Red Hind Data from Puerto Rico

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Abstract

Three sources of data are provided on the abundance and size distribution of red hind (*Epinephelus guttatus*) from western Puerto Rico and Mona Island. The data were obtained utilizing visual censuses by divers. During the first study surveys were conducted throughout Mona Island to determine the spatial distribution of coral reef fishes by ontogenetic stage in relation to the landscape configuration of benthic habitats in 2005. In the second study sampling was partially replicated in 2010 to determine temporal changes in the abundance and biomass of red hind in coral reef habitat at the Mona Island marine reserve. Finally data on the size distributions of red hind is available from a continuous monitoring project at two known spawning aggregation sites, one at Mona Island and the other at Abrir la Sierra on the insular platform of western Puerto Rico. The two main survey techniques used were belt transects and roving surveys (with and without GPS tracking) to estimate density and measure changes over time during the aggregation. The size of each individual was estimated visually during these surveys. These data were used to compare with the passive acoustic monitoring that has been going on for this species in western Puerto Rico since 2007. The quantity of sounds produced by red hind during territorial and courtship displays has demonstrated diel, daily and lunar temporal patterns that coincide with peak reproductive activity.

I. USING LANDSCAPE ECOLOGY TO DESCRIBE HABITAT CONNECTIVITY FOR CORAL REEF FISHES

Michelle T. Schärer-Umpierre (2009) PhD dissertation at the Department of Marine Sciences, Universtiy of Puerto Rico, Mayagüez, PR, 0068

Introduction

Landscape composition and habitat configuration were tested to explain the presence and abundance of ontogenetic stages of reef fishes. Mona Island's insular shelf was sampled by quantifying habitat metrics and fishes in 613, randomly stratified belt-transects (60 m^2). Nursery habitats (nearshore seagrass, hardbottom (bedrock), coral reef) were species-specific and cross-shelf ontogenetic migrations were identified for the coral reef fish assemblage.

Methodology

Underwater visual census (UVC) techniques were used to provide quantitative assessments of fish abundance. Belt transects (30 × 2 m) were sampled by divers at each sampling point selected randomly but stratified by habitat limited to 30 m in depth. Divers swam one way for 8–10 min along the transect line identifying and estimating the size of each fish observed within a distance of 2 m on each side of the line. After each belt transect, a 5-min roving survey was used to help better determine the presence and relative abundance of large and less abundant species. Divers were trained and the sampling methodology practiced prior to actual sampling to minimize biases inherent in UVC.

Study Site

Mona and Monito Islands are located in the Mona Passage between the Dominican Republic and Puerto Rico. The islands lie due east of Saona Island, southern Dominican Republic and due west of Puerto Real, Cabo Rojo in Puerto Rico (Figure 1). The Insular platform of Mona is located at longitude 67.89 W and latitude 18.09 N and measures approximately 81.6 km^2. Both islands lie on separate (by depths of 250 m) carbonate platforms formed approximately 15 million years ago (Late Miocene to early Pliocene) and uplifted from the seafloor due to tectonic movements. Mona Island occupies most of its insular platform (55 km^2), and only the southern half of the island is bordered by relatively shallow waters with coral reef and associated habitats.

