

# Gray's Reef National Marine Sanctuary Advisory Council – Science Advisory Group Meeting



GRAY'S REEF NATIONAL MARINE SANCTUARY  
ADVISORY COUNCIL  
SCIENCE ADVISORY GROUP MEETING – FEBRUARY 26, 2014

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## **ACKNOWLEDGEMENTS**

The caliber of scientists that have supported research and monitoring for Gray's Reef National Marine Sanctuary is extraordinary. Because of their efforts and support throughout the 2013 field season despite continuing lean budgets, we would like to thank Peter Auster, Samantha Bruce, Risa Cohen, Cindy Cooksey, Jeff Hyland, Danny Gleason, Chris Freeman, Mike Judge, Laura Kracker, Kenan Matterson, and Roldan Munoz; along with a fabulous array of students, technicians and dive support personnel including Brian Degan, Jeff Godfrey, Dave Grenda, Heather Kelley, Debbie Meeks, Brittany Poirson, Alicia Reigel, and Jenny Vander Pluym. These partnerships are among the sanctuary's greatest assets.

The ability to leverage research from the sanctuary's small boats is a tremendous benefit, not only for the site but for the researchers who are supported from them. Without the tireless marine operations and diving efforts of Gray's Reef Captain Todd Recicar, LTJG Chris Briand and multi-tasking Team Ocean volunteers Randy Rudd and Jeff Hart, we could never accomplish the amazing amount of work that takes place.

## WELCOME, INTRODUCTIONS AND MEETING OBJECTIVES

Gray's Reef National Marine Sanctuary (GRNMS) Acting Superintendent George Sedberry and Science Advisory Group Chair Peter Auster welcomed everyone to the annual meeting. They emphasized the desire to keep the information flowing comfortably and allow opportunities to ask and respond to questions.

At that time, Acting Deputy Superintendent and Acting Science Coordinator Sarah Fangman explained that the primary objectives of the meeting: to review the scientific data collected at GRNMS in 2013 and to compare it to data collected since 2011. This announcement was followed by introductions around the room. Many of the participants were involved in the establishment of the Research Area. Part of that process was to create the Science Advisory Group to provide oversight for pertinent research development and coordination with a planned full report out in 2016. The main findings and resolutions from this meeting were to be communicated to the Sanctuary Advisory Council on the following day.

A significant portion of research area field work is conducted during the annual GRNMS research cruise aboard the NOAA Ship *Nancy Foster*. The 2013 data collection efforts aboard NOAA Ship *Nancy Foster* were interrupted by Tropical Storm Andrea. The storm caused cessation of operations while the storm passed through the sanctuary. Once back on site, research was hampered by high sea states and poor visibility. Researchers and Team Ocean Volunteers continued to collect many types of data despite the weather. Fisheries acoustics surveys were conducted even when dive operations were halted, thereby collecting valuable fish biomass data that would later be compared with visual census surveys. Lionfish surveys were conducted and resulted in multiple removals of the invasive species. Photographic and video documentation of benthic habitats and sea turtles were taken for further analysis. Education and outreach materials were produced while at sea using real-time data and images.

## RESEARCH PRESENTATIONS

### GRNMS Piscivory 2013

Dr. Peter Auster, University of Connecticut Department of Marine Sciences & NURTEC, Sea Research Foundation - Mystic Aquarium.

Dr. Auster has been studying species interactions at GRNMS since 2008. He has focused efforts on describing and quantifying the behavior of demersal and mid-water piscivores. His work has resulted in multiple publications describing behavior webs of piscivores using visual census methods coupled with high-resolution sonar on live-bottom reefs. Through these research approaches, Dr. Auster has recognized consistent patterns of piscivore behavior, based on composition of mixed species groups and associations between demersal and mid-water groups. He is currently investigating how these relationships could be used to assess the status of reef fish communities and to determine the demographic consequences of such interactions.

The hardbottom reefs of Gray's Reef National Marine Sanctuary provide the unique opportunity to observe the species interactions readily, a characteristic not common at reef systems in other regions. With the ability to observe species interactions in the absence of fishing pressures, Dr. Auster has been comparing predation events inside the Research Area to sites outside the RA within GRNMS since 2011. The very first year of the management designation provided cooperative weather: calm seas, continuous operational days, good visibility—which all resulted in a large sample size. The following year, 2012, surveys were not conducted due to unresolved issues about dive reciprocity between AAUS and NOAA. Unfortunately, the 2013 research cruise was impacted by Tropical Storm Andrea which produced rough seas and low visibility resulting in a low sample size.

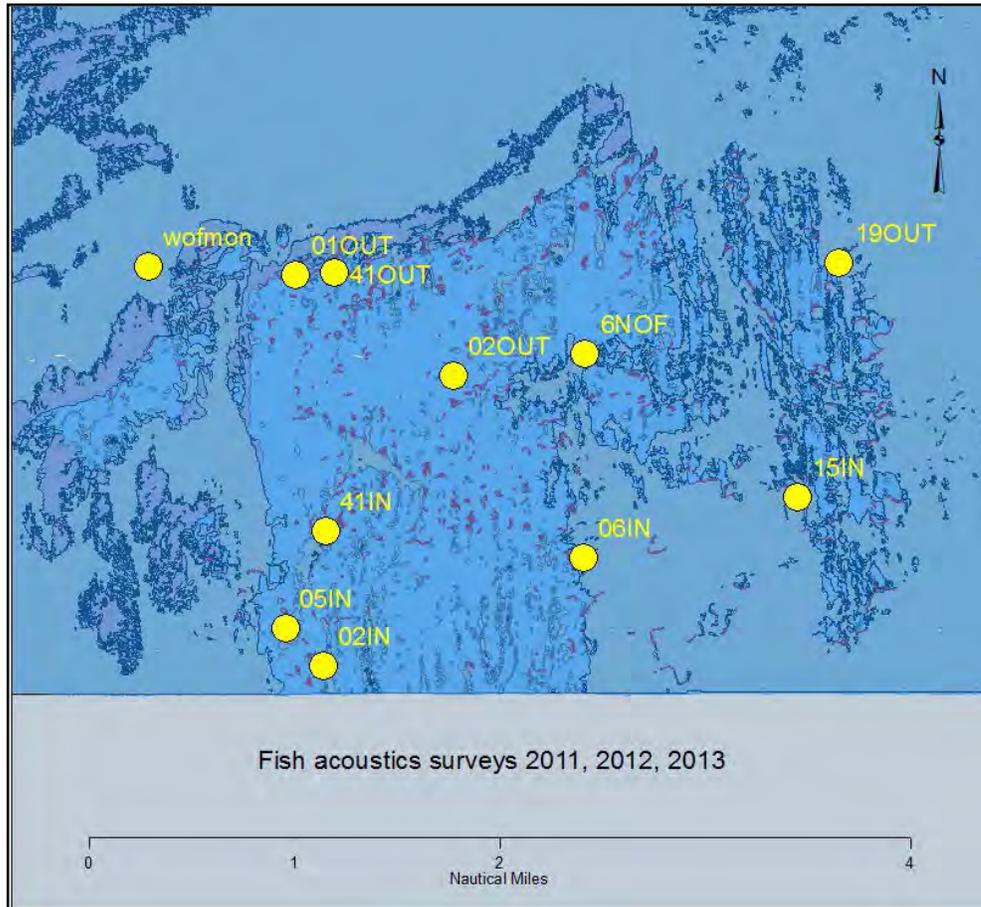
The 2013 sampling efforts yielded 44 predation events, 20 of which were mixed species (15 inside, 5 outside) with 14 species observed overall. Comparisons between 2011 and 2013 data are difficult with such a difference in samples size (2011: 161 events vs. 2013: 44 events). Some observations from the 2013 data are: 1) fewer mixed species groups of predators, reduced Young-of-year (YOY) great barracuda (*Sphyraena barracuda*), and reduced numbers of high density prey patches. There were almost no scamp or gag grouper sighted.

Using geo-referenced hydroacoustic data collected at select study reefs across all three years, Drs. Auster and Laura Kracker plan to assess changes in patterns of prey patchiness using moving split-window analysis. Initial data exploration suggests changes due to time of day and reef location. It is possible tide and light availability had effects on dawn and dusk differences identified by the sampling.

### Hydroacoustic Fisheries Surveys at GRNMS 2011-13 and Beyond

Dr. Laura Kracker, NOAA's National Centers of Coastal Ocean Science, CCMA-Biogeography

Fisheries acoustic surveys have been conducted inside and outside the Research Area (Figure 1) during dawn and dusk hours in conjunction with Dr. Auster's fish behavior dives in 2011 (N=7), 2012 (N=8), and 2013 (N=7). Data was collected along transects 50 m apart with resulting data summarized as fish density per 100 m<sup>2</sup>.

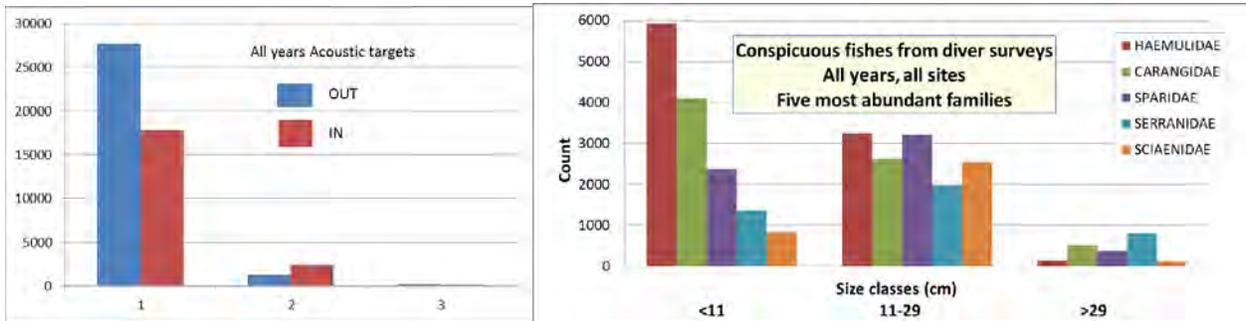


**Figure 1. Sites sampled by acoustic surveys over a three year period, three of which were sampled all years. Sites designated OUT are located outside the Research Area, conversely, those designated as IN are inside the Research Area.**

Ecologically relevant size classes identified by acoustic surveys fall into three bins: <11 cm (small), 11-29 cm (medium), and >29 cm (large). After three years of consistent data collection, pairing acoustic data with fish identified through dive surveys by Muñoz, Buckel, and Auster is used to identify fish species within the acoustic size bins, which is not possible from the sonar signal alone.

