Reef Fish Observations in two Marine Protected Areas in the northeastern Gulf of Mexico during 2010

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Introduction

Living and relic coral reefs on the outer edge of the continental shelf are used as spawning aggregation sites by several species of economically valuable reef fish (Koenig et al., 2000; Gledhill and David, 2004). In response to the 1997 stock assessment, which suggested gag grouper (*Mycteroperca microlepis*) may be undergoing overfishing, the Gulf of Mexico Fishery Management Council (GMFMC) implemented two marine reserves in June 2000 to increase stock size of gag grouper by protecting their spawning aggregations. The closures were also expected to provide conservation benefits for other reef fish species, such as other grouper and snapper, which utilize the habitat. The areas selected, Madison-Swanson and Steamboat Lumps, contain extensive paleo-reef habitat fostering diverse assemblages of reef-dependent vertebrate and invertebrate species (Gledhill and David, 2004). The combined area of these two MPAs is approximately 219 square nautical miles.

Life history characteristics of gag grouper make them vulnerable to overfishing. They are protogynous hermaphrodites with highly female-skewed sex ratios, even in unfished populations (Coleman et al., 1996). Aggregate spawning with strong interannual site fidelity is also common, offering knowledgeable fishermen the possibility to harvest large numbers of reproductively active fish in a short period of time. Dominant males aggressively defend these spawning aggregations and are more easily caught than during non-spawning periods, leading to further skewing of the sex ratios (Gilmore and Jones, 1992).

The marine reserves were established to evaluate their effectiveness as a management tool and were therefore initially set to expire after four years. Preliminary results from research conducted by NOAA Fisheries and Florida State University indicated that grouper were more abundant within the reserves compared to adjacent open-to-fishing areas; however the time frame was too short to determine if there was a significant impact. The Council subsequently extended the closures for an additional six years with a new sunset date in June 2010, during which time additional research could be conducted. The adoption of Amendment 30B to the Reef Fish Fishery Management Plan made the Madison-Swanson and Steamboat Lumps closures permanent in 2009. Amendment 30B also established an area between Madison-Swanson and Steamboat Lumps as a seasonal closure to offer additional protection for gag. This new closure is known as The Edges, it encompasses approximately 390 square nautical miles, and is closed to bottom fishing between 01 January and 30 April each year.

The objective of this study was to characterize habitat and examine densities of economically valuable reef fish (e.g. snapper and grouper species) both inside the MPAs and in the surrounding areas. Specifically, our goals were to: 1) Determine the presence of spawning aggregations of gag (*Mycteroperca microlepis*) in the Madison-Swanson and Steamboat Lumps MPAs and the adjacent open-to-fishing area, Twin Ridges; 2) Determine distribution and abundance of fish within the MPAs and adjacent areas; and 3) Determine length frequency distribution of reef fish within the MPAs and adjacent areas.

Methods

The R/V *Caretta* (F/5801) departed Pascagoula, MS on 06 February 2010 in route to Panama City, FL to stage the 2010 survey of the Madison-Swanson (M-S) Marine Protected Area (MPA), and the Twin Ridges control area (Figure 1). The cruise was divided into two transit legs and three survey legs operating from Panama City, FL. Delayed funding resulting in a shortened survey window did not allow for sampling of Steamboat Lumps MPA. Closely spaced winter weather systems resulted in only three short legs. Therefore, Steamboat Lumps and Twin Ridges were not sampled this year. A total of eight sea-days were completed. The R/V *Caretta* returned to Pascagoula after the cruise on 23 February 2010.

Sites within the Madison-Swanson MPA were selected by stratified random sampling. Five strata were defined within Madison-Swanson based on multibeam bathymetry: 1 northeast, 2 ridge, 3 central, 4 pinnacles, and 5 mounds. Sites within the Twin Ridges control area were selected randomly. Sites were sampled with a stereo/video camera array. The stereo/video camera array was comprised of four custom made housings, each containing a pair of Videre black-and-white stereo cameras and a color mpeg2 video camera, mounted orthogonally at a height of 30 cm above the bottom. This stereo/video camera array was baited with squid and allowed to soak on the bottom for 40 minutes per deployment.