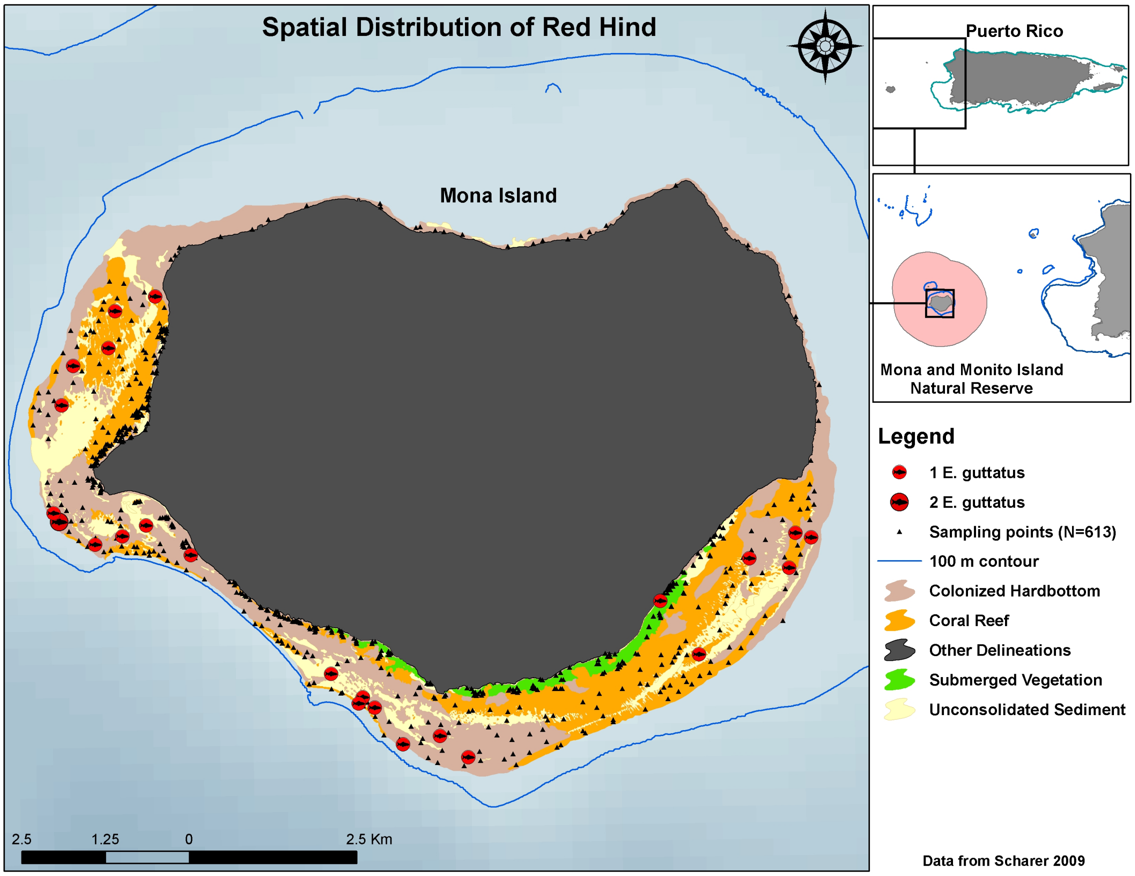

Figure 1. Sampling locations with red hind (*E. guttatus*) during 2005/2006 at Mona Island (Schärer 2009).

Results and Discussion

The frequency of occurrence for red hind in this study was 3.9%, and 25 individuals were observed overall. Due to the low number of red hind present within belt transects the complete ontogenetic migration patterns of this species could not be fully described. Nonetheless two very small early juvenile stages were observed: one in the rhizomes of a seagrass patch and one in a shallow rubble patch located in backreef zones near shore.

Density of red hind pooled for all habitat types was an average 0.068 individuals/100m^2 (SD = 0.0139 individuals/100m^2; N= 611) in 2006. For adult red hind observed within belt and in roving transects the main habitat types occupied were not high relief coral reef patches; twice as many observations were made in colonized pavement and colonized pavement with sand channels than in other habitat types (Figure 2). Therefore adult red hind at Mona Island were most commonly observed in habitats with low coral cover and medium structural relief.

Considering the low number of individuals sighted, the length frequency distribution of red hind at Mona Island (Figure 3). Required pooling all observations from both sampling methods (belt and roving) and both for the 2005 (Schärer 2009) and 2010 (Mateos-Molina 2011) studies. These data were not collected at the spawning aggregation site, although some sampling events were conducted during the spawning season, and the latter data were collected five years after supposed protection.

