Examination of proposed additional closed areas on the West Florida Shelf.

A report to the Gulf of Mexico Fishery Management Council

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Abstract

The Gulf of Mexico Fishery Management Council (GMFMC) implemented two marine reserves (Madison-Swanson and Steamboat Lumps) in June 2000 to increase stock size of gag grouper (*Mycteroperca microlepis*) by protecting spawning aggregation sites. In 2008, the Council selected five areas as candidates for additional reserves (see Figure 1). These areas would provide further protection for the local gag grouper populations in addition to the two reserves already established. Early in 2009, a preferred option was selected, an area known as The Edges which lies along the outer continental shelf between Madison-Swanson and Steamboat Lumps. While Madison-Swanson and Steamboat Lumps are closed to bottom fishing year round, The Edges would only be closed for four months each year, 1 January – 30 April. This period encompasses the peak spawning season for gag, however resident males would be vulnerable to fishing during the remaining eight months of the year. During April 2008, the NOAA Fisheries Laboratory in Panama City, FL completed a research cruise with the objective of characterizing habitat and examining densities of economically valuable reef fish (e.g. snapper and grouper species) both inside the Madison-Swanson reserve and in four of the five newly selected additional reserve options. Vermilion and red snapper were the most abundant snapper species and were observed in their highest densities in The Edges and Extended Madison-Swanson, respectively (both proposed closed areas outside the Madison-Swanson reserve). Scamp was the most abundant grouper species and found in all areas surveyed. Grouper densities, in general, were highest at a bathymetric feature known as the Mounds inside the Madison-Swanson reserve; however, gag densities (the species of interest) were most abundant in Extended Madison-Swanson followed closely by The Edges. From the perspective of snapper-grouper densities and percentage of complex habitat, Extended Madison-Swanson and The Edges proved to be the most productive areas examined.

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 that 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).

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 NMFS 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. In 2008, the Council suggested five areas as candidates for additional reserves to provide further protection for the local gag grouper populations. In 2009, one of these areas, a site on the outer continental shelf between Madison-Swanson and Steamboat Lumps known as The Edges, was selected and proposed as an annual four month closure to bottom fishing. This seasonal closure would be in effect between 1 January and 30 April and would be designed to protect gag and other groupers during their respective spawning seasons.

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 Madison-Swanson reserve and in the surrounding proposed reserve extension areas. Specifically, we wanted to: 1) establish baseline estimates of reef fish density and species composition associated with bottom features within the reserve and surrounding proposed areas, especially for species of groupers and snappers; 2) describe significant habitat features in the reserve and surrounding proposed areas; and 3) document the relationship between habitat and species assemblages. This report is National Marine Fisheries Service Panama City Laboratory Contribution Number 09-07.

Methods

A remotely operated vehicle (ROV) owned and operated by the National Undersea Research Center (NURC) at the University of North Carolina at Wilmington (UNCW) was used to gather imagery for the characterization of habitats and the estimation of fish densities. Multibeam maps produced during a previous and separate NOAA project were used to select sampling sites and guide the course of ROV dives. Currents required the use of a downweight to keep the ROV umbilical cable near the bottom throughout the dives. This downweight was tethered to the ROV umbilical and the ROV operated on a 30 m leash which provided sufficient freedom of movement to investigate habitat features within visual range of the transect line. The downweight configuration also allowed the ROV to hover just above the bottom at a controlled over-the-ground speed of approximately 1.4 km/hr (range 0.9 to 2.8 km/hr). The geographic position of the ROV (± 3m) was constantly recorded throughout each dive with a tracking system linked to the ship's GPS system. The ROV was equipped with lights and a forward-looking digital color video camera which provided continuous imaging data. These dives resulted in approximately 16.5 hours of underwater video documentation. The video footage was used to delineate and quantify habitat type as well as fish species presence and density within each habitat type. All fish within a 5 m radius of the transect line on the video tapes were identified to the lowest discernable taxonomic level and counted (5 m was determined as the maximum distance that fish could reasonably be identified). Fish densities (#/m^2) were determined by estimating the area of view of the video camera during transects. The area of each transect was determined from transect length (L) and width (W). Transect length was calculated from latitude and longitude recorded by the ROV tracking system. The width of each transect was calculated using the following equation: $W=2(\tan(\frac{1}{2}A))(D)$ where A is the horizontal angle of view (78º, a constant property of the camera) and D is the distance from the camera at which fish could always be identified. The average distance (D) was 2.5 m (range from 1 m to 3.5 m) and was determined by the clarity of the water. Transect area (TA) was then calculated as: $TA=(LxW) - \frac{1}{2}(WxD)$ (all equations from Koenig *et al.*, 2005). Densities of grouper and snapper species were calculated by dividing the number of each species by the TA. Average densities were calculated for each grouper and snapper species and then compared among the different areas examined. Preliminary analyses demonstrated that snapper densities were not significantly different among habitat types. Their densities were, therefore, averaged among all hardbottom habitats, whereas, grouper densities are displayed by habitat type for each area.