Figure 1. Location of Madison-Swanson, Steamboat Lumps and Twin Ridges

A Seabird SBE911 Conductivity/Temperature/Depth (CTD) profiler was deployed at each site sampled to obtain water column profiles of dissolved oxygen, temperature, salinity, transmissivity and fluorescence. A Temperature/Depth recorder (TDR) was placed on the camera array to obtain the depth of the array as it soaked on the bottom.

The seabed in Stratum 3 (Central area) is primarily a sand-clay substrate. The occurrence of snappers and groupers is rare. Stratum 3 was therefore deleted in the estimation of indices of abundance. We investigated using a delta-lognormal approach (Lo et al., 1992), however, there was no reduction in the variance of abundance indices compared to simple random sampling. Indices of abundance were therefore calculated using simple random sampling estimators.

Results

A total of 33 sites were sampled during the R/V Caretta Cruise 10-01 (Table 3 and Figure 2). The video and stereo image data were returned to the NMFS Pascagoula Laboratory for viewing and analysis. CTD profiles were collected with a Seabird SBE911 profiler at all 33 stations (Table 3). CTD data were processed while at sea and returned to the Data Management Team at the NMFS Pascagoula Laboratory. TDR data were collected at 33 stations (Table 1). The data were converted from psi to depth in meters and

entered into the Reef Fish database at sea. All TDR data were returned to the NMFS Pascagoula Laboratory.

Analysis of video imagery was delayed as a result of the DWH/MC 252 oil spill which resulted in all video analyst technicians being retasked to response and restoration duties for approximately 15 months. These analyses were recently completed and summary data provided to the project managers. Fishes observed were catalogued into 38 taxonomic groups, 29 of which were identified to the species level (Table 4). There were no gag spawning aggregations observed during the abbreviated sampling period available in 2010. We have only observed an aggregation of more than 8 gag once in Madison-Swanson during the entire 2001-2010 time series and this was in 2002. Red porgy (*Pagrus pagrus*) were seen at more sites than any other taxon, occurring at 72.7% of the 33 sites. Other widely distributed species (in rank order) included red snapper (*Lutjanus campechanus*), scamp (*Mycteroperca phenax*), red grouper (*Epinephelus morio*), and gag (*M. microlepis*). Red snapper and scamp were present at 66.7% of the sites while red grouper and gag were present at 60.6%. Additional species of commercial interest included greater amberjack (*Seriola dumerili*, 57.6%), almaco jack (*S. rivoliana*, 45.5%), gray triggerfish (*Balistes capriscus*, 21.2%), vermilion snapper (*Rhomboplites aurorubens*, 18.2%), and speckled hind (*E. drummondhayi*, 12.1%). Abundance estimates estimated using a delta-lognormal approach for the major reef fish species observed in 2010 are shown in Table 1. The nominal index (LoIndex) is the estimated mean mincount for 2010 (the minimum number of individuals seen at each station). This index was standardized by the means of the entire time series (StdIndex). Fish total length (mm) was determined for the four dominant economically valuable species in the MPAs; gag, red grouper, scamp and red snapper. The means, minimums, maximums, and standard errors are shown in Table 2. A future report will detail time series analyses over the 2001-2010 period. However analysis of variance on this larger dataset indicates, for Madison-Swanson, gag were larger in 2010 than any other year (except 2008 which was not statistically different), red grouper continue to increase in size (2004-2010 > 2002-2003), scamp were larger (2007-8 & 2010 > 2002-2006 & 2009) and red snapper are also larger (2007-8 & 2010 > 2002-2006 & 2009).

