South Atlantic marine protected areas: year six of an evaluation of habitat and fish assemblages in a network of reserves.

A report to the South Atlantic Fishery Management Council
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Abstract

The South Atlantic Fishery Management Council (SAFMC) and the National Oceanic and Atmospheric Administration (NOAA) have implemented a network of eight marine protected areas (MPAs) between Cape Hatteras, NC and the Florida Keys to protect seven species of grouper and tilefish, all members of the deepwater snapper-grouper complex. In May 2010, the NOAA Fisheries Laboratory in Panama City, FL completed its sixth annual survey of the MPA sites. Previously, four pre-closure surveys were conducted (2004, 2006-2008) and now two years of post-closure data have been collected (2009 and 2010). A remotely operated vehicle (ROV) was used to examine the areas with four main objectives: 1) establish estimates of species composition and fish abundance, especially for species of grouper and tilefish; 2) describe habitat features; 3) document the relationship between habitat and species assemblages; and 4) begin to investigate any changes in fish species composition and/or abundances between pre- and post-closure data as well as comparisons between areas inside and outside the MPAs. In 2010, we focused our survey on the Florida, Edisto, and northern South Carolina MPAs. Four of the targeted species were observed including; speckled hind (*Epinephelus drummondhayi*), yellowedge grouper (*Epinephelus flavolimbatus*), snowy grouper (*Epinephelus niveatus*), and blueline tilefish (*Caulolatilus microps*). While not all of the target species were observed, numerous other members of the snapper-grouper complex were present including seven different species of grouper, which is more than any year prior to the implementation of the fishery closures in early 2009. While lionfish (*Pterois volitans/miles*) abundances were down from 2009, they still remain relatively high as they were more abundant than the most common grouper, scamp (*Mycteroperca phenax*) at all surveyed MPAs. Gag grouper are an important species in the snapper-grouper complex and, while not targeted by these MPAs, were more abundant in 2010 than in any other survey year. This study has presented a unique opportunity to examine MPA sites before implementation of fishing restrictions, thus providing fishery managers with robust pre-closure data upon which efficacy evaluations of closures can be made.

Introduction

The South Atlantic Fishery Management Council (SAFMC) and the National Oceanic and Atmospheric Administration (NOAA) have implemented eight Type II marine protected areas (MPAs) between Cape Hatteras, NC and the Florida Keys to protect seven species of the deepwater snapper-grouper complex. These consist of five species of grouper; snowy grouper (*Epinephelus niveatus*), yellowedge grouper (*E. flavolimbatus*), warsaw grouper (*E. nigritu*)*)*, speckled hind (*E. drummondhayi*), and misty grouper (*E. mystacinus*) and two species of tilefish; tilefish (*Lopholatilus chamaeleonticeps*) and blueline tilefish (*Caulolatilus microps*). These species are considered to be at risk due to currently low stock densities and to life history characteristics which subject them to substantial fishing mortality. Based on recent stock assessments (SEDAR, 2004), four of these are considered to be overfished including snowy grouper, warsaw grouper, speckled hind, and tilefish. Yellowedge grouper are not considered overfished, and the status of misty grouper and blueline tilefish is unknown at this time. Life history characteristics of several of the targeted species make them more vulnerable to overfishing. Many are protogynous hermaphrodites with highly female-skewed sex ratios, even in unfished populations. 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 aggregation sites and are more easily caught than during non-spawning periods, leading to further skewing of the sex ratios (Gilmore and Jones, 1992; Coleman et al., 1996). The MPAs are known to contain habitat which supports populations of economically valuable reef fish including the seven target species and other reef-associated fishes. Our goal was to conduct examinations inside and outside the MPAs evaluating changes in abundance and distribution over time as well as relationships between habitat type and certain fish species. We focused our 2010 efforts on three of the natural hardbottom MPAs including Northern South Carolina (hereafter denoted as SC), Edisto (ED), and North Florida (FL) (Figure 1). In 2010, our logistics were complicated by NOAA's response to the DWH oil spill, and we were forced to pay for a charter vessel for the survey instead of using sponsored time on a NOAA vessel. This required scaling back the survey and we decided to eliminate the Snowy Wreck MPA off the coast of North Carolina from the survey because it has the least amount of habitat for the target species and the Georgia MPA because it was established primarily to protect tilefish. The primary tilefish habitat is the muddy slope area of the MPA for which we have no multibeam bathymetric maps and minimal local knowledge. Three of the eight proposed MPA sites have never been included since the inception of this survey in 2004, one artificial reef site off Charleston, SC and two sites off extreme southern Florida. The artificial reef site was excluded because the project focused on fish-habitat relationships in natural areas. The south Florida sites were excluded for logistical reasons related to their remoteness from the remaining five natural habitat sites in the South Atlantic Bight.

