Survey of coral and fish assemblages on Pulley Ridge, SW Florida: Year 3

A report to the Gulf of Mexico Fishery Management Council

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Abstract

The coral reef community covering Pulley Ridge is the deepest known light-dependent coral reef on the US continental shelf. Located off the southwest coast of Florida, the ridge is a drowned barrier island colonized by several species of hermatypic coral and a fish community comprised of both deep and shallow water species. Pulley Ridge has been designated a habitat area of particular concern (HAPC) due to the presence of these coral formations. The Gulf of Mexico Fishery Management Council (GMFMC) has expressed concerns over ongoing damage to the habitat by fishing operations and is considering additional protective measures. The primary goals of this project were to determine the extent of scleractinian corals, especially *Agaricia* spp. as it is the most abundant hermatypic coral on the ridge, and examine fish diversity both inside and outside the HAPC. A remotely operated vehicle (ROV) was used to complete 14 dives in September 2009 to examine habitat and the fish community. As seen in years before, there was a distinct difference in habitat inside and outside the HAPC, which resulted in distinct fish community compositions between the areas as well. With the exception of one site, habitat outside the HAPC was characterized as one of four types: sand, pavement, low relief outcrops, and moderate relief outcrops, the latter three displaying varying degrees of live bottom coverage including several species of sessile and encrusting invertebrates and algae. Habitat inside the HAPC as well as one site to the west of the HAPC was characterized as rock rubble with varying coverage of algae, coralline algae, hermatypic corals, solitary and encrusting sponges, octocorals, and antipatharians. Sand tilefish (*Malacanthus plumieri*) mounds and red grouper (*Epinephelus morio*) pits were common in this area. Fish diversity was highest inside the Pulley Ridge HAPC on rock rubble habitat. While grouper abundances were low inside the HAPC, diversity of grouper species was the highest there along with moderate relief outcrop habitat observed outside the HAPC. *Agaricia* spp. was only observed on rock rubble habitat at depths between 62 and 69 m, almost exclusively inside the HAPC, with the exception of a single observation to the west of the HAPC. Results from this study will be valuable to the GMFMC in making future effective management decisions.

Introduction

The deepest known hermatypic coral reef in the continental U.S. is located on Pulley Ridge off the southwest coast of Florida (Hine *et al.*, 2008). The ridge itself is a drowned barrier island approximately 100 km long by 5 km wide northwest of the Dry Tortugas and running parallel to the Florida peninsula. The shallowest areas on the ridge are about 60m deep. Surprisingly, at this depth, large areas with up to 60% live coral coverage have been located on the ridge (Halley *et al*., 2003) even though only 1-2% of surface light is available to the reef community (Jarrett *et al*., 2005). The coral *Agaricia* spp. (Figure 1) is one of the most abundant hermatypic corals along Pulley Ridge. This coral forms plates up to 50 cm in diameter and are adapted to low light environments. In excess of 60 fish species have been reported, comprised of a mixture of shallow and deep water species (Halley *et al*., 2003).

Pulley Ridge is one of the last hermatypic scleractinian coral reefs in the U.S. to receive protection from targeted fishing activity, specifically bottom longlines. It was designated a Habitat Area of Particular Concern (HAPC) in 2005 by the Gulf of Mexico Fishery Management Council (GMFMC) and some fishing activities have been restricted, but growing concern for corals in the area may lead to additional management actions.

The goals of this project were to determine the extent and magnitude of scleractinian corals and other adjacent habitats and examine fish diversity both inside and outside the HAPC. Data on the abundance and distribution of flora and fauna on the ridge will be needed to make effective management decisions. Of greater scientific value will be acquisition of data on shallow water species living in these depths, interactions between deep and shallow species in this unique ecosystem as well as searches for evidence of coral bleaching or other deleterious effects of climate change described in shallower ecosystems inhabited by similar species. This report is National Marine Fisheries Service Panama City Laboratory Contribution Number 10-03.

Figure 1. Down looking shot of *Agaricia* sp. taken during a remotely operated vehicle (ROV) dive in September 2009. Also in the picture is a rock beauty (*Holacanthus tricolor*), yellowtail reeffish (*Chromis enchrysurus*), and sponge.