The five most abundant families recorded from dive surveys inside and outside the RA for all three years include: Haemulidae (grunts), Carangidae (jacks), Sparidae (porgies), Serranidae (sea basses and groupers), and Sciaenidae (drums).

Acoustic data from 2011 and 2012 suggest that there are more small (<11 cm) fish outside the RA than inside (Figure 2 left). In addition, more medium size fish were detected inside the RA (11-29 cm). Species can only be inferred from diver data (Figure 2 right) collected at the same sites as the acoustic surveys.



**Figure 2.** Results of acoustic data for 2011 and 2012 for size classes found inside (IN) and outside (OUT) the Research Area (left). The top five families of conspicuous fishes documented by diver surveys over all three years, all sites, pooled are shown in the panel on the right.

## Assessment of Sessile Benthic Invertebrates Inside and Outside the GRNMS Research Area

Dr. Daniel F. Gleason, Georgia Southern University, Department of Biology

The objective of this research is to assess how benthic invertebrate populations change over time inside and outside the GRNMS Research Area. Foundation species play a disproportionate role in determining the final structure of a community; for GRNMS the cover of benthic invertebrates fill that role on the live hardbottom habitats of the sanctuary (ledges, mixed HB/S, pavement, outcroppings).

Work characterizing benthic invertebrate communities in GRNMS was initiated in 2011 and consisted of pairing photo quadrats that were later analyzed topside with *in situ* visual quadrat methods to estimate benthic cover and identify organisms to the lowest taxa possible. A similar sampling protocol was followed in 2012. A statistical comparison of photo and *in situ* quadrats showed that *in situ* methods were preferable, resulting in the use of only *in situ* visual census methods in the 2013 sampling.

Statistical analyses were only run on quadrat data from 2011 and 2013 because tropical storm Beryl prevented adequate sample sizes from being obtained in 2012. Results show no significant differences in species richness, diversity, or total percent cover of invertebrates for sites inside the RA when compared with those outside in both 2011 and 2013 (Figure 3). There were also no major shifts in composition over the three years for the most dominant invertebrate phyla found on the reefs (sponges, tunicates, cnidarians, bryozoans, and annelids; Figure 4). However, species richness and total percent cover of invertebrate groups sampled, regardless of management zone, were significantly lower in 2013 than in 2011 (Figure 4). It is hypothesized that this decrease in richness and percent cover is the result of physical disturbance, especially fall out of resuspended sediment, created by tropical storm Beryl when it passed over the region in 2013. Such a conclusion is reasonable given that longitudinal data collected for 10 years on a reef site 10 km north of GRNMS have shown a similar pattern of declines in richness and percent cover in heavy storm years.

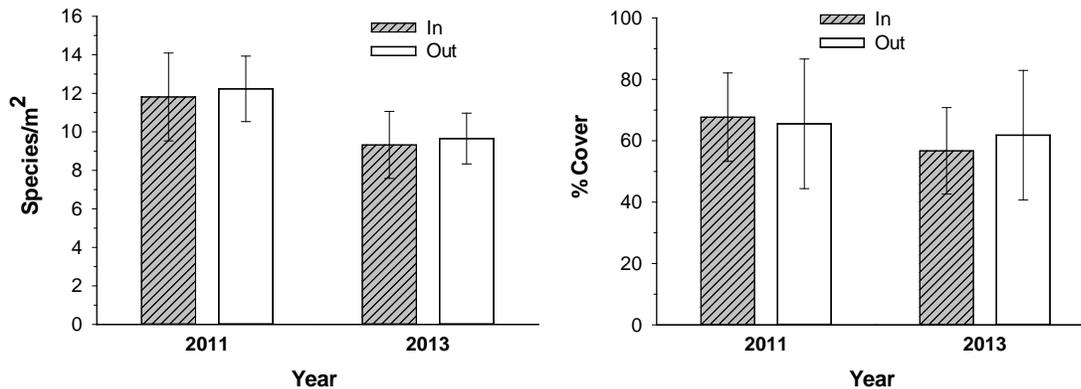
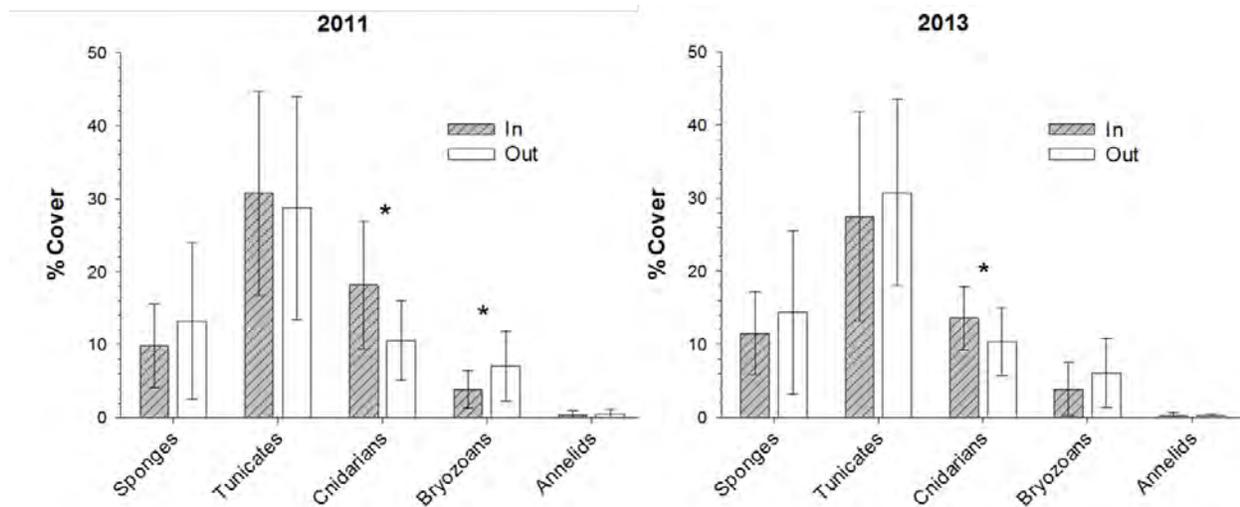


Figure 3. Species richness and total percent cover for sessile benthic invertebrates found in 0.25 m<sup>2</sup> quadrats sampled in 2011 and 2013 for sites inside (In) and outside (Out) the Research Area at GRNMS. For both variables, repeated measures ANOVA showed no significant differences in location (In versus Out), but did show significantly higher values in 2011 than 2013.



**Figure 4. Percent cover of the five most dominant invertebrate phyla found in 0.25 m<sup>2</sup> quadrats sampled in 2011 and 2013 (sponges, tunicates, cnidarians, bryozoans, and annelids) for sites inside (IN) and outside (OUT) of the RA in GRNMS.**

Repeated monitoring of the benthos is also resulting in species being added to the database of benthic invertebrates of GRNMS. In 2013, two sponge and one tunicate species fell in this category. When encountered, these specimens are photographed, collected, and preserved for eventual identification and inclusion in the GRNMS benthic invertebrate museum collection housed at Georgia Southern University.

Finally, in addition to the benthic monitoring described above, a companion project using settlement plates to investigate the effect of extant community structure on recruitment of invertebrates at GRNMS was completed in 2013. Community development was tracked for fourteen months at four rocky outcrops in GRNMS to address the predictions that (i) developing sessile invertebrate communities in this system do not exhibit a predictable pattern of succession and (ii) recolonization patterns for small patches of open space that become available are influenced by the composition of the invertebrate community in the immediate vicinity. Community development was followed for 14 months on paving tiles (30 x 30 cm) deployed in July 2012 by photographing these tiles, along with the adjacent natural community, each month through September 2013. Species composition, percent cover, and diversity were determined each month.

Sessile invertebrate taxa colonizing tiles were similar across all four sites in the first three months after deployment, but diverged over time. At all sites, developing communities exhibited lower percent cover and diversity than their adjacent existing communities over the fourteen months of the study, but analyses of similarities (ANOSIM) did provide evidence of convergence over the long term. These results indicate that succession of sessile invertebrates is not a predictable process at GRNMS and that the extant community plays a role in deciding the final outcome of species re-establishment.

**Fish and Structural Habitat Surveys from Gray's Reef National Marine Sanctuary Research and Open Management Zones, 2010-2013**

Dr. Roldan C. Muñoz (NMFS, Beaufort Lab) and Christine A. Buckel (NCCOS, Beaufort Lab)

The objective of this research was to establish baselines of benthic habitat characteristics (vertical relief of biotic and abiotic physical structure; tall ledges [ $>25$  cm] = different community of fishes than short ledges [ $\leq 25$  cm]) and conspicuous and prey fish communities (community structure, densities and size structure). These baselines could then be compared to data collected over time to determine differences between managed areas (research versus open).

Surveys in 2011 involved divers swimming 25 x 10 meter transects. However, resuming in 2012, transects were extended to 50 meters since comparisons between 2010 (50 m) and 2011 at GRNMS as well as other studies indicate that surveys that encompass a larger area are necessary to adequately sample larger, more mobile species. Every 5 meters, divers measured maximum height of algae, sessile invertebrates, ledges and ledge undercuts. As divers swam out a transect, all conspicuous fishes ( $>10$  cm) were identified and counted. Upon their return, divers noted prey species ( $<10$  cm) observed within a 25 x 2 meter transect. Fish and structural habitat surveys were also coordinated with benthic invertebrate surveys that provide higher resolution percent cover and species composition information (available in another section). Due to favorable weather, the greatest number of stations were sampled in 2011 (37 sites: 19 in Research Area, 18 outside) and 2013 (61 sites: 30 research, 31 outside), so we restricted many of our comparisons to these two years.