Early in 2007, the SAFMC announced the preferred alternatives for closure. In January 2009, the Council presented the final rule for review and the closures were implemented in February 2009. Since 2004, we have examined all of the potential alternatives for the MPAs (a total of 15 areas). Areas not selected for final MPA investiture remain in our sample site universe as open-to-fishing control areas. Within and adjacent to each MPA, we characterized habitat and documented fish species composition and abundances of all fish encountered with emphasis on economically important species. Our specific objectives were to: 1) establish estimates of reef

fish abundance and species composition associated with bottom features within and outside the MPAs; 2) describe habitat features within and outside MPAs; 3) document the relationship between habitat and species assemblages; and 4) begin to investigate any changes in fish species composition and/or abundances between pre- and post-closure data as well as inside compared to outside the MPAs. The majority of areas surveyed which were outside of the MPAs were inside one of the original alternatives which were not selected for closure. This project supplements similar work conducted in 2004, 2006 - 2009 which provided four years of pre-closure and one year of post-closure information on fish communities and habitats both inside and outside the MPAs. This report is National Marine Fisheries Service Panama City Laboratory Contribution Number 11-04.

Methods

Ideally, assessment of the efficacy of MPAs for increasing populations of economically valuable reef fish would entail a sequential approach of mapping, habitat delineation, and fishery surveys. High resolution maps are extremely crucial in site selection for this type of study. Multibeam maps, however, exist only for a small portion of the GA and SC MPAs. Sampling site selection for this cruise was based on these multibeam maps as well as results from previous cruises and information gathered from other researchers. The MPAs were designed to protect deep reef grouper and tilefish, which are structure-oriented fish, thus suspected hardbottom and reef sites were the primary targets.

The gear used to characterize habitat and estimate fish abundance was a remotely operated vehicle (ROV) owned and operated by the National Undersea Research Center (NURC) at the University of North Carolina at Wilmington (UNCW). High 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 from the surface to near the bottom and the ROV operated on a 30 m leash below the downweight which provided sufficient freedom of movement to investigate habitat features within visual range of the transect line. The downweight configuration allowed the ROV to drift 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 color digital video camera which provided continuous imaging data and a digital still camera used to produce high resolution, downward-looking images at set intervals for habitat classification purposes. These dives resulted in approximately 17 hours of underwater video documentation. The video footage was used to delineate and quantify habitat type as well as fish species presence and abundance within each habitat type both inside and outside the MPAs. Each dive was divided into 2 minute transects within individual habitat types. All fish within a 5 m radius of the transect line were identified to the lowest discernable taxonomic level and counted (5 m was determined as the maximum distance that fish could reasonably be identified). Average abundances of fish species inside versus outside each MPA were calculated by habitat type for the following: the target species of grouper and tilefish observed; the most abundant grouper species, scamp (*Mycteroperca phenax*); and lionfish (*Pterois volitans/miles*). The percentage of each habitat type occurring within the ROV transects inside and outside each MPA was also calculated.

Results and Conclusions

The cruise took place between 4 and 9 May 2010. A map displaying locations of ROV dives at all sampled MPAs is shown in Figure 1. The original cruise plan was to conduct ROV dives inside and outside each of the three selected MPAs. Inclement weather precluded some operations, only three dives were made at Edisto, one outside and two inside the MPA, and no dives were made outside the FL MPA. Sites outside the MPAs were either from proposed MPA alternatives which were not chosen for closure or in the immediate surrounding area.

A total of 17 ROV dives were made. The same five major habitats categories were identified from the dives and utilized in analysis as in previous years: 1) soft substrate/sand (hereafter denoted as SA), 2) 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 occasional cracks/crevices up to 2 m deep. LRO consisted of rock outcrops with < 1 m vertical 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. Not all habitats were observed in each MPA or control site; however some quantity of hardbottom was observed inside and outside each MPA. The percentage of each habitat type encountered for all MPAs and control areas can be seen in Table 2. Higher relief (MRO & HRL) was only observed inside the FL and SC MPAs.