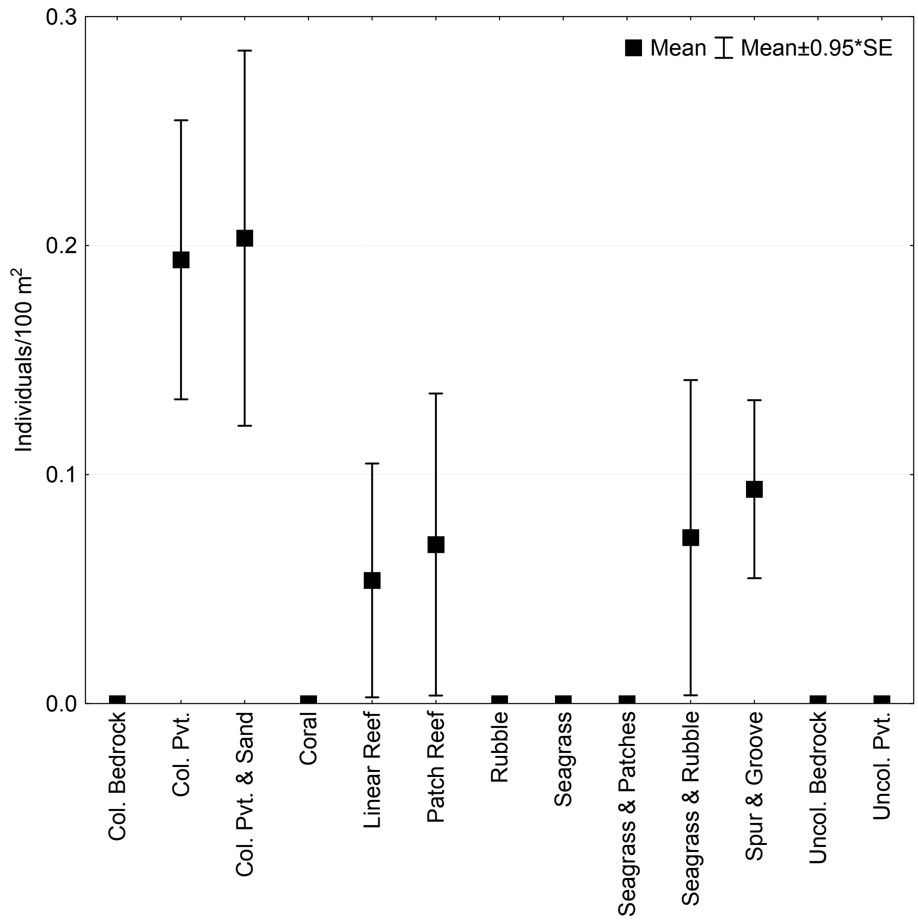

Figure 2. Density of red hind (*E. guttatus*) by habitat type at Mona Island, 2006 (N=611).

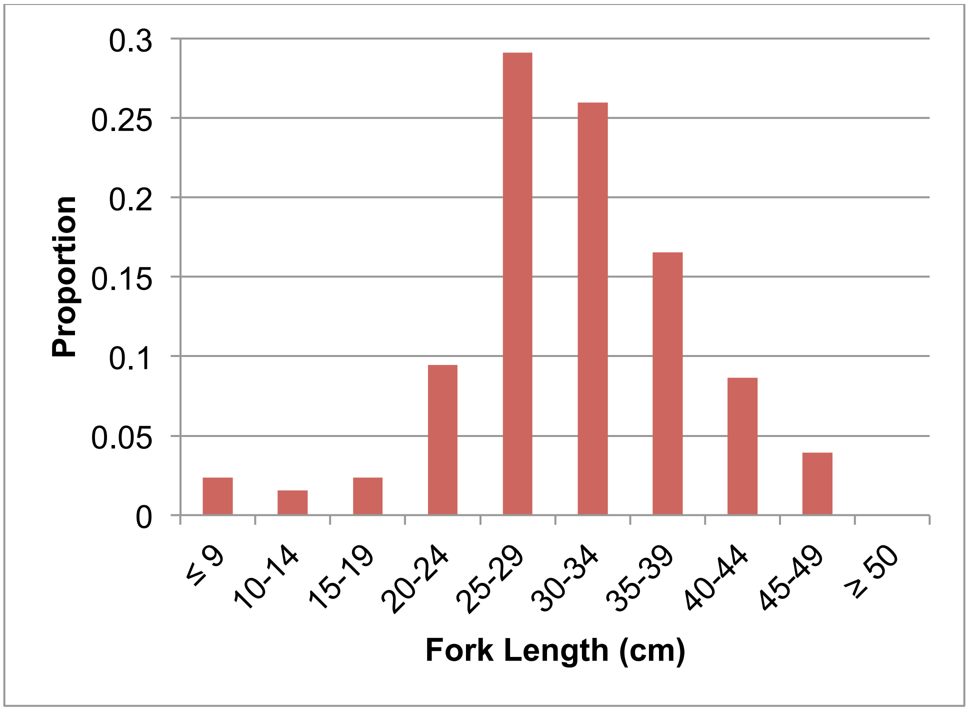

Figure 3. Red hind (*E. guttatus*) length frequency distribution for Mona Island based on visual estimates of in situ UVC sampled in all habitats during 2005 and only in coral reef habitats during 2010 (N=127).