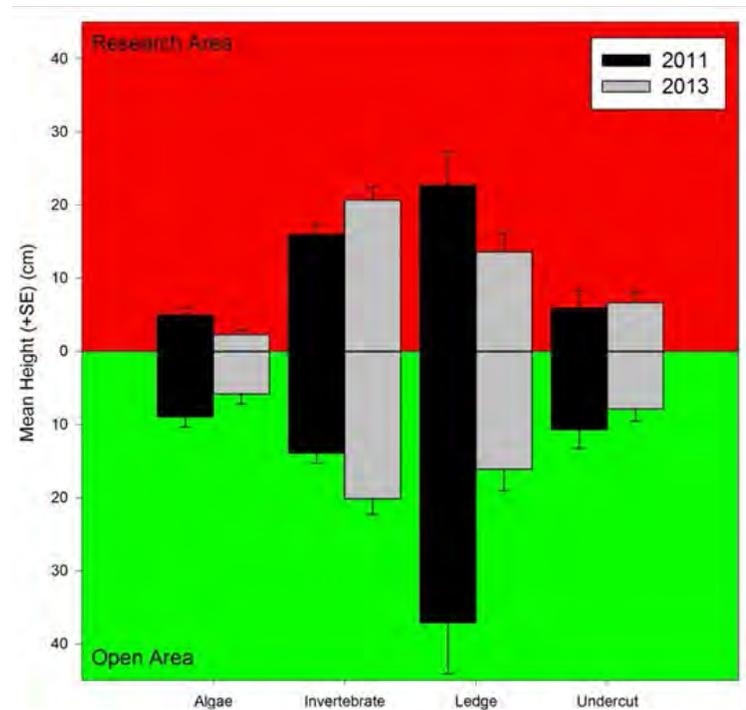
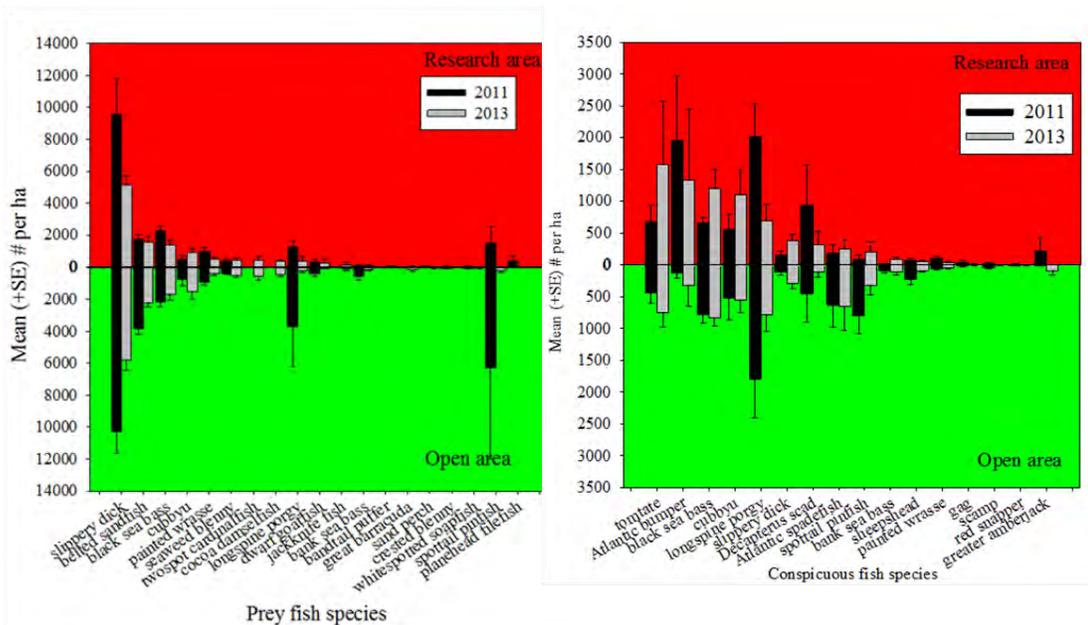


Figure 5. Mean height ( $\pm$ SE, cm) of structural components of habitat for sites located inside and outside the RA.

For benthic fishes, increased numbers of surveys since 2011 have resulted in the census of a greater number of species (total of 95 to date).

Research and open areas were generally similar in structural habitat and fish community composition, though taller algae were observed in the open area (mean  $\pm$  SE for 2011 & 2013 combined =  $3.44 \pm 0.59$  cm research,  $n=48$  vs.  $6.98 \pm 1.03$  cm open,  $n=49$ , Mann-Whitney Rank Sum test,  $T=1982.5$ ,  $P = 0.008$ , Figure 5), where ledges are taller and tall ledges are more numerous.

Community structure for both conspicuous and prey fishes did not differ by management zone, but did differ between years (permutational multiway analysis of variance, conspicuous: year pseudo-F = 4.02, P = 0.0001, pairwise test 2011 vs. 2013, t = 2.23, P = 0.0001, Figure 6.1; prey: year pseudo-F = 5.44, P = 0.0001, pairwise test 2011 vs. 2013, t = 2.75, P = 0.0001, Figure 6.2). Fish community structure differences among years reflected differences in the abundance of ubiquitous species, including conspicuous Longspine Porgy, Tomtate, and Black Sea Bass, as well as prey fishes such as juvenile Tomtate, Slippery Dick, Belted Sandfish, and juvenile Black Sea Bass.



**Figure 6.1 & 6.2. Mean density (#/ha) for prey (left) and conspicuous (right) species that are important to fish community structure by management zone and year.**

Size distributions of large snapper/grouper (Gag, Scamp, and Red Snapper) continued to generally overlap between management zones. In contrast, the size distributions of more common Black Sea Bass are in flux. Abundance of large snapper and grouper appears to have declined in both management zones from 2011 to 2013, though differences were not significant. Significantly larger fish were observed in the open area in 2011 (mean  $\pm$  SE research [n=314] vs. open [n=332],  $18.0 \pm 0.54$  vs  $19.4 \pm 0.54$  cm total length [TL], Mann-Whitney Rank Sum test, T=96399, P = 0.022), and this pattern reversed in 2013 ( $17.8 \pm 0.32$  cm TL research [n=1094] vs.  $16.6 \pm 0.33$  cm TL open [n=931], Mann-Whitney Rank Sum test, T=913973.5, P = 0.021). Over all years (2010-2013), the Belted Sandfish, a small serranid and prey species, occurred in higher abundance (Mann-Whitney Rank Sum test, T=3130.5, P = 0.001) in the open area ( $2579.89 \pm 207.77$  fish per ha, n=61) compared with the Research Area ( $1646.0 \pm 189.47$  fish per ha, n=61). Its abundance was weakly but positively correlated with the height of benthic algae (Spearman correlation, r=0.222, P = 0.01), which may provide shelter for Belted Sandfish or their prey (microcrustacea and small fishes), and perhaps improved foraging substrata for this microcarnivore.

Common species such as Black Sea Bass and Belted Sandfish may show responses to different management zones before the detection of responses is possible (due to lower statistical power) in larger, less common species such as Gag, Scamp, and Red Snapper.

**The SERFS Reef Fish Monitoring Program: an Overview**

Dr. Marcel Reichert, South Carolina Department of Natural Resources

The Marine Resources Monitoring, Assessment and Prediction Program (MARMAP)/South East Area Monitoring and Assessment Program(SEAMAP)/South East Fishery Independent Survey (SEFIS) is a collaborative fishery-independent sampling program that collects data on fish populations associated with natural live-bottom reefs from Cape Lookout North Carolina to St. Lucie Inlet, Florida. The project does not sample artificial reefs or wrecks.

MARMAP has been in place since 1972, with reef fish sampling since the late 1970's. MARMAP has used a consistent method (chevron trap) since the early 1990s. SEAMAP came into existence in 1986, with reef fish sampling since 2009. SEFIS began in 2010, and added a video survey and expanded the number of samples collected. Sampling in GRNMS began in 1993, and typically includes between 20-25 stations.

The primary tasks of these surveys are to monitor the abundance of reef fishes using various gear including traps and video, conduct life history studies, conduct research and provide data and analyses in support of stock assessments and fisheries management, and to conduct bottom habitat mapping using side scan sonar, multibeam, and video. Because the chevron trap is equipped with a digital camera and two video cameras, the survey data can be used to verify bottom types, identify trap specific behavior, investigate catchability and selectivity issues, develop indices of species with low trap catches (i.e. lionfish), and conduct community studies.

Traps are baited with clupeids and deployed for 90 minutes in water depths up to 120 meters. Traps are deployed in sets of 6 (>200 m apart). Conductivity, temperature and depth (CTD) casts are also conducted to measure temperature, salinity, etc. Once the trap is recovered, catch is deposited in bins (300-350 gallons of seawater) and vented. All individual fish are counted, measured and returned to the sanctuary alive. As a result, taking samples for life history analysis (age and reproduction) is not included in GRNMS sampling.

SEFIS was able to complete 15 valid collections (12 random and 3 non-random) in GRNMS in 2013 aboard the R/V *Savannah* at a mean depth of 18.2 m. The 2013 collections included 29 species with Whitespotted Soapfish (*Rypticus maculatus*) being caught in the sanctuary for the first time during the MARMAP/SEFIS sampling. The catch was mostly comprised of Black Sea Bass (90.1%) and *Stenotomus* sp. (4.1%) followed by Tomtate (3.9%) and Pinfish (1.1%, Table 1).