Methods

Multibeam bathymetry and acoustic backscatter maps have been produced for approximately 60% of the Pulley Ridge HAPC, however the existing coverage comprises nearly 100% of suspected coral habitat. These maps were used for site selection and to guide the remotely operated vehicle (ROV) during dives. Suspected hardbottom and reef sites were the primary targets. Surveys of the HAPC and surrounding areas were conducted in September 2009 on the NOAA ship Gordon Gunter.

The principle gear used to characterize habitat and fish assemblages was a 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 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 allowed the ROV to drift just above the bottom at a controlled over-the-ground speed of approximately 1.34 km/hr (range 0.93 to 2.8 km/hr). The geographic position of the ROV (± 3 m) was constantly recorded throughout each dive with a tracking system linked to the ship's DGPS system. The ROV was equipped with lights, a forward-looking color digital video camera for providing continuous imaging data, as well as a digital still camera on a pan and tilt mechanism allowing still shots to be taken looking either forward or down. Both cameras were augmented with a pair of lasers which enabled size estimation of objects within the field of view.

These dives resulted in approximately 15 hours of underwater video documentation. The video footage was used to quantify *Agaricia* abundance as well as fish diversity. A fish species list was accumulated for each dive and the location and depth of each observed plate of *Agaricia* coral was noted. Abundance of grouper species was also evaluated using the video footage. Approximately 300 down looking still photos were taken, which will be used for habitat quantification at a later time. For the purpose of this report, location and depth of all *Agaricia* coral in the still photos was noted to determine its extent.

Results and Conclusions

A total of 14 ROV dives were made inside and outside the HAPC (Figure 2). Five dives were made north of the HAPC, 6 dives inside the HAPC, and 3 dives to the west of the HAPC. A distinct difference in habitat types existed inside and outside the HAPC. The northern sites were characterized by four major habitats: 1) soft substrate/sand (hereafter denoted as SA); 2) pavement (PAV); 3) low relief outcrops (LRO); and 4) moderate relief outcrops (MRO). SA habitats exhibited no relief and were composed of fine to coarse sand, sometimes mixed with shell hash. PAV habitats were composed of hardbottom with no relief, some degree of coverage with sessile and encrusting invertebrates and algae, and the presence of cracks/crevices up to 2 m deep. LRO and MRO habitats both consisted of rock outcrops and some degree of coverage of sessile and encrusting invertebrates and algae, but with distinct relief, LRO <1m relief and MRO between 1 and 3m relief. Sites to the north of the HAPC as well as 2 dives to the west of the HAPC primarily supported a heterotrophic octocoral-dominated community which lacks the reefal accumulation which is characteristic inside the HAPC. Habitats within the HAPC as well as 1 dive to the west of the HAPC were consistently similar, but drastically different from the other sites. The HAPC was characterized as having anywhere from 70-100% rock rubble covered in varying degrees with encrusting organisms providing some vertical relief. Coral

species observed included *Agaricia undata*, *Agaricia lamarcki*, *Montastraea cavernosa*, and *Leptoseris cucullata*. Various species of coralline algae were common as were the fleshy green alga *Anadyomene menziesii*, *Halimeda* sp., and the red alga *Kallymenia* sp. Other live bottom included solitary and encrusting sponges, octocorals, and antipatharians. Sand tilefish (*Malacanthus plumieri*) mounds (Figure 3) were common, approximately 1 m high and 1 m wide, and made entirely out of rock rubble. On several occasions, we observed sand tilefish hovering near their mound and then diving inside as the ROV approached, utilizing a hole excavated on one side of the mound. Small reef fish such as chalk bass (*Serranus torugarum*), several species of damselfish (*Chromis* spp.), orangeback bass (*Serranus annularis*), and cherubfish (*Centropyge argi*) often aggregated on the mounds. Large pits, created and utilized by red grouper (*Epinephelus morio*) were also quite common in the HAPC. The majority of these pits were up to 2 m wide and 1 m deep, but a few were larger, approximately 3-4 m wide and 1-2 m deep. Often, exposed hardbottom in the form of rock outcrops was visible in the bottom of the pits. Fish were usually abundant inside the pit because of the habitat complexity and often a single red grouper was present.