II. ASSESSING THE EFFECTS OF MONA ISLAND MARINE PROTECTED AREA ON CORAL REEF FISHES

Daniel Mateos-Molina (2011) MS thesis at the Department of Marine Sciences, Universtiy of Puerto Rico, Mayagüez, PR, 0068

Introduction

In this study we assessed the effects of a no-take zone within the Mona Island marine protected area (MPA), located within the Mona Passage, a partial biogeographic barrier. We used the robust asymmetrical before-after-control-impact (BACI) design to evaluate changes in population size for fishery target species four years after designation. Data on fish abundance and size were collected within randomly placed belt transects and roving surveys. Permutational multivariate analysis of variance (PERMANOVA) and similarity percentages (SIMPER) were used to detect changes in the coral reef fish assemblage and community structure. Biological responses in abundance and biomass were calculated at different levels of the assemblage grouped by body size or ontogenetic stage. Additionally, univariate models provided insight on the magnitude and direction of NTZ effects.

Methodology

Underwater visual census (UVC) techniques were used to provide quantitative assessments of fish abundance, as they have little impact on the ecosystem and are therefore particularly suited for use in marine reserves. Baseline data for the initial time period, as well as the sampling design and intensity were from Schärer-Umpierre (2009). Belt transects (30 × 2 m) were sampled by SCUBA divers within each of the three sites within each location in coral reef habitat limited to between 10 and 20 m in depth. Divers swam one way for 8–10 min along the transect line identifying and estimating the size of each fish observed within a distance of 2 m on each side of the line. After each belt transect, a 5-min roving survey was used to help better determine the presence and relative abundance of large and less abundant species (*L. jocu, E. guttatus, E. striatus, M. tigris, M. venenosa)*. Divers were trained and the sampling methodology practiced prior to actual sampling to minimize biases inherent in UVC.

Study Site

The Mona Island Natural Reserve is the largest marine protected area (MPA) in Puerto Rico, with 266 km^2 of seafloor surface area (Figure 4). The MPA includes several habitat types: small lagoons of seagrass, shallow fringing reefs, deeper patch and spur-and-groove reefs along the eastern, southern and western shores. This MPA was established in 1986 (Aguilar-Perera et al. 2006) with the primary aim of protecting marine biodiversity, and favoring social and economic activities linked to the sea, especially recreational and commercial fisheries. A no-take zone (NTZ) was established within of the Mona Island MPA in 2004, extending 0.5 nautical miles (926 m) from shore around the island except a swath on the western coast where fishing was allowed. In 2007 this zone was modified to include areas up to the 100 fathom (182 m) depth contour (PR-DNER 2007).

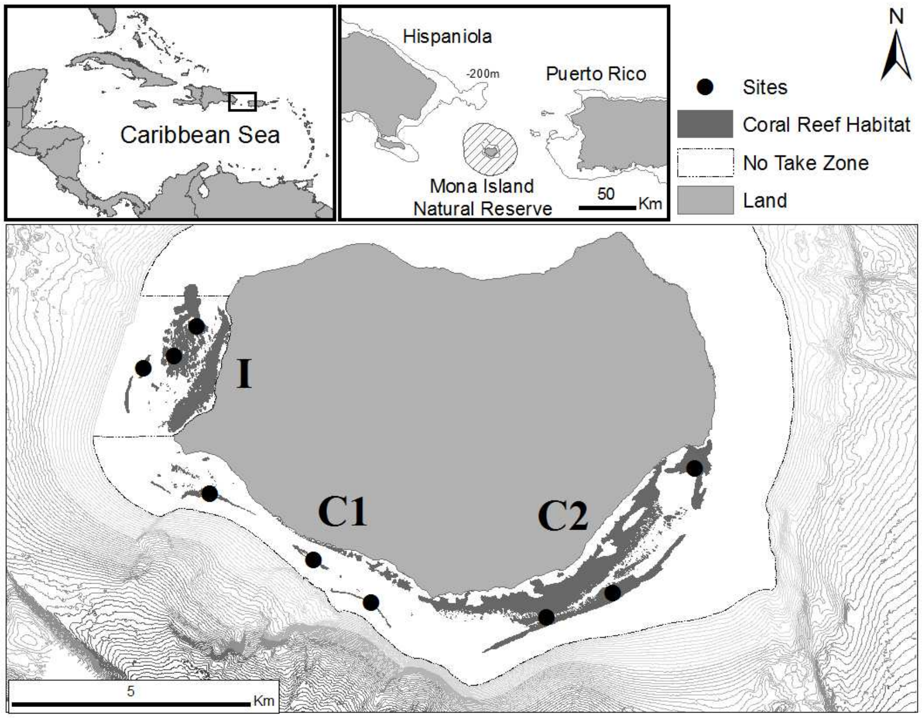

Figure 4. Sampling sites for BACI study on coral reef habitat at Mona Island (Mateos-Molina 2011).

