Survey of Fish Assemblages and Habitat within Two Marine Protected Areas on the West Florida Shelf

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ABSTRACT

The Madison-Swanson and Steamboat Lumps MPAs were established by the Gulf of Mexico Fishery Management Council in 1999 to protect spawning aggregations of groupers. The primary goals of this project were to:

i) Establish baseline estimates of fish abundance, especially for species of groupers and snappers;
ii) Describe significant habitat features in the Madison-Swanson and Steamboat Lumps MPAs; and,
iii) Analyze the relationship between habitat and species assemblages.

The secondary objective was to locate spawning aggregations of gag (*Mycteroperca microlepis*), and scamp (*Mycteroperca phenax*). Side scan mosaics and multibeam bathymetry were used to stratify each MPA based upon benthic topography and geology. The Madison-Swanson, and Steamboat Lumps MPAs were surveyed during 5 cruises between February, 2001 and May, 2002. Gear employed during the surveys included stationary video camera arrays, (Hi-8 cameras or digital cameras), chevron fish traps, and an ROV. Spawning aggregations of gag and/or scamp were confirmed within the Madison-Swanson MPA in 2001 and 2002. Species assemblages varied with habitat. At sites along ridges and rocky outcrops, species observed included gag, scamp, red grouper (*Epinephelus morio*), snowy grouper (*Epinephelus niveatus*), speckled hind (*Epinephelus drummondhayi*), red snapper (*Lutjanus campechanus*), silk snapper (*Lutjanus vivanus*), vermilion snapper (*Rhomboplites aurorubens*), red porgy (*Pagrus pagrus*), knobbed porgy (*Calamus nodosus*), gray triggerfish (*Balistes capriscus*), and greater amberjack (*Seriola dumerili*). At sites on sandy substrates, species observed included honeycomb moray (*Gymnothorax saxicola*), bank sea bass (*Centropristis ocyurus*), and bandtail puffer (*Sphoeroides spengleri*).

KEY WORDS: Gulf of Mexico, Marine Protected Area, reef fish

Estudio de Congregados y Habitat de Peces dentro de Dos Areas Marinas Protegidas en la Plataforma de Florida Oriental

Las áreas protegidas (MPA) de Madison-Swanson y Steamboat Lump fueron establecidas por el concejo de manejo pesquero del Golfo de México en 1999 para proteger las agregaciones desovantes de meros. Las primeras metas de este proyecto fueron:

i) Establecer estimaciones básicas de abundancia de peces, especialmente para las especies de meros y huachimnangos;
ii) Describir las características significativas del hábitat en el Madison-Swanson y Steamboat Lump MPAs; y
iii) Analiar la relación entre el hábitat y los congregados de la especie.

El objetivo secundario fue localizar las agregaciones desovantes de mordaza (*Mycteroperca microlepis*), y pícaro (*Mycteroperca phenax*). Se utlizaron análisiss de mosaico por lado y mutiemisión batimétrica para estratificar cada MPA basado en la topografía del bentos y geología. Madison-Swanson, Steamboat Lump y una área de control adyacente (bordes gemelos) fueron muestreados durante 5 cruceros entre febrero, 2001 y mayo, 2002. El equipo empleado durante los estudios incluyeron cámaras de video en form estacionaria (Hi-8 cámaras o cámaras digitales), señales de trampas de pesces, y un ROV. Las agregaciones desovantes de mordaza y/o pícaro fueron confirmadas dentro del Madison-Swanson MPA en 2001 y 2002. Los congregados de la especie variaron con el hábitat. En los sitios a lo largo de los bordes y los afloramientos rocosos, se observaron especies que incluyen al mordaza, pícaro, mero rojo (*Epinephelus morio*), mero nevado (*Epinephelus niveatus*), speckled hind (*Epinephelus drummondhayi*), huachinango rojo (*Lutjanus campechanus*), huachinango de seda (*Lutjanus vivanus*), huachinango café (*Rhomboplites aurorubens*), el red porgy (*Pagrus pagrus*), porgy del knobbed (*Calamus nodosus*), el triggerfish gris (*Balistes capriscus*), y el gran amberjack (*Seriola dumerili*). En los sitios muestreados sobre substratos arenoso, las especies observadas incluyen la morena apanalado (*Gymnothorax saxicola*), bank sea bass (*Centropristis ocyurus*), y bandtail puffer (*Sphoeroides spengleri*).