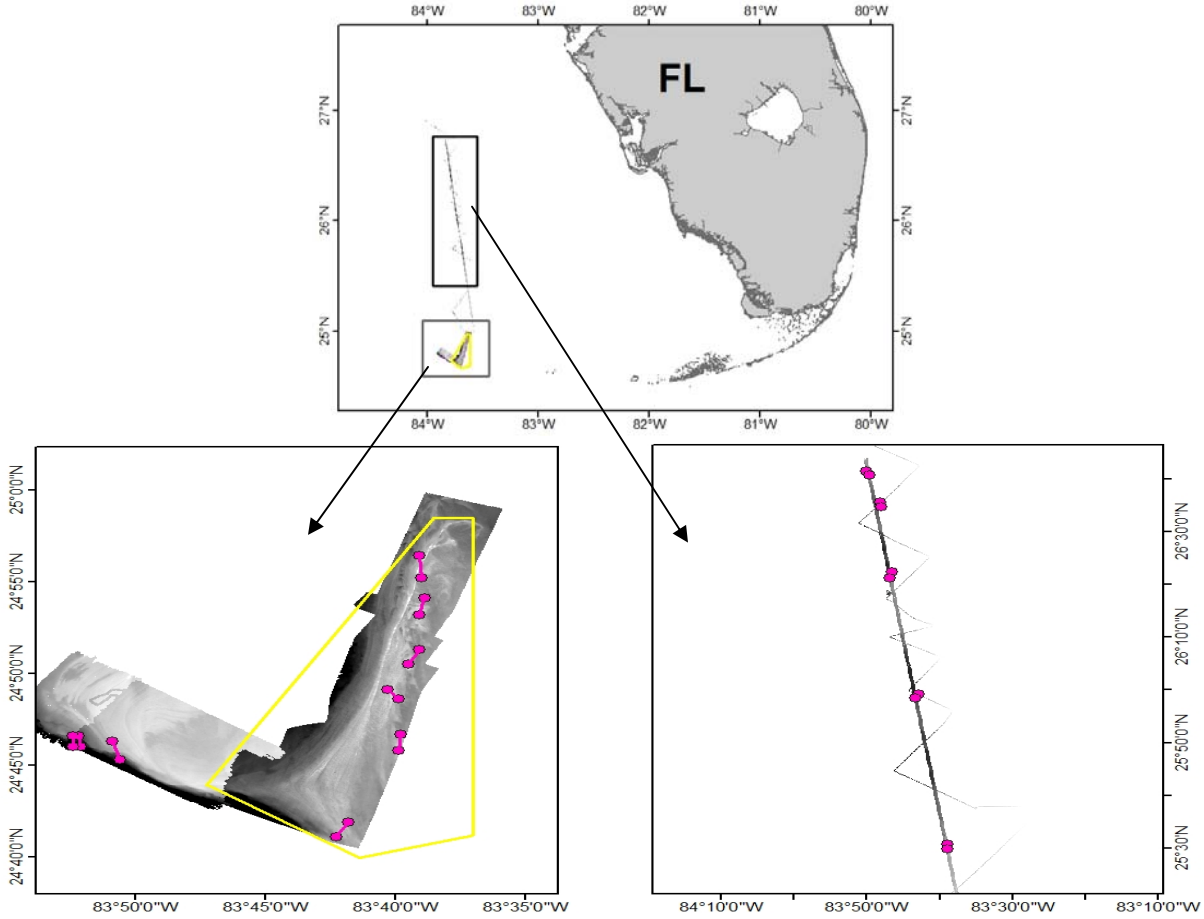

Figure 2. ROV dive locations. The yellow box represents the Pulley Ridge HAPC. Two pink dots connected by a line represent the beginning and end of each dive.

Figure 3. Sand tilefish *(Malacanthus plumieri*) mound. Visible on the bottom-left portion of the mound is an opening where the tilefish has excavated an entrance/exit hole.