Approximately 82 fish species were identified from the ROV dives, including four of the seven targeted reef fish; speckled hind, yellowedge grouper, snowy grouper, and blueline tilefish. Table 1 displays all the fish species present inside and outside each MPA. While not all of the target species were observed, numerous other member of the snapper-grouper complex were present including seven different species of grouper, which is more than any pre-closure survey year. Yellowedge grouper, snowy grouper, and blueline tilefish were only observed on the two deep dives (> 150m) completed. These deep dives displayed a significantly different suite of fish species compared to the majority of dives which were conducted in waters < 75m. Other fish species that were only observed in deeper water include: boarfish (*Antigonia* sp.), red hogfish (*Decodon puellaris*), Darwin's slimehead (*Gephyroberys darwinii*), apricot bass (*Plectranthias garrupellus*), and shortbeard codling (*Laemonema barbatulum*).

As expected, grouper and lionfish were found on all hardbottom habitats (PAV, LRO, MRO, and HRL) but not on sand. While lionfish abundances were down from 2009, they still were relatively high as they were more abundant than the most common grouper, scamp, at all surveyed MPAs. Lionfish were most abundant at the SC MPA site where they were more prevalent outside the MPA compared to inside (Figure 3). At the Ed MPA site, however, lionfish abundances did not significantly differ between inside and outside the MPA. Scamp was the most common grouper species observed and displayed the same trends as lionfish (Figure 4). Speckled hind were observed at the FL and ED MPAs only on hardbottom habitats except PAV (Figure 5). Speckled hind abundances were low and they were not observed inside the ED MPA. Snowy grouper and blueline tilefish were only observed on the two deep dives; one conducted inside the SC MPA and one outside the SC MPA. Both species were observed on the lower relief hardbottom habitats (PAV, LRO, and MRO) (Figure 6). Both species were rare, but more abundant inside the MPA compared to outside. Like the snowy grouper and blueline tilefish, yellowedge grouper were only observed in deeper waters. A single yellowedge was observed outside the SC MPA on PAV habitat.

Usually, examination of marine reserves does not begin until after the closures have been implemented. This study presented a unique opportunity to examine these areas before fishing restrictions were implemented allowing pre-closure data to be collected. The closures became effective in February 2009, thus four years of pre-closure data (2004, 2006, 2007, and 2008) have been acquired and we now have two years of post-closure data (2009 & 2010). As more post-closure data is collected, we will be able to compare the population levels of these sites under reduced fishing pressure.

Acknowledgements

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Table 1. Fish species presence (denoted with a X) observed with the ROV inside and outside all sampled MPAs (FL, SC, and ED). IN represents inside the MPA while OUT indicates outside the MPA. * denotes a member of the snapper-grouper complex. Those species in bold represent target species.

		FL	SC		ED	
Common Name	**Species Name**	**IN**	**IN**	**OUT**	**IN**	**OUT**
*almaco jack	*Seriola rivoliana*				X	
*amberjack	*Seriola* sp.	X	X		X	
angelfish	*Pomacanthus* sp.	X	X			
anthiids	Anthiinae	X	X	X		
apricot bass	*Plectranthias garrupellus*		X	X		
bandtail puffer	*Sphoeroides spengleri*		X	X	X	X
bank butterflyfish	*Chaetodon aya*	X	X		X	X
*bank sea bass	*Centropristis ocyurus*	X	X			
bicolor damselfish	*Pomacentrus partitus*		X	X		
bigeye	*Priacanthus arenatus*	X	X	X		
bignose shark	*Carcharhinus altimus*		X			
blackbar drum	*Paraques iwamotoi*	X	X	X		
blackbar soldierfish	*Myripristis jacobus*	X	X			
blue angelfish	*Holacanthus bermudensis*	X	X	X	X	X
blue goby	*Ioglossus calliurus*		X			
***blueline tilefish**	***Caulolatilus microps***		**X**	**X**		
bluespotted cornetfish	*Fistularia tabacaria*	X				
boarfish	*Antigonia* sp.		X	X		
burrfish	*Chilomycterus* sp.			X		
butterflyfish	*Chaetodon* sp.	X	X	X	X	
cardinal soldierfish	*Plectrypops retrospinus*		X			
cardinalfish	*Apogon* sp.		X	X		
cherubfish	*Centropyge argi*		X			
cornetfish	*Fistularia* sp.				X	
cowfish	*Lactophrys* sp.	X	X	X	X	
creole-fish	*Paranthias furcifer*	X	X			
cubbyu	*Equetus umbrosus*	X	X	X	X	X
damselfish	*Chromis* sp.	X	X		X	X
darwin's slimehead	*Gephyroberys darwinii*		X	X		
doctorfish	*Acanthurus chirurgus*	X	X	X		
flounder	Bothidae			X		
flying gurnard	*Dactylopterus volitans*	X	X			
french angelfish	*Pomacanthus paru*	X	X			
french butterflyfish	*Progathodes guyanensis*		X			
*gag	*Mycteroperca microlepis*	X	X	X		
gray angelfish	*Pomacentrus arcuatus*		X			
*graysby	*Epinephelus cruentatus*		X	X	X	X

