Characteristics of the Snapper-Grouper-Grunt Complex, Benthic Habitat Description, and Patterns of Reef Fish Recruitment at Sonnier Bank in the Northwestern Gulf of Mexico

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ABSTRACT

Bathymetric highs punctuate the continental shelf of the northwestern Gulf of Mexico, serving as important naturally occurring habitats for exploited fish species. Until recently, the reef fish assemblages, benthic communities, and fish recruitment patterns at these mid-shelf banks have been described only qualitatively. Consequently, data for monitoring ecological changes are limited. Since 2004, we have been addressing this gap at Sonnier Bank, designated an EFH Habitat Area of Particular Concern (HAPC) by the GMFMC. Surveys with SCUBA and a remotely operated vehicle (ROV) have characterized the snapper-grouper-grunt (SGG) complex as well as benthic composition. Between 2004 and 2005, the SGG complex was similar and dominated by *Lutjanus griseus*, *Rhomboplites aurorubens*, *Epinephelus adscensionis*, *Paranthias furcifer*, and *Haemulon aurolineatum*. In 2006, significant reductions in abundances of *P. furcifer* and *H. aurolineatum* and pronounced increases in *L. griseus* and *R. aurorubens* were observed. Also in 2006, we recorded newly recruited species that included juveniles of *L. buccanella*, *Mycteroperca phenax*, and *E. guttatus*. Though the benthos at Sonnier has been previously described as a *Millepora*-sponge community (>20 years ago), more than half of the benthic coverage was a mixture of algae species. Further, algal coverage increased in 2006. Recently, we have deployed artificial settlement structures to provide information on the composition of newly settled reef-fishes and the importance of predation.

KEY WORDS: snappers, groupers, grunts, Gulf of Mexico, coral banks, visual census

Características y Descripciones de los Hábitat Bénticos del Complejo Pargos-Meros-Roncadores y los patrones del reclutamiento de los peces arrecífales del banco Sonnier al Noroeste del Golfo de México

Los colmos bathymetricos puntúan la plataforma continental del Golfo de México del noroeste, sirviendo como habitades importantes que ocurren naturalmente para la explotacion de especies de pesces. Hasta hace poco tiempo, las ensambladuras de pesces del filón, comunidades bénticas, y los patrones de reclutamiento de pesces en estos bancos mediados han sido solamente descritos cualitativamente. Por lo tanto, datos para supervisar cambios ecológicos son limitados. Desde 2004, hemos estado tratando este boquete en el banco de Sonnier, señalando una área de habitat de preocupación especial (HAPC) del EFH por el GMFMC. Los exámenes de buceo y un vehículo controlado remotamente (ROV) han caracterizado el complejo snapper-grouper-grunt (SGG) así como la composición béntica. Entre el 2004 y 2005, el complejo de SGG era similar y dominado por *Lutjanus griseus*, *Rhomboplites aurorubens*, *Epinephelus adscensionis*, *Paranthias furcifer*, y *Haemulon aurolineatum*. En el 2006, reducciones significativas en abundancias de *P. furcifer* and *H. aurolineatum* y aumentos pronunciados en *L. griseus* y *R. aurorubens* fueron observados. También en el 2006, registramos especies nuevamente reclutadas que incluyeron juveniles de *L. buccanella*, *Mycteroperca phenax*, y *E. guttatus*. Aunque el bentos en Sonnier se ha descrito previamente como una comunidad de la esponja-*Millepora* (hace mas de 20 años), más que la mitad de la cobertura béntica era una mezcla de especies de algas. Además, la cobertura algal crecio en el 2006. Recientemente, hemos desplegado estructuras de establecimiento artificiales para proporcionar información en la composición de pesces del filo'n nuevamente colocados y la importancia de la depredación.