As a result of differing habitats, fish assemblages were also dissimilar inside and outside the HAPC. A list of all fish species present in each habitat type can be found in Table 1. A total of 73 species were observed. Rock rubble habitat (the only habitat found in the HAPC as well as 1 site to the west of the HAPC) had the highest fish diversity with 51 different species. Low relief outcrops and pavement had 38 species, followed by moderate relief outcrops with 29 species, and finally 12 different fish species on sand habitat. Note that moderate relief outcrops were only observed on a single dive for approximately 16 minutes. Some fish species were observed in all habitat types such as: tattlers (*Serranus phoebe*), reef butterflyfish (*Chaetodon sedentarius*), yellowtail reeffish (*Chromis enchrysurus*), and wrasse (*Halichoeres* spp.). Reef butterflyfish and yellowtail reeffish are not typically found on sand, however, their presence in that habitat can be explained by the hardbottom that was in the vicinity. Some species were observed exclusively over rock rubble such as: cherubfish, blue chromis (*Chromis cyaneus*), yellowtail damselfish (*Microspathodon chrysurus*), bicolor damselfish (*Chromis partitus*), yellowhead wrasse (*Halichoeres garnoti*), parrotfish (*Sparisoma* spp.), blue tang (*Acanthurus coeruleus*), and yellowhead jawfish (*Opistognathus aurifrons*). Chalk bass were also exclusively found over rock rubble with the exception of two fish observed on a rock rubble tilefish mound located in the low relief outcrop habitat north of the HAPC. Within the HAPC, small reeffish densities were highest on top of the ridge (i.e. the shallowest portions of the ROV dives).

Table 1. Fish species observed by habitat. Outside the HAPC, four habitats were observed: SA= sand, PAV=pavement, LRO=low relief outcrops, MRO=moderate relief outcrops. Pulley Ridge HAPC was made up of RR=rock rubble. X denotes presence of a fish species in a particular habitat.

Taxa	Common Name	SA	PAV	LRO	MRO	RR
Rajidae						
Raja sp.	undetermined skate			X		
Muraenidae						
Gymnothorax moringa	spotted moray eel					X
Gymnothorax spp.	undetermined moray eel		X			
Synodontidae						
Synodus intermedius	sand diver	X	X	X		
Synodus spp.	undetermined lizardfish	X	X	X	X	
Ogcocephalidae						
Ogcocephalus corniger	longnose batfish			X		
Holocentridae						
Holocentrus spp.	undetermined squirrelfish		X	X	X	X
Myripristis jacobus	blackbar soldierfish					X
Plectrypops retrospinis	cardinal soldierfish				X	
Scorpaenidae						
Undetermined	undetermined scorpionfish	X	X	X	X	
Serranidae						
Anthiinae	anthiids		X	X	X	X
Centropristis ocyurus	bank sea bass			X		X
Epinephelus adscensionis	rock hind				X	
Epinephelus cruentatus	graysby					X
Epinephelus drummondhayi	speckled hind				X	
Epinephelus morio	red grouper		X	X	X	X
Epinephelus sp.	undetermined grouper			X		
Gonioplectrus hispanus	spanish flag				X	
Hemanthias vivanus	red barbier		X			
Liopropoma eukrines	wrasse bass		X	X	X	X
Mycteroperca bonaci	black grouper					X
Mycteroperca phenax	scamp		X	X	X	X
Mycteroperca sp.	undetermined grouper					X
Paranthias furcifer	creole-fish			X	X	
Pronotogrammus martinicensis	roughtongue bass		X	X	X	X
Serranus annularis	orangeback bass		X	X		X
Serranus phoebe	tattler	X	X	X	X	X
Serranus spp.	undetermined sea bass		X			X
Serranus tortugarum	chalk bass			X		X
Undetermined	undetermined sea bass					
Undetermined	undetermined grouper		X	X	X	
Priacanthidae						

