishing	Bottom Fish/Bottom Fishing			
Requirements	Fishing Gear Effects	Recovery Rates	Indirect Effects	Effect of Predator Removal	Direct Effects	Recovery Rates	Spearfishing v angling	Spearfishing effects on fish behavior
Education/Outreach	yes--why this is being done	why, how who	why, how, who	why, how, who	why, how, who	why, how who	why, how, who	why, how, who
Ancillary Data Requirements	Bottom maps for expanding results of plots to similar habitats in Sanctuary	Bottom maps	Population size estimates for all trophic levels	Need to determine the species of predators (who eats what)	need estimates of actual effort to make results meaningful	need life history (growth rates, size & age structure)--might be able to get from other locations (MARMAP data)	need estimate of number of participants in each fishery and frequency of their fishing to make results more meaningful	need to know number and behavior of spearfishermen to make results meaningful to what actually happens at GRNMS
Cost	$150K	$150K	$300K	$300K	$500K	$500K	$500K	$150K

Definitions for Requirements

Study Name

Objective—Simple problem statement about the purpose/need for the study

Habitat Type/Specific Place(s)—Indicate habitat (e.g. densely colonized live bottom, sparsely colonized live bottom, or sand) in which this study would have to take place, and if possible, indicate a specific place(s) within GRNMS that could be used to conduct the work.

Size—Size of individual study areas. Include control and treatment.

Number—Number of individual study areas required. Include control and treatment.

Design Option—Chose from Workshop (Research Area Options, page 17) report or propose a new design option

Time—Time required to conduct the study

Research/Sampling Requirements—Frequency of sampling and type of sampling required (collections, counts, instruments, etc.)

Marking—Buoys, permanent markers, etc.

Enforcement—On-site or remote surveillance required to ensure the integrity of the study site and its resources

Displacement/Prohibited Activities—Requirements for temporary or permanent restrictions on harvesting or access within the study site. Options for displacement of current activities to other locations outside the study site.

Education/Outreach—Requirements for public notification and periodic announcements and updates regarding this study and the study area.

Ancillary Data Requirements—Additional data required to support this study. For example, oceanographic, meteorological, chemical, biological, socioeconomic (e.g. use levels), etc.

Cost—Estimate as to the overall cost of conducting this project for the full duration.

Matrix 3c: Individual Study Requirements Matrices Completed by Participants of Research Area Working Group

Leslie Sautter	**Study**							
	Sessile Invertebrates/Bottom Fishing			Mobile Invertebrates/Bottom Fishing	Bottom Fish/Bottom Fishing			
Requirements	Fishing Gear Effects	Recovery Rates	Indirect Effects	Effect of Predator Removal	Direct Effects	Recovery Rates	Spearfishing vs. angling	Spearfishing effects on fish behavior
Education* (Outreach** not included here)	3 full-time graduate assistantships: 2 research; 1 management (at contributing scientists' institutions) 2 graduate student summer internships: on site at GRNMS (in addition to above) 4 summer undergraduate interns: 2 on-site at GRNMS; 2 in contributing scientists' labs			1 full-time graduate assistantship (research)	4 full-time graduate assistantships: 2 research; 2 management (at contributing scientists' institutions) 2 graduate student summer internships: on site at GRNMS (in addition to above) 4 summer undergraduate interns: 2 on-site at GRNMS; 2 in contributing scientists' labs		1 full-time graduate assistantship (research)	
Ancillary Data Requirements	Each student must develop web resource(s) pertaining to his/her research, w/purpose of communicating results to (a) a public audience, and (2) to an introductory college audience.							
Cost	All costs are per year, before fringe and indirect 3 grad assistants @$14,000 = $42,000 2 summer grad interns: @$4,000 = $8,000 4 summer undergrad interns @$3,000 = $12,000 Total, 9 students: $62,000 Webmaster for education site devel./mainten. (2 mos): $8,000			All costs are per year, before fringe and indirect 1 grad assistant: $14,000 Webmaster for education site devel./mainten. (.5 mos): $2,000	All costs are per year, before fringe and indirect 4 grad assistants @$14,000 = $56,000 2 summer grad interns: @$4,000 = $8,000 4 summer undergrad interns @$3,000 = $12,000 Total, 9 students (before fringe/ind.): $76,000 Webmaster for education site devel./mainten. (2 mos): $8,000		All costs are per year, before fringe and indirect 1 grad assistant: $14,000 Webmaster for education site devel./mainten. (.5 mos): $2,000	

Definitions for Requirements (Sautter's version)

***Education**

a) Full-time assistantships (both research and management) for graduate students; and summer research internships for grad. and undergrad. students.

b) Web resource development of research results, targeting (1) educated public audience (see above) and (2) introductory college students.

****Outreach (not included in the matrix, above)**

a) Requirements for public notification and periodic announcements and updates regarding this study and the study area.

b) Web resource development of research activities targeting an educated public audience, including pre-college teachers, and middle- and high school students.

(Please refer to "Sautter's Comments" for what I hope will be some clarification!)

APPENDIX D

- Table D.1: Summary of Distillation Matrix of Proposed Studies in Research Area
- Matrix 4: Distillation Matrix of Proposed Studies in Research Area

Table D.1: Summary of Distillation Matrix of Proposed Studies in Research Area

Evaluation of Requirements for Studies to be Conducted at GRNMS

Study Requirements:	Discussed Study Requirements Not Included in Distillation Matrix	Comments*
Sessile Inverts/Bottom Fishing:		
Fishing Gear Effects		
Recovery Rates		
Indirect Effects		
Mobile Inverts/Bottom Fishing:		
Effect of Predators		
Bottom Fishing/Bottom Fishing:		
Direct Effects		
Recovery Rates		
Spearfishing vs. Angling	Spearfishing vs. Angling	RAWG participants agreed the study design for spearfishing would be very difficult and complex. The practicality of implementation was also questioned. Also, should spearfishing be banned in GRNMS (as currently proposed in the GRNMS draft management plan), the research design would not be possible. (74)
Determine What Aspects of Fish Behavior are Affected, the Extent of Effects, and Impacts of Changes Caused by Spearfishing	Determine What Aspects of Fish Behavior are Affected, the Extent of Effects, and Impacts of Changes Caused by Spearfishing	

*These comments clarify why certain Research Area study requirements were not brought forward into the final Distillation Matrix. Comments can be found in the RAWG Meeting II Minutes in Appendix G (pp 74).

Matrix 4: Distillation Matrix of Proposed Studies in Research Area

	Proposed Studies to be conducted in a Research Area at GRNMS					
	Sessile Invertebrates/Bottom Fishing			Mobile Invertebrates/ Bottom Fishing	Bottom Fish/Bottom Fishing	
Requirements	**Fishing Gear Effects**	**Recovery Rates**	**Indirect Effects**	**Effect of Predators**	**Direct Effects**	**Recovery Rates**
Objective	Evaluate the impacts of bottom fishing gear on benthic invertebrate populations (priority organisms include sponges and coral80 to look outside.	Determine the rate of recovery of populations of sessile inverts following various levels of disturbance by bottom fishing gear	Determine the nature and extent of indirect effects (e.g., changes in benthic food webs) caused by changes in benthic communities due to bottom fishing	Characterize the mobile invert communities in the absence of fishing	Determine the level to which benthic fish populations are reduced by bottom fishing effort	Determine the rate of recovery for species targeted by bottom fishing
Research/ Sampling Requirements	Document incidences of injury only (simple counts) vs. more detailed benthic characterizations including injuries	Lower end - follow recovery of documented injury in Fishing Gear Effects study - Compare recruitment, abundance, condition and growth in closed vs reference areas or manipulative experiment	High end - trophic structure studies (i.e. gut contents, predator-prey, energy flow models)	Low end - 1)Predator exclusion/ inclusion experiment w/cages, 2)Predator and prey censuses before and after closure	Low end - 1) Benthic fish censuses before and after closure	Low end - 1) Benthic fish censuses before and after closure
Habitat Type/ Specific Place	Densely and Sparsely colonized Live Bottom			All habitats		
Size	VS			S, M, L	M-L	
Number of Research Areas	3 VS or 1 M-L (to accommodate plots)			3S or 1 M-L (to accommodate plots)	3M or 1 L (to accommodate plots)	
Design Option	A or B (C or BC if outside)					
Duration	2 - 5 years	5 -10 years	3 - 10 years	5-7 years		10-15 years
Marking	Yes, buoys for closed area					
Enforcement	Yes, Onsite and/or remote - requires outreach and education					
Outreach	Yes to tell what, why and for how long - seminars, flyers, print, news, web, visualization techniques, media, marking on charts, buoy labeling, notices to mariners, etc.					
Displacement/ Prohibited Activities	Bottom Fishing, Spearfishing, Bottom-impinging trolling,					
Ancillary Data Requirements	Fishing Effort by gear type, compliance, Physical measurements including episodic events	Fishing Effort by gear type, compliance, Physical measurements including episodic events, Lit Review (e.g., growth rates)	Fishing Effort by gear type, compliance, Physical measurements including episodic events, Lit Review (e.g., population and community ecology)	Predator and Prey home ranges, Gut content studies, compliance, Physical measurements including episodic events, Lit Review	Benthic fish home ranges, compliance, Physical measurements including episodic events, Lit Review, fishing effort by gear type	Benthic fish home ranges, compliance, Physical measurements including episodic events, Lit Review, fishing effort by gear type
Research Costs	$15K to $200K/yr above and beyond GRNMS logistical support (would include grant funds)		>$300K	$50K - $100K/yr		
Notes	Assuming no anchoring, unclear about the effects of bottom-impinging trolling, also practicality of enforcement might be easier to close the area to all fishing, if GRNMS staff had time to participate the research costs would be substantially reduced, more buoys = increased cost and more hassle, assume minimum 3 year baseline data prior to implementation of research area, concern for the potential impact of non-permitted/ recreational divers on experiments.	assume minimum 3 year baseline data prior to implementation of research area, concern for the potential impact of non-permitted/recreational divers on experiments.	Formulation of specific questions and feasibility of study depend on results from fishing gear effects and recovery rate studies. assume minimum 3 year baseline data prior to implementation of research area, concern for the potential impact of non-permitted/recreational divers on experiments.		Alternative to measuring removal of target species can be done through census of fishing effort by gear type. Should the spearfishing ban not be adopted at GRNMS, it could be included in this study	

Appendix E

- Matrix 5a: Analysis of Potential Research Area Size Options (Blank)
- Table E.1: Summary of Analysis of Research Area Size Options
- Matrix 5b: Analysis of Potential Research Area Size Options (Completed Version)

Matrix 5a: Analysis of Potential Research Area Size Options (Blank)

Size of Research Area (km)	Total Score	Ease of Enforcement			Statistical power			Scientific usefulness		
		pros	cons	score (1-10)	pros	cons	score (1-10)	pros	cons	score (1-10)
1- 1X1	0									
2-1X1	0									
3-1X1	0									
1-2X2	0									
1-3X3	0									
1-4X4	0									
Rectangle	0									
Irregular polygon	0									

Table E.1: Summary of Analysis of Research Area Size Options
Evaluating Size Options of Potential Research Area at GRNMS

Preliminary Matrix: Size of Research Areas (km)	Sizes Not Included in Matrix 5	Comments*
1-1x1		
2-1x1	2-1x1	RAWG participants agreed to remove the research size categories of multiple research areas ("replicates") because of the difficulty to enforce multiple sites and because such a small site would reduce edge effect and disable random sampling and stratification. (87)
3-1x1	3-1x1	
1-2x2		
1-3x3		
1-4x4		
Rectangle	Rectangle	It was determined by RAWG participants that a square would maximize the core research area and can be marked on corners and on latitudinal and longitudinal coordinates. It was also agreed that a square area would be preferred for studying mobile species. (85)
Irregular Polygon	Irregular Polygon	

*These comments clarify why certain Research Area sizes were not brought forward in the final analysis in Matrix 5. These comments can be found in the RAWG Meeting III Minutes in Appendix H. The page(s) is noted in parentheses at the end of each comment.