PALABRAS CLAVES: Snapper-Grouper-Grunt, Golfo de México, bancos, censo visual

INTRODUCTION

Compared to low-relief soft-sediment environments that dominate the continental shelf of the northwestern Gulf of Mexico, hard banks support diverse fish and coral communities that represent important naturally occurring aggregation areas for species in the families Lutjanidae, Serranidae, and Haemulidae, i.e., the snapper-grouper-grunt (SGG) complex (Rezak et al. 1985, Dennis and Bright 1988). Most of these banks are unmonitored and their importance to critical life stages of fishery resources has not been quantified (Asch and Turgeon 2003, Coleman et al. 2004). We have been developing new information on one such bank, Sonnier Bank (approximate location: 28° 20'N, 92°27'W). In our initial surveys of Sonnier Bank (Kraus et al. 2006), we identified that the snapper-grouper-grunt complex was dominated by *Lutjanus griseus*, *Rhomboplites aurorubens*, *Paranthias furcifer*, *Epinephelus adscensionis*, and *Haemulon aurolineatum* at depths <31m.

At these same depths, benthic habitats were predominately composed of large patches of mixed algae species that were interspersed by *Millepora alcicornis*, *Neofibularia nolitangere*, *Ircinia strobilina*, and *Agelas clathrodes*. With subsequent surveys in 2005, we observed no significant changes in the fish community (except for a small but significant increase in density of *E. adscensionis*; Rooker et al. 2006). In addition, whereas Rezak et al. (1985) characterized the crest of Sonnier Bank as a "*Millepora*-Sponge Zone", our results indicated that it should be called more appropriately an Algae-*Millepora*-Sponge community. We report here on additional surveys from 2006, where we replicated surveys of the snapper-grouper-grunt complex and the benthos. We also present preliminary information on the use of artificial settlement structures to quantify recruitment of fishes at this site. Finally, after our surveys in 2005, Hurricane Rita passed within 30 km of Sonnier Bank as a category-4 storm on September 23rd; therefore, we consider storm perturbation as a potential factor contributing to the differences in the biological community that we observed in 2006.

METHODS

To quantify density of species in the SGG complex, we modified the stationary point count method of Bohnsack and Bannerot (1986), counting all SGG species within an imaginary cylinder of radius 5m. Divers visualized the cylinder and accuracy was checked against a 5m length of line placed on the bottom. In 2005, we conducted a total of 63 fish counts at the two main peaks. Samples were distributed among three depth zones which stratified our survey design (20 to 24m, 24 to 28m, and 28 to 32m). In 2006, we used a similar approach and were able to make 57 independent point counts. The surveys were conducted during summer months (June and August) in both years. For analysis, we normalized the count data to number per 100 m^2, and modeled these as a Poisson distribution with year (2005 and 2006), and depth (continuous covariate) as explanatory variables (using SAS/STAT(c) software version 9.0). To account for overdispersion in the data, we scaled the covariance matrix by the deviance (Kleinbaum et al., 1998). Depth effects were either inconsistent between years, influenced by a few observations (e.g., for *L. griseus* and *R. aurorubens*), or depth effects were slight (e.g., there is probably little ecological significance of a decline of 0.02 individuals with each meter increase in depth for *E. ascensionis*). Therefore in this report, we removed depth from the analysis. Significance level of alpha=0.05 was established prior to statistical hypothesis testing.

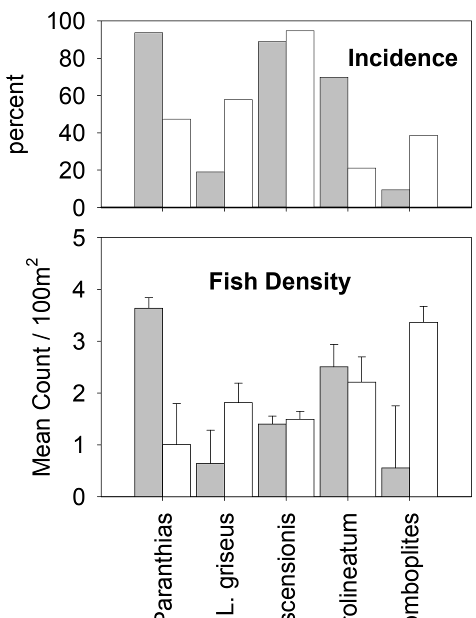

Figure 1. Density and incidence of the 5 most abundant species in the snapper-grouper-grunt complex at Sonnier Bank in 2005 (gray bars) and 2006 (open bars). Counts were made visually by SCUBA divers, and incidence is defined here as the proportion of counts where at least one of the species was observed. Error bars show the upper 95% confidence limit of the mean.