**Table 1. Species composition and abundance of 15 Chevron traps that sampled GRNMS in September 2013.**

Common Name	Scientific Name	2013 n	2013 Total W(gram)	2013 % by number	2012 % by number
Black Sea Bass	<i>Centropristis striata</i>	1856	444040	90.1%	90.9%
	<i>Stenotomus</i> sp.	84	9300	4.1%	1.2%
Tomtate	<i>Haemulon aurolineatum</i>	81	11400	3.9%	4.0%
Cubbyu	<i>Pareques umbrosus</i>	23	3240	1.1%	0.03%
Gray Triggerfish	<i>Balistes capriscus</i>	8	10180	0.4%	1.8%
	<i>Opsanus</i> sp.	3	860	0.1%	0.0%
Pinfish	<i>Lagodon rhomboides</i>	2	240	0.1%	1.9%
Pigfish	<i>Orthopristis chrysoptera</i>	2	340	0.1%	
Whitespotted Soapfish	<i>Rypticus maculatus</i>	1	80	0.05%	
Gag	<i>Mycteroperca microlepis</i>	1	800	0.05%	
Spottail Pinfish	<i>Diplodus holbrookii</i>				0.1%
Sand Perch	<i>Diplectrum formosum</i>				0.04%
Bank Sea Bass	<i>Centropristis ocyurus</i>				0.06%
n=		2061			1652

Black Sea Bass continue to be a species of interest for the entire region. The species is considered to react relatively quickly in population level metrics to management actions. Compared with the Charleston Inshore (an area sampled with equal effort) catch per unit effort (CPUE) follows similar trend lines with GRNMS. In recent years, GRNMS samples have contained greater numbers of Black Sea Bass CPUE. This past effort in 2013 showed an increase in both regions from 2012 effort, but still below the peak levels of 2011 (Figure 7).

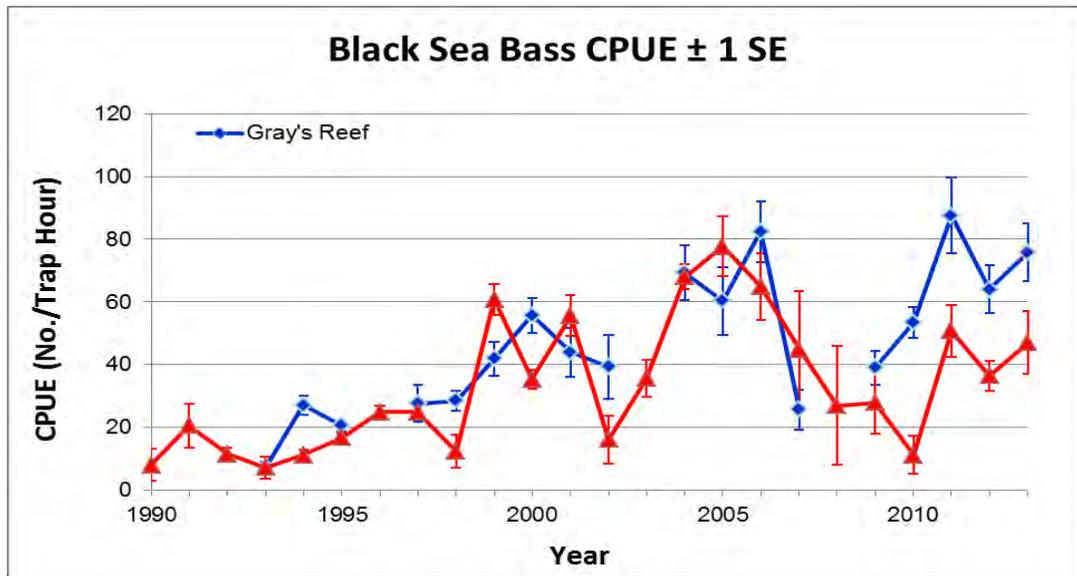


Figure 7. Mean catch per unit effort (number of fish per trap/hr  $\pm$ SE) for all traps deployed in GRNMS (blue) and Charleston Inshore (red) from 1990 to 2013.

Although trap catches of Black Sea Bass were lower inside the RA than outside, mean length was greater inside the Research Area than the rest of the sanctuary (Figure 8). The average length of Black Sea Bass has generally increased over time in both managed areas, but data from 2013 indicates a dip for both areas. This decrease in mean length could indicate overfishing inside the sanctuary and surrounding areas.

Catch rates for the other major components of trap samples, *Stenotomus* sp. and Tomate; do not follow the same trend as Black Sea Bass. *Stenotomus* sp. showed a slight increase but still far below catch rates from five years ago. Tomtate catch dropped from 2012, but the difference was not significant.

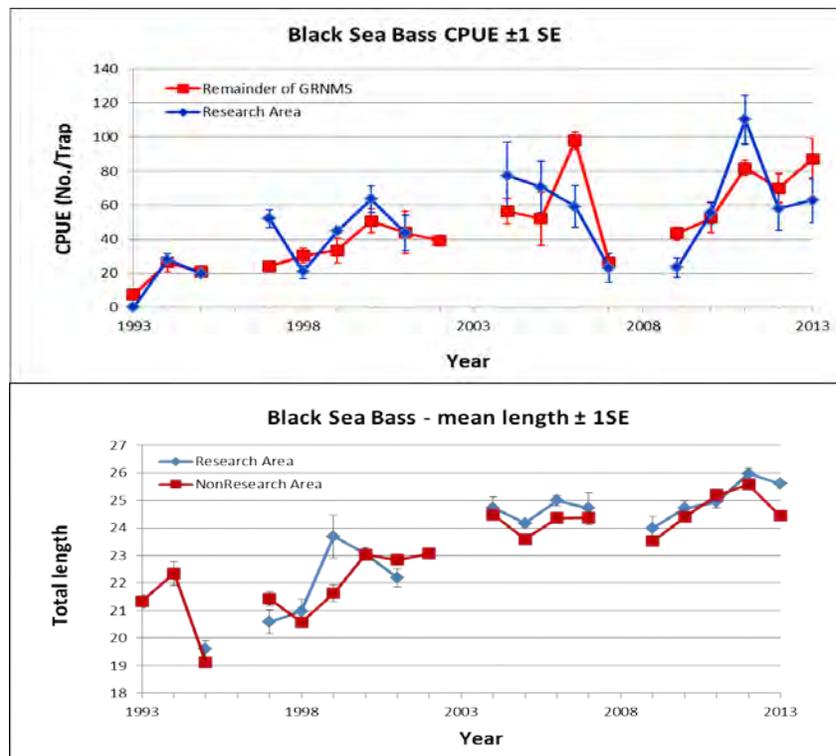


Figure 8. Top: Black Sea Bass CPUE ( $\pm$ SE) by year for the Research Area and rest of the sanctuary. Bottom: Black Sea Bass mean length ( $\pm$ SE) by year for the Research Area and rest of the sanctuary.

Environmental conditions within the sanctuary may influence the sampling efforts. Bottom temperatures are thought to dictate what species are caught in the traps causing a possible bias in the data. Temperature is extremely important in structuring fish communities and this should be considered when using the catch data.

MARMAP hopes to continue routine monitoring of GRNMS in the future, contingent on funding. Ideally, the number of sampling stations could be increased in both the fished and non-fished areas. Continued coordination with other users is critical to ensure that sampling does not impact other Research Area monitoring efforts. In addition analysis of trends in species composition, CPUE, and mean length will also continue. Effects of the Research Area on CPUE and other trends will continue to be assessed. Results from GRNMS will be compared with other areas and data will be analyzed to examine the effects of the closed area on CPUE and other trends. There is a possibility of incorporating tagging studies to investigate population sizes within the sanctuary.

### Long-term Monitoring of Ecological Condition at Gray's Reef National Marine Sanctuary

Dr. Jeff Hyland, Cynthia Cooksey, Dr. Mike Fulton, NCCOS-Charleston, SC

The Center for Coastal Environmental Health and Biomolecular Research in Charleston SC, part of NOS's National Centers for Coastal Ocean Science, has been working with the sanctuary since 2000 in efforts to assess the status of ecological condition and stressor impacts throughout its boundaries and surrounding shelf area, with a major focus on the soft-bottom benthos and sediment quality. This ongoing work, which incorporates a probabilistic sampling design and multiple indicators of ecological condition (Figure 9, Table 2), provides periodic assessments of the status of condition and a quantitative basis for tracking potential changes in these properties through time due to either natural or human events. The most recent sampling, conducted in summer 2012-2013 at 20 random stations, is a follow-up to previous surveys conducted in 2000 and 2005 using common indicators and sampling protocols.

Results of the first two surveys (Hyland et al. 2001, 2006; Cooksey et al. 2004, Balthis et al. 2007) suggest that the sanctuary is in "good health" with respect to the various measured indicators. Sediments have been relatively clean with respect to chemical contaminants, with levels falling well below probable bioeffect guidelines for benthic organisms. Contaminants in tissues of the arc shell *Arca zebra* and Black Sea Bass *Centropristis striata* also have been at relatively low levels below human-health guidelines. However, trace concentrations of pesticides, PCBs, and PAHs have been detected in both sediments and biota (albeit at low concentrations) demonstrating that chemicals originating from human activities are capable of reaching the offshore sanctuary environment, either by atmospheric fallout or cross-shelf transport from land. Moreover, results thus far have shown that the sandy substrates that comprise the majority of the sanctuary's seascape support a highly diverse and abundant benthic infaunal community. Mean number of taxa/grab (0.04 m<sup>2</sup>, 0.5 mm sieve) was consistently high in both sampling efforts thus far, 45 in 2000 and 47 in 2005, which is typically twice the number found in nearby estuaries of comparable salinity. A total of 588 taxa (371 identified to species) have been found at GRNMS since the spring 2000 baseline survey, with new taxa being added with each new sampling effort. Species accumulation curves based on these data predict a theoretical total in excess of 600 species (Balthis et al. 2007).

Table 2. Parameters measured by probabilistic sampling in 2000, 2005, and 2012-13 at 20 random stations in GRNMS.