		FL	SC		ED	
Common Name	**Species Name**	**IN**	**IN**	**OUT**	**IN**	**OUT**
greater soapfish	*Rypticus saponaceous*	X	X			
greenband wrasse	*Halichoeres bathyphilus*	X	X	X		
*grey triggerfish	*Balistes capriscus*	X	X	X	X	X
*grouper	*Epinephelus* sp.		X			
*grouper	*Mycteroperca* sp.					X
*grunt	*Haemulon* sp.	X		X	X	
hake	*Urophycis* sp.					X
*hogfish	*Lachnolaimus maximus*	X	X	X	X	X
honeycomb cowfish	*Lactophrys polygonia*		X		X	
jack-knife fish	*Equetus lanceolatus*		X		X	X
lionfish	*Pterois volitans*	X	X	X	X	X
lizardfish	*Synodus* sp.	X	X		X	
*margate	*Haemulon album*			X		
moray eel	*Gymnothorax* sp.				X	
moray eel	Muraenidae		X			
ocean surgeonfish	*Acanthurus bahianus*	X	X		X	X
orangeback bass	*Serranus annularis*	X	X		X	X
*porgy	*Calamus* sp.	X	X	X	X	X
*porgy	Sparidae		X			
puffer	Tetraodontidae	X				
purple reeffish	*Chromis scotti*	X	X		X	X
queen angelfish	*Holacanthus ciliaris*		X		X	
*queen triggerfish	*Balistes vetula*		X		X	
*red grouper	*Epinephelus morio*		X	X	X	
red hogfish	*Decodon puellaris*		X	X		
*red porgy	*Pagrus pagrus*	X	X	X	X	
reef butterflyfish	*Chaetodon sedentarius*	X	X	X	X	X
rock beauty	*Holacanthus tricolor*		X	X		X
roughtongue bass	*Pronotogrammus martinicensis*	X				
saddle bass	*Serranus notospilus*	X	X	X		
sand diver	*Synodus intermedius*			X		
sand tilefish	*Malacanthus plumieri*	X	X	X	X	
*scamp	*Mycteroperca phenax*	X	X	X	X	X
scorpionfish	Scorpaenidae		X	X		
scrawled cowfish	*Lactophrys quadricornis*	X		X		X
sea bass	*Serranus* sp.		X	X		
sea bass	Serranidae			X		
sharpnose puffer	*Canthigaster rostrata*	X	X	X	X	X
sharptail eel	*Myrichthys acuminatus*		X			
short bigeye	*Pristigenys alta*	X	X	X	X	X
shortbeard codling	*Laemonema barbatulum*			X		

		FL	SC		ED	
Common Name	**Species Name**	**IN**	**IN**	**OUT**	**IN**	**OUT**
*snapper	*Lutjanus* sp.	X	X			
snow bass	*Serranus chionaraia*	X				
***snowy grouper**	***Epinephelus niveatus***		**X**	**X**		
soldierfish	Holocentridae	X				X
***speckled hind**	***Epinephelus drummondhayi***	**X**				**X**
spiny puffer	Diodontidae	X			X	
spotfin butterflyfish	*Chaetodon ocellatus*	X	X	X	X	X
spotfin hogfish	*Bodianus pulchellus*	X	X	X	X	X
spotted goatfish	*Pseudupeneus maculatus*	X	X			
spotted moray eel	*Gymnothorax moringa*		X			
spotted snake eel	*Ophichthus ophis*					X
squirrelfish	*Holocentrus adscensionis*	X	X	X	X	X
squirrelfish	*Holocentrus* sp.	X	X	X	X	X
striped burrfish	*Chilomycterus schoepfi*					X
sunshinefish	*Chromis insolatus*	X	X	X		X
surgeonfish	*Acanthurus* sp	X	X			X
tattler	*Serranus phoebe*	X	X	X	X	X
*tomtate	*Haemulon aurolineatum*	X	X		X	X
twospot cardinalfish	*Apogon pseudomaculatus*		X			
*vermilion snapper	*Rhomboplites aurorubens*	X	X			
*white grunt	*Haemulon plumieri*		X	X		
wrasse	*Halichoeres* sp.	X	X	X	X	X
wrasse bass	*Liopropoma eukrines*	X	X	X		X
***yellowedge grouper**	***Epinephelus flavolimbatus***		**X**	**X**		
yellowhead wrasse	*Halichoeres garnoti*	X	X			X
yellowtail reeffish	*Chromis enchrysurus*	X	X	X	X	X

Figure 1. Map of ROV dives (pink circles) completed inside and outside the three surveyed MPAs in 2010.