To quantify benthic habitat characteristics, we collected underwater photographs using quadrats (0.25 x 0.25 m square pvc frame) as a size reference. At each fish count location, a quadrat was placed in the center of the cylinder and photographed so that the pvc frame filled the picture, standardizing distance from the camera. Ideally, the frame was flipped over three times on different sides so that an entire square meter in the middle of the cylinder was recorded, but often fewer than 4 pictures were recorded due to limited dive times. Subsequently, we used image analysis software to outline benthic species and quantify 2-dimensional area. We analyzed a total of 161 and 76 photographs encompassing total areas of 26.8 and 19.2m^2, respectively from trips in 2005 and 2006. We examined two aspects of benthic species coverage in the images: fragment (or patch) size (cm^2) and percent coverage (total within the quadrat). These variables were analyzed with ANOVA using depth zone (same as defined for the fish counts, above), year, and their interaction as fixed effects.

We explored possible associations between benthic species composition and fish density using principle components analysis (PCA). Some pictures were poor quality and unusable for image analysis; therefore, matched records for fish density and benthic species composition represented a reduced data set for the PCA; only 91 of 120 total cases were included (note that multiple pictures characterize a single fish count - thus the difference between fish counts and pictures analyzed). We included 11 variables in the analysis (densities of the 5 most abundance fishes and % coverage of 6 categories of benthos), and examined the first three principal components. Standardized variables were used for the analysis.

We were also interested in the dynamics of fish recruitment at our study sites, which are unique in that they harbor a combination of sub-tropical species in the middle of their range and tropical species at the northern edge of their range. Therefore in 2006, we developed some initial density information on the recruitment of juveniles in the snapper-grouper-grunt complex and juvenile Pomacentridae using visual surveys of 0.25m^2 quadrats. In addition, we deployed artificial settlement structures that were designed to attract settling fishes by providing unoccupied space and which could be retrieved to collect fishes that colonized the structures. These structures were constructed from artificial coral heads (commercially available and made from polyester resin) that were fastened to a block of concrete. We enclosed some of the structures in a plastic mesh to exclude predators, and as a positive control treatment we cut large holes in the mesh of some structures to allow access to predators. We are currently processing the fish that we collected to determine daily ages from otoliths. As we have only conducted a single deployment of the structures, we present only the densities of Pomacentridae that colonized the structures as determined visually prior to retrieval, and we provide some comments on the feasibility of use of these structures.

RESULTS

In both years, the five most abundant species in the snapper-grouper-grunt complex were *Lutjanus griseus, Rhomboplites aurorubens*, *Paranthias furcifer, Epinephelus adscensionis*, and *Haemulon aurolineatum*. The inci-