Indicator	Factors measured
Habitat conditions	Water: depth, temperature, salinity, pH, DO, turbidity Sediment: TOC, grain size
Stressor levels	Contaminants: metals, pesticides, PCBs, PAHs Other: High sediment TOC, low DO
Sediment Toxicity	Microtox
Macro-infauna	Diversity and abundance
Aesthetic quality	Anthropogenic debris, visible oil sheens, noxious sediment odor, water clarity/turbidity
Organismal Tissue Contaminants	Target benthic/demersal species (arc shells & Black Sea Bass at selected stations): metals, pesticides, PCBs, PAHs

In July 2012, the third benthic survey was initiated at GRNMS to generate additional data points for the long-term monitoring record, as a basis for tracking status and trends in sanctuary conditions and providing support to important management products such as the GRNMS management plan (NOAA 2006) and the GRNMS Condition Reports (Office of National Marine Sanctuaries 2008, 2012). As in prior efforts, the sampling design consisted of synoptic sampling of multiple ecological indicators at 20 sites using a probabilistic sampling frame. While sampling in 2012 was completed at 11 of the 20 sites, the cruise was cut short due to engine failures on the research vessel (i.e. the R/V Joe

Ferguson). Sampling at the remaining nine stations was completed in June 2013 on Leg 1 of the Gray's Reef 2013 Expedition on the NOAA Ship Nancy Foster. In the end, all 20 sites were sampled for all targeted sediment and water-quality indicators. In addition, a total of 20 tissue samples were collected for analysis of chemical contaminants from 13 of the 20 sites, including 10 arc-shell samples (one from each of the 10 sites where mussels were collected) and 10 sea bass samples (two replicates from each of the five sites where fish were collected). Resulting data from this latest 2012/13 study will be compared to earlier data from 2000 and 2005 to look for trends in the measured variables and any evidence of changes in the quality of the sanctuary condition including potential signals of anthropogenic stress. A final report is scheduled for completion in FY15. The information should help fulfill important science and management goals of the sanctuary including providing valuable support to future management plans and condition reports.

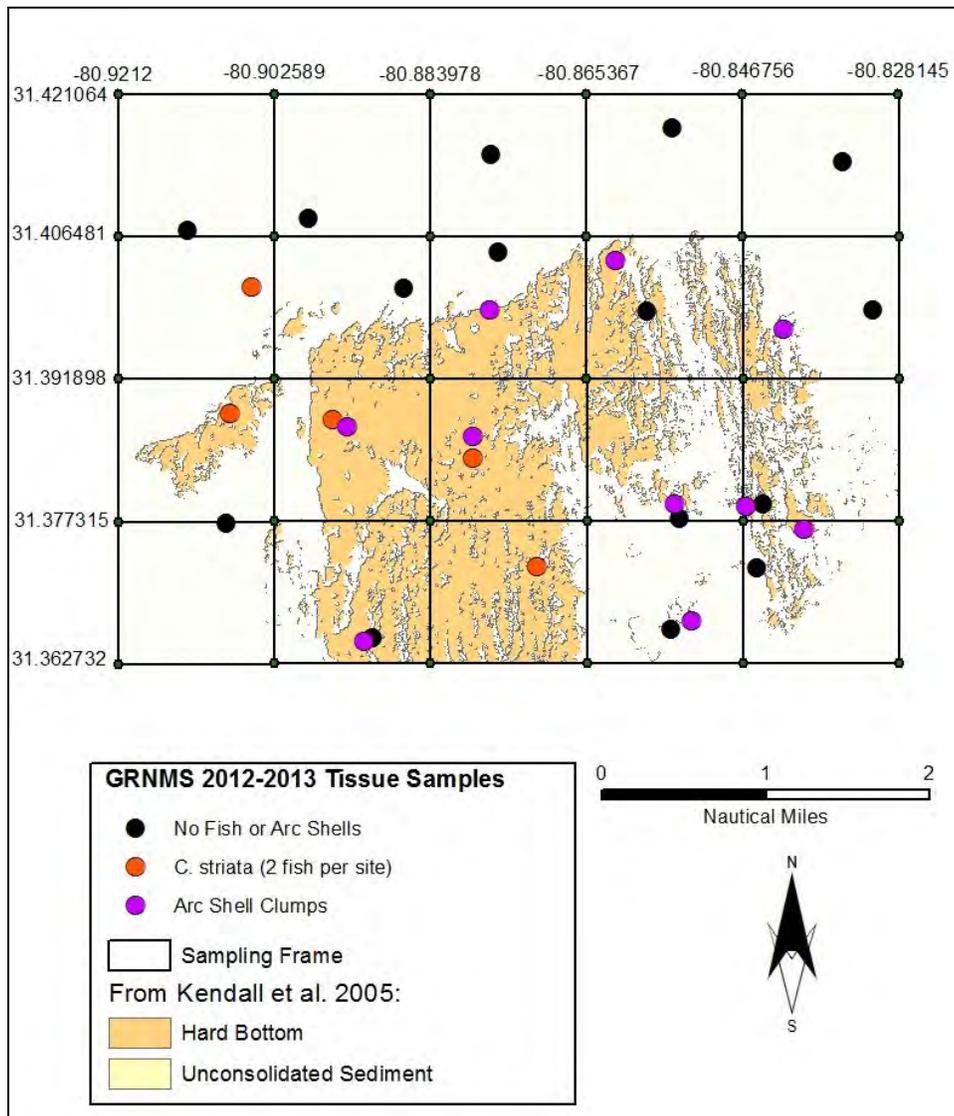


Figure 9. Map of 20 randomly selected sites (black and red dots) sampled in 2012-13 within GRNMS. All sites were sampled for sediment and water quality indicators and 13 were also sampled for contaminants in arc shells and Black Sea Bass. Purple dots represent adjacent hard-bottom substrates where arc shells were collected.

### Carbon Dioxide (CO<sub>2</sub>) and Water Quality Monitoring at Gray's Reef National Marine Sanctuary

*Dr. Scott Noakes, University of Georgia (presentation of these results were given by Dr. George Sedberry as Dr. Noakes was unable to attend the meeting)*

In January 2013, NOAA's National Data Buoy Center (NDBC) and the United States Coast Guard replaced the Gray's Reef data buoy. This buoy deployment offered an excellent opportunity for NOAA's Pacific Marine Environmental Laboratory (PMEL) and the University of Georgia (UGA) to service CO<sub>2</sub> (measuring air-sea interface) and water quality (temperature, dissolved oxygen, salinity, chlorophyll, turbidity, and pH) sensors also installed on the Gray's Reef data buoy. These sensors are part of an international CO<sub>2</sub> monitoring program coordinated by PMEL. UGA researchers also monitor CO<sub>2</sub> and water quality at the sediment-water interface where the Gray's Reef benthic community thrives. With the resulting long-term trends in surface and seafloor CO<sub>2</sub>, scientists hope to better understand ocean acidification and the effect it may have on the Gray's Reef community.

Gray's Reef sits in a very unique and dynamic region along the divide between the inner and middle shelf with water depths in the 65 foot range. The water at the sanctuary is primarily controlled by the middle shelf oceanic dynamics, but during heavy rain events, it can be affected by freshwater plumes coming from numerous rivers along the coast. Temperature plays a major role in CO<sub>2</sub> variability with seasonal changes being apparent. During the winter months, more of the seawater CO<sub>2</sub> is dissolved into various carbon species decreasing CO<sub>2</sub> concentrations to levels below the atmospheric concentrations making the Grays Reef area a net CO<sub>2</sub> sink. During summer months when the water warms up, the dissolved carbon is converted back to CO<sub>2</sub> to levels above that found in the atmosphere making it a CO<sub>2</sub> source.

To date, seven and a half years of CO<sub>2</sub> data have been collected at Gray's Reef (Figure 10). Over this time, both the atmospheric and seawater CO<sub>2</sub> levels have increased. Atmospheric CO<sub>2</sub> levels have increased by 0.77% per year which is approximately what has been measured at the Mauna Loa Observatory in Hawaii. The seawater CO<sub>2</sub> levels at Grays Reef have increased by 2.7% per year. This increase was considerably higher than the 0.5% per year that has been estimated for the Atlantic Ocean offshore Georgia. The Aloha site in Hawaii saw pCO<sub>2</sub> increase by approximately 2% and the New Hampshire buoy recorded 1.6%.

**Atmospheric CO<sub>2</sub>**  
21 ppm in 7 years  
Average=391.7 ppm\*  
=0.77%/year

**Seawater CO<sub>2</sub>**  
78 ppm in 7 years  
Average=411.6 ppm\*  
=2.7%/year

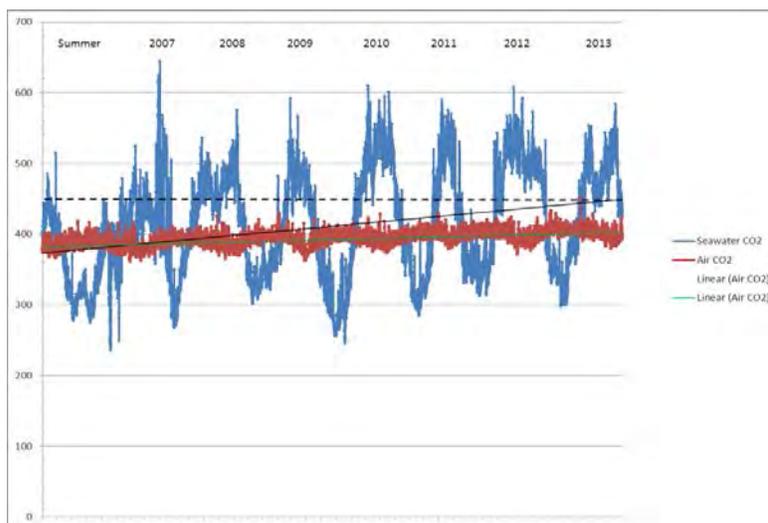


Figure 10. pCO<sub>2</sub> data collected at GRNMS.

This increase in seawater CO<sub>2</sub> results in a pH decrease of approximately 0.03 which is 30% of the predicted pH decrease expected over the next 100 years. Seasonally, Gray's Reef experiences a pH variation of approximately 0.15 as the CO<sub>2</sub> levels in the seawater change due to temperature (Figure 11). It should be noted that these results are from a relatively short time frame and that the trend can change as more data is collected. The CO<sub>2</sub> and pH data from the Gray's Buoy can be found at PMEL's website <http://www.pmel.noaa.gov/co2/story/Grays+Reef>.