Priacanthus arenatus	bigeye		X	X		X
Pristigenys alta	short bigeye		X	X	X	
Fistulariidae						
Fistularia tabacaria	bluespotted cornetfish			X		
Apogonidae						
Apogon pseudomaculatus	twospot cardinalfish		X	X	X	X
Apogon spp.	undetermined cardinalfish				X	X
Malacanthidae						
Malacanthus plumieri	sand tilefish		X	X		X
Carangidae						
Decapterus spp.	undetermined scad	X				X
Seriola dumerili	greater amberjack	X				X
Seriola spp.	undetermined amberjack		X			X
Lutjanidae						
Lutjanus campechanus	red snapper		X		X	X
Lutjanus spp.	undetermined snapper					X
Rhomboplites aurorubens	vermilion snapper		X			
Haemulidae						
Haemulon plumieri	white grunt					X
Haemulon spp.	undetermined grunts					X
Sparidae						
Calamus spp.	undetermined porgy		X	X	X	X
Pagrus pagrus	red porgy	X	X	X	X	
Undetermined	undetermined porgy			X		
Sciaenidae						
Equetus lanceolatus	jack-knife fish		X	X	X	X
Equetus umbrosus	cubbyu		X	X	X	
Mullidae						
Pseudupeneus maculatus	spotted goatfish					X
Chaetodontidae						
Chaetodon aya	bank butterflyfish		X	X		X
Chaetodon ocellatus	spotfin butterflyfish		X	X	X	X
Chaetodon sedentarius	reef butterflyfish	X	X	X	X	X
Chaetodon spp.	undetermined butterflyfish		X			
Pomacanthidae						
Centropyge argi	cherubfish					X
Holacanthus bermudensis	blue angelfish		X	X	X	X
Holacanthus tricolor	rock beauty		X			X
Pomacanthus arcuatus	gray angelfish			X		X
Pomacentridae						
Chromis cyaneus	blue chromis					X
Chromis enchrysurus	yellowtail reeffish	X	X	X	X	X
Chromis insolatus	sunshinefish				X	X
Chromis scotti	purple reeffish			X	X	X
Chromis spp.	undetermined damselfish		X			X

Microspathodon chrysurus	yellowtail damselfish					X
Pomacentrus partitus	bicolor damselfish					X
Labridae						
Bodianus pulchellus	spotfin hogfish		X		X	X
Decodon puellaris	red hogfish		X	X		
Halichoeres bathyphilus	greenband wrasse	X				
Halichoeres garnoti	yellowhead wrasse					X
Halichoeres spp.	undetermined wrasse	X	X	X	X	X
Lachnolaimus maximus	hogfish		X			
Scaridae						
Sparisoma spp.	undetermined parrotfish					X
Gobiidae						
Ioglossus calliurus	blue goby		X			X
Acanthuridae						
Acanthurus coeruleus	blue tang					X
Sphyraenidae						
Sphyraena barracuda	barracuda		X			X
Opistognathidae						
Opistognathus aurifrons	yellowhead jawfish					X
Bothidae						
Undetermined	undetermined flounder	X		X		
Balistidae						
Balistes capriscus	gray triggerfish		X			
Balistes spp.	undetermined triggerfish					X
Balistes vetula	queen triggerfish					X
Monacanthus ciliatus	fringed filefish			X		
Monacanthus hispidus	planehead filefish			X		
Monacanthus spp.	undetermined filefish			X		X
Xanthichthys ringens	sargassum triggerfish		X			X
Ostraciidae						
Lactophrys trigonus	trunkfish					X
Lactophrys quadricornis	scrawled cowfish		X	X		
Lactophrys spp.	undetermined cowfish			X		
Tetraedontidae						
Canthigaster rostrata	sharpnose puffer		X	X	X	X
Sphoeroides nephelus	southern puffer	X				
Sphoeroides splengleri	bandtail puffer	X		X		X
Diodontidae						
Chilomycterus spp.	undetermined puffer					
Undetermined	spiny puffer					

A total of 131 grouper were observed on the ROV dives. 51 grouper were observed over pavement, 40 over moderate relief outcrops, 28 over low relief outcrops, and 10 over rock rubble (Figure 4). Even though grouper abundances were not high on rock rubble, diversity of grouper species was the highest on this habitat type along with moderate relief outcrops. Because of the pits in the HAPC, red grouper was the most abundant grouper species in that area, however, scamp (*Mycteroperca phenax*) was the most frequently observed grouper outside the HAPC. Rock hind (*Epinephelus adscensionis*) and speckled hind (*Epinephelus drummondhayi*) were only found on moderate relief outcrops. Black grouper (*Mycteroperca bonaci*) were only observed on rock rubble.