Matrix 5b - Analysis of Potential Research Area Size Options (Completed Version)										
Size of Research Area (km)	Total Score	Ease of Enforcement			Statistical Power			Scientific usefulness		
		pros	cons	score (1-10)	pros	cons	score (1-10)	pros	cons	score (1-10)
1X1	13	* Buoy cost is lowest * More acceptable, better compliance		10	* more reference area available	* # of samples too low * sample independence	1	* Addresses invertebrate issues and some reef fish issues	* Edge effect too large * Unlikely to encompass home range * Possibly displaces fishing pressure on reference area	2
2X2	22		* Buoy costs are higher. Need 8 buoys (assuming 1 buoy per km)	9	* Better than 1X1 * Leaves adequate reference area		6	* May encompass close to 50% of high relief hardbottom * May be situated to reduce edge effect * Potential to examine 4 different treatments (2in, 2out)	* Edge effect potentially large * Hard to locate away from reference * Possibly displaces more fishing pressure on reference area	7
3X3	23		* Increasing buoy costs	8	* Better than 2X2 depending on reference area left	* May not leave adequate reference	7	* Reduced edge effect * More likely to include home range of target organisms	* Possibly displaces more fishing pressure on reference area	8
4X4	20		* Increasing buoy costs	7	* More sites for sampling * Greater sample independence	* Fewer options for reference	5	* Least edge effect * Most likely to include home range of target organisms * Include greater number of species	* Possibly displaces more fishing pressure on reference area	8

**Total scores were calculated by adding the individual scores of the ease of enforcement, statistical power, and scientific usefulness of each of the proposed sizes. A high total score signifies an acceptable Research Area size. The Research Area Working Group determined that the best size for a potential Research Area in GRNMS would be a 2x2 or 3x3 plot, scoring 22 and 23, respectively.

Appendix F

- Minutes RAWG Meeting: May 3-4, 2004

GRAY'S REEF NATIONAL MARINE SANCTUARY

Research Area Concept Working Group Workshop I Meeting Minutes

May 3-4, 2004
Savannah, GA

GRAY'S REEF NATIONAL MARINE SANCTUARY
MARINE RESEARCH AREA WORKING GROUP
Workshop I, May 3-4, 2004

Homewood Suites, Savannah, GA

Monday, May 3

Distributed Materials

- Meeting Agenda
- Participant List
- Research Area Concept Background Text
- Research Area Concept Timeline
- Sanctuary System Goals
- Research and Monitoring Action Plan Objectives

Attendees

(Refer to distributed participant list.)

Welcome and Opening Remarks

Marine Research Area Working Group Chair Dr. Joe Kimmel welcomed everyone to the meeting and asked for introductions. Sanctuary Manager Reed Bohne provided a brief discussion on the background and purpose of the meeting. Reed noted that this meeting is the first step in a long process but is necessary to address important questions and to facilitate discussion. Reed highlighted four mandates in the National Marine Sanctuaries Act (NMSA). Reed then introduced Paul Orlando who reviewed the workshop agenda and process.

Agenda and Workshop Process

Paul Orlando briefly mentioned meeting logistics and participants' roles and responsibilities. Paul emphasized the importance of participants contributing in a meaningful and respectful manner. He discussed meeting objectives and outcomes, including concept exploration and information gathering as well as the process agenda. The process includes discussing the initial "pros" and "cons" of a research area; defining natural resources and issues of concern; and determining intersects of natural resources and issues of concern. Options will then be characterized for potential research areas and an evaluation of initial options will occur.

Henry Ansley asked how meeting outcomes would be reported to the Gray's Reef National Marine Sanctuary (GRNMS) Advisory Council. Reed stated that the methods of reporting and of making recommendations to the Advisory Council was up to meeting

participants. Dr. Herb Windom asked: What is the commitment of the National Oceanic and Atmospheric Administration (NOAA) and GRNMS to establishing a research area? Reed emphasized that this will be a long process and noted that NOAA will examine and assess any recommendations that this group presents. Dr. Jim Bohnsack asked Reed to clarify a "long" process, to which Reed answered that if the decision is to proceed with establishing a research area, designation could take approximately two years from the time of that decision. Reed also touched on the Marine Protected Areas (MPAs) and Coral Reef Executive Orders. Dr. Doug Rader asked if the group should consider placing a research area outside of the boundaries of GRNMS, which calls for the discussion of the role of GRNMS and the National Marine Sanctuary Program (NMSP) in the larger context of the South Atlantic Bight (SAB). Reed answered that it is perfectly legitimate for this group to consider different options, including those outside the existing boundaries of GRNMS. Joe Kimmel noted that, in his opinion, the goal of a research area is to set aside a small area in GRNMS to determine if the larger area of the sanctuary is in good health. Reed commented that the focus of the discussion has been within GRNMS boundaries but does not have to be. Paul Orlando reiterated that this meeting is for information gathering and is pre-decisional. He stated that the focus is on site-specific needs but that the boundaries of a marine research area might not be defined by sanctuary boundaries themselves.

Background Information

Becky Shortland presented background information on the formation of the marine research area working group and the discussion of establishing a research area (*refer to handout of background information and timeline)*. The idea of setting aside a research area was introduced during public scoping for review of the existing 1983 management plan. The topic was then discussed in detail with the Advisory Council and further characterized as a primary issue to address in the revised management plan. Specifically, the issue (problem) and solution (desired outcome) were defined as:

Problem Statement: There are no naturally occurring, live-bottom sites within the Sanctuary exclusively established for research.
Outcome Statement: Increase opportunity to discriminate scientifically between natural and human-induced change to species populations in the Sanctuary.

Strategies to address the issue were then evaluated during the Species Conservation and Research and Monitoring Workshops in 2001. In January 2004, the Advisory Council approved establishing a working group to explore the research area concept and agreed not to convene a working group until public comment on the Draft Management Plan/Draft Environmental Impact Statement (DMP/DEIS) was ended on December 31, 2003. Reed noted that the management plan is reviewed every five years; thus, if a research area were implemented in 2007, it would then be subject to discussion in 2009 during the next management plan review. In response to a question from Joe Kimmel, Becky discussed the difference between a marine reserve and a research area and presented one possible definition of a "research area." Becky emphasized that discussions should not begin with the preconceived notion of a no-take area; whether the area is a "take" or "no-take" area should be considered by the working group.

Greg McFall commented that a research area would not be a "playground for researchers." Greg emphasized the NMSA mandates, including promoting research and enhancing public awareness. He also presented a brief history and description of GRNMS. Greg defined a "live-bottom habitat" and commented on why GRNMS is so unique. He presented information on GRNMS' invertebrate and fish communities as well boat count images from overflight and on-water surveys. Greg discussed topics of concern that are unknown in the sanctuary, such as human impact on, and level of protection of, natural resources. Herb Windom noted that the impact of this discussion extends beyond fisheries to a more open view of research and human activities. Willie Olliff pointed out that technology may not lessen the pressure on the reef, but it also does not increase pressure because more advanced boats often go further out and not to GRNMS. Joe Kimmel stated that sanctuary mandates and goals are important to keep in mind during discussions.

Paul Orlando commented on the definition of a research area, emphasizing that debate on the definition is important to broaden the discussion itself. Important points to consider are a meaningful size and scale, control, and replication. Paul asked for any questions or input on what was covered in the background portion of the day's meeting.

Pros and Cons

Paul Orlando asked Steve Gittings to present a few images to the group relating to discussion on research area options: permanent (single/multiple/outside reference) vs. temporary (flexible). Steve mentioned temporary with a focus on topical research and permanent with a focus on monitoring and topical research. Henry Ansley pointed out that research could affect monitoring within a designated area. Paul stated that the group would be putting ideas on the table and hopefully narrow down the options to help define a research area. Paul then asked for input from participants regarding positive and negative impacts (pros and cons) for establishing a research area; discussion followed (*refer to Pros and Cons list*).

Defining Natural Resources & Issues of Concern

Paul commented on the value of the previous exercise. He stated that the issues would be discussed in regards to the mandates and goals of the sanctuary (*refer to matrix 1*). Participants discussed applicability of specific categories of natural resources. Debate ensued over whether to adjust the "water column" portion of natural resources column (i.e., should the water column be considered as part of the discussion in development of a research area?). Suggestions were made to move "water column" under the "Habitat" category and to add the water column as a "natural driver." In order to understand the natural drivers, Jim Bohnsack suggested that the group ask whether mortality from human events is greater than mortality from natural processes. Herb Windom also suggested adding a "subsurface (ground water)" row as a habitat consideration. Additionally, "artificial structure" and "microbial communities" were added under the natural resource column.

Participants then discussed applicability of specific categories of issues of concern. They agreed to change "introductions" to "exotics and invasives." In relation to boating, participants listed effects of discharges, noise, and anchoring. Doug Rader suggested adding "nutrients" to the "contaminants" column (disrupting nutrient cycles, airborne contaminants, surface/groundwater sources). "Climate change," "hydrodynamics," and "meteorology" were also added to the natural drivers column. Most participants felt that production and loss were not necessarily natural "drivers" but were, in fact, natural "processes"; thus, the column name was changed accordingly.

Adjourn for Lunch

Reconvene
Paul Orlando asked for any comments or questions before continuing. Joe Kimmel commented again on "management" as an anthropogenic influence. Participants agreed to add the column of "management (indirect effects)" as an anthropogenic influence. Dr. George Sedberry stated that two major factors influence fish populations – fishing and management – and that they are both important anthropogenic influences. Willie Olliff commented on significant economic impacts of establishing a research area, which Henry Ansley previously mentioned.

Determining Intersects
Using the matrix, Paul asked that participants key in on what influences and processes are relevant to which natural resources. Paul began with the natural resources of rippled sand and worked across the matrix (*refer to matrix 1*):

> Production*
> Herb Windom stated that rippled sand increases seawater processing, microbial production, and primary production.
> Hydrodynamics/Meteorology*
> Herb also mentioned that rippled sand circulates water much more effectively.
> Contamination/Nutrients
> Greg McFall noted that rippled sand contains adsorb to clay fraction.
> Anchoring
> Reed Bohne stated that anchoring is a disturbance on benthic infauna and habitat.
> Diving
> Judy Wright noted that divers could disrupt the sand by standing on it or moving it.
> Pathogens and Loss
> Dr. Brian Keller and Jim Bohnsack commented that microorganisms could accumulate on organic material in troughs, whether pathogenic or non-pathogenic.

Paul then asked if certain questions or issues have a higher priority (**starred items*). Henry and Doug asked the following questions about establishing a research area: Is it necessary? Is it sufficient? Is it beneficial? Herb noted that following the matrices in a detailed manner is a good step towards a later overall process of developing a research

area. Paul agreed and noted that addressing the various questions may help lead the group to the answer of whether or not to establish a research area. Reed suggested that discussion begin with issues of concern rather than benefits of a research area. Discussion continued among participants regarding wording and relevance of column headings/questions. With Paul's facilitation, participants worked through matrix questions in relation to rippled sand (*refer to matrix 2*). Paul suggested that the group break from development process and examine natural characteristics/processes. Jim stated that his major question is concerned with the variability of GRNMS as compared to the Georgia shelf rather than the "trivial" variability within GRNMS itself. Herb questioned the uniqueness of GRNMS or if the sanctuary boundaries were arbitrarily defined; he stated that his impression was that GRNMS is a unique area. John Duren, Willie Olliff, and Jim Bohnsack agreed that the area is not just representative of a larger area but is, in fact, unique. Paul proposed that the group consider analysis of research areas in the context of natural variability, and Reed agreed that this might be a good approach. Joe Kimmel, however, preferred to continue on with the matrix. Paul clarified his proposal that the group take a look at the five columns dealing with natural variability, identify several key questions, then roughly define what a research area might look like to address natural variability. Herb stated that, inherently in research design, natural variability must be considered before anthropogenic effects can be determined.