The ROV dives were divided into 6 different areas both inside the Madison-Swanson reserve and in four of the five proposed reserve candidate areas (Figure 1). Those areas surveyed outside Madison-Swanson were named by the GMFMC while the areas inside the reserve were named by NOAA Fisheries for the distinct features they represent. The six areas examined include: The Edges (a proposed closed area located between Madison-Swanson and Steamboat Lumps reserves), Cross Shelf Madison-Swanson Extension (a proposed closed area which extends from the Madison-Swanson reserve north toward the coastline), Extended Madison-Swanson (a proposed closed area just north of the Madison-Swanson reserve), The Ridge (an area just north of the Madison-Swanson reserve located in both the Extended Madison-Swanson and Cross Shelf Madison-Swanson Extension proposed closed areas which is an extension of the Ridge feature inside the reserve and, therefore, analyzed separately), The Mounds and the Pinnacles (both areas named for specific features located within the Madison-Swanson reserve). Multiple

dives were completed at The Edges and Extended Madison-Swanson and densities from those dives were combined and averaged for each area.

Results

The West Florida Shelf ROV dives were conducted between 7 and 11 April 2008. A map displaying dive locations is shown in Figure 1.

A total of 12 ROV dives were made. Five major habitat types were identified from the dives: 1) soft substrate/sand (hereafter denoted as SA), 2) flat rock resembling pavement (PAV), 3) low relief outcrops (LRO), 4) moderate relief outcrops (MRO), and 5) high relief ledge (HRL). SA habitats exhibited no relief and were composed of fine to coarse sand, sometimes with a shell hash. PAV habitats were composed of hardbottom with no relief and usually had some degree of coverage with sessile and encrusting invertebrates and a presence of cracks/crevices up to 2 m deep. LRO consisted of rock outcrops with < 1 m relief. MRO habitat was made up of rock outcrops with 1-3 m relief and HRL exhibited > 3 m relief often with large boulders and overhangs. It is widely accepted that reef fish utilize hardbottom habitats (Grimes et al., 1982; Quattrini and Ross, 2006) and since the objective was to examine snapper and grouper densities among the proposed closed areas, SA was eliminated from all analyses. Hardbottom habitat type percentages for each area are shown in Figure 2. The Extended Madison-Swanson proposed closed area had the highest percentage of HRL, followed closely by The Edges. It is important to note that the percentage of each habitat type is a relative measure of the habitats encountered by the ROV and not an absolute measurement of the entire reserve candidate area.

Snapper densities for each of the areas examined are shown in Figure 3. Vermilion (*Rhomboplites aurorubens*) and red snappers (*Lutjanus campechanus*) were the most abundant snapper species, while the 'other' snapper category consisted of gray snapper and snappers not identifiable below genus level. The highest densities of snapper were observed in The Edges where schools of vermilion snapper were found and Extended Madison-Swanson where red snapper were most abundant. Gray snapper dominated in the Cross Shelf Madison-Swanson Extension.

Grouper densities for each hardbottom habitat type and examined area are displayed in Figure 4. Scamp (*Mycteroperca phenax*), gag, and red grouper (*Epinephelus morio*) were the most abundant grouper species while the 'other' grouper category consisted of rock hind (*Epinephelus adscensionis*), speckled hind (*Epinephelus drummondhayi*), and groupers not identifiable below genus level. Scamp densities were significantly lower in PAV compared to the other habitats (One-way ANOVA, $p=0.006$). Gag grouper densities were significantly higher in HRL compared to other habitats (One-way ANOVA, $p=<0.001$). Red grouper densities were not significantly different among habitat types. As expected, grouper densities increased with increasing habitat complexity. Scamp were the most abundant grouper and found in all of the areas examined. The Mounds (located inside the Madison-Swanson reserve) had the highest densities of grouper followed by the Extended Madison-Swanson and The Edges proposed closed areas. The species of interest, gag grouper, had the highest densities in the Extended Madison-Swanson followed closely by The Edges (both proposed closed areas).