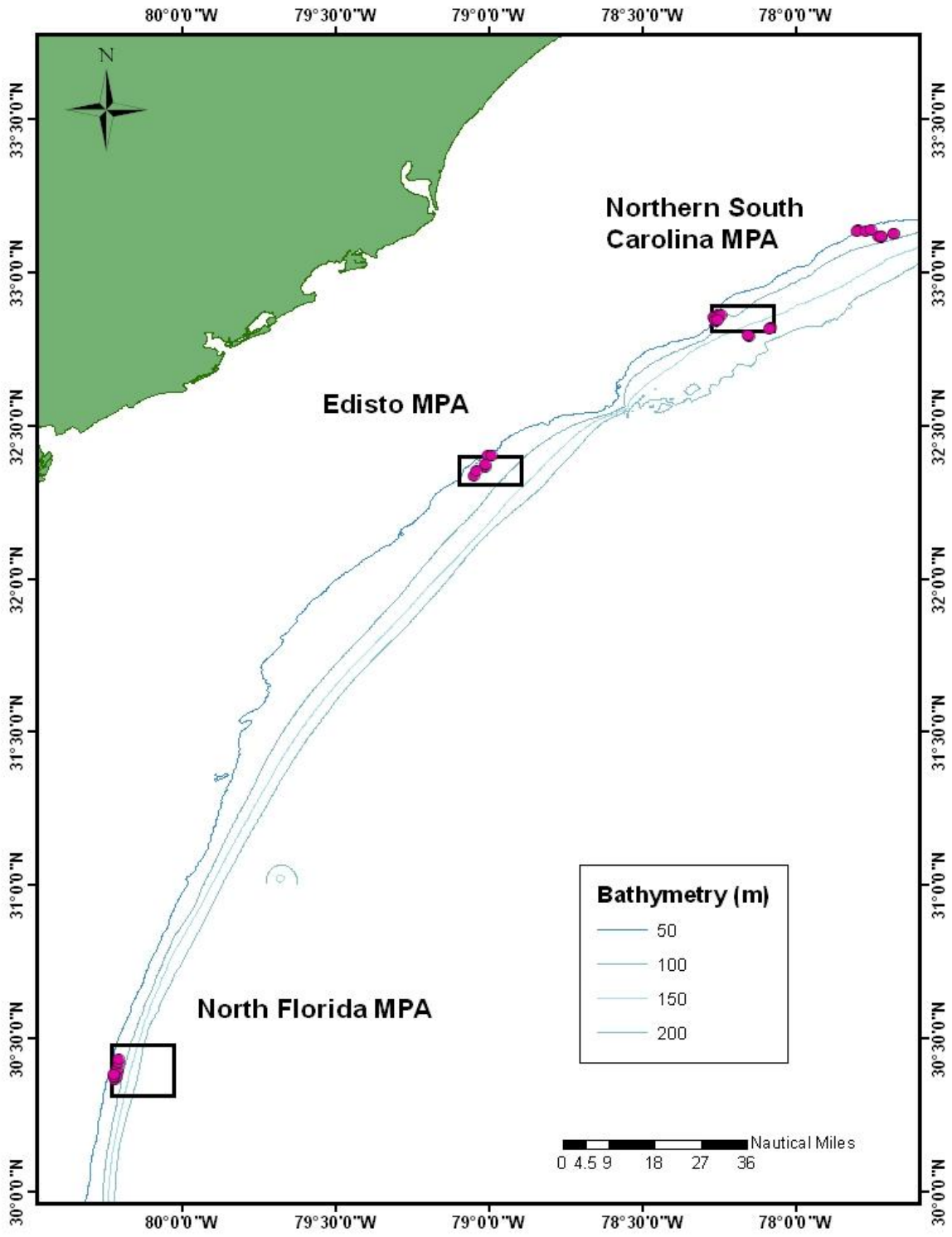

Figure 2. Breakdown of habitat types encountered on ROV transects inside and outside all sampled MPAs (FL, ED, and SC). IN denotes inside the MPA while OUT indicates outside the MPA. SA=sand, PAV=pavement, LRO=low relief outcrops, MRO=moderate relief outcrops, and HRL=high relief ledge.