Herb Windom asked if the purpose of this working group is to determine the necessity of a research area with limited access or to develop a research agenda to address management questions. Jim stated that the key questions are to understand the impacts of the anthropogenic influences. Reed then reiterated the purpose and goals of this group: information gathering to eventually build a document from which the Advisory Council and NOAA/GRNMS can make decisions on whether to proceed with establishing a research area. John questioned whether GRNMS is the right and/or best place to study human impacts; Doug shares his concern (i.e., can we translate impacts at Gray's Reef to other areas of the ocean; other options are not necessarily available). Doug felt that a real need for research in GRNMS exists, but all questions about fishing impacts in the SAB cannot be answered just by studying GRNMS. Joe Kimmel stated that establishing a research area in a portion of the sanctuary is a way to measure the health of the resources without closing the entire sanctuary (i.e. take a small area and compare it to the status of the surrounding area). Henry commented that the Advisory Council wants to know the reasons and merits for establishing a research area based on what experts (i.e. working group members) say. In response to comments from Herb, Judy Wright emphasized that the research area would not just focus on impacts on fisheries. Becky further explained that the issue is whether or not GRNMS can do the work that needs to be done with conditions and regulations that currently exist, or as Greg states, is it necessary that a research area be set aside in order to adequately answer questions regarding the marine resources and their protection. Greg noted that, although discussion should not focus solely on fishing or diving, they are the only allowable extractable activities within the sanctuary. Reed commented that this is an experimental process and that effects of establishing a research area will go under review as the management plan review process reoccurs. Steve stated that certain information needs exist in GRNMS that require different types of research areas. In reporting to the Advisory Council, the group should

say: "Here are the information needs, and these are the ones which we feel would be addressed by setting aside a research area." Paul then recapped the previous discussion. He emphasized the need to be able to provide justification for a research area (i.e., what cannot be addressed without it, what can be addressed with it, and what are priority research issues?). The group agreed to discuss and prioritize the following natural resources on Tuesday:

- High relief habitat
- Sessile invertebrates
- Mobile invertebrates
- Bottom fish
- Pelagic fish
- Bait fish

Adjourn

Paul thanked everyone for their attendance and active participation. The meeting was adjourned at 5:00 p.m.

Tuesday, May 4, 2004

Welcome and Opening Remarks
Paul Orlando recapped the previous day's discussion and outlined the day's agenda.

Working Through Matrices
Paul asked participants to look at the first, high priority matrix. Working through the first intersect of marine debris and high relief hard bottom, Greg McFall clarified "marine debris" as various debris including fishing line, lures, corks, plastics, etc (*refer to small matrix in matrix 1 for high, medium, and low priority*). Discussion ensued to prioritize issues of intersect in the small matrix, and questions were developed that will be moved to matrix 2 to address issues.

Questions for Matrix 2
Sessile Inverts:
- How much is fishing gear affecting sponges and sessile inverts (i.e. quantitative)? **<R4>***
- What are recovery rates for affected species? **<R5>**
- What are indirect effects on community structure mediated by altered fish communities? **<R6>**

Mobile Inverts:
- What impact does removal of predators have on mobile inverts? **<R7>**

Bottom Fish:
- What are direct effects of bottom fishing on species composition, abundance, age, reproduction, and size structure? **<R8>**
- Recovery rates following cessation of fishing? **<R9>**
- What are the effects of spearfishing versus angling? **<R10>**
- What are the effects of spearfishing on behavior of bottom fish? **<R11>**

Bait Fish:
- How much does take of pelagic fish affect bait fish populations (and therefore reef structure by cascading effects)? **<R12>**
- What are effects of removal of bottom fish on bait fish? **<R13>**
- What percent of bait fish activity occurs inside GR versus outside GR? **<R14>**

Pelagic Fish:
- What is the comparison of areas (structure, fish populations, etc) where pelagics are removed versus areas where they are not removed? **<R15>**
- Site fidelity and residency – what are fishing effects on migratory behavior? **<R16>**

**Note: Questions cross-referenced with rows from Matrix 2.*

After proposed questions were transferred to Matrix 2, Paul then asked participants to answer questions from Matrix 2 based on questions from intersects (*refer to Matrix 2*). Discussion ensued on whether or not to keep the term "absolutely" in the question "Is a research area *absolutely* necessary?" Participants agreed to remove "absolutely" from the question. Participants continued to work through Matrix 2 to answer intersect questions. Gregg Waugh stated that, from the South Atlantic Fishery Management Council (SAFMC) view, the successes in this type of closed area are not only important to the

SAFMC but are critical to the kinds of decisions the SAFMC is trying to make regarding bottom fishing. Participants discussed whether or not a research area is necessary for observing and measuring the effects of spearfishing on fish behavior. Several people felt that it would be difficult to measure fish behavior if no control existed to measure normal behavior; in addition, fish response to divers in general was also an issue of concern to differentiate effects of spearfishing versus effects of the presence of the diver. Lad also mentioned that behavior of fish could affect many of these studies due to diver presence during visual observation. Participants also debated over whether a research area could provide significant information about effects of pelagic fishing. Judy suggested that fisherman participating in king mackerel tournaments at GRNMS report catch and release data, which could be utilized for population statistics. Moreover, participants agreed that obtaining estimates of removal rates at GRNMS would be beneficial and discussed means of gathering this information. Joe emphasized the importance of convincing recreational anglers to accurately submit information on catch and release.

Paul suggested that participants consider various research design aspects in a pro and con fashion similar to the previous day's discussion on research areas in general after lunch.

Adjourn for Lunch

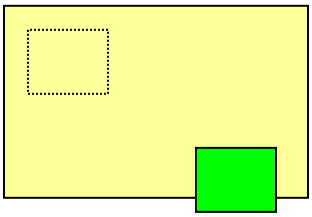
Investigating Research Area Options

Paul discussed four conceptual research area options that were discussed yesterday. Steve suggested cross-referencing the schematics with the research questions from Matrix 2. Reed suggested adding another schematic to represent a satellite research site under the GRNMS management similar enough in habitat to, but not within, GRNMS. Doug added that, within the multiple or replicate diagram, replication needs to occur outside of GRNMS as well. Participants decided on the following legend for the options diagram:

Yellow	**=**	**Gray's Reef**
Blue	**=**	**Ocean under SAFMC regulations**
Green	**=**	**Research site with special regulations**
Solid line	**=**	**Sanctuary regulations**
Dotted line	**=**	**Reference site (no new regulations)**

Participants discussed practical application of the temporary/flexible research design. General discussion determined that the temporary concept would be tabled and has low priority. Paul then asked participants to discuss "pros" and "cons" of each design. *(Note: The size of the following research area boxes is for illustration only. Discussion of size and shape of proposed areas did not occur during Workshop I):*

A. Single

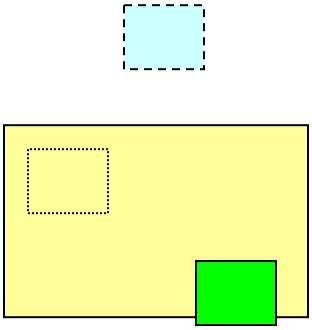


Pros

- Easily recognized
- More acceptable and less disruptive to user groups
- More achievable with increased public trust
- Less expensive to study and maintain
- Less expensive and easier to enforce
- Good starting point
- Maximize core area (reduced edge effect)
- May be applicable to priority questions (could provide useful results)
- Baseline data (extend / transfer to other issues or question)

Cons

- Low "power" (statistical and analytical)
- No outside reference
- Possible conflict among research designs
- Depends on size capacity to cover representative habitats



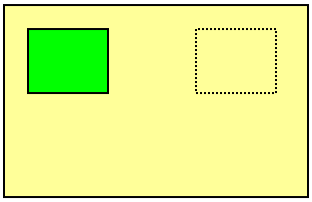
C. Outside Reference

Pros

- Same benefits as "A" but with more "pseudo-power" (debate over word-choice) due to outside reference site
- Able to perform comparative work with sites outside GR and able to evaluate effectiveness of sanctuary (scientific credibility)

Cons

- Same cons as "A"
- More research cost due to outside site
- May need approval from other authorities
- Challenge to find representative habitats in outside area



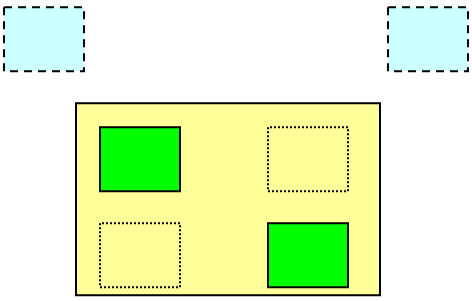
B. Replicate

Pros

- More "power" than "A" or "C"
- More applicability to more priority research questions
- May increase access to more and multiple habitats
- May disperse research efforts (less conflict for scientists)
- Able to investigate larger scales

Cons

- Harder to enforce
- Less public acceptance
- More effort, more costs (possibly - depending on design)
- No outside comparison
- More edge, less core
- Difficult to find replicate habitat



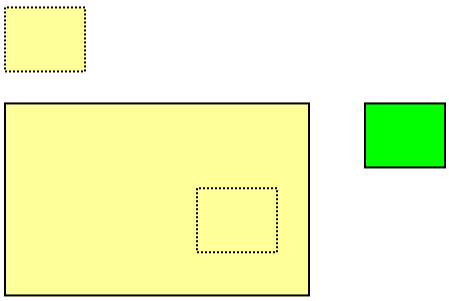
B./C. Hybrid (i.e. Replicate with two outside reference sites)

Pros

- Scientifically preferred
- Ditto "B" and "C" but with more "power," replication, comparability, and hypothesis testing

Cons

- Ditto "B" and "C" but more costs



D. Single (a)

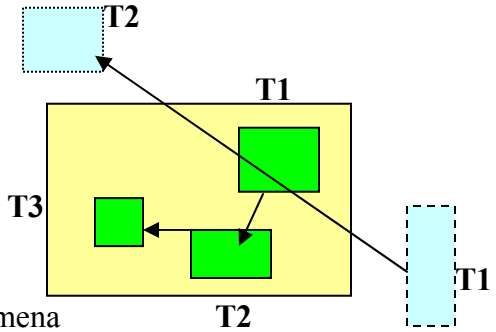
Pros

- Most acceptable (no displacement from GR)
- Set up to answer questions for SAB and provide context for GR

Cons
- Least acceptable (public may question expanded jurisdiction)
- Questionable treatment from scientific perspective (Does it address GR questions? Applicable to GR?)
- Concern that area outside represents shallow water MPA

E. Temporary/Flexible

(Note: T1, T2, T3 indicates Time 1, Time 2, Time 3, etc.)



Pros
- Temporary study of specific phenomena
- Flexibility of location to accommodate study needs
- Potentially more acceptable ("short term closure")
- Spatial randomization through time

Cons
- Does not bring closure to public
- Logistically difficult to enforce
- Lack of long term data sets
- Maybe difficult from administrative perspective
- Frequent revisit

During this research option pro/con discussion, Herb stated that effective and positive communication to user groups is extremely important to establish an effective research area. Debate continued about establishing a research area within versus outside of GRNMS. Willie commented that "selling" a research area within GRNMS, versus outside of GRNMS, to fishermen would be more difficult; he continued to say that the best site inside GRNMS would be the southeast quadrant with allowable trolling for king mackerel.