Habitat characterization is best accomplished when large areas of benthos can be examined, such as with an ROV. This survey uses stationary video camera arrays to minimize behavioral changes in the fish in response to the presence of the gear. Habitat observed with the cameras is noted, but this is only descriptive of the immediate area around the array, less than 10m normally. While the habitat type is noted in the dataset, no profound information was elucidated this year beyond what is well known and widely reported – grouper prefer rocky substrate, snapper utilize hardbottom but are more wide ranging, and open sand has few fish with eels and flatfish predominating in these areas.

Table 1. Mean abundance estimates for major reef fish in Madison-Swanson MPA in 2010. Values are delta log normal transformed estimates weighted by stratum area. Stratum 3 is a large area of unconsolidated sand and clay with little to no relief or hardbottom, it was excluded from these mean calculations due to its historical paucity of reef fish.

Species	Frequency	N	LoIndex	StdIndex	SE	CV	LCL	UCL
Gag	0.66667	30	0.70961	1.07621	0.15193	0.21410	0.70472	1.64355
Red Grouper	0.66667	30	0.85496	1.48192	0.17586	0.20570	0.98629	2.22661
Scamp	0.73333	30	1.37832	0.57020	0.33003	0.23944	0.35559	0.91435
Red Snapper	0.73333	30	2.89776	2.21238	0.82271	0.28391	1.26771	3.86098

Table 2. Length information for major reef fish in Madison-Swanson MPA in 2010.

Species	N	Mean TL (mm)	Minimum (mm)	Maximum (mm)	SE (mm)
Gag	14	796.69	688.39	943.40	20.39
Red Grouper	18	613.48	472.76	729.61	20.66
Scamp	43	442.46	84.95	799.25	17.46
Red Snapper	31	554.16	409.79	743.79	17.17