Discussion

Five areas were considered as possible locations for expanding the West Florida Shelf reserves. The area known as The Edges was selected from that list and has been proposed for closure from 1 January to 30 April to protect grouper spawning aggregations. Based on data collected from this study, two areas stood out as the most productive of all the locations considered. They include: The Edges and the Extended Madison-Swanson areas. While all of the proposed areas had some degree of hardbottom present, these two locations had the highest percentages of high relief ledge (the most complex habitat type). Gag grouper densities were the most abundant in the Extended Madison-Swanson area followed closely by The Edges. The highest overall grouper densities (primarily comprised of scamp) were observed at the Mounds (a feature inside the Madison-Swanson reserve). Red snapper densities were highest in the Extended Madison-Swanson area.

Usually, examination of marine reserves does not begin until after the closures have been implemented. This study presented an opportunity to examine these areas before fishing restrictions have been implemented allowing pre-closure data to be collected. Location of reserves is critical if enhancement of fishery yields is to occur (Stockhausen *et al.*, 2000). Once the additional reserve is implemented, frequent replication of species abundance and distribution data will be necessary to track trends in population levels over time.

An on-going problem for marine reserves is enforcement of fishing restrictions. In order to effectively evaluate the efficacy of reserves, fishing must cease in those designated areas. In lieu of cessation of fishing, the level of fishing effort should be determined. A monitoring program written into the FMP amendment incorporating an effort survey and annual fish assessments would be beneficial to future evaluations. Any undocumented fishing activity will make it difficult to evaluate the impact of closure on fishery productivity. Even relatively moderate levels of poaching can quickly deplete gains achieved by closure (Roberts and Polunin, 1991).

Acknowledgements

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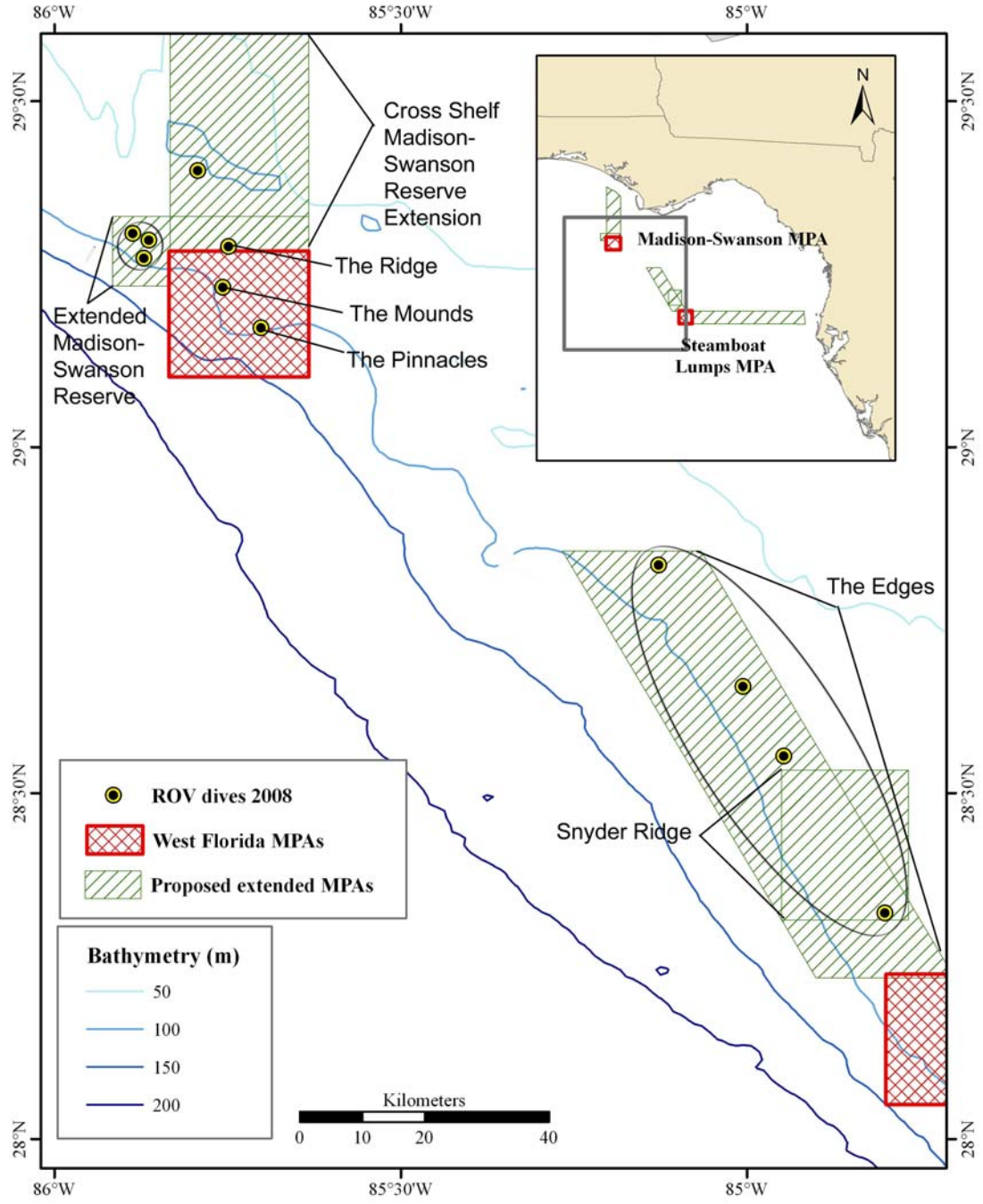