After discussing pros and cons of research schematics, Paul asked participants to review general information needs prior to establishment of research area (*refer to Matrix 2, column G*):

* Size options for research areas
  - Look at similar areas
  - Tighter coupling to design options
* Inventory of spp at similar areas and applicability to GRNMS

* Select appropriate targets for GRNMS spp (indicators?)
* Define "fishing gear effects"
    - Degree of severity
* Literature review
    - Fishing gear lit review (M. Barnett at NMFS)
* Similar studies
    - Set up
    - Short / long term
    -Gear / techniques
* Usage patterns
    - Location of boats over time (from overflights)
* Removal estimates
* Identify potential sites
    - Similar / multiple habitats
* Determine if "outside" candidate areas exist
* Scope non-GRNMS reference sites

Paul asked that the group reflect on the current and previous days' discussions. He stated that the task was vague, and the progress was positive. The group was able to capitalize on and capture a diversity of opinion and expertise. Paul commented that the group has taken a step towards developing a recommendation concerning the utility of a research area concept; the recommendation is not a black and white issue but is clearly dependent on the purpose of and issues concerning a research area. Paul noted that Greg brought forward important management questions with a research focus and relevance. The matrix process thus helped to develop answers or ways to answer these questions. Paul noted that he is not sure if the group is able to answer a "yes" or "no" to the question of whether to develop a research area, but the group now has a foundation for justifying an answer; this foundation was developed in a fair and diverse way. Paul commented that the evaluation of research design concepts was a good addition to the agenda. Important information was obtained that help the group to take the next steps towards making a recommendation to the Advisory Council. Paul stated that participants have a lot to contribute to this process and that they made their contributions in a structured and meaningful way. He thanked participants for their willingness to contribute with enthusiasm and valuable content.

Greg McFall thanked the group for their attendance and participation. He thanked Willie, John, and Charlie for representing the fishing community. Greg also thanked the scientists for taking time out of their busy schedule. He thanked members of the Advisory Council who volunteer their time because they believe in what they are doing. Greg also thanked Paul for a wonderful job of facilitating. He noted that a lot of work lies ahead in the interim and encourages continued discussion and participant involvement.

Reed Bohne thanked participants for attending the meeting. He recognized the large commitment it takes to be involved in the working group and is grateful for attendance and active participation. Reed commented that the meeting and discussion was a major

step forward for the sanctuary in looking at this concept. He noted that the meeting was the first step in what will be a long process but that talking about and developing thoughts and materials is critical; the best information comes from spending time with experts and with the public. Reed stated that opportunities exist to enlist support from people outside of the group to look at this concept for GRNMS and for coastal Georgia. He noted that most people are conservation-minded and will see the long-term value of being able to observe and record change in a natural environment; he was not suggesting, however, that a decision has been made but that the group has come up with very compelling reasons for examining this concept. Reed commented that the group participated in excellent and constructive conversation; he hopes that everyone will continue to participate and remain involved and will be able to help staff in developing an interim product. Lastly, Reed thanked Paul for guiding the group through the meeting.

Joe Kimmel thanked Paul for his accurate recap of the past two days. He admitted that he was not sure how the meeting would turn out but was pleasantly surprised with the results given the time frame. Joe thanked participants for their attendance and for offering ideas, thoughts, and suggestions. He then thanked GRNMS staff for their hard work and preparation for the meeting. Joe felt that the meeting was very successful, and he appreciates the opportunity to chair such an esteemed group of scientists and experts.

Adjourn
The meeting was adjourned at 3:45pm.

APPENDIX G

- Minutes RAWG Meeting II: October 6-7, 2004

GRAY'S REEF NATIONAL MARINE SANCTUARY

Research Area Concept Working Group Workshop II Meeting Minutes

October 6-7, 2004
Savannah, GA

RESEARCH AREA
WORKING GROUP MEETING II
October 6-7, 2004
Savannah, GA

Wednesday, October 6, 2004
Homewood Suites – Savannah, GA

Distributed Materials

- Meeting Agenda
- PowerPoint Presentation
- Requirements Matrix
- Size Classification
- Distillation Matrix

Attendees

Reed Bohne (GRNMS), Greg McFall (GRNMS), Jim Sullivan (GRNMS), April Fendley (GRNMS), Paul Orlando (NMSP), Steve Gittings (NMSP), Joe Kimmel (NOAA Fisheries), Lad Akins (REEF), Doug Rader (Env. Defense), Matt Kendall (NOAA Biogeography Team), Jim Siler (CCA), Tim Vincent (GA DNR), Leslie Sautter (College of Charleston - Geology), Brian Keller (FKNMS), Charlie Phillips (SAC), Henry Ansley (GA DNR, SAC), Judy Wright (SAC Chair)

Welcome and Opening Remarks

Joe Kimmel welcomed everyone to the second working group meeting. Reed Bohne thanked participants for attending the workshop. Reed stated that this working group is trying to be systematic in reviewing pros and cons for setting aside a research area within the sanctuary. Based on the group's recommendations, the SAC will review these recommendations and will then present their recommendations to GRNMS. Reed also commented that Fishery Management Councils around the nation are also examining the idea of setting aside marine protected areas.

Process Introduction and Ground Rules

Paul Orlando also welcomed participants and briefly reviewed the meeting agenda (refer to hand-out). Paul emphasized that the group should work through the matrices in a timely and efficient manner. Paul also commented on meeting logistics and ground rules.

Review of Previous Workshop

Greg McFall discussed sanctuary system goals and presented an overview of the research area working group process (refer to presentation hand-out). Greg also reviewed the research area concept timeline, from1999 to Spring 2005-2007. Reed noted that

extensive opportunities will exist for public interest and involvement in this process. Greg continued to review the process and products of the previous workshop. Pros and cons of setting up a research area were discussed at the previous meeting, which led the group to brainstorm various research area options. A list of pros and cons were also generated for each research area. Issues of concern ("intersects") were then determined and prioritized to create the first matrix. Considerations for the value of a research area were then proposed, which led to the development of the second matrix. Answers from Matrix 2 were used to develop the requirements matrix; participants were asked to complete this matrix independently. Greg noted that the goal of this meeting is to compare responses from the requirements matrix, to discuss pros and cons of recommending a research area, and to discuss pros and cons of research area designs.

Distillation Matrix

Jim Sullivan provided a process overview in regards to the requirements matrix, i.e. combined responses, defined research area size, synthesized responses, and developed a distillation matrix. Jim Sullivan asked participants for their opinions on size classifications. Reed commented that the size depends on principle questions addressed in the research. Steve noted that participants should review the size classification table to determine whether the classifications are congruent with the dimensions listed. Henry Ansley stated that the table provides a good point of reference. Greg noted that the research area, regardless of size, should incorporate all four habitat types in the sanctuary (i.e. densely colonized [ledge], sparsely colonized, rippled sand, and flat sand. Doug asked for clarification of the extent of political commentary on size classification recommendations; he noted that scaling questions exist on either end of the spectrum. Jim Sullivan asked Brian Keller from FKNMS about the range of research areas within the Florida Keys; Brian stated that the smallest he can think of is $\geq 1 km^2$. In response to Reed's question, Greg stated that these size options take into consideration the various research designs. Joe noted that an area larger than what is needed to answer the research question should not be chosen.

Jim Sullivan then reviewed part of the distillation matrix (refer to distillation matrix hand-out). Brian Keller asked how many responses were received, to which Jim answered 11-12. Jim noted that he tried to capture as much and as direct input as possible.

Paul emphasized that Jim Sullivan tried to interpret the range of ideas that were submitted to him in regards to the size classifications and the distillation matrix; these tables should be used as frames of reference for current discussion. Paul suggested that the group work through the distillation matrix.

Sessile Invertebrates / Bottom Fishing x Fishing Gear Effects

Paul began the discussion of the distillation matrix with fishing gear effects on sessile invertebrates/bottom fishing; he asked participants if they agreed with the research objective listed. Joe noted that this information should be expanded upon, including what is listed and associated anchor damage. Judy reminded participants that an anchor restriction is proposed in the current draft management plan that is being considered.

Reed suggested that anchoring not be included in this objective; Lad requested that the notes reflect that a prohibition on anchoring is assumed. Doug asked if "live bottom" was enough information to determine target habitat type. Steve noted that he wants to be consistent with habitat maps; Matt Kendall stated that this is an important distinction, where impacts on high-relief versus low-relief areas may differ. Greg stated that densely-colonized areas are typically on ledges. Lad pointed out that fishing is often focused around densely-colonized areas and ledges. Brian stated that effects on habitat types can be distinguished through sampling; a research area that is solely a ledge will be difficult to isolate. Matt commented that "live-bottom" may miss important areas. Doug requested that the four specific habitat types be identified in this row. "Live bottom" was then changed to "densely and sparsely colonized live bottom." Matt clarified that "densely colonized" referred to ledges and often varied in amount of colonization and relief even within the habitat classifications.

In reference to size, Doug noted that the size indicates an effective size to gather significant scientific data. Greg noted that replication is ideal for statistical analysis. In reference to number, Joe stated a minimum of three areas should be required; Matt noted that he interpreted this requirement to represent the number of research areas. Doug commented that a complex array of research sites will be difficult to enforce in this publicly-accessible area. Participants agreed that "number" be clarified; this row represents the number of study areas rather than replicates. Brian still partitions between a reference study site and a treatment study site; he suggested 6 areas, 3 reference and 3 treatment (refer to research design "B"). Lad asked if "number of research areas" refers to reference or to treatment areas or both. Reed commented that practicality of plots must be considered. In response to Brian's comment, Greg suggested that a larger area be used as the treatment site and random sampling occur at various areas within this treatment site. Henry commented that a distinction between several small areas versus one larger area affects enforcement. Doug noted that this discussion does not have to be resolved right now. Reed suggested that participants consider what is best to answer the objective. Steve commented that the treatment areas should include both habitat types indicated in row 5, column B ("habitat type"). Greg stated that he does not feel that reference sites should be considered in the discussion because these areas can come from within or outside the sanctuary.

Doug suggested that the term "replicate" be removed from discussion because it confounds the research design. Research area option "B" and "BC" will now be called "multiple" instead of "replicate." Discussion about design options and about incorporation of outside reference areas ensued. Paul summarized: Initially questions were being geared towards effects inside the sanctuary questions; these questions were expanded to identify whether resources within sanctuary are being protected in relation to areas outside sanctuary. Paul asked for the group to decide whether the design options incorporate areas outside the sanctuary. Paul suggested that the group go with the original intent of applying questions to areas within the sanctuary. The objective was edited to include the phrase "Can be expanded to look outside sanctuary." And design option was edited with parentheses to reflect options within the sanctuary and options

relative to the region (outside the sanctuary). Reed noted that the issue of sanctuary-specific and sanctuary-plus-regional will arise for every research question.