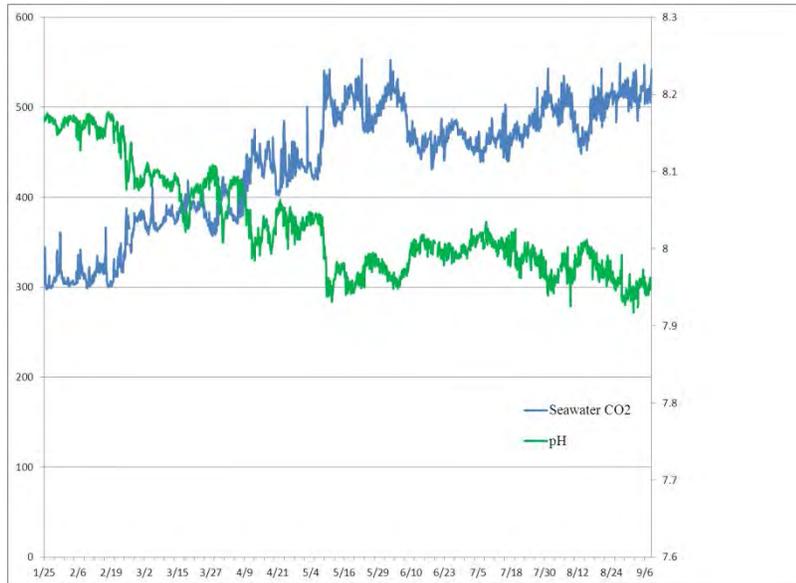


Figure 11. Plot of pCO<sub>2</sub> versus pH as recorded at GRNMS.

Water quality parameters at Gray's Reef have remained relatively constant over time. However, some changes were apparent during 2013. As the drought came to an end early in 2013, more freshwater from Georgia's rivers made it out to Gray's Reef (Figure 12). This is represented by a drop in salinity in February 2013. The dissolved oxygen sensor on the Wetlabs WQM showed some fluctuation during the early part of the year. When the sensors were replaced in May 2013, the new sensor appeared stable giving proof that it was a sensor issue and not an environmental problem.

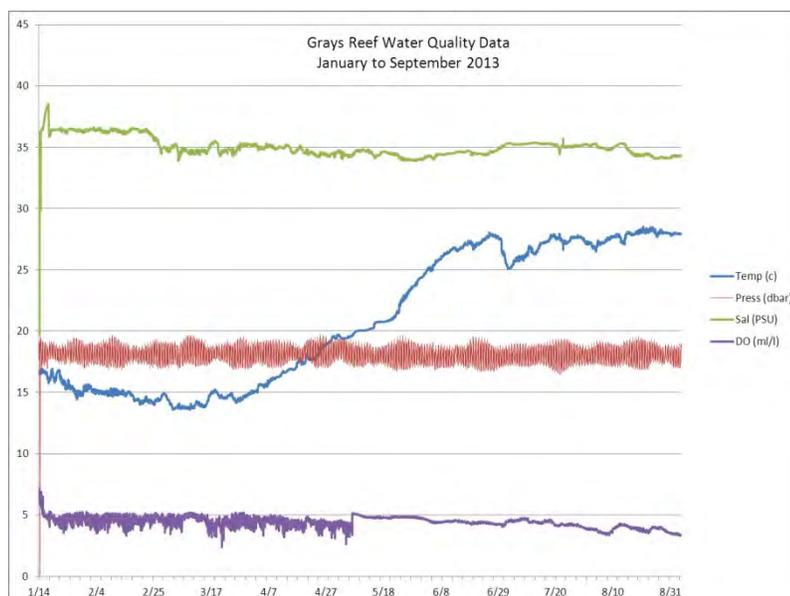


Figure 12. Water quality parameters at GRNMS.

Several algal blooms were measured during 2013 along with corresponding turbidity events (Figure 13). These events are normal for Gray's Reef and are part of naturally occurring processes. There were also a number of turbidity events recorded which were most likely related to the heavy rains and resulting river plumes pushing offshore Georgia.

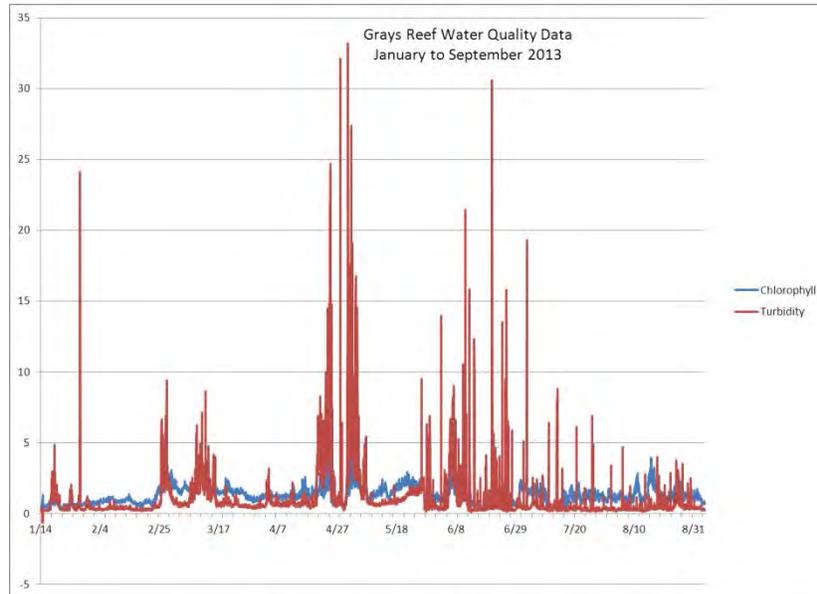


Figure 13. Chlorophyll and turbidity measurements at GRNMS.

It is anticipated that continued CO<sub>2</sub> and water quality research at Gray's Reef will explain how the benthic community will adapt and hopefully thrive as the Atlantic Ocean changes due to man-made pressures. Organisms at Gray's Reef already undergo considerable seasonal changes in seawater chemistry so hopefully will prove to be resilient as seawater CO<sub>2</sub> increases and pH decreases. As part of a joint effort, The University of Georgia and Georgia Southern University have expanded their research efforts to include the effects of ocean acidification on the benthic community at GRNMS. *Oculina*, one of the hard corals found at GRNMS, will be the first benthic organisms to be studied. It is hoped that as a result of this research, a better understanding will be achieved as to how *Oculina* will adapt to the rising seawater CO<sub>2</sub> and lower pH. Eventually, research will be expanded to test how other GRNMS organisms, such as sponges, will respond to their changing environment.

## Restoring Fish Habitats via Artificial Reef Restoration

Pat Geer and January Murray, Georgia Department of Natural Resources, Coastal Resources Division

The Artificial Reef Program is a collaborative effort dedicated to restoring fish habitats for recreational fishers by deploying donated materials of opportunity to act as artificial reefs. The program also strives to establish new and maintain existing partnerships. To date there are 30 offshore artificial reef sites (Figure 13). The past couple of years have been very successful: 5 substantial donations of stable materials for deployment, four deployments of artificial reef materials (vessel hull, pallet balls, barge and power poles, barge, chicken coops), coordination with the Navy for donation of 8 towers for artificial reefs, an expansion of the GDNR dive team, 15 of 30 sites were visually inspected and monitored with divers, and contaminant samples collected to monitor impact of artificial materials on surrounding sediments. Plans are in motion for 2014 to continue deployments, expand program staff to include another biologist, and expand the collaboration with the Navy to include a deployment plan for future materials for reef enhancement.

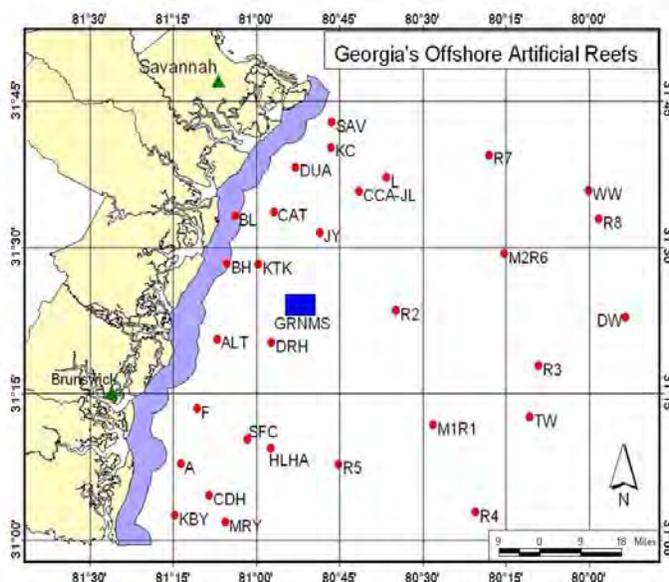


Figure 13. Map of 30 artificial reefs located offshore Georgia.

There are also inshore artificial reefs aimed at restoring fish habitat in inland waters. The 13 tidal and two sub-tidal sites consist primarily of concrete materials (pallet balls, culverts, FADs) that are marked by pilings. Each site is assessed annually and compliance to regulations is monitored by opportunistic flyovers. Side scan imagery is collected annually at each site for monitoring purposes (Figure 14). Plans for 2014 include replacement of pilings and signage at the Timmons site and signage for 4 Mile site. There are also efforts to deploy power poles to an existing reef at High Point. Reef coordinate updates were shared with the public via press release. Future plans include additional deployments as materials become available.

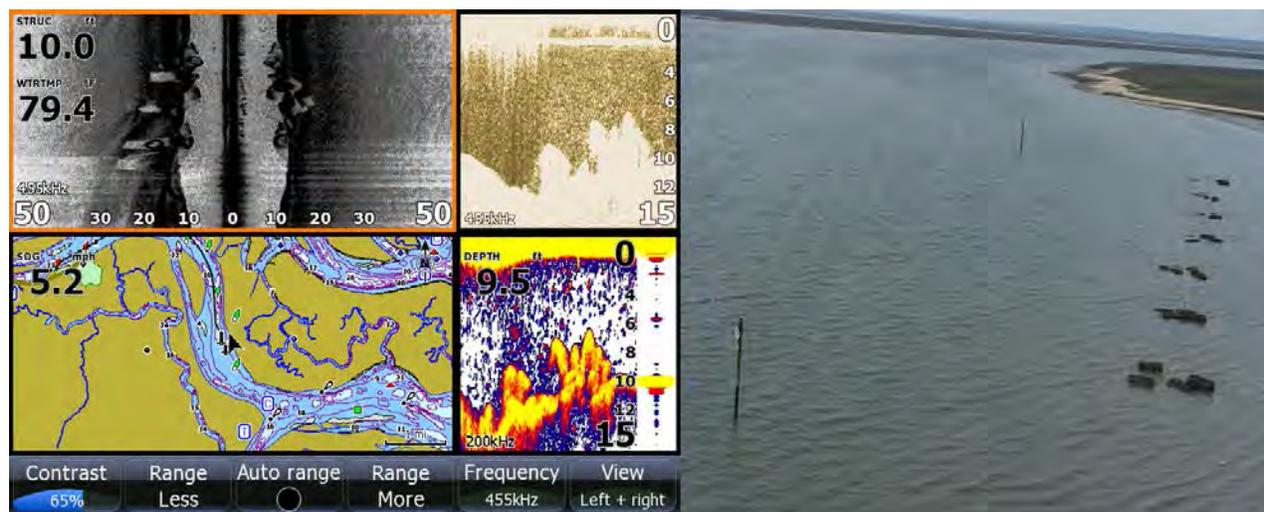


Figure 14. Side-scan imagery compared with aerial photographs confirming location of artificial reefs. Fish finder imagery shows the fish biomass aggregating around the reef materials at high tide.