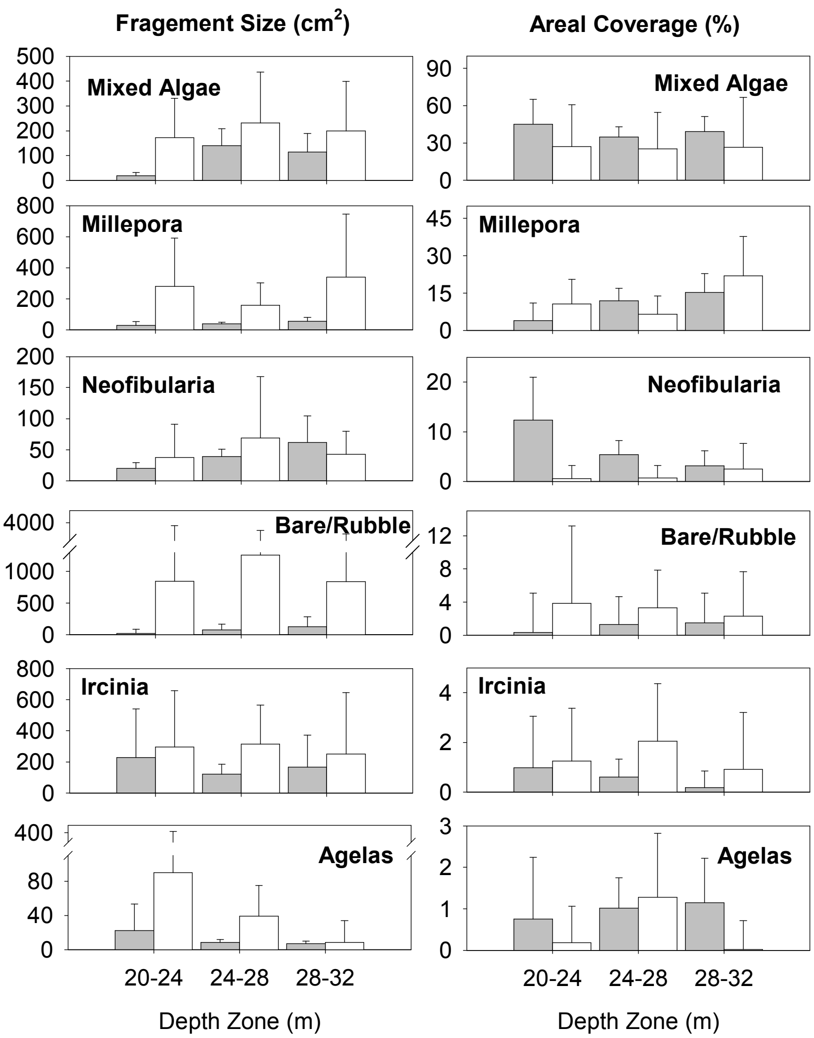

Figure 2. Inter-annual comparison of fragment size and percent coverage in the 6 most abundant categories of benthos, as determined from photographic surveys and image analysis. Error bars show the upper 95% confidence limit of the mean.

dence and density of *E. adscensionis* remained similar between years with an average density between 1 and 2 individuals per 100 m^2 observed at almost every count location (incidence = 89 to 95%; Figure 1). By comparison, the other four most abundant species showed considerable differences between years. Incidence declined 2 and 3-fold for *P. furcifer* and *H. aurolineatum*, respectively (Figure 1). Whereas the density of *P. furcifer* also declined significantly, indicating that abundance changed between years at our survey sites, the density of *H. aurolineatum* did not change significantly (Figure 1), indicating that *H. aurolineatum* were simply more aggregated in 2006. The dominant Lutjanidae were more abundant in 2006, with 2 to 3-fold higher incidence and density for *L. griseus* and *R. aurorubens*, respectively (Figure 1). We also noted the occurrence of juveniles (<10 cm standard length) of several species in the snapper-grouper-grunt complex that were only present in 2006. These juveniles were *L. buccanella*, *Cephalopholis cruentata*, *E. guttatus*, *Mycteroperca phenax*, *M. interstitialis*.

The benthic species composition was dominated by algal species that together typically made up between 35 and 45% of the total area of a quadrat. The parts of the pictures (called fragments in this report) that contained a mixture of algae species ranged in size on average between 20 and 230 cm^2 (Figure 2), and were comprised of crustose coralline algae, red filamentous algae, *Lobophora* sp., Y-branching algae, and green macro-algae. We have not yet identified each species of algae; therefore, each of these common name descriptors may include multiple species. Whereas the fragments of mixed algae were significantly larger in 2006 (especially at the shallowest depth zone), the total coverage was similar between years at all three depth zones (Figure 2).