Results and Discussion

Density of red hind in coral reef habitats was higher in the latter sampling, showing a potential reserve effect (Figure 5). The data revealed an increase over time in abundance from an average of 0.108 individuals/100m^2 (SD = 0.412 individuals/100m^2; N= 108) to an average of 0.169 individuals /100m^2 (SD = 0.642 individuals/100m^2; N= 108) in transect surveys. In the same way, roving surveys showed an increase in the frequency of individuals per transect over time, from 10.2% to 17.6%. Both, roving and transect surveys, showed non-significant differences between two sampling times due to the high variability and high number of zeros in the data. Although, the raw data showed first signals of an effective NTZ for *E.guttatus*, further improvement of the data collection methods are needed to account for natural variability.

The power for the before BACI experimental design comes from repeated samples over time and long-time series. It is challenging to detect significant changes over only two sampling times in commercial species which are rare or found in very low abundances. Continuous monitoring to obtain data yearly is suggested and also, during the year at different times to eliminate potential seasonal effects due to reproductive migrations. GPS technology should be integrated in roving method to improve data precision and robustness, as well as the potential for spatial data analysis.

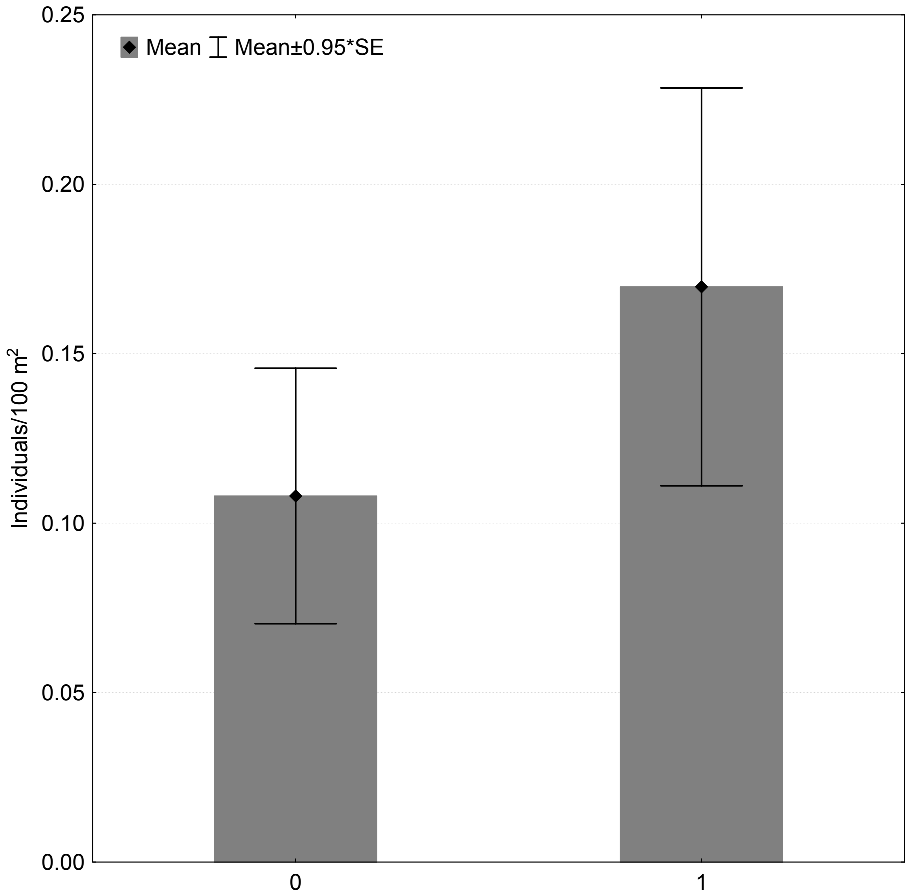

Figure 5. Density of red hind (individuals/100m^2) at Mona Island prior to (2005) and after (2010) marine reserve designation.

III. Spawning aggregation site monitoring at Mona Island and Abrir la Sierra, western Puerto Rico

Michelle T. Schärer - Umpierre Caribbean Coral Reef Institute Department of Marine Sciences, Universtiy of Puerto Rico, Mayagüez, PR, 0068
Tim Rowell - MS Thesis, 2012. Passive Acoustics as an Indicator of Red Hind, *Epinephelus guttatus*, Density at a Spawning Aggregation. Department of Marine Sciences, Universtiy of Puerto Rico, Mayagüez, PR, 0068
Richard Appeldoorn - Caribbean Coral Reef Institute Department of Marine Sciences, Universtiy of Puerto Rico, Mayagüez, PR, 0068

Introduction

Passive acoustic monitoring (PAM) has been used to detect the location (Rowell et al. 2011), timing (Appeldoorn et al. 2013) and temporal changes (Rowell et al. 2013) in the reproductive activity of red hind. The species-specific sounds produced during territorial and courtship displays (Mann et al. 2010) can be recorded at multiple sites continuously with recorders deployed on the seafloor. The fieldwork that was conducted during the studies to characterize the multi-species aggregation site at Mona (Schärer et al. 2012) and also data used to compare sound intensity and density at Abrir la Sierra (Rowell et al. 2012) generated a large dataset of observations of size and abundance over a series of years at two sites on the western platform of Puerto Rico.