Figure 1. Map displaying 2008 ROV dives in the West Florida Shelf reserves (in red) and surrounding proposed additional closed areas (green). Dives in The Edges and Extended Madison-Swanson reserve were combined for analyses (those dives circled together) and Synder Ridge was not used in the analyses as the one dive in it was combined with the other Edges dives. The Mounds and the Pinnacles were analyzed separately as they are two distinct features within the reserve and the Ridge was analyzed separately as it is a unique feature that stretches inside and outside the reserve.

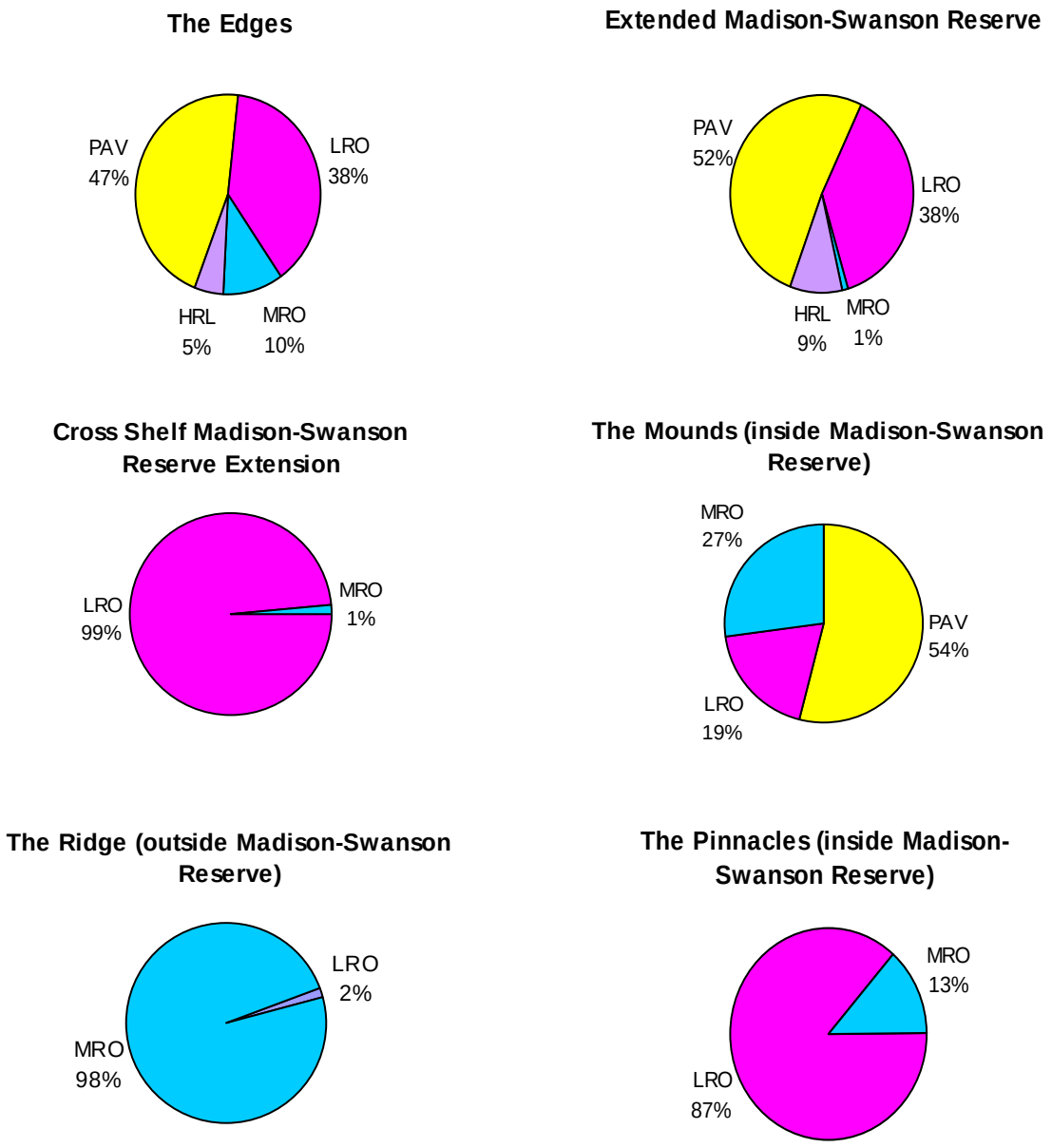

Figure 2. Percentages of habitat types observed within each of the six areas examined. PAV = pavement, LRO = low relief outcrops, MRO = moderate relief outcrops, HRL = high relief ledge.

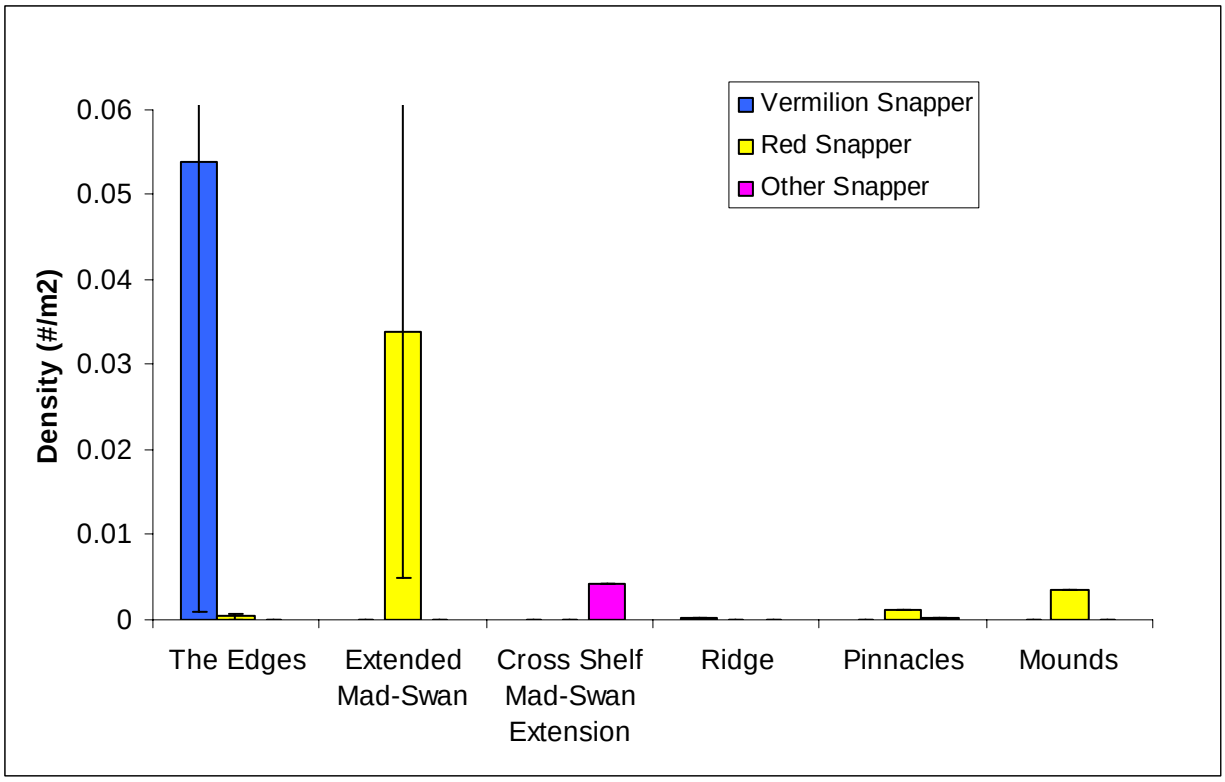

Figure 3. Snapper densities (#/m² ± S.E.) for each area examined. Other snapper consisted of gray snapper and snapper not identifiable below the genus level. Mad-Swan is an abbreviation for Madison-Swanson.