PALABRAS CLAVES: Golfo de México, areas marinas protegidas, peces

INTRODUCTION

The Madison-Swanson and Steamboat Lumps Marine Protected Areas (MPAs) on the West Florida Shelf were established by the Gulf of Mexico Fishery Management Council (GMFMC) in 1999 (Figure 1). They were established primarily to protect spawning aggregations of gag grouper (*Mycteroperca microlepis*), which is considered to be at risk since this protogynous species is attracted to high-relief sites where they aggregate to spawn (Gilmore and Jones

1992, Coleman el al. 1996). These reserves contain areas of reef structure that support populations of economically valuable reef fish and other reef-associated fishes and invertebrates (Koenig et al. 2000). The MPA designations, which included no-take regulations, went into effect on June 19, 2000. The MPA designations will expire on June 16, 2004 unless extended by the Gulf Council at their May, 2003 meeting. It is therefore important to document the extent and nature of the reef habitat within each MPA, document the species composition and relative abundance of the dominant economically-important reef fishes, and monitor these parameters for changes which have occurred after the reserves were established. Our objectives were to establish baseline estimates of the fish assemblages associated with bottom features within each MPA, especially for species of groupers and snappers, describe significant habitat features in the Madison-Swanson and Steamboat Lumps MPAs, and document the relationship between habitat and species assemblages. The secondary objective was to locate spawning aggregations of gag (*Mycteroperca microlepis*), and scamp (*Mycteroperca phenax*).

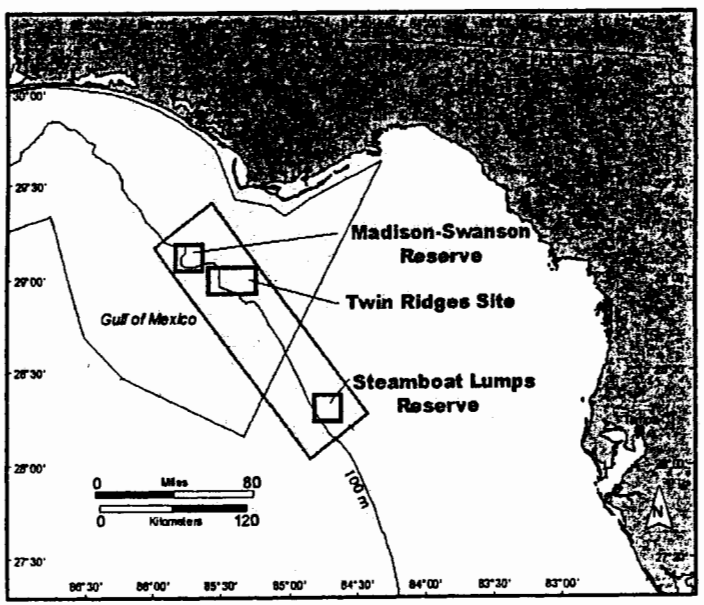

Figure 1. Location of Madison Swanson and Steamboat Lumps MPAs.

METHODS

The Madison-Swanson and Steamboat Lumps MPAs were mapped using side-scan sonar (Scanlon et. al. USGS, Woods Hole, unpublished data.), and multibeam sonar (Gardner et al. 2001). The MPAs were stratified using bathymetry, acoustic backscatter, and features apparent on multibeam and side-scan mosaics. Madison-Swanson was divided into seven strata:

i) Northeast (51 km²),
ii) Ridge (4 km²),
iii) Central (140 km²),
iv) Pinnacles (18 km²),
v) Mounds (1 km²),
vi) Snake feature (1 km²), and
vii) Northwest (2 km²).