The principal components analysis emphasized inter-annual trends and revealed associations between the benthos and the fish density data that were not immediately apparent in other analyses. The variability explained by the first three principal components was relatively low – only 45% of the total variance in these data. Still, the com-

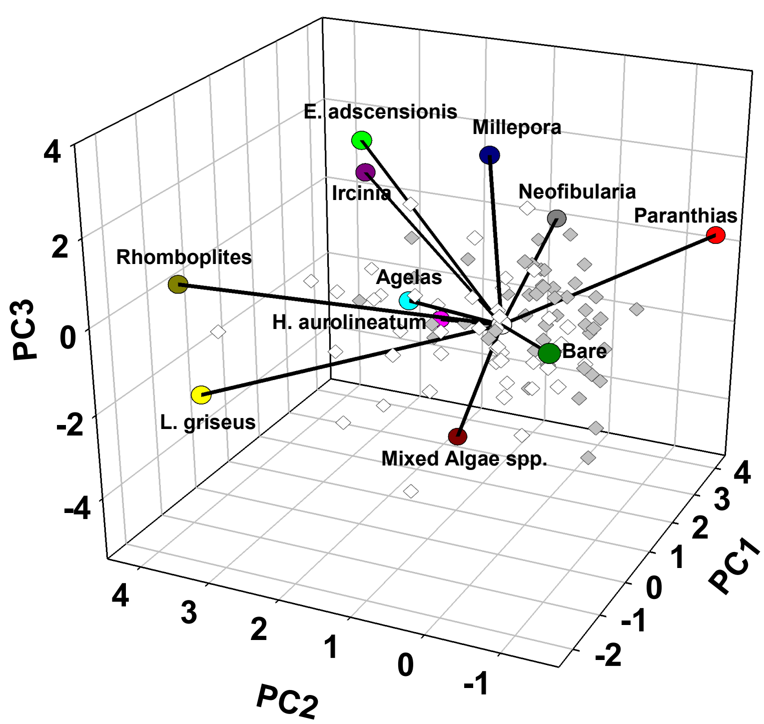

Figure 3. Principal components analysis of fish density and percent coverage of benthos. Only 45% of the variance in the data was explained by the first 3 principal components. Diamonds represent individual observations for 2005 (gray) and 2006 (open). Eigenvectors (black lines w/ circle endpoints) for each of the 11 variables included in the analysis have been multiplied 7-times in order to view them on the same plot with the component scores.

ponent scores showed separation between years that was indicative of the differences observed for individual fish species or categories of benthos. For example, opposite inter-annual trends were observed between *P. furcifer* and the two Lutjanidae; therefore, the vectors for these variables are in opposite directions corresponding to the years in which they had the highest densities (2006 for *R. aurorubens* and *L. griseus*, and 2005 for *P. furcifer*; Figure 3). In addition, the vectors for *E. adscensionis* and *I. strobilina*, for which point counts and image analysis showed no significant inter-annual changes, were oriented perpendicular to the inter-annual axis of separation between *P. furcifer* and the Lutjanidae. Further, the vectors for *E. adscensionis* and *I. strobilina* were oriented very close together showing positive correlation between density and % coverage in these two species, respectively.

The juvenile fishes collected from the artificial settlement structures are currently being analyzed in the laboratory. The visual survey results suggest that the fish community that becomes established on the artificial structures differs in composition and density from the natural substrate. For example, the densities of the four most abundant Pomacentridae were significantly higher in the quadrat surveys of natural areas compared to the densities on the artificial structures. The most abundant species were *Stegastes variabilis* and *S. leucostictus*, and density in natural areas was significantly higher than on the artificial structures (difference = 0.6 to 0.8 individuals per 0.25 m^2, respectively). Whereas mean density of *Chromis cyanea* observed in quadrat surveys of natural areas was 0.4 per 0.25 m^2, they were not recorded from the artificial structures. Slightly higher densities were also observed in natural areas for *C. scotti*, but the density was not significantly different from the artificial structures (0.3 per 0.25 m^2, pooled mean).