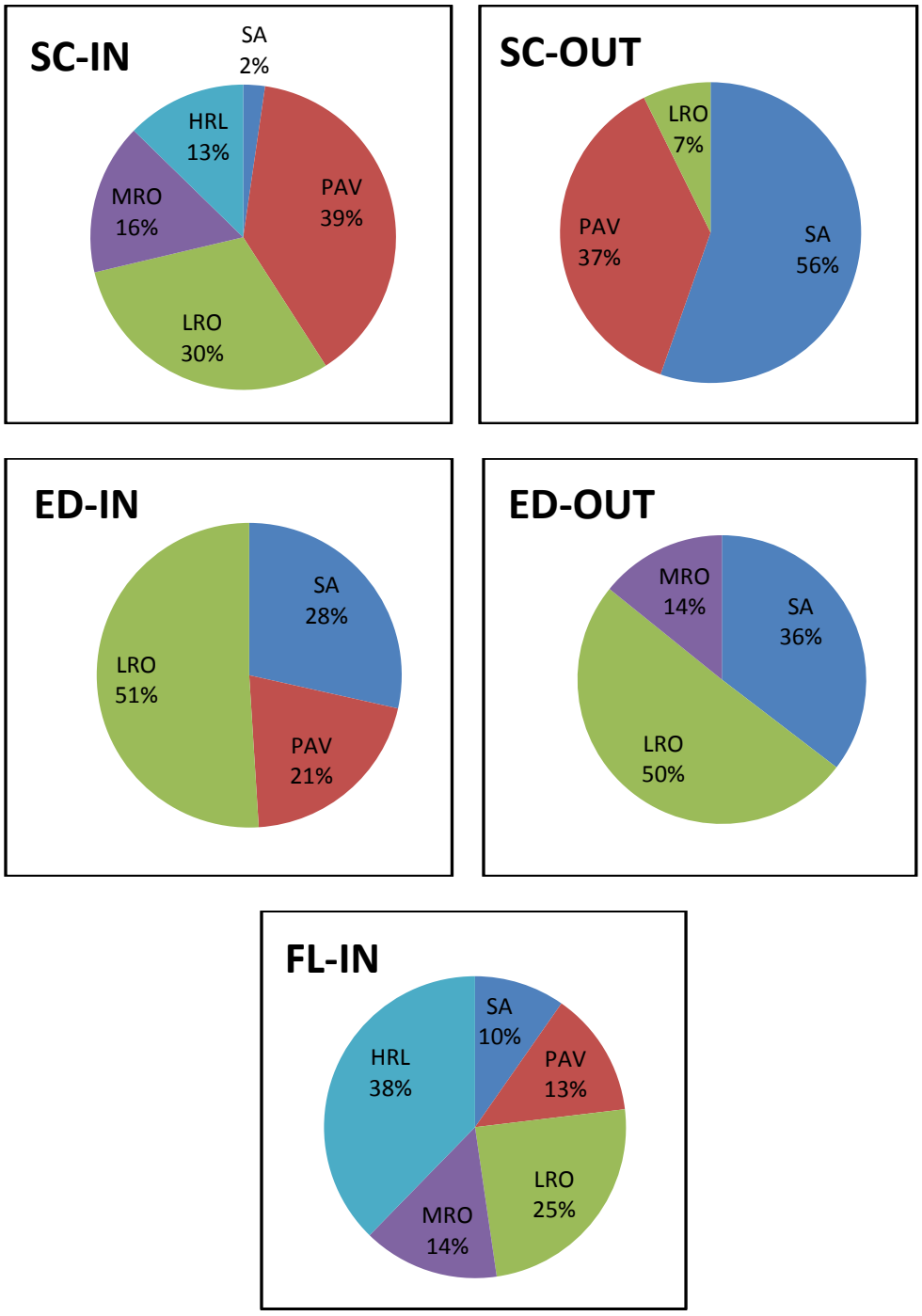

Figure 3. Average abundance (±S.E.) of lionfish inside versus outside each MPA by habitat type. PAV= pavement, LRO= low relief outcrops, MRO= moderate relief outcrops, and HRL= high relief ledge.