Steamboat Lumps was divided into five strata:

i) Northeast (105 km²),
ii) Pits (1 km²),
iii) Central (200 km²),
iv) South Paleo-shore (12 km²), and 5
v) Ridge (3 km²).

The areas (km²) were estimated for each stratum, and used for stratum weights in estimators of fish abundance. We used a stationary video camera array to determine the relative abundance of fish within each MPA. Two different camera arrays were used. In March, 2001, Madison-Swanson was sampled with an array comprised of four Sony Hi-8mm video cameras mounted orthogonally at a height of 30 cm above the bottom of the array. The remaining surveys employed either Sony VX1000 or Sony VX2000 digital camcorders. The camera arrays were allowed to soak on the bottom for at least thirty minutes. This ensured twenty minutes of video tape, which was viewed with all fish identified to the lowest discernable taxonomic level. The estimator of abundance was the maximum number of fish of each species in the field of view at any time during the twenty-minute video tape. Stratified means and variances were calculated (Cochran 1977). We also employed an ROV, chevron fish trap, and hook and line gear to collect fish for age and growth studies. However, only used video data is reported in this paper.

RESULTS

Forty-three sites were examined within Madison-Swanson in 2001, and fifty-one sites in 2002. Spawning, aggregations of gag and scamp were confirmed at sites located along the pinnacles in both 2001 and 2002. Substrate at all sites was dominated by sand-clay, with rock and soft-coral found primarily along a ridge located at the 74 m isobath (Stratum2), the pinnacles (Stratum 4) and at a topographic feature we named the snake (Stratum 6) (Table 1). A total of 55 taxa were observed in 2001, and 64 taxa were observed in 2002 (Figure 2).

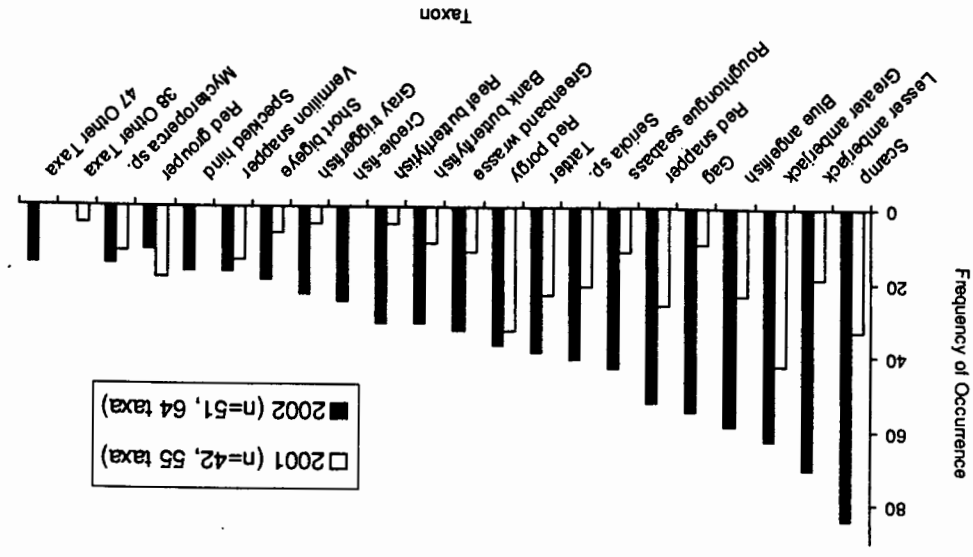

Figure 2. Most frequently observed taxa at Madison-Swanson MPA during 2001 and 2002 surveys

Table 1. Substrate percent composition discerned from video at stations sampled within Madison-Swanson (n = 93) and Steamboat Lumps (n = 63) MPAs during 2001 and 2002.