Discussion about research time-frame then ensued. Joe asked if a range could be used rather than a specific time. Matt noted that this is a baseline survey, and Steve stated that recovery may require more time; this study is only quantification. Doug noted that detection of statistical differences may take a significant amount of time. The group agreed that 2-5 years is a significant amount of time to gather data on fishing gear effects. Henry stated that an understanding of research requirements (answering the "why" question) would be beneficial for the SAC. In reference to marking, Tim noted that buoy's must be large enough and well-marked. As far as enforcement, Tim also stated that the DNR has a daily presence on the water but that the officers will not be able to determine what is happening underneath the water. Reed commented that this is a surveillance process. Brian stated that enforcement is a continuous process of public education, warnings, and penalties. Reed noted that GRNMS has more of a resident population, rather than a tourist population like the Florida Keys. According to Brian, the requirement of no fishing will not be an instantaneous transition but will occur with compliance over time. Tim asked if this amount of time will be 5 years, to which Brian responded that the amount of time is subjective. The group agreed that enforcement of some kind would be needed for this particular study.

Although most participants understood Education/Outreach to refer to public education and compliance, Paul noted that Leslie Sautter put forth recommendations for Education/Outreach as it relates to formal education (graduate assistants, internships, etc). Lad asked for clarification on the definition of this requirement. Leslie suggested that row 14 heading be changed to "outreach/informal education" and another line be added for "formal education." With that in mind, Paul noted that the content of the outreach/informal education was pretty consistent. The group added web, visualization techniques, and notice to mariners to the outreach requirement. In response to Leslie's education opportunity recommendations, Henry stated that these opportunities are sanctuary-wide and not specific to a research area. The term "requires outreach and education" was added to enforcement, and the row of outreach/informal education was removed as a requirement consideration. Doug noted that this row follows the same basis of formal education that is encouraged but not required for the need for and/or choice of research design.

Break

Distillation Matrix (cont'd)

Paul clarified that the group agreed to address the matrix under the assumption of no anchoring. He also stated that he received a recommendation during the break to re-insert the "outreach" component of the requirements because it goes hand-in-hand with enforcement. The group agreed with this recommendation.

For displacement/prohibited activities, the group listed various activities that may be prohibited in order to study effects of bottom fishing gear on sessile invertebrates. Tim

stated that the preferred law enforcement would be no entry into the research area (minus researchers), but Steve responded that the question would need to be changed; in order to observe bottom fishing effects, it should be the only activity prohibited within the research area. Reed commented that fishing gear/activities prohibited should include any type of gear or activity in which bottom fish are targeted; for example, trolling and spearfishing should be prohibited since they can target bottom fish. Paul suggested that the group redefine the question or specify the types of activities/gear that should be prohibited to address this research question. Steve proposed that the question be changed to state "the effects of fishing on the bottom." April reminded the group that the intersect of bottom fishing was determined in the first workshop and that the group should try to recall the discussion that resulted in agreement on bottom fishing as an intersect. Jim Siler stated that it is difficult to differentiate bottom fishing from pelagic fishing. Jim Sullivan stated that effects can be identified more accurately when only one type of activity is prohibited rather than general effects from prohibiting a range of activities; identifying which activity produces which effect would be difficult in this case. Steve commented that any fishing that could affect the bottom is what is being identified here. Charlie noted that the types of fishing were separated so that user groups could continue to catching King Mackerel. Doug said that the prescription should be on bottom-impinging gears. Paul recommended that the group stick with the current question and document the activities that should be prohibited. The group agreed to include bottom fishing, bottom-impinging trolling, and spearfishing as prohibited activities. The matrix notes reflect the consensus that the group is unclear about the effects of bottom-impinging trolling and that regulations might be easier to enforce if the area is closed to all fishing.

Steve and Henry suggested that fishing effort by gear type and compliance be added to ancillary data requirements. Greg suggested that bottom map be removed, and Lad stated that physical measurements should include episodic events. In reference to cost, Henry asked how the cost of the research relates to the cost of enforcement in the research area. Matt stated that cost should impact the SAC's decision to put forth recommendations for a research area to GRNMS. Does the cost requirement row include costs of implementation, enforcement, and socioeconomics? Discussion of cost focused on how to determine what part of costs was associated with establishing and maintaining the research area versus conducting actual research. The row was clarified to read "research costs." Brian stated that research/sampling requirements affect costs, so he suggested that the group provide a wide range of cost to cover many variables. Jim Siler commented that cost should not even be included in the discussion since most participants are not qualified to accurately propose a research cost. Reed stated that some research activity is included in baseline operations budget, so Leslie suggested that the group identify a doubling or tripling of the operations budget that would be required. Doug said that a general cost estimate would be beneficial when asking Congress to fund a research area. Matt commented that since most research area cost estimates are similar, the utility of presenting to the SAC which research options would be less costly or more costly is lost. Reed suggested that the group propose a baseline cost including sanctuary-sponsored boat trips, divers, etc per year. Matt noted that current research monies allocated to GRNMS region (i.e. two two-week trips per year, four divers a trip) are

around $160,000/year. The group initially agreed to identify a cost of $200K/year above and beyond GRNMS logistical support. Judy suggested that the cost be clarified to note that this could include grant funds; also, the costs would be substantially reduced if GRNMS staff had time to participate. Participants also agreed to come back to the cost discussion at another time. Steve noted that the nature of data gathered has not been considered and may affect cost (referring back to row 10 research/sampling requirements). Reed asked, "What are minimal requirements to achieve objective?" Steve suggested that the research/sampling requirements should be to document incidences of injury (simple counts) versus more detailed benthic characterizations including injuries; cost range was adjusted to indicate a lower-end study: $15K to $200K.

Sessile Invertebrates / Bottom Fishing x Recovery Rates
The group agreed to add recovery of populations of sessile invertebrates to the objective. Participants continued to move through the matrix, keeping content of many cells the same as the fishing gear column. Steve noted that recovery would be difficult to measure in two years, so the length of the study was changed to be 5-10 years; "time" was changed to "duration" for clarification. He also stated that the rate of change in a closed area versus in a reference area would be studied, so the parameters would be comparisons of recruitment, abundance, condition, and growth. At the low end, the study would follow recovery of documented injury in the fishing gear impact column in relation to these comparisons versus reference areas or manipulative experiment.

In reference to marking, Henry Ansley noted that more buoys mean more costs and more hassle for maintenance. Enforcement and prohibited activities remained the same as in fishing gear effects. For ancillary data, Joe stated that literature (e.g. growth rates) would be needed. Costs were determined to be the same as fishing gear research costs.

Sessile Invertebrates / Bottom Fishing x Indirect Effects
Judy asked for clarification of "benthic food webs"; Doug explained that it explains the "who eats whom" of the benthic community.

Doug suggested that if the study of indirect effects of bottom fishing on sessile invertebrates includes the study of juvenile or adult fishes, it would require a larger area than that required for just the study of indirect effects of bottom fishing on sessile invertebrate communities by itself. On table (D16) the costs could be more than $300k because the indirect effects are harder to gauge than the two studies for fishing gear effects and recovery rates.

Adjourn

Thursday, October 7, 2004
Homewood Suites – Savannah, GA

Additional Attendees
Herb Windom (SkIO), John Duren (CCA), George Sedberry (SC DNR), Russell Kent

Overview and Recap
Paul Orlando asked for introductions and recapped the previous day's progress. The distillation matrix provides a requirements outline to produce a recommendations document about the feasibility and possibility of a research area in the sanctuary. Paul noted that a lot of numbers being proposed may be on the "high side"; some lower cost alternatives may exist. Greg McFall then reviewed the definitions/clarifications of the requirements in the distillation matrix.

Continue Work on Consensus Matrix
Mobile Invertebrates / Bottom Fishing x Effect of Predator Removal
Joe Kimmel asked for clarification of priority species listed in the objective; Greg stated that these species of interest are prey species. Matt Kendall stated that he feels all habitat types should be considered in this research design, so the habitat type text was changed accordingly. Herb Windom asked if a separate type of study would need to be considered for each habitat type. Greg replied that one habitat type would be difficult to isolate; Doug also added that the species studied would be foraging or mobile species. In reference to size, Herb stated that the size would depend on the design of the study. Steve noted that these animals are mobile, so size depends on the minimal size of a research area required to effectively study these mobile animals. Matt stated that some juvenile grunt species move around ~200 meters (adults even greater), but size of research area would be dictated by resident predator range. Lad suggested that ancillary data be considered before deciding on a size. John Duren reminded participants to think about appropriateness of the scope of research in order to determine size. Greg said that the size of the research area should be the distance roamed by bottom fish that move the most. In response to Herb's question about the scope of the research, Steve stated that researchers identify the baseline populations of prey and predator species in the area. Doug noted that the idea here is more general – to determine an area that could answer this question, not necessarily to create a specific research design.

In an attempt to brainstorm the actual research and/or sampling requirements, Greg stated that a low end study would involve a predator exclusion/inclusion experiment. John asked if this study would occur in all four habitat types; Steve noted that this would be determined by the target species identified and the easiest species to count. Doug stated that another alternative would be to close off an area to fishing and examine the population changes of prey and predator species. But Steve asked if that actually answered the question of effect of predator removal or if this a predator introduction. Herb stated that the original question seemed very simple: What would the mobile invertebrate communities look like in the absence of fishing? The objective was changed accordingly and the intersect was edited to read "Effect of Predator." Research option included gathering predator and prey censuses before and after closure.

During discussion of size, Joe Kimmel felt that small to medium research area would be sufficient, but Doug noted that the issue of sizes goes back to the previous day's discussion of choosing several smaller areas or one larger area with study plots inside. The group agreed that several small or one larger area would be beneficial. The design

options would then be design A or B (C or BC if looking outside the sanctuary). Gathering baseline data was considered in the duration of the study, but this baseline data could be gathered in the years prior to research area implementation. Five to seven years was determined to be a good length of time to gather data to answer this question.

Discussion ensued about which activities should be prohibited. Greg reminded the group that the impact of pelagic fishing on mobile invertebrates was considered to be small (from the first workshop), these studies would be concerned with the effects of bottom fishing. Predator and prey home ranges as well as gut content analyses was considered ancillary data. Herb also stated that regional oceanography (gulf stream intrusion) would also need to be studied. Steve noted that the regional oceanography would be a good ancillary data *recommendation* but is not a *requirement*, which is the purpose of this matrix. Participants decided that a cost range of this study would be $50K-$75K/yr on top of baseline operations budget.

Bottom Fish/Bottom Fishing x Direct Effects
Brian Keller stated that this particular study is a subset of the previous discussion. The group agreed that fish in sandy habitats may be affected by bottom fish population changes as a result of bottom fishing on ledges. Steve felt that a small area would not be sufficient to study this intersect effectively; a larger research area would incorporate smaller sampling plots. He also noted that fishing effort by gear type as well as benthic fish home ranges be including in ancillary data requirements. Tim Vincent noted that costs for education/outreach for enforcement would increase.

Bottom Fish/Bottom Fishing x Recovery Rates
Steve agreed with Doug that the direct effects study can be inferred or gathered from a recovery rates study. Participants agreed to add in the notes of the direct effects study that an alternative to measuring the removal of target species can be done through census of fishing effort by gear type.