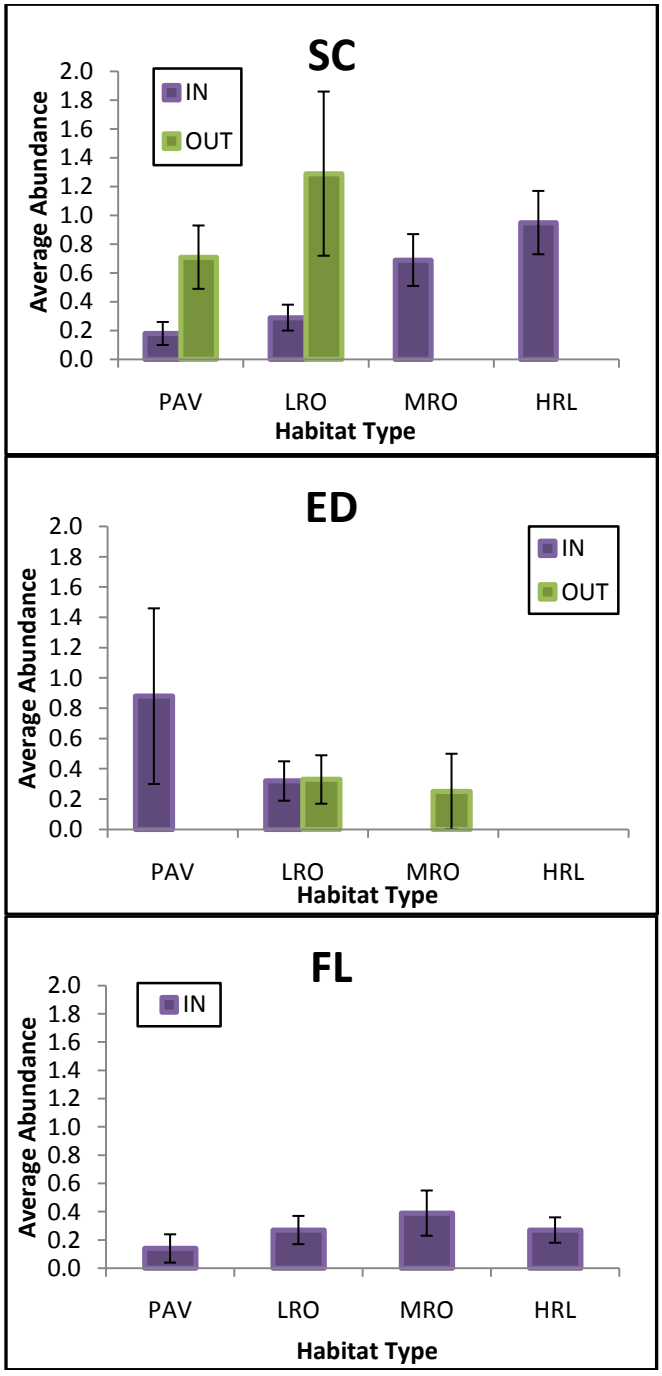

Figure 4. Average abundance (±S.E.) of scamp inside versus outside each MPA by habitat type. PAV= pavement, LRO= low relief outcrops, MRO= moderate relief outcrops, and HRL= high relief ledge.