		Substrates								
MPA	**Stratum**	**Sand-Clay**	**Shell-gravel**	**Rock**	**Coral**	**Soft-coral**	**Sponge**	**Seawhips**	**Algae**	**Sessiles**
Madison-Swanson	1-NE	73.78	17.67	-	-	2.33	0.22	0.11	1.22	4.67
	2-Ridge	40.04	5.84	29.68	-	14.20	0.36	0.60	2.64	6.52
	3-Central	82.50	5.83	1.67	-	4.17	-	2.33	0.00	3.50
	4-Pinnacle	43.27	9.59	20.00	0.62	16.54	-	1.54	2.03	5.51
	5-Mounds	90.50	3.75	-	-	3.75	-	-	-	1.25
	6-Snake	70.17	5.00	7.50	-	10.50	-	0.33	2.67	3.33
	7-NW	95.33	2.33	-	-	-	-	-	-	2.33
Steamboat Lumps	1-NE	88.28	88.28	6.72	0.72	0.72	-	-	0.11	1.78
	2-Pits	79.00	79.00	6.60	1.30	0.20	-	-	8.20	4.70
	3-Cental	91.32	91.32	5.21	0.68	0.32	-	0.11	0.63	1.79
	4-S Shore	94.86	94.86	1.86	0.00	0.43	-	0.00	0.86	2.00
	5-Ridge	60.25	60.25	12.50	3.50	6.75	1.00	0.30	9.75	6.00

Scamp (*Mycteroperca phenax*), lesser amberjack (*Seriola fasciata*), greater amberjack (*S. dumerili*), blue angelfish (*Holacanthus bermudensis*), gag, and red snapper (*Lutjanus campechanus*) were the most frequently observed taxa (Figure 2). Other species included red porgy (*Pagrus pagrus*), vermilion snapper (*Rhomboplites aurorubens*) and red grouper (*Epinephelus morio*). Frequency of occurrence of these species, and most of the top twenty taxa were generally higher in 2002 than in 2001. The abundances of snappers and groupers were highest at the ridge, pinnacles and snake features (Table 2). The mounds and northwest strata were not sampled in 2002, so those strata were not used in estimates of stratified mean abundance. Mean abundance of snappers and groupers ranged from 0.1 fish to 3 fish per site (Table 3). The estimates of scamp, gag, and red grouper abundance all increased from 2001 to 2002.

Forty-three sites within Steamboat Lumps MPA were sampled in 2001, and 20 sites in 2002. Since all sampling was conducted during the summer and after gag and scamp spawn, no aggregations were observed. Substrate within all strata was dominated by sand-clay (Table 1). The most diverse substrate composition was found at the ridge (Stratum 5). A total of 53 taxa were observed in 2001, with 50 taxa observed in 2002 (Figure 3). Red porgy, tattler (*Serranus phoebe*), flatfish (Bothidae), vermilion snapper, and bank seabass (*Centropristes ocyurus*) were observed with the highest frequency (Figure 3). Species of grouper and snapper were observed in the greatest abundance at the ridge located at the 74-m isobath (Stratum 5), and a nearby area with pits (stratum 2) (Table 2). These areas were small, with an estimated area of 3 km² for the ridge and 1 km² for the pits (Stratum 2). Stratified mean abundance for groupers and snappers were lower in Steamboat Lumps than within Madison-Swanson (Tables 3 and 4). Mean abundances within Steamboat Lumps were near-zero for most of the grouper-snapper species. Among groupers and snappers, scamp had the largest abundance (1.5 fish per site in 2002), but overall, red porgy abundance was highest at 4.7 fish per site in 2002. Abundances were generally greater in 2002 than 2001 (Table 4).

Table 2. Mean counts of groupers and snappers by stratum observed at Madison-Swanson and Steamboat Lumps MPAs during 2001 and 2001 surveys.