### Gray's Reef National Marine Sanctuary Activities Update

*Sarah Fangman, Acting Deputy Superintendent and Research Coordinator for GRNMS*

Overview of diving effort: 154 dives conducted in 2013 with a total bottom time of approximately 61 hours of bottom time. Dives were distributed around the sanctuary, both inside and outside the research area, as well as outside GRNMS at JY Reef and Anchor Ledge. Sites with the most dives conducted (18 or more dives) included 41 OUT, 30IN and 06IN. The following sites were visited between 11 and 17 times by divers: 07OUT and the Data package. The remainder of sites within Gray's Reef was visited between 2 and 10 times over the course of the year.

Divers observed 15 lionfish during operations in 2013. Ten lionfish were seen in the RA, two were observed at sites outside the RA. Lionfish were also seen on dives outside the sanctuary: one lionfish was observed at JY Reef and two were seen at Anchor Ledge. Six of the 15 lionfish were removed by divers.

In 2013, GRNMS teamed up with scientists from the NMFS Lab in Beaufort, NC to collect information on sea turtle sightings. Divers documented information on size, species, barnacle growth on the carapace and other life history information. When possible, photographs and video were collected for individual identification. A total of 26 loggerhead sea turtles were documented both inside and outside the Research Area in 2013 (both by divers and by operators observing sea turtles surfacing). The NMFS Beaufort Lab has a database of turtles and requested footage and images to be shared with them for identification purposes. This data will expand the reach of the mark recapture methods used to aid in estimations of turtle populations.

Update on telemetry work: GRNMS began using telemetry in 2008 to track movement of fish in the sanctuary. Over six years, researchers tagged 63 fish: 13 Scamp Grouper (58-85.5 cm FL), 1 Red Grouper (72.5 cm FL), 14 Black Sea Bass (34-45.7 cm FL), 6 Red Snapper (49-80.5 cm FL), and 29 Gag Grouper (38-85 cm FL). One of the Gag Grouper tagged, MM1, was the fish detected most number of days (570 days over 1.5 years).

Sanctuary staff deployed 18 acoustic receivers inside and outside the Research Area to detect tags as fish swim within range of each receiver. Detection distances appear to be variable according to detection range tests. The data was downloaded every 2-6 months depending on accessibility to the site. In 2013, the site also deployed an array of receivers around a single ledge inside the Research Area to track fine scale fish movement. Initial tracks of several of the fish tagged in the vicinity of the array were shown to the SAG.

Another new effort for 2013 was the use of acoustic receivers attached to a glider. Dr. Catherine Edwards at the Skidaway Institute launched a SLOCUM electric glider outfitted with technology capable of detecting GRNMS tagged fish. The glider, Modena, was equipped with a VEMCO Mobile Transceiver in order to detect all coded tags within range of the glider (Figure 16).



Figure 16. Left, PUMA unmanned aircraft being launched on NOAA Ship *Nancy Foster* to demonstrate the ship's ability to launch and recover gliders. Right, SKIO's SLOCUM glider, 'MODENA', with the VMT attached on top ready for deployment.

Gray's Reef was also able to collaborate with OMAO and NMFS to deploy a PUMA unmanned aircraft system (Figure 16). Using the NOAA Ship *Nancy Foster*, the PUMA was launched and piloted from aboard the ship. The project was an attempt to test the ship's ability to successfully conduct unmanned aircraft operations. Future work with this technology is planned with the goal of eventually using this technology to survey human use in GRNMS.

The 2013 data collection efforts aboard NOAA Ship *Nancy Foster* were interrupted by Tropical Storm Andrea. The storm caused cessation of operations while the storm passed through the sanctuary. Once back on site, research was hampered by high sea state and poor visibility. Researchers and Team Ocean Volunteers continued to collect many types of data regardless of the weather. Fisheries acoustics surveys were conducted even when dive operations were halted collecting valuable fish biomass data that would later be compared with visual census surveys. Lionfish and fish community surveys were conducted and resulted in multiple removals of the invasive species. Photographic and video documentation of benthic habitats and sea turtles were taken for further analysis. Education and outreach materials were produced while at sea using real-time data and images.

## GUEST PRESENTATION

### *Marine Sanctuaries as Sentinel Sites: Ocean Observing Sites for Ecosystem Integrity and Early Warning* *Dr. Steve Gittings, Office of National Marine Sanctuaries, Conservation Science Division, Science Coordinator*

The Office of National Marine Sanctuaries is branding sanctuaries as sentinel sites to capture and convey the purpose of the conservation science program, which has always been to help us understand ecosystems and how they're changing. Purposeful protection from threats, as well as mitigation and restoration, demand such knowledge. This presentation describes a Sentinel Monitoring Program that we are working on for marine sanctuaries, but that could be applied within any MPA. For us in the ONMS, it is a way to organize current monitoring efforts and to build future capacity to track both ecosystem integrity and early warning indicators.

Why sanctuaries as sentinel sites? They're already known to be special places the people care about, where we invest people and assets, and generally have data in support of monitoring and research. They're places where the public looks to see how our nation's conservation efforts are doing. Sanctuaries already have shown ecological and economic value on a regional and national scale. They are representative ecosystems that have been managed, protected, restored and monitored for long periods of time. These heavily studied areas have existing baseline data and already have identified gaps in data for further study. All sanctuaries have mandated stakeholder involvement and public engagement as part of their management plans.

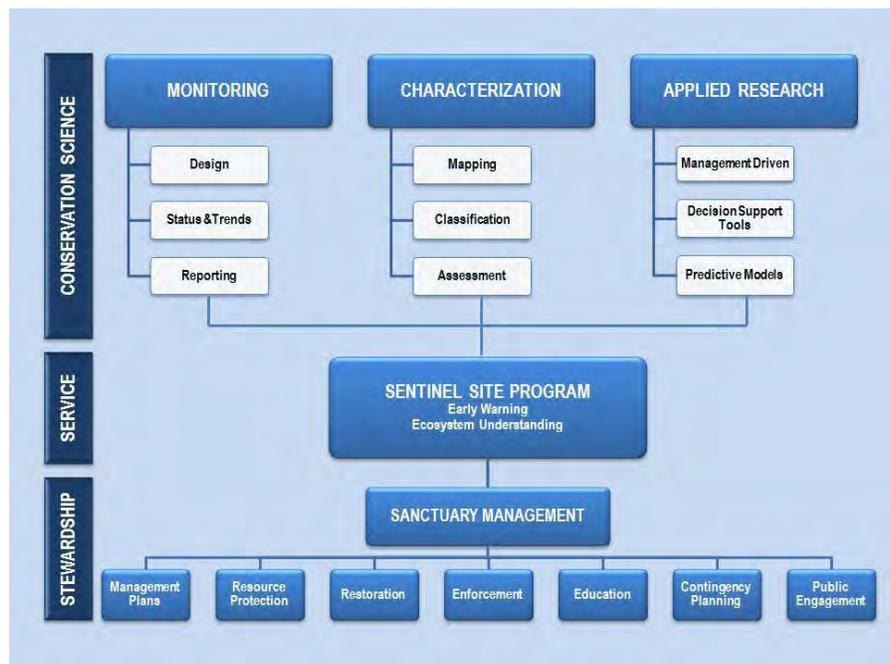


Figure 17. Diagram of main focus areas of ONMS Conservation Science and how Sentinel Sites will integrate all aspects of sanctuary science into one approach, including stakeholder engagement and education.

This is the way we would like people to think about the concept of sentinel sites. We want people to see sanctuaries as **sentinel sites** that are intensely studied and monitored areas. We want **monitoring** to inform management by increasing understanding of ecosystems and by providing early warnings of ecosystem change. And we want our **sentinel site programs** to attract and support collaboration and advance conservation science (Figure 17). A very important outcome could be increasing the involvement of communities around marine sanctuaries, as well as bringing the science of marine sanctuaries to the classrooms, potentially all over the country.

Conservation science in marine sanctuaries is what makes them sentinel sites. Certainly the monitoring work, but also much of the characterization and applied science that happens in sanctuaries contributes to an understanding of ecosystems that is critical to tracking change. So in reality, a "Sentinel Site Program" is a legitimate descriptor of much of our science effort. It incorporates both better ecosystem understanding and early warning to help sanctuaries plan for and respond to change.

These are the reasons we're moving in the direction of sentinel sites: fewer resources, NOAA climate initiatives, and National Ocean Policy. We're evolving at a time when there are no new resources, trying to develop new partnerships, and keeping ourselves relevant by answering the calls for sentinel site monitoring from several higher level planning initiatives that have taken place over the last couple years.

At the NOAA level (actually it started under the direction of NOS), there is a sentinel site initiative focused on a single issue – sea level change. What's important about this, however, is not so much the issue, but the model used to implement the program. We had a working group develop a vision for the program, definitions that could be used by virtually any institution operating at any geographic scale, and the concept of regional cooperatives, consisting of numerous governmental and academic institutions working together to make observations, conduct research, share data, and support decisions that could have long-term consequences in the region.