DISCUSSION

Previously, Rezak et al. (1985) characterized the crest habitats at Sonnier Bank as a "*Millepora*-sponge zone" remarking that crustose coralline algae are "rare" in this zone, but our more recent surveys show that the dominant category of the benthos is patches of mixed algae species that often included crustose coralline algae. It is not clear whether this difference indicates a change in the biological community because the surveys by Rezak et al. (1985) were expansive in scope (covering numerous sites and characterizing all aspects hydrological, geological and biological) and only qualitative in their assessment of the biological communities at these banks. We propose to amend Rezak et al.'s designation of the crest environment at Sonnier Bank, describing it instead as an Algae-*Millepora*-sponge zone. The high abundance of algae species in addition to the classification of other important benthic species as either *M. alcicornis* or sponges supports our proposition. The condition of Sonnier Bank as an Algae-*Millepora*-sponge zone does not match any another category (other than the *Millepora*-sponge zone) in the Rezak et al. typology of zone classification for banks in the Gulf of Mexico; therefore, Sonnier Bank may very well be fundamentally different from what Rezak et al. described more than 20 years ago. The quantitative results that we have presented will allow better assessment of long-term changes, as monitoring of Sonnier and similar banks seems to occur infrequently or is infrequently recorded in scientific literature. Finally, the changes in the benthos that we observed are consistent with perturbation due to storm action and may in part have been caused by Hurricane Rita in 2005. Still, the changes were minor and included predictable increases in algae and exposed bedrock and rubble and what appeared to be reduction of the sponge, *N. nolitangere*. This confirms Rezak et al.'s conclusion that although Sonnier Bank is subject to relatively high variability in physical conditions (compared to shelf-edge banks) and the occasional storm event, the benthic community is stable over long (geologic) time-scales.

On the other hand, the fish community is more dynamic, and differences that we observed in 2006 in the 5 major species of the snapper-grouper-grunt complex are not clearly linked to potential impacts from Hurricane Rita. Work by Patterson et al. (2001) has confirmed that storm events can play a major role in the redistribution of individuals across continental shelf habitats in the Gulf of Mexico. Highlighting the differences in 2006, our previous work indicated that the abundances of the five dominant species in the snapper-grouper-grunt complex were similar between 2004 and 2005, but the sample size in 2004 was only half as large as in 2005 (Rooker et al. 2006). As there are many other factors influencing the abundances of these species (e.g., fishing, natural predation, physical habitat changes not related to Rita), it is not yet possible to suggest that the changes are due to storm perturbation. In addition in 2006, we noted the appearance of newly recruited juveniles of several species in the snapper-grouper-grunt complex. Although for these species local information on spawning is not available, spawning periods for most of these would be expected to occur earlier in 2006 after the episodic effects of Hurricane Rita (for *E. adscensionis*, *C. cruentata*, *C. cephalopholis*, *C. guttaus, M. phenax,* and *M. interstitialis* see Bullock & Smith 1991, and for *L. buccanella* see Allen 1985). Sizes of these individuals also indicated that they were young-of-the-year, and we have ongoing work to age some of these individuals from otoliths to examine hatch dates.

A better understanding of aspects of fish recruitment at Sonnier Bank and other banks in the Gulf of Mexico is greatly needed. Some of the most important endeavors should include investigations of the role of larval supply and identification of source populations (from either genetics or otolith microchemistry) to understand the dynamics and structure of fish communities at these banks. In addition, Almany and Webster (2006) provided evidence that the early settlement phase of reef fish life can be a period of significant mortality (55% over the first few days). To better understand processes during this phase of recruitment, we developed artificial settlement structures designed to allow us to quantitatively sample new recruits and develop information on growth and survival during this phase. We will also be able to examine questions about source populations (from genetic markers), and additional standard ichthyoplankton surveys at the bank would address questions of larval supply. With the collection of several early juveniles of some important Serranidae, the results from the settlement structures are promising. In the near term, we have identified some design and logistical issues that should be straight-forward to correct. Primarily, with the current design we had to bag the structures from the top and then use a second bag that was carefully slid underneath the structure and first bag in order to retrieve the structure. We intend to modify the structures so that only one bag is necessary (reducing handling time and dive time), perhaps such that the first bag attaches to a skirt that is integrated into the structure.

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