MPA	STRATA															
Madison-Swanson	1-NE (n = 9)		2-Ridge (n = 26)		3-Central (n = 6)		4-Pinnacles (n = 40)		5-Mounds (n = 4)		6-Snake (n = 6)		7-NW (n = 3)	
	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE
Epinephelus sp.	-	-	-	-	-	-	0.03	0.03	-	-	-	-	-	-
Snowy grouper	-	-	-	-	-	-	0.05	0.05	-	-	-	-	-	-
Warsaw grouper	-	-	-	-	-	-	-	-	-	-	-	-	0.33	0.33
Speckled hind	-	-	0.24	0.09	-	-	0.13	0.08	-	-	-	-	-	-
Red grouper	0.44	0.18	0.20	0.10	0.50	0.22	0.08	0.04	-	-	-	-	-	-
Mycteroperca sp.	-	-	0.04	0.04	0.50	0.34	0.30	0.13	-	-	0.33	0.21	-	-
Gag	-	-	0.32	0.11	0.33	0.21	1.00	0.21	-	-	1.50	0.81	-	-
Scamp	0.78	0.38	2.16	0.52	1.50	0.81	2.83	0.41	1.00	1.00	5.00	1.61	-	-
Lutjanus sp.	-	-	-	-	-	-	-	-	-	-	0.17	0.17	-	-
Red snapper	3.33	3.09	2.16	0.74	0.17	0.17	1.15	0.35	-	-	0.17	0.17	0.33	0.33
Vermilion snapper	-	-	8.04	2.62	-	-	0.08	0.06			5.00	2.97	1.33	1.33
Red porgy	-	-	1.96	0.70	-	-	0.70	0.27	1.00	1.00	7.50	2.47	2.00	2.00
Steamboat Lumps	1-NE (n=19)		2-Pits (n=9)		3-Central (n=19)		4-S Shore (n=7)		5-Ridge (n=8)					
	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE				
Red grouper	-	-	0.33	0.33	0.05	0.05	-	-	0.13	0.13				
Mycteroperca sp.	-	-	0.33	0.33	-	-	-	-	0.38	0.18				
Gag	-	-	-	-	-	-	-	-	0.25	0.16				
Scamp	-	-	0.78	0.66	0.37	0.37	-	-	2.88	0.72				
Red snapper	-	-	0.11	0.11	-	-	-	-	-	-				
Vermilion snapper	-	-	16.22	6.11	-	-	-	-	1.88	1.26				
Red porgy	0.05	0.05	8.67	1.70	0.95	0.95	1.29	0.89	7.75	2.66				

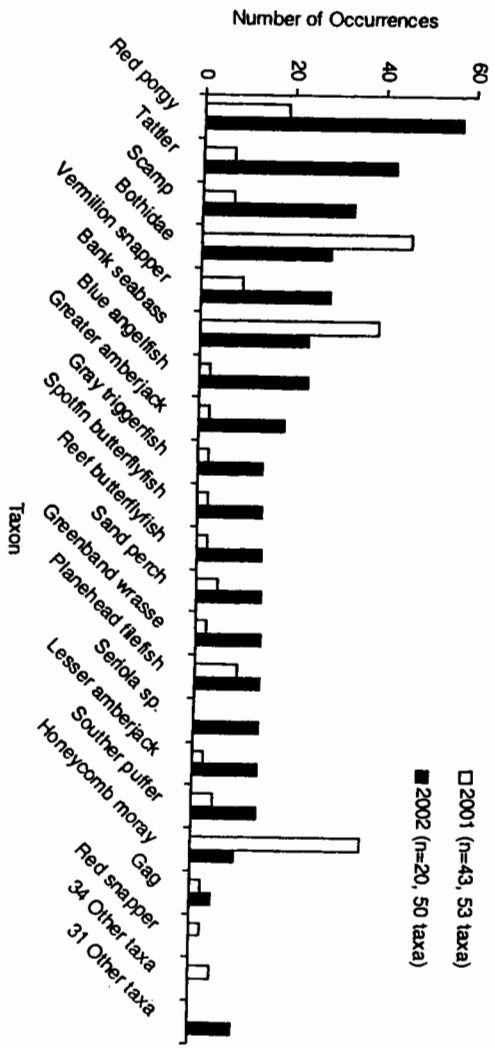

Figure 3. Most frequently observed taxa at Steamboat Lumps MPA during 2001 and 2002 surveys

Table 3. Stratified mean counts of groupers and snappers observed at Madison-Swanson MPA during 2001 and 2002 (Strata 1,2,3,4, and 6 only).