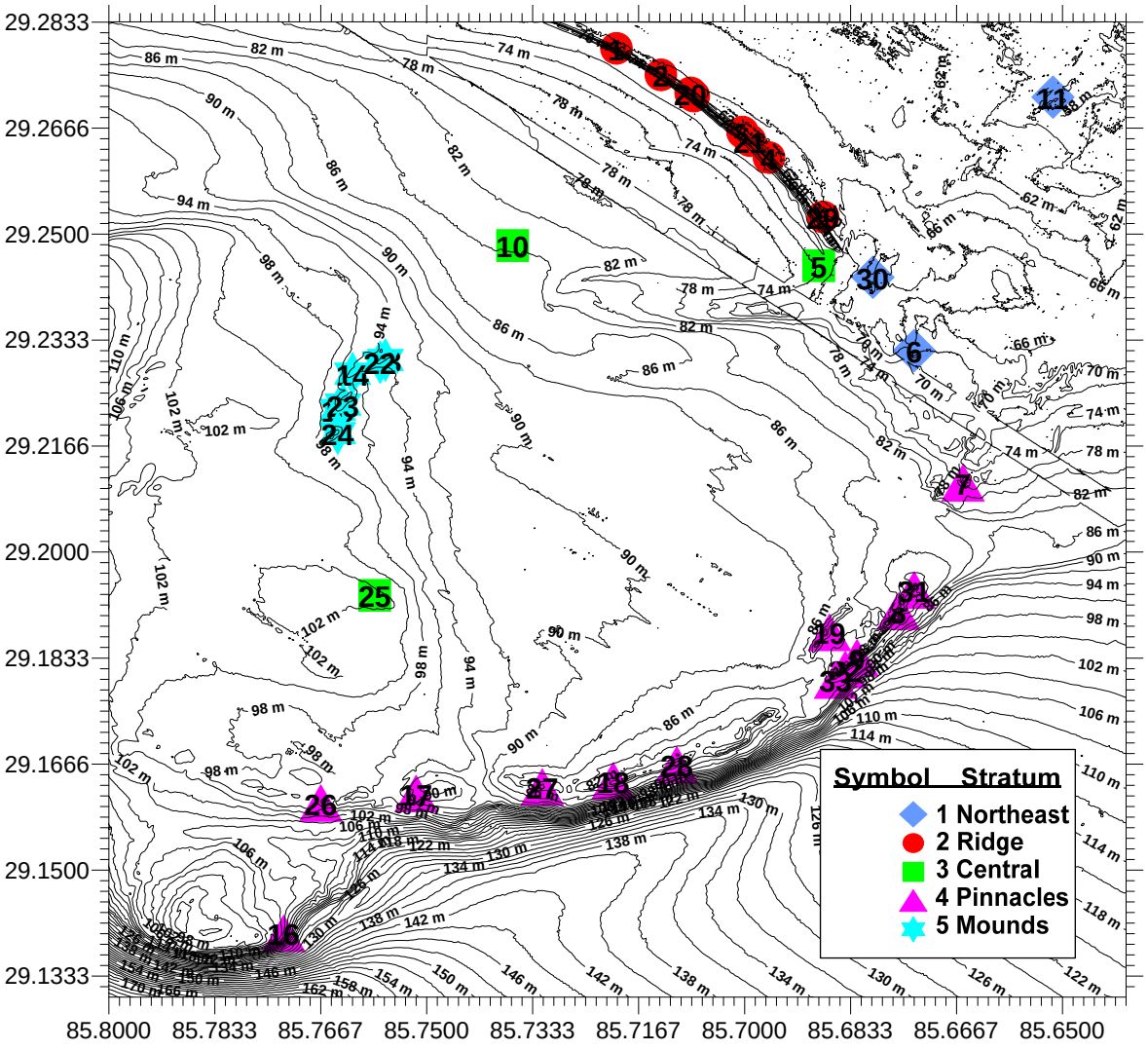

Figure 2. Location of stations sampled by stratum within Madison-Swanson MPA during R/V *Caretta* Cruise 10-01, February 2010.

Table 3. Stations sampled in Madison/Swanson MPA during R/V *Caretta* cruise 10-01. (SVC= Stereo Video camera array, CTD= SBE-911 environmental water profiler, TDR= Temperature / Depth Recorder)

Station	Latitude	Longitude	Depth(m)	Stratum	Site	Gear
1	29° 16.75	85° 43.21	62.80	2	54	SVC, CTD, TDR
2	29° 16.50	85° 42.79	71.70	2	101	SVC, CTD, TDR
3	29° 15.96	85° 42.02	60.90	2	232	SVC, CTD, TDR
4	29° 15.72	85° 41.77	63.10	1	281	SVC, CTD, TDR
5	29° 14.70	85° 41.30	72.10	3	2639	SVC, CTD, TDR
6	29° 13.90	85° 40.40	67.50	1	143	SVC, CTD, TDR
7	29° 12.65	85° 39.94	75.40	4	177	SVC, CTD, TDR
8	29° 11.44	85° 40.55	70.70	4	162	SVC, CTD, TDR
9	29° 11.00	85° 40.94	75.40	4	140	SVC, CTD, TDR
10	29° 14.89	85° 44.19	81.20	3	2710	SVC, CTD, TDR
11	29° 16.29	85° 39.09	57.50	1	31	SVC, CTD, TDR
12	29° 16.30	85° 42.48	64.00	2	154	SVC, CTD, TDR
13	29° 13.81	85° 45.39	85.50	5	13	SVC, CTD, TDR
14	29° 13.68	85° 45.70	90.40	5	9	SVC, CTD, TDR
15	29° 13.34	85° 45.84	91.90	5	4	SVC, CTD, TDR
16	29° 08.40	85° 46.35	105.00	4	38	SVC, CTD, TDR
17	29° 09.72	85° 45.10	87.30	4	52	SVC, CTD, TDR
18	29° 09.84	85° 43.24	75.60	4	78	SVC, CTD, TDR
19	29° 11.24	85° 41.20	81.40	4	120	SVC, CTD, TDR
20	29° 16.33	85° 42.51	62.70	2	143	SVC, CTD, TDR
21	29° 15.88	85° 41.95	66.00	2	243	SVC, CTD, TDR
22	29° 13.79	85° 45.44	87.40	5	12	SVC, CTD, TDR
23	29° 13.39	85° 45.79	91.90	5	5	SVC, CTD, TDR
24	29° 13.12	85° 45.84	83.10	5	3	SVC, CTD, TDR
25	29° 11.59	85° 45.49	100.00	3	842	SVC, CTD
26	29° 09.63	85° 46.00	93.80	4	46	SVC, CTD, TDR
27	29° 09.78	85° 43.91	79.30	4	62	SVC, CTD, TDR
28	29° 09.99	85° 42.64	73.50	4	93	SVC, CTD, TDR
29	29° 15.16	85° 41.26	62.40	2	376	SVC, CTD, TDR
30	29° 14.59	85° 40.79	67.00	1	85	SVC, CTD, TDR
31	29° 11.64	85° 40.40	70.20	4	170	SVC, CTD, TDR
32	29° 10.89	85° 41.05	69.70	4	136	SVC, CTD, TDR
33	29° 10.79	85° 41.14	79.10	4	128	SVC, CTD, TDR