Bottom Fish/Bottom Fishing x Spearfishing vs Angling
The group then discussed the issue of the selectivity of spearfishing and what are the differences in the effects of spearfishing versus the effects of angling. Doug noted that the complexity of experimental design would increase to study these effects; four treatments would be needed: an all-fishing zone, a no-fishing zone, a zone closed to angling, and a zone closed to spearfishing. Discussion ensued as to whether spearfishing should be separated from angling rather than "taking fish" by any method in general. Lad noted that although the level of spearfishing in GRNMS may be low, spearfishing gear has been found on the reef; he and Leslie agreed that the effect of spearfishing should be studied for management plan purposes. Doug reminded participants that a ban on spearfishing is currently proposed in the draft management plan and that this research design would not be possible if this proposal is adopted. Judy stated that people are going to GRNMS and surrounding areas to spearfish, and this number of people will continue to grow. Russell felt that differentiating between spearfishing and angling is difficult; a danger exists in singling out one group, and the effect is a different way of doing the same thing – fishing. Joe stated that the selectivity (e.g., targeting of spawning

aggregations) is important to consider. Brian felt that isolating, studying, and quantifying effects of both angling and spearfishing is important; this goes back the four treatment designs. Greg said that participants need to consider the practicality of implementation and selling that to the public. Brian stated that the opportunity exists to try to begin to resolve a recurring discussion/debate over effects of spearfishing vs effects of angling. Doug stated that this matrix should be approached under the assumption that no anchoring and that no spearfishing will be approved as preferred alternatives in the draft management plan. Scientists agreed that this particular study design would be very difficult and complex. Henry commented that he would couch spearfishing on the other columns/research questions (e.g. direct effects) and remove the two spearfishing columns. Doug stated that spearfishing vs angling effects should be an overarching question for upcoming research in the sanctuary; should the sanctuary not be closed to spearfishing, these research options will be reconsidered and examined further. Jim Sullivan noted that costs for socioeconomic surveys are already included in the GRNMS budget; surveys will be utilized to ascertain fishing effort.

Recommendations

Paul noted that, upon removing the intersects relating directly to spearfishing, six research questions/intersects remain in a consensus matrix. He suggested that participants develop cogent recommendations for the SAC that best represent the entirety of the six studies and how best to proceed with implementation.

The updated and consolidated distillation matrix was printed out for participants' review. When reviewing the research design option, Greg reminded the group that GRNMS has no regulatory authority outside of the sanctuary boundaries. Herb noted that the outreach component is almost a study in itself and should be separated from this discussion; expand outreach beyond compliance and enforcement. Participants agreed that the study area would either be three small or one large area and should include all habitat types. Steve commented that the approach should be separated into sessile invertebrate studies versus mobile invertebrate studies. Doug stated that recommendations should include requirements for intermediate reporting to ensure that research is being conducted (i.e. interim products and performance measures). Steve suggested that if fishing gear effects on sessile invertebrates are found to be negligent, then research would stop; if these effects are found to be significant, recovery rates and indirect effects could then be studied. Jim Sullivan reminded the group that the management plan is reviewed every five years; the working group and/or SAC could request that a report be presented at the beginning of management plan review to discuss research progress. John and Joe agreed that an annual report would be beneficial to notify SAC and public about research progress. Doug suggested a formal review/evaluation at the 10-year mark (post-establishment). As for effects on mobile invertebrates, Steve stated that no direct effects can be observed without measuring recovery rates.

Paul suggested that Matt Kendall explain the habitat characterization map of GRNMS. Subsequently, the group will examine actual placement of potential research area(s) within the sanctuary. Matt described the various habitat types and their distribution in relation to the sanctuary boundaries. Discussion ensued regarding research areas.

Russell and John commented that three separate areas would be difficult to sell to the public and would be difficult to enforce.

Break for Lunch

Recommendations (cont'd)
After contemplating over lunch, Judy Wright commented that prohibiting recreational divers from accessing the research area has not really been discussed and may alter experiments. Steve noted, however, that the goal of the experiment is to "tease out the effects of fishing," so all other activities should be permitted. Herb stated that an area with restricted fishing activity might attract divers and actually increase numbers of recreational divers. Judy suggested that only divers with permits be allowed in the research area. Lad stated that he was not sure that having a boundary around a larger area would focus attention on the specific study sites. He also noted that a call-in permit is required to enter protected areas in the Florida Keys. Brian suggested gathering ancillary data of the distribution and abundance of diving activity in the sanctuary; results may lead to looking at recreational diving as another treatment. For the sessile invertebrate intersects on the consensus matrix, the notes reflect a concern for potential impact of non-permitted/recreational divers on experimental design. Tim suggests closing to all activity and allowing permits for anyone who requires access to the area; Greg noted, however, that trolling without bottom-impinging gear is not listed as a prohibited activity in this discussion.

In response to a question from Lad regarding the group's role in determining a specific research area, Greg suggested that the group determine whether they will draw the lines or will give the SAC guidance for how lines should be drawn; he emphasized that this is only a recommendation and may be altered later on. Russell and Leslie agreed that laying out options or providing a representation that meets scientific criteria for a specific research area will give the public a sense of scale. Matt suggested that the group establish criteria for delineating a research area rather than actually designating specific area(s).

Matt discussed variables that he weighed to examine which research option would be most palatable (e.g. number of ledges, location of research sites, and fishing pressure/boat sightings).
Steve noted that the quality of the bottom and ledge height is the most significant factor for isolating a research area. Matt noted that fish data would also be important to weigh. Brian commented that he perceives some desire to use the process used in delineating the Tortugas protected area to design and inform the public about a research area in GRNMS; Joe noted that the user groups and public perceptions are different than in Tortugas. Matt stated that this process needs to be defined and presented to the SAC. Leslie suggested that the group present criteria today, then whoever is available can reconvene to determine boundaries of research area. Participants agreed that utilizing Matt's methodology and GRNMS staff knowledge of habitat in GRNMS would allow for a later determination of recommendations for specific research sites. George discussed research previously conducted in the sanctuary; Lad also noted that his group has obtained some

data as well. Paul recognized a reluctance of the group to go further in drawing off a proposed research site or sites but to instead put this off to a later date upon further examination of site criteria. Steve asked the group to recognize the statistical problems with selecting a larger research site and randomly sampling areas inside this larger area. Brian agreed that statistical replicates would be difficult to define/create with that particular research design. Doug and Steve suggested recommending a range of alternatives to the SAC. Some participants agreed that help from a professional statistician would be beneficial. Discussion continued regarding size of research area, including advantages and disadvantages of various sizes, (3 1x1's, 2x2, 4x4). Henry stated that a larger site decreases edge effect and takes movement into account. He also noted that a larger area with all habitat types will accommodate both experiment groups (sessile and mobile invertebrates). Greg noted that the fish may or may not aggregate around high relief, densely colonized areas. Russell said that he normally looks for 2 feet elevation when fishing. Doug stated that another consideration is whether the current long-term research site should be within the new research area. Russell suggested weighting criteria; participants agreed to double weight of habitat criteria in ranking process. Brian noted that the size of the area does not have to be square (can be 2x3, 3x4, etc); Herb reminded participants about edge effect. Tim stated that enforcement would be easier with buoys that are properly marked and visible. Herb commented that the design ultimately has to be communicated to the public, thus a simplified design and criteria will be easier to communicate.

Criteria for 3 benthic studies:

- Habitat (2x weight)
  - 4 types
    - 5th type → colonization refined by height (number & area of ledges >0.5 m)
  - Method to look at habitat representation (e.g. proportional to GR %)

- Boat use
  - Minimize displacement

- Existing studies
  - Maximize utilization
  - Use trap data to examine if target species occur in modeled areas (habitats)

- Size (km x km)
  - 3 – 1x1, 1 – 2x2, 1 – 3x3, 1 – 4x4

Paul asked if the group had any further suggestions for moving further in determining boundary alternatives and/or criteria. Matt will perform additional GIS data analyses before the group reconvenes at a later date. Greg noted that he hopes to reconvene again some time in February or beginning of next year; he will send around an email to confirm. In response to Greg's questions, participants agreed that they prefer GRNMS

staff to write up formal recommendations (including an executive summary) to present to the SAC based on discussions and matrices from the workshops.

Greg thanked everyone for their active participation. Any questions or comments can be sent to GRNMS staff. Greg also thanked Sammy, Matt, Jim Sullivan, and April for their work in this process.

Adjourn

APPENDIX H

- Minutes RAWG Meeting III: March 23, 2005
- Diagram H.1: Research Area Siting Criteria Map

GRAY'S REEF NATIONAL MARINE SANCTUARY

Research Area Concept Working Group Workshop III Meeting Minutes

March 23, 2005
Savannah, GA

RESEARCH AREA
WORKING GROUP MEETING III
March 23, 2005
Savannah, GA

Wednesday, March 23, 2005
Homewood Suites – Savannah, GA

Distributed Materials

- Meeting Agenda
- Sample Matrix 5
- Items for Discussion to Improve Spatial Analysis
- Research Area Size Analysis

Attendees

Reed Bohne (GRNMS), Greg McFall (GRNMS), Jim Sullivan (GRNMS), April Fendley (GRNMS), Becky Shortland (GRNMS), Paul Orlando (NMSP), Steve Gittings (NMSP), Matt Kendall (NOAA Biogeography Team), Kate Eschelbach (NOAA Biogeography Fellow), Joe Kimmel (NOAA Fisheries), Brian Keller (FKNMS), Judy Wright (SAC Chair; Island Dive Center), Tim Vincent (GA DNR), George Sedberry (SC DNR), Lad Akins (REEF), Jim Siler (CCA), John Duran (CCA), Russell Kent (Georgia Southern University and CCA), Leslie Sautter (College of Charleston – Dept. of Geology)

Welcome and Opening Remarks

Working Group Chair Joe Kimmel welcomed participants and discussed background leading up to this meeting. Joe called for participant introductions. Greg commented on the purpose of the day's meeting.

Process Introduction and Ground Rules

Paul Orlando thanked participants and provided an overview of the working group process and ground rules. He then reviewed the meeting agenda and objectives.

Review of Previous Workshop

Jim Sullivan (GRNMS) presented an overview of the research area concept process. In the first working group meeting, pros and cons of establishing a research area and of possible research area designs were discussed. Matrices were developed to analyze research intersects and research area concerns. In the second meeting, a distillation of study requirements was developed as a distillation matrix. Research area designs and siting criteria were also developed. Jim commented on Matt Kendall's GIS analysis of various research area designs using siting criteria. He discussed goals for the day's meeting.

Using Geospatial Data as a Placement Analysis Tool
Matt Kendall (NMSP) presented the work that he and his biogeography team have done after the second RAWG meeting, i.e. a systematic optimization study based on habitat, number of boats, and previous research sites. He provided a conceptual approach to the analysis. Matt then described the ranking equation used to analyze research areas. Steve Gittings noted that boat ranking was established to minimize the displacement of users, e.g. a higher ranked area would have fewer boat sightings. Matt discussed data used in the analysis: bottom type data, boat distribution, prior research sites. Matt commented on the problem with the boat distribution data, which was gathered mostly during Kingfish tournaments (who are not bottom fishing). Should we assume that displacement would be the same for bottom fishermen?

Matt then described the research size analysis and presented the top five areas based on size analysis. He showed the best areas based on habitat include many boats and some research sites. However, he showed that the highest ranked areas have good bottom type, fewer boats, and a lot of research sites. Matt discussed a summary of caveats and variables to review (refer to handout):

- Ratio of other bottom types
- Absolute number of ledges
- High, medium, and low ledges
- Some amount of prior fishing may be "good"
- Could select range of equally suitable sites based only on habitat, THEN apply boat sighting, research, and other variables

Steve G noted that the group has not discussed a particular reference site of equivalent habitat quality, ledge, fishing, etc. Matt agreed and noted that this analysis tool would allow the group to locate this reference area. John Duran stated that the group should have proposed or alternative coordinates for a research area before presenting to SAC and public. Reed commented that the group can make a recommendation to the SAC that a research area is or is not useful; the SAC can then further this recommendation to GRNMS staff. GRNMS would hold scoping meetings with the public to develop options and alternatives that could be presented to NMPS/NOAA. George Sedberry noted that some prior research sites may be more relevant than others. Matt responded that it depends on objectives of research conducted in research area; he feels like some prior research does not provide good baseline data to be criteria for research area location. Greg stated that placement focus should remain on ledges. Lad commented that not all ledges are created equal – some may be more relevant to particular research questions. Brian Keller noted that both types of research sets are beneficial; some baseline is better than no baseline. In the Florida Keys, baseline data was collected before areas were designated no-take. Steve asked if priority ledge areas could be mapped before further GIS analysis. Lad stated that he found a good correlation of fish with ledge height. Matt agreed that ledge height criteria could be expanded. Paul summarized the previous discussion and asked for input on next steps.