	2001			2002		
	n	Mean	V_{str}	n	Mean	V_{str}
Epinephelus sp.	35	-	-	51	0.003	0.00001
Snowy grouper	35	-	-	51	0.006	0.00002
Speckled hind	35	-	-	51	0.148	0.0001
Red grouper	35	0.397	0.029	51	0.747	0.0063
Mycteroperca sp.	35	0.281	0.069	51	0.684	0.0002
Gag	35	0.150	0.017	51	0.787	0.0005
Scamp	35	0.982	0.273	51	3.088	0.008
Lutjanus sp.	35	0.001	0.0001	51	-	-
Red snapper	35	1.302	1.254	51	0.332	0.027
Vermilion snapper	35	0.089	0.002	51	0.228	0.005
Red porgy	35	1.409	0.128	51	2.042	3.636

Table 4. Stratified mean counts of groupers and snappers observed at Steamboat Lumps MPA during 2001 and 2002.

	2001			2002		
	n	Mean	V_{str}	n	Mean	V_{str}
Red grouper	43	0.002	0.00001	20	0.210	0.043
Mycteroperca sp.	43	0.005	0.00002	20	0.004	0.00001
Gag	43	0.003	0.00001	20	0.002	0.00001
Scamp	43	0.019	0.0002	20	1.489	2.114
Red snapper	43	0.0008	0.00001	20	-	-
Vermilion snapper	43	0.104	0.0014	20	0.040	0.0005
Red porgy	43	0.479	0.080	20	4.65	1.12

DISCUSSION

Early work along the west Florida shelf focused on identifying locations of spawning habitat for gag (Koenig et al. 2000). Several areas along the west Florida shelf were considered as possible locations for establishing MPAs for protecting of gag spawning aggregations (see Figure 1 in Koenig et al. 2000), with the majority of the sites known to be established fishing grounds for the reef-fish fishery (Moe, 1963). The Gulf of Mexico Fishery Management Council selected the Madison-Swanson and Steamboat Lumps areas. The mapping and biological assessments of these MPAs along the west Florida shelf was a team effort between the National Marine Fisheries Service, the U.S. Geological Survey (USGS), Florida State University, and the University of South Florida (USF). Prior to sampling fish, each MPA was first mapped. Kathy Scanlon (USGS - Woods Hole, MA) produced side scan maps of the MPAs, James Gardner (USGS - Menlo Park, CA) produced multibeam maps of major portions of the same areas, and David Naar (USF - St. Petersburg, FL) completed the multibeam mapping of Madison-Swanson. Both the mapping work, and the biological sampling efforts we report indicate the distribution of reef fish is concentrated on hard-bottom features within each MPA. A larger

proportion of the bottom within Madison-Swanson was comprised of high-relief, hard-bottom features than was found at Steamboat Lumps. In Madison-Swanson, groupers and snappers were among the most frequently occurring and abundant taxa. This was not the case for Steamboat Lumps, where red porgy and tattler dominated the fish assemblage. Scamp were found at Steamboat Lumps, but their abundance was much lower than at Madison-Swanson. This difference in fish assemblage structure is most likely explained by the greater amount of high-relief habitat at Madison-Swanson. The MPAs have been in effect for two years. We have noticed an increase in some species of groupers during this time, however, two years do not necessarily indicate a trend. Previous work has shown that recovery of reef fish populations within established MPAs make take ten years or more (Russ and Alcala 1996).

One problem has been limited enforcement within the two MPAs. We have noticed during all of our sampling trips commercial vessels fishing within each reserve. The amount of fishing activity within each MPA is not known. This is of great concern since the ultimate success of any no-take MPA depends on strict enforcement of no-take regulations. Recently the US Coast Guard has increased enforcement patrols in the MPAs which has resulted in reduced levels of illegal fishing.

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