Table 4. Taxon frequency of observation at stations sampled during R/V *Caretta* cruise 10-01 (n=33).

Taxon	Name	Frequency	Percent Frequency
Pagrus pagrus	red porgy	24	72.727
Lutjanus campechanus	red snapper	22	66.667
Mycteroperca phenax	scamp	22	66.667
Epinephelus morio	red grouper	20	60.606
Mycteroperca microlepis	gag	20	60.606
Seriola dumerili	greater amberjack	19	57.576
Seriola rivoliana	almaco jack	15	45.455
Holacanthus bermudensis	blue angelfish	11	33.333
Balistes capriscus	gray triggerfish	7	21.212
Holanthias martinicensis	roughtongue bass	7	21.212
Anthiinae	Anthiids	6	18.182
Rhomboplites aurorubens	vermilion snapper	6	18.182
Calamus nodosus	knobbed porgy	4	12.121
Caulolatilus chrysops	goldface tilefish	4	12.121
Chaetodon aya	bank butterflyfish	4	12.121
Epinephelus drummondhayi	speckled hind	4	12.121
Paranthias furcifer	creole-fish	4	12.121
Halichoeres bathyphilus	greenband wrasse	3	9.091
Mustelus sp	dogfish	3	9.091
Pristigenys alta	short bigeye	3	9.091
Sphyraena barracuda	great barracuda	3	9.091
Anomura	decapod crustacean	2	6.061
Calamus bajonado	jolthead porgy	2	6.061
Caulolatilus sp.	tilefish	2	6.061
Muraena retifera	reticulate moray	2	6.061
Bodianus pulchellus	spotfin hogfish	1	3.030
Bothidae	lefteye flounders	1	3.030
Brachyura	crab	1	3.030
Calamus proridens	littlehead porgy	1	3.030
Chaetodon sedentarius	reef butterflyfish	1	3.030
Clypeaster sp.	sand dollar	1	3.030
Gymnothroax moringa	spotted moray	1	3.030
Hemiperonotus novacula	pearly razorfish	1	3.030
Labridae	wrasses	1	3.030
Opistognathus aurifrons	yellowhead jawfish	1	3.030

Table 3. Continued.

Taxon	Name	Frequency	Percent Frequency
Scomberomorus sp.	mackerel	1	3.030
Seriola sp.	amberjack	1	3.030
Serranus notospilus	saddle bass	1	3.030
Serranus phoebe	tattler	1	3.030
Sphyrna sp.	hammerhead shark	1	3.030
Synodontidae	lizardfishes	1	3.030

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