Study Sites

Two distinct spawning aggregation sites are presented in this section. Abrir la Sierra on the western Puerto Rican insular platform and Mona Island located on a separate insular platform to the west (Figure 6). The aggregation site at Abrir la Sierra is situated at a depth of 20-30 m. The substratum is a low rugosity hard bottom that is sparsely colonized by sponges, gorgonians, and scleractinian corals with sandy patches in lower lying areas. At this site only red hind have been observed during the spawning season (Rivera et al 2011). At Mona Island the spawning site for red hind is located at the shelf break between 20 and 30 m depth, where the benthic habitat is dominated by low relief seafloor, colonized with scattered corals, octocorals, sponges and macroalgae interspersed with sand patches in slight depressions. The spawning site at Mona Island includes various species of groupers including *E. guttatus, M. venenosa, M. interstitialis* and *M. tigris,* although they are separated spatially and temporally (Nemeth et al., 2007). At least ten other reef fish species have been observed spawning at this site (Schärer et al., 2010). Currents can be strong at both sites, and generally flow parallel to the shelf break.

Currently the aggregation site at Mona Island is located within the boundary of a one-nautical mile no-take zone designated in 2004 (PR DRNA

2010). This area is supposed to be protected from fishing throughout the year. Abrir la Sierra and two other sites (Tourmaline and Bajo de Sico) have been closed to all fishing from 1 December to the last day of February in order to protect the red hind spawning aggregation (CMFC 1996). In 2004, a fishing ban on red hind during the spawning period was established for all PR waters (< 9 nm offshore) for the same time period and, in 2005 was expanded to include all PR and federal waters west of 67°10'W (Federal Register 2005, PR DRNA 2007 & 2010).