Jim Sullivan emphasized that he would like to see the group review criteria in a systematic way; methodology can be reviewed and adjusted later. Greg agreed that criteria and pros and cons of different sizes would be excellent to present to the SAC along with a recommendation, if the recommendation is to investigate establishing a research area. Reed noted that size is major issue to the public and should be considered along with the utility of different sized research areas. John Duran stated that the group should look at other equivalent areas for fishing if major displacement occurs.

Paul asked for input regarding data caveats. In regards to ledge height, consider:

- Absolute rank of ledge heights
- Correlation of ledge heights to biodiversity of target species
- *+/- 0.75m needs finer resolution* *
    - Be sure to have high relief sites (>1.5m)
- Use maximum ledge height as multiplier in equation
    - Look at maximizing variance?
- Full range of habitat types
- *Focus on priority questions / purpose – impact on bottom areas* *
- *A simple algorithm* *

Criteria: *

- Fish – biodiversity
- Fish – target species
- Habitat biodiversity
- Benthic assemblage density

Lad noted that there will be a diversity of ledge height because the ledges taper. Matt asked for input on how to weight ledge heights, but Steve G suggested using actual height. Brian Keller stated that objective analysis is good, but the group should not get too involved with objective analysis; some of this should be done in public/NEPA process. He also stated that habitat diversity should be ranked, so Matt inquired about how to determine ratio and ranking of diversity. Russell Kent noted that if the focus is on bottom fishing, only certain types of habitat should be considered or should be weighted more heavily. Lad added that other research questions could be raised, however. Discussion ensued about habitat types within an area. Judy stated that criteria should be kept simple because it will be a public process without compromising research conducted. Reed stated that they need to tell the public "why" – what are you trying to achieve with a research area – that is, to better understand effects of human use on the area. In order to sell this to the public, you need a clear statement of purpose. Steve G responded that given certain research questions, minimizing displacement may not answer them. Russell stated that most fishermen do not care about details but are concerned about whether this is one step towards closing GR as a marine protected area. He also emphasized the importance of a clear and understandable statement of purpose. Discussion continued regarding ledge height and habitat types. Greg stated that ledge

height does not specify preferred or particular habitat; some ledges are undercut, which are important habitats for those larger fish.

Paul then asked about the next data caveat, i.e. bias of boat data sightings. Russell Kent stated that he did not feel that the boat data was representative/relevant for the research questions being asked. He noted that bottom fishing will occur from December to April – 90% of people are going out to catch black sea bass, others are red snapper and grouper. He added that most people do not know where to go to fish; they pull maps off internet and look for high relief. Without using boat data, most people will be in two particular places to fish for black bass. Lad asked George about tag returns. Russell asked the reasons for minimizing displacement: for an easier sell to the public. The boat data may be skewing the optimal place for a research area, so he suggested asking the public where they think it should be placed. Joe noted that the purpose for including boat data was to show the public that displacement was considered. Russell responded that they should mention that boat data was considered but the group did not feel that it was relevant as criteria for establishing research area; thus, they decided to ask the public for input on location/placement. Russell added that as long as fishermen see other areas with the basic criteria for them to fish, they will be able to live with establishment of research area especially if they have input in determining its location.

Caveats:

- Do not use boat data in model
    - Show boat data and allow public process to evaluate displacement
- Existing boat data not as representative of priority questions
    - Perhaps compare "trolling" to other "fishing" data sets
- Use boat data "after the fact" during public process once site selection is proposed / alternatives

Next, Paul asked about the third data caveat: prior research sites. Brian suggested using prior research sites *after* model runs based on habitat data – maybe bring sites in as post facto research. Reed noted that in areas where traps have been dropped regularly, there is a good notion of abundance of black sea bass there that could be valuable for determining research area. Discussion ensued about using prior research data / sites to determine research area. Steve G noted that discussion should consider two sites: one for research and one for reference. Leslie stated that including prior research is important for inclusion of baseline data. Steve G added that prior research needs to be specified and weighted for relevance.

Caveats:

- Do not use prior research sites as part of initial model runs, but look at sites that would be incorporated in a research area determined by habitat
    - MARMAP, REEF, L-T Site, GRNMS '04, Hyland
    - Requires analysis / examination of existing data
    - *Action:* Identify other data sets specific to priority questions

- In versus out of research area

Alternative:
- Select sites based on habitat alone, then establish monitoring (e.g. 2-3 yrs) to build more baseline data specific to priority questions
    - Especially high relief sites

Reed asked if baseline data should be collected before controls are implemented since there is limited prior research / baseline data. Brian noted that one time sampling events are better than none. He also stated that data should be examined based on relevance to research questions. Greg added that habitat should be considered before considering prior research sites; e.g. draw a box based on habitat and use prior research sites that are included in this box. Russell stated that he likes that approach better: determine the research area box based on habitat, look at prior research that has been conducted in that box, then utilize relevant research for the model. Brian suggested comparing optimal research areas that are determined by considering 1. habitat only, 2. both habitat and prior research, and 3. habitat, prior research, and boat counts.

Paul then directed the discussion to review other variables that needed to be refined.

Lunch
Reconvene

Discussion reconvened about the size and shape of the research area. Joe Kimmel asked Tim (DNR) about the enforceability of different sizes and shapes. Tim stated that a square or rectangle is easier to enforce, as long as it is clearly marked with line-of-sight buoys. In regards to edge effect, Jim Sullivan commented that placement of the research area should consider how close ledges are to the borders of the area. Greg noted that for relatively mobile species, a square is preferred. Steve G agreed that science would be best served by a square and research area may include a buffer area. Russell emphasized that the bottom line to fishermen is the area that will be closed off. John D stated that fishermen will prefer the smallest size possible; he asked how effectively research questions can be answered in various sized boxes. Greg responded that matrix five should address that issue. Matt stated that a square maximizes core area, can be marked on four corners, and can be marked on lat/long coordinates. The option to rotate the square on its axis was proposed, to which George S responded that he believes recreational fishermen would prefer boundaries be parallel to lats and longs. Tim also reminded the group that buoys move and disappear. Greg suggested marking more than four corner buoys.

Other Variables:

Shape:
- Square or rectangle for enforcement purposes
    - Is there a minimum size to be enforceable
- How close is ledge to edge of research area

- Hold open possibility of rotating square 45* on axis for those chosen as possible research areas to address displacement, edge effect, etc.
- Try to align with lat / long coordinates

Russell (who had to leave the meeting) commented that he feels a research area should go forward. He likes the analyses that have been done, and he appreciates the consideration of boat displacement.

Statistical Consideration of Power, Size, and Placement Parameters
Steve Smith (RSMAS) joined the meeting via conference phone. He commented on the issue of stratification for reef fish in the sanctuary: bottom substrate type (4 types). He noted that the goal is to analyze what is going on with various species in the sanctuary, not necessarily to impose a treatment to a plot. The group should focus in on types of habitats and their proportions within the sanctuary that could be set aside for research. He also commented that the area needs to be large enough to randomize and to select a good number of samples. The group also needs to consider fishing pressure and edge effect. Steve S agreed that a square is optimal for enforcement and for minimizing edge effect. In response to Greg's question, Steve S provided guidelines for a minimum size of research area that enables random sampling/stratification. He stated that a 4x4 would be the largest to consider. He suggested a possible minimum of 20% of each habitat type. Steve S also noted that minimizing displacement does not allow accurate studies of fishing effects, i.e. you should have some representative habitat that are intensely fished and have some habitat that are not as fished. He stated that pilot sampling data needs to be analyzed to give a better idea of placement and how many samples should be required in area. Greg inquired about a reference area, to which Steve responded that random sampling outside of the research area would be okay: i.e. sample GR as a whole outside of the research area. Steve G asked if a fishing area in addition to a non-fishing area with relatively equal habitat would be a more appropriate design. Steve S stated that finding a replica of habitat would be very difficult and that the sampling would even out in the research design that he suggested because the outside sampling would occur in a larger area than that in the research area; he said that they can do local type habitat specific analysis. In response to a question from John D, Steve S stated that baseline data must be required before a research area is implemented; he felt that gathering baseline data during the interim process is essential. A sonic tagging study of grouper may be conducted at GRNMS, according to Greg. Steve S responded that such a study definitely should be conducted. In response to a question regarding amount of each habitat type being studied, he recommended at least 20% of each type but that looking at it from a perspective of home range is ideal.

Statistical Considerations:

- Research area as large as possible
    - Optimal size = 2.5x home range
- Minimum # sites: Use pilot data sets to determine min # sites fro preset detection limit
- Reference area

    - Not defined
    - More sampling outside of research area
- Baseline data required before treatment
    - Data from other locations is transferable

Steve G and George S disagreed with the arbitrary number of 20% as criteria for placement because it has no scientific basis. Several participants liked the notion of looking at home or core range. Lad asked if there is a way to look at how close to the edge key components of analysis are, i.e. specify how far from boundary. In response to a question from Reed, George S stated that a sense of black sea bass home range may be determined from MARMAP data; he noted that the data needs to be analyzed further. Matt asked if discussion should focus on one particular species. Jim Siler inquired about Steve S' comments regarding the issue of prior research.

Matrix 5 – Analysis of Research Area Size Options
Greg described the fifth matrix. Discussion ensued about matrix categories and analysis. Based on Steve S' recommendations, the group agreed to remove research size categories of multiple research areas ("replicates") as well as the "irregular polygon." The group also agreed to add the category of diamond shape (i.e. rotated square) based on previous discussion. Reed noted that this matrix does not address what sizes adequately capture home range. Jim Sullivan pointed out the range of percent of highest ledge habitat captured by the various size options in Matt Kendall's draft analysis. Joe Kimmel suggested that 2x2 be the minimum size considered to answer proposed research questions and to incorporate habitat and species. Leslie suggesting adding the category of public acceptance; however, participants felt that "public" incorporated too many user groups with varying opinions. Participants then discussed pros and cons of a 1x1 km research area. John D stated that a 2x2 will incorporate a lot of hard bottom while allowing sufficient reference area outside of research area. He also felt that only a small part of the reef is heavily bottom-fished. <Refer to matrix for discussion of research area size pros and cons.> Reed asked if reference sampling could occur outside of GR boundaries; George S stated that the research area could be used to compare to other areas in the region. Participants felt that the concept becomes too complicated when sampling outside of the boundaries. Discussion continued in order to fill in the matrix. Reed suggested eliminating discussion about rectangle or diamond shapes, since they can be addressed later on; participants agreed.

Paul then directed participants to score each intersect based on pros and cons.

Recommendation to SAC
Reed identified next steps in the process. Paul asked participants for input regarding recommendations to the Advisory Council.