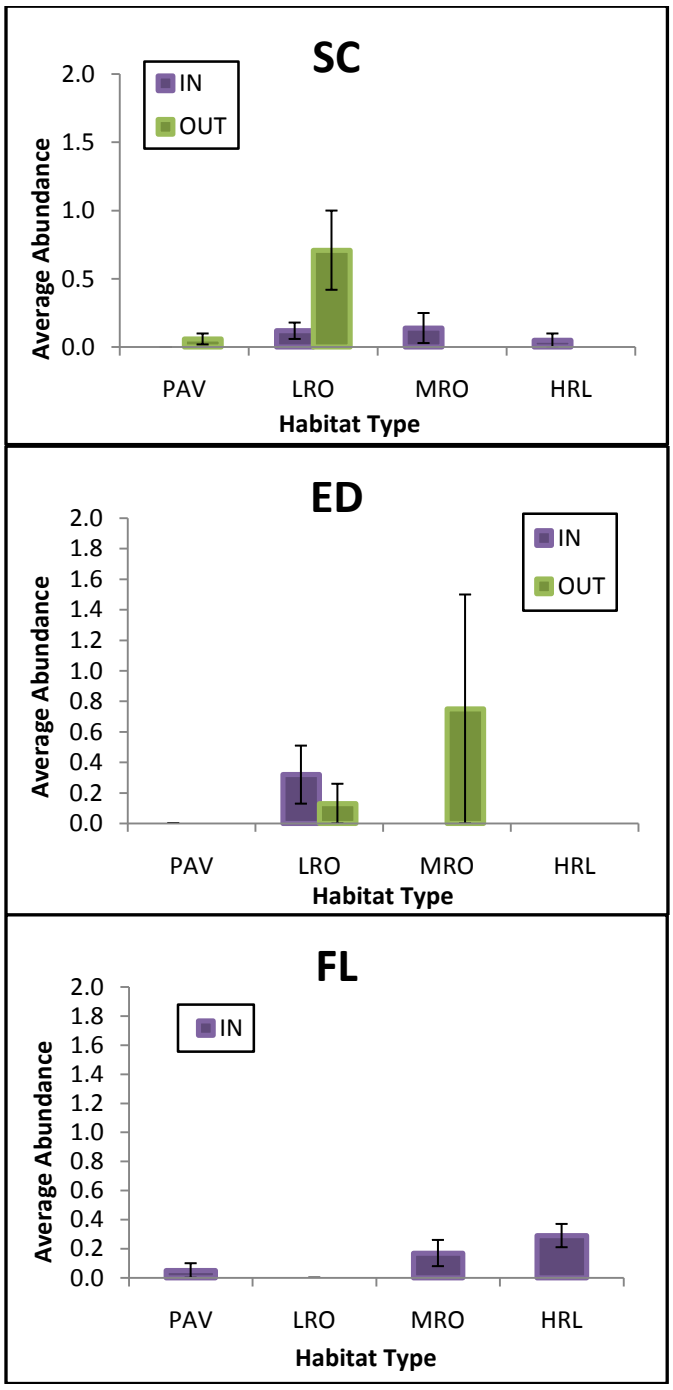

Figure 5. Average abundance (±S.E.) of speckled hind inside versus outside each MPA by habitat type. PAV= pavement, LRO= low relief outcrops, MRO= moderate relief outcrops, and HRL= high relief ledge. No speckled hind were observed in the SC MPA.

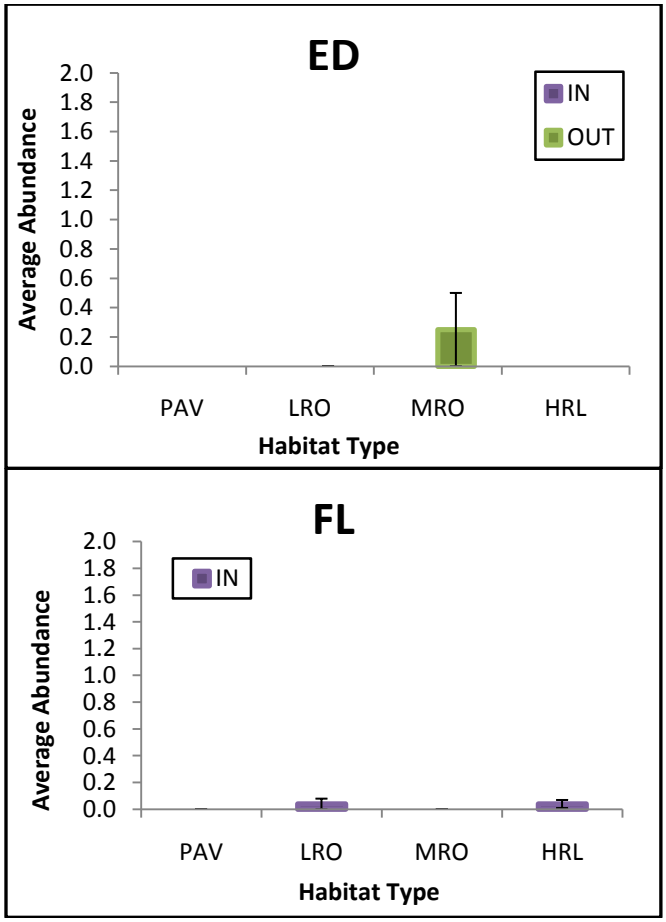

Figure 6. Average abundance (±S.E.) of snowy grouper and blueline tilefish inside versus outside each MPA by habitat type. PAV= pavement, LRO= low relief outcrops, MRO= moderate relief outcrops, and HRL= high relief ledge. Neither species were observed in the ED and FL MPAs.