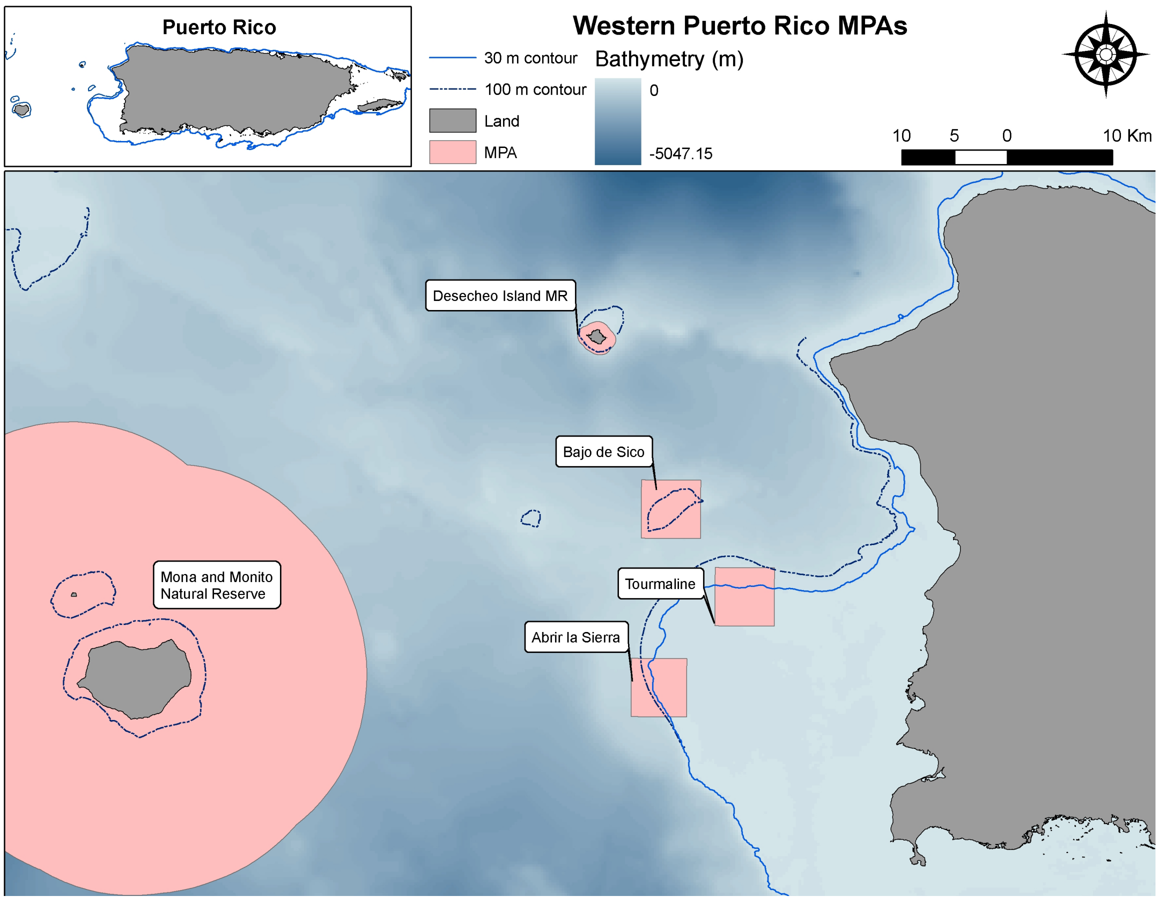

Figure 6. Mona Island and Abrir la Sierra located west of the Puerto Rico coastline.

Results and Discussion

Pooling all sampling times (2005 to 2012) the red hind fork length (FL) estimates are summarized for each spawning aggregation site (Mona Island and Abrir la Sierra) in the length frequency distributions (Figure 7). At ALS a greater proportion of smaller red hind are encountered at the spawning aggregation in comparison with Mona Island. These differences could be due to differences in the age of red hind at Mona Island, where fishing pressure is less intense or these are separate populations with different characteristics. Less than 10% of red hind at Abrir la Sierra are greater than 40 cm FL, while at Mona Island more than 28% of red hind at the aggregation site are greater than 40 cm FL. At Mona

Island's spawning aggregation site the average size of red hind is significantly larger (t-test p=0.00) than that of Abrir la Sierra. This difference may reflect different populations at each site, since the spawning peak times were also different, based on passive acoustic data collected simultaneously (Mann et al. 2010).