We also agreed that a fully-functioning sentinel program does more than just establish places to observe and monitor. One of NOAA's foundational principles is to connect science, service, and stewardship. Sentinel sites start with regular observing, but are places where observations lead to greater understanding that allows us to predict the consequences of different phenomena, transfer that data and information to managers in sanctuaries and elsewhere, and apply that knowledge to decision-making. Some of these decisions will lead to policies and protocols for dealing with an issue that pertain to more than just one sanctuary or location.

Some issues are big enough that they apply to all marine sanctuaries. Biodiversity conservation is one of those. It's something we care about in a fundamental way, albeit in different ways for different sanctuaries, but generally speaking as the foundation of ecological integrity. Nationally, it is one way we can assess our success in meeting our program responsibilities to maintain or improve living resource quality in the marine sanctuary system. Sentinel monitoring and networks in MPAs can also be included in larger networks in order to adequately populate an area with measurements to address particular issues of interest, such as ocean acidification.

Initially, our efforts on sentinel sites will be more "repackaging" and "marketing" than "new investment." We consider it a priority to build a framework for the future by putting sanctuary monitoring and research on ecosystem integrity and early warning under a single umbrella, and putting a spotlight on it through basic infrastructure, like the website, for example. As time goes on, we expect that the attraction of these places will help us leverage resources and fill observing and science gaps with funding, investments by partners, and citizen and volunteer participation. Our initial investment will be in accumulating existing information, and building the web capability that will make this program accessible to the science and resource management communities, educators, and others.

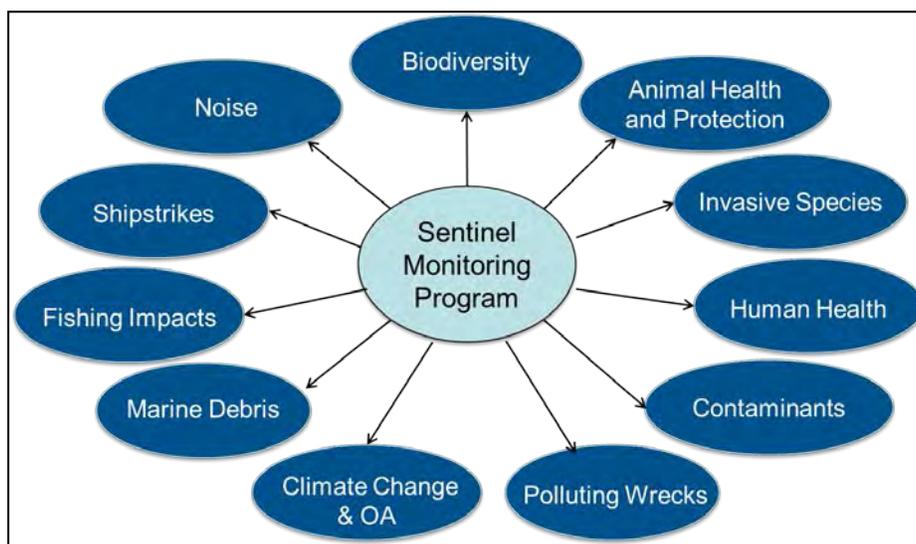


Figure 18. The ONMS Sentinel Monitoring Program Priority Issues.

In the sanctuary system, we believe that sentinel sites, and networks of sentinel sites, will help us understand and respond to issues related to many aspects of ecosystem integrity. We need to track changing patterns of biodiversity and animal health, and the impacts of invasive species and contaminants on ecosystems. There are aspects of climate change that we need to track and understand far better than we do, including ocean acidification and temperature stress. We also need to assess the risks of specific threats like marine debris to habitats and certain species, the impacts of shipstrikes on large animals, and more and more, how changing patterns of noise in the ocean affect species that vocalize to communicate. These are being considered as the initial areas of focus for the sanctuary program's sentinel site effort (Figure 18).

We are moving forward with this program. We've already conducted an inventory of monitoring activity in the sanctuaries. The rest of the steps involve building the web presence - a critical step that will make sentinel sites real to the rest of the world - showing what sanctuaries have to offer, where research and monitoring are conducted, and showing what we are finding. We also need to keep working with key partners on activities that are or may soon be underway - such as an NOS sea level change sentinel sites, and ocean acidification studies. As resources become available, we'll be improving web capabilities, linking the initiative to our periodic condition reports, facilitating use of our sentinel sites, and supporting sentinel monitoring that extends beyond sanctuary boundaries, and using the program to support education efforts.

Some marine sanctuaries already have active monitoring and research programs underway. But most are under-resourced and don't have what we would consider as comprehensive monitoring by any stretch of the imagination. Our hope for the work we're doing to package what we have in the sentinel site framework is that we'll draw attention to the progress we've made, but more importantly shed light on needs that can be met either by new funding or strategic partnerships with other NOAA programs, or outside parties interested in contributing to, and benefiting from sanctuary sentinel sites.

Gray's Reef is one of those sites that already has active monitoring, available baseline data, environmental data linked to an NDBC buoy, a designated Research Area, dive and boat support, socioeconomic assessments and well defined science needs. The sanctuary is already partnered with regional lionfish initiatives to track and control numbers. The sentinel sites web content is focused on reaching the research community over other audiences.

There are also some changes of condition reports for the next versions. Questions will now address climate change directly. There are 12 identified ecosystem services within three categories that will dictate the content of the reports: cultural (sense of place, tourism and recreation, science and education, heritage); provisioning (food, ornamentals, biotechnology, energy); and regulating (clean water, biodiversity, coastal protection, climate stability). For each conclusion from research that is used in the condition reports, a level of certainty must be designated to qualify the likelihood of that data. In this way, conclusions can be qualified by the robustness of the data.

### Research Area Planning for 2014 and Future Years

The group decided on a 2-year alternating cycle of monitoring activities one year followed by process studies in the following year. This decision aligns with the research reporting goals for 2016. Monitoring will take place in 2014 and 2016 with a year of process studies and other activities in 2015.

Field work was discussed for late May to early June involving Peter, Roldan, Laura, and Danny to conduct a combination of fish and invertebrate community monitoring as well as predator/prey interactions using GRNMS vessels.

Process studies and information gap discussions yielded 10 priority objectives for 2015 (**bold** indicates high priority):

1. Black Sea Bass tagging – local and regional movement; rates of return; life history studies
  - a. Question arises of permitting for life history studies, may need to adjust their permit
  - b. Conduct studies outside GRNMS in 2016 not to influence census studies in the sanctuary?
2. **Assess local fishing pressure**
  - a. Land-based surveys (phone and or creel) – GA database for emails/phones;
  - b. At sea (intercepts and drone flyovers)
3. Long term monitoring status ecological condition— Jeff Hyland; benthic community health and sediment quality.
  - a. Pending funding; next would be about 4 years.
4. Soundscapes: Noise field characterization; biodiversity changes and anthropogenic use
5. Mobile invertebrates: large crustaceans (not easy because many are cryptic)
6. Ocean acidification and ecological consequences
7. Biogenic habitat fish associations: manipulations
8. Benthic community development: variation; temporal resolution
9. Spatial and temporal variation of prey fishes
10. Sea turtle use and ID and acoustic tagging

Throughout the presentations, multiple suggestions were made for further discussion. When discussing Jeff Hyland et al.'s work, questions regarding detecting contaminants from superfund sites on the coast were posed. The methodology used by Hyland is similar to the study conducted on Sapelo Island and will also be able to detect the same compounds found on Sapelo. It was mentioned that in regards to looking at connections of coastal activities to contaminants in the sanctuary, Holly Bamford is also interested in making connections from the Altamaha River Watershed out to GRNMS. She has interest in marine mammal populations found in the Sapelo Sound area and how they are connected as well. Also of concern for the sanctuary is harbor deepening. This heavy work could cause resuspension of sediments that could then be transported across the shelf. Grain size could be of concern depending on the distance of the work. Jeff's work also brought up interest in comparing fish community data with infaunal data for patterns of occurrence and density. It was suggested that 'halo-type' effects might be seen.

Main conclusions coming out of Research Area investigations include:

- Benthic communities are similar inside and outside RA
- No major shifts in species composition between 2011 and 2013
- Lower mean species richness and percent benthic cover decreased in 2013, TS Andrea
- Structural habitat and fish community general similar inside and outside of RA
- Fish community differs by years regardless of management zone
- Acoustics show a trend of more small fish (<11 cm) outside the RA and possibly more medium (11-29 cm) fish inside the RA
- Larger Black Sea Bass (mean size per CPUE) inside the RA



## Gray's Reef NMS - Science Advisory Group Meeting – February 26, 2014

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Location - Skidaway Institute of Oceanography, 10 Ocean Science Circle Savannah, Georgia 31411, Marine & Coastal Science Research & Instruction Center (MCSRIC). Directions: <http://www.skio.usg.edu/?p=aboutus/geninfo/directions>

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### Agenda

- 9:00 AM Welcome and introductions – George Sedberry, Acting GRNMS Superintendent and Peter Auster, Science Advisory Group Chair  
Meeting Objectives – Sarah Fangman
- 9:30 AM Presentations - Research Area data (about 30 minutes each):
- Peter Auster
  - Laura Kracker
- 10:30 AM Break
- 10:45AM Presentations, continued
- Danny Gleason
  - Roldan Munoz
  - Marcel Reichert
  - Jeff Hyland
  - George Sedberry (for Scott Noakes)
  - Pat Geer
  - Sarah Fangman
- 12:45 Lunch
- 1:30 PM Steve Gittings – ONMS Lionfish Plan, Trap Development, X-Prize; Sentinel Sites
- 2:30 PM Research Area planning for 2014 and future years:
- Vessel support
  - Mapping
  - Other
- 3:00 PM Break
- 3:15 PM Research Area planning discussion, continued.
- 3:50 PM Next steps
- 4:00 PM Adjourn

## Participants:

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Sarah Fangman, Acting GRNMS Deputy  
Superintendent and Research Coordinator  
Jared Halonen, Vessel Operations Coordinator  
Jody Patterson, Administrative Coordinator  
Amy Rath, Education and Outreach Coordinator  
Becky Shortland, Resource Protection Coordinator  
Todd Recicar, Marine Operations Coordinator