John Duran suggested that the recommendation state that the working group "recommends a research area to address priority questions developed in previous matrices." Steve G added "with regard to fishing impacts on benthic communities and demersal fish assemblages." John D emphasized that evaluation and monitoring of a

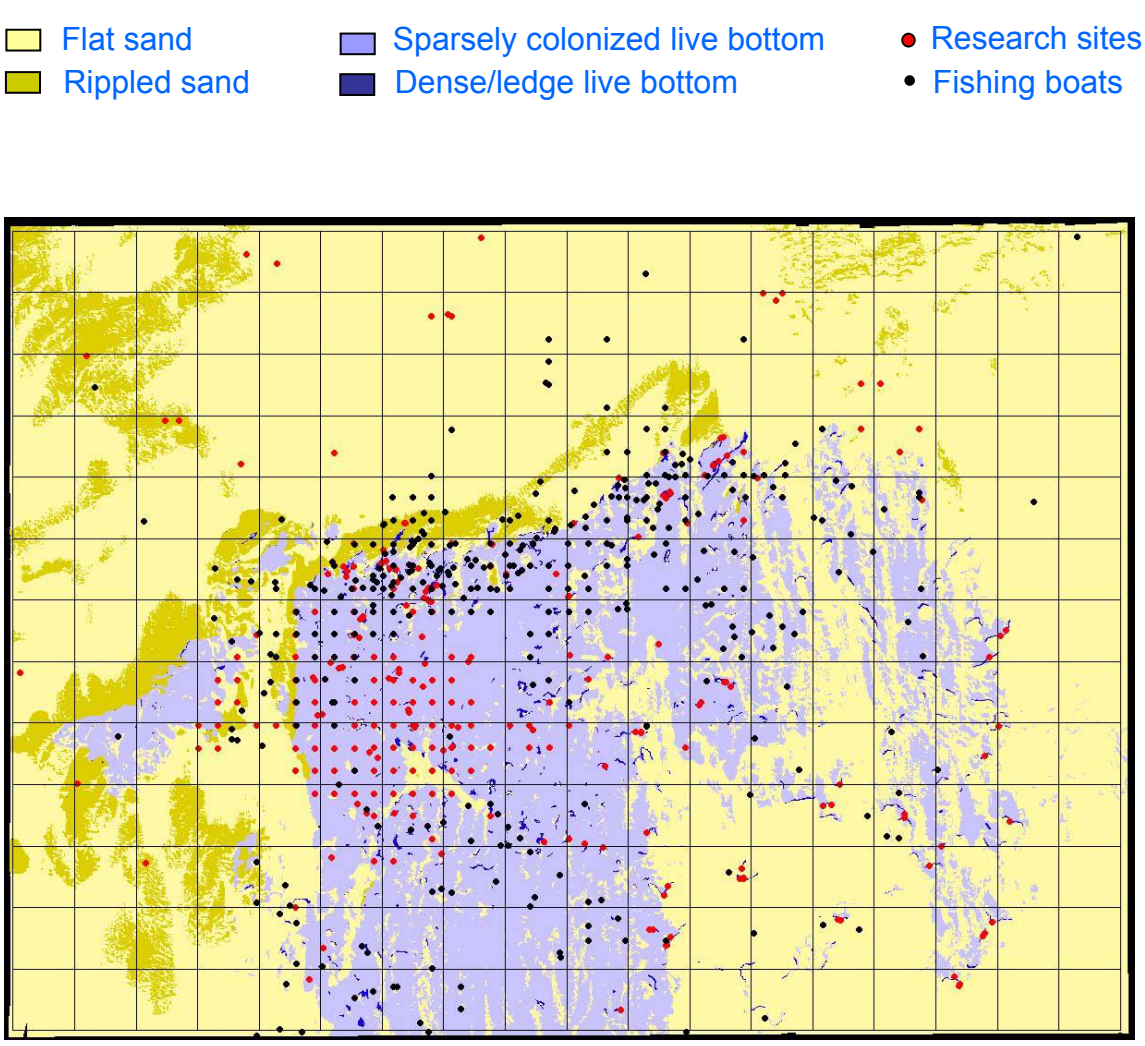
research area needs to be an important part of this recommendation. The group prefers a min. 2x2 km research area based on ease of enforcement, scientific control, and statistical power (pending model refinement and data on home range of target species); Joe Kimmel noted that this is an important sell for public. The group agreed that the model focus on a research area that is selected based on target habitats and using secondary data layers for prior research; seek input regarding fishing activities / resource information. Brian added that the recommendation should indicate a broader applicability to entire region. It should also reference the NEPA process / public involvement. The group added to the recommendation that there will be an evaluation process if a research area is created. Joe also stated that the recommendation needs to mention using the remainder of sanctuary as a reference area / control, i.e. supplemented by adequate sampling throughout sanctuary as reference.

Joe moved to further this recommendation to the SAC. All participants were in favor of the recommendation.

Reed thanked meeting participants for their time and input. He stated that the working group process and its outcomes will have great applications to the region and to other marine sanctuaries. Greg reiterated Reed's sentiments and thanked participants for their involvement. Greg also thanked Paul for facilitating the working group meetings. He thanked Jim, Becky, and April for their work behind the scenes. Joe thanked Matt for his analyses and presentation. Lastly, Greg thanked Joe Kimmel for chairing the working group meetings.

Adjourn

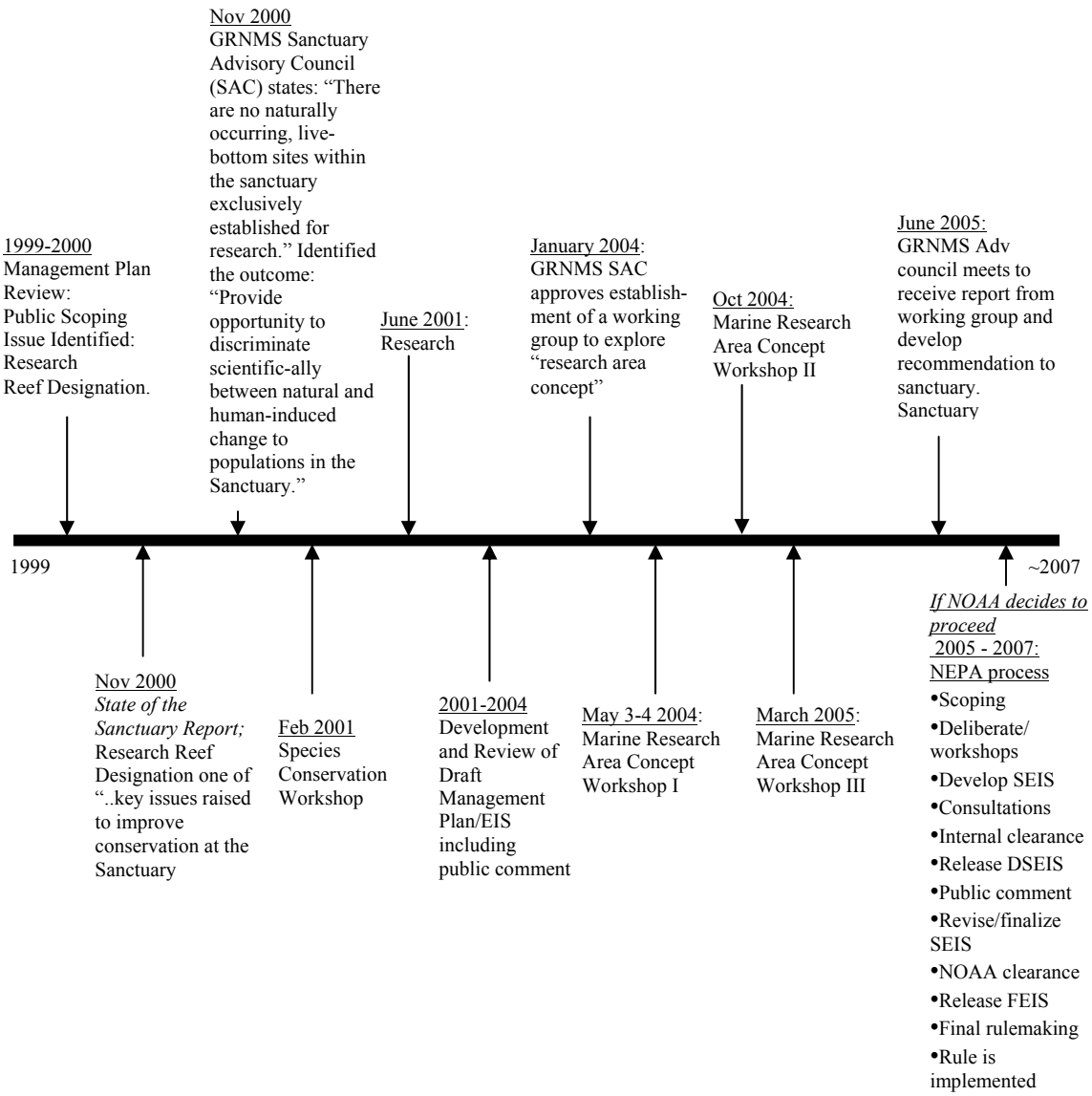
Diagram H.1: Research Area Siting Criteria Map



APPENDIX I

- Gray's Reef Research Area Concept Timeline

Gray's Reef Research Area Concept Timeline



APPENDIX J

- Gray's Reef National Marine Sanctuary Draft Management Plan/Draft Environmental Impact Statement, Strategy RM-2

STRATEGY RM-2:
INVESTIGATE DESIGNATION OF A MARINE RESEARCH AREA

BACKGROUND

During the initial scoping phase of management plan review, a number of comments suggested that NOAA staff consider designating a research area within the Sanctuary. This recommendation is considered separate and distinct from the comments submitted advocating marine reserve status for the Sanctuary referred to on page 64 of this document. The marine reserve recommendation was put forward primarily to address fisheries sustainability. The marine research area concept has been proposed to improve the value of the Sanctuary for scientific research purposes, as a control site. There are currently no natural live bottom areas in the SAB that have been set aside for use as a scientific control area. However, further south in the Florida Keys National Marine Sanctuary, 24 areas have been designated as Sanctuary Preservation Areas, Special Use Areas, or Ecological Reserves, which restrict activity to non-extractive uses. These areas have shown tremendous value as control sites to monitor a variety of parameters such as reef fish populations and diversity, habitat productivity, and socioeconomic impacts (U.S. Department of Commerce, Florida Keys National Marine Sanctuary).

An area that is available primarily for research in the Sanctuary will provide scientists with a control area useful for the comparison of natural processes with human-induced change at GRNMS. Some scientists have suggested that even a small portion of the 11,000-acre Sanctuary delineated as a research area will be very useful to the science community to learn about living resource population changes compared with similar sites in the Sanctuary. Opinions on the appropriate size of a research area vary greatly. Many scientists, however, agree that without having an area of the naturally occurring live bottom feature devoted to research, it becomes very difficult to scientifically contrast community structure between natural reefs and reefs that are used frequently for recreational and commercial purposes.

After consideration of the public comments and the factors discussed above, the Advisory Council recommended that the Sanctuary establish a working group to advise the Advisory Council on the development of this concept. The working group report and the Advisory Council recommendation regarding such an area will be reviewed by NOAA to determine whether to proceed with the concept. If a decision were made to develop the concept, a separate public review process will be initiated. The review and assessment will be conducted as a supplemental environmental impact statement under the provisions of NEPA and the NMSP, which will be separate and distinct from this management plan review. The new plan addressing a marine research area would be developed in close coordination with the SAFMC and GADNR.

ACTIVITIES

The following are activities proposed by GRNMS to investigate designation of a marine research area.

Activity A: Direct a working group established by the Advisory Council to study a marine research area concept. The working group will be conducting its study in year one and will be comprised of experts in the field of marine research areas as well as

representatives of the fishing and diving communities, and local, regional, private, state, and federal organizations. The working group will study the feasibility of establishing a GRNMS research area, evaluating options for size of the area and appropriate use restrictions needed to ensure it provides a proper scientific control. The working group will report to the Advisory Council, which will make its recommendation to the Sanctuary Manager. If NOAA decides to propose a marine research area, the proposal will be developed through a supplemental environmental impact statement that includes scoping meetings, public hearings, and extensive coordination with the Advisory Council, governmental agencies, and the public.