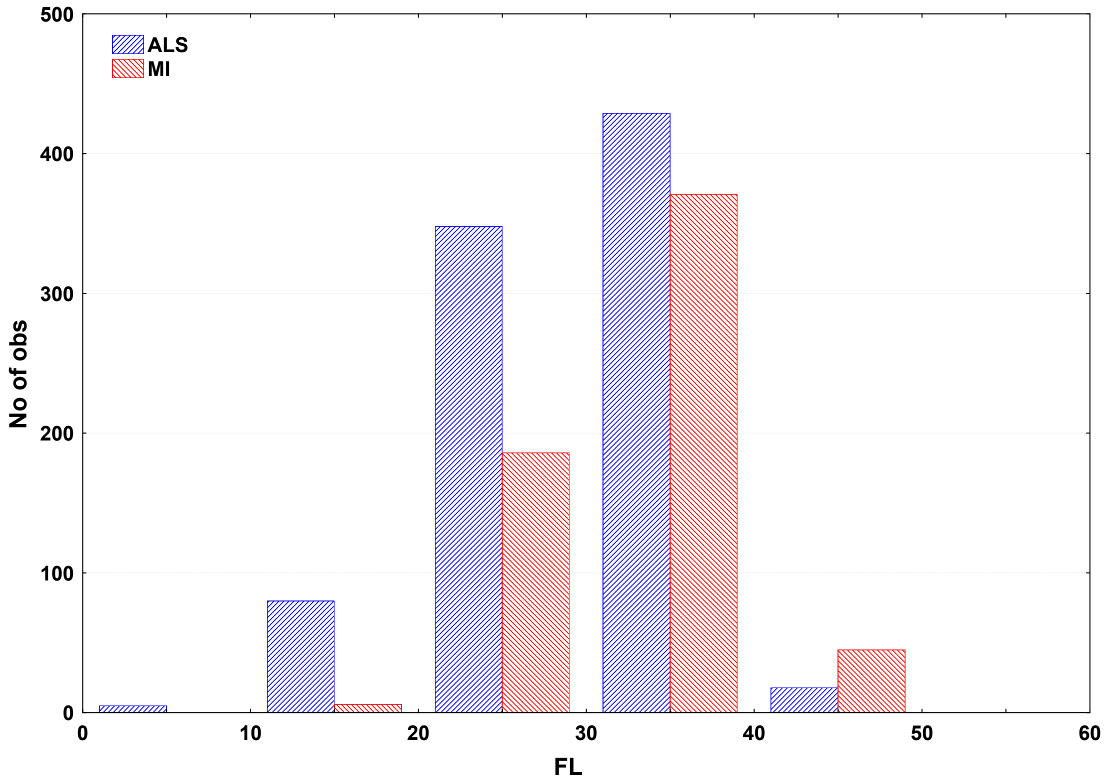

Figure 7. Size frequency distribution of red hind visual estimates for Abrir la Sierra (ALS, N=880) and Mona Island (MI, N=609) from 2005 to 2012.

The density of red hind during the spawning season is up to 5 times greater than background values, yet varies greatly due to the location or timing of sampling. Data collected from 2005 through 2012 indicate significant differences between sampling months due to the concentration effect of spawning aggregation dynamics. Most of the abundance data collected to date in underwater visual surveys at both these aggregation sites indicates January and February as the main spawning months, with considerable variability during December (Figure 8). However there has been very little sampling done *in-situ* during March and April.

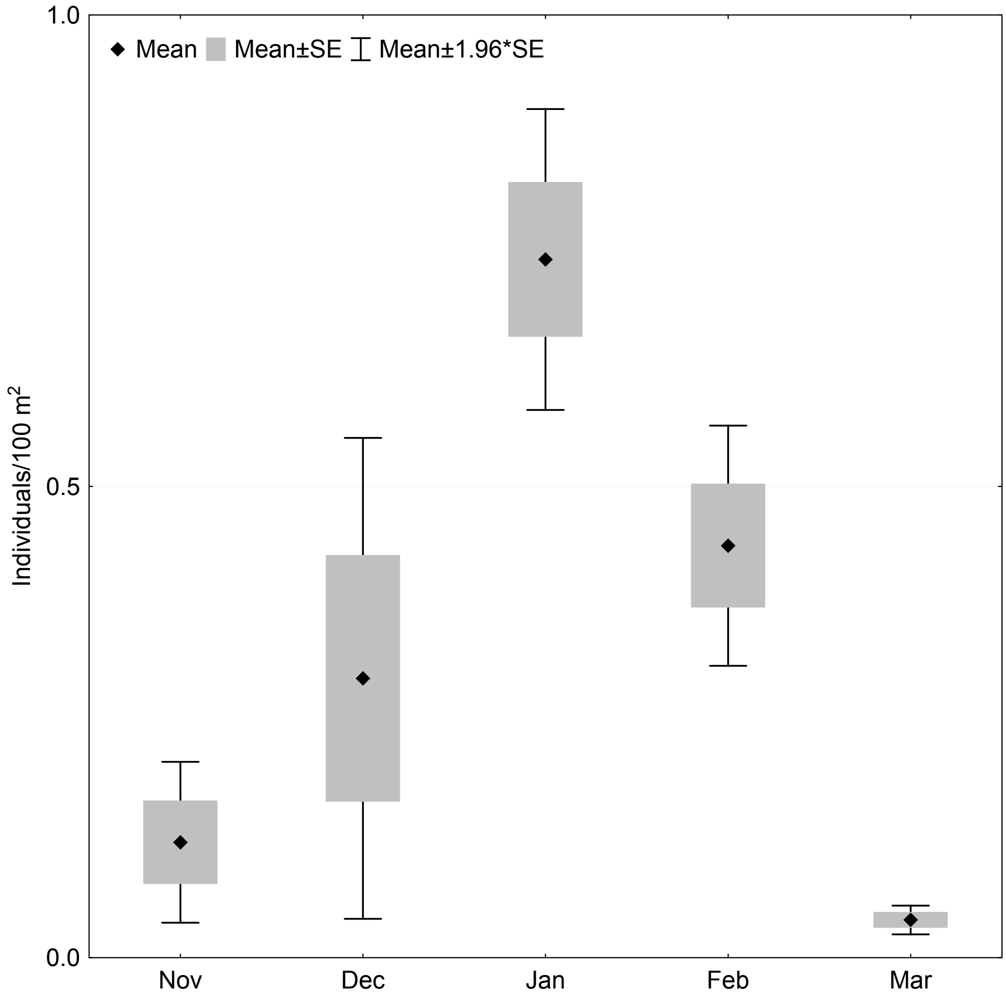

Figure 8. Density of red hind (*E. guttatus*) pooled for both spawning aggregation sites in western Puerto Rico by month (N=144).

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