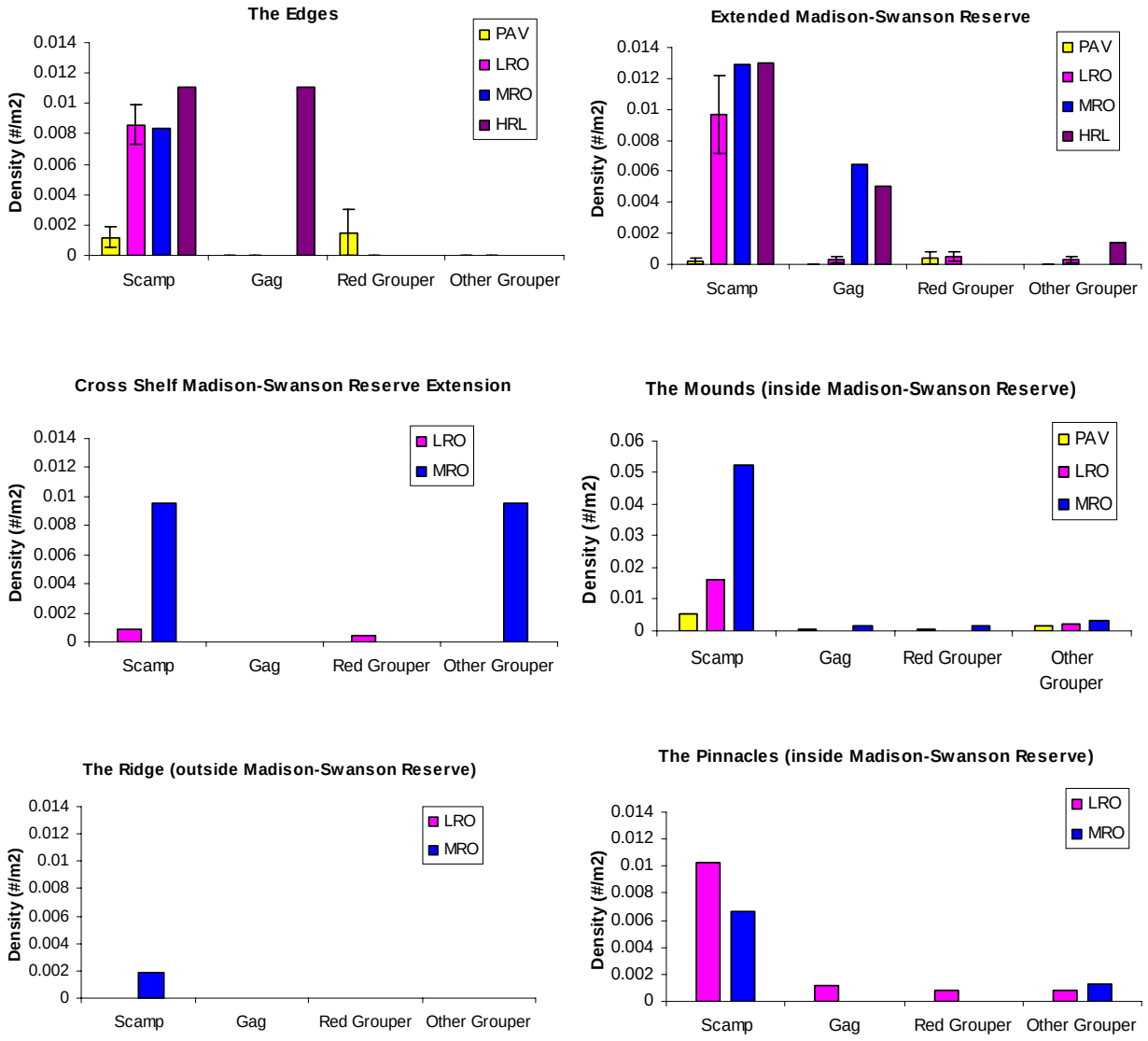

Figure 4. Grouper densities (#/m² ± S.E.) for each area examined. Other grouper consisted of rock hind, speckled hind, and grouper not identifiable below the genus level. PAV = pavement, LRO = low relief outcrops, MRO = moderate relief outcrops, HRL = high relief ledge. Note that the density scale is the same for all graphs except The Mounds.