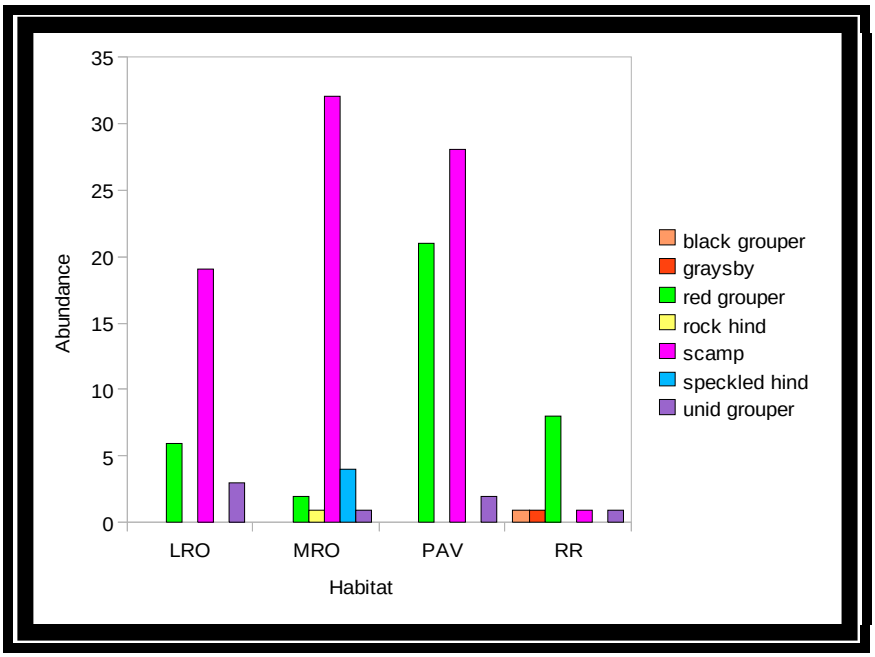

Figure 4. Grouper abundances by habitat type. LRO=low relief outcrops, MRO=moderate relief outcrop, PAV=pavement, and RR=rock rubble. No grouper were observed over sand. LRO, MRO, and PAV habitats were found outside the HAPC. RR was the only habitat observed in the HAPC. Unid grouper=unidentifiable grouper (not able to be identified down to species).

Pulley Ridge contains the deepest known hermatypic coral reef in the U.S. The most common scleractinian corals are species of *Agaricia*. We observed *Agaricia* spp. only on rock rubble habitat, inside the HAPC and a single observation on a dive to the west of the HAPC (Figure 5). *Agaricia* was found in depths between 62 and 69 m with plates of coral ranging in diameter between 5 and 30 cm. One interesting observation was the abundance of dead *Agaricia*. It was common to see plates of coral which contained significant areas of dead tissue, however no stressed or bleached corals were seen. Corals appeared to be either healthy or dead (Figure 6).

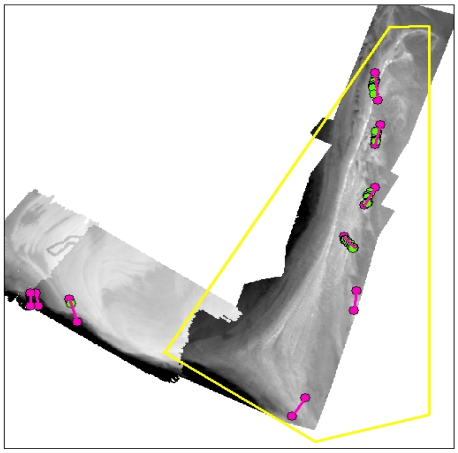

Figure 5. *Agaricia* observations along Pulley Ridge ROV dive tracks, denoted by green dots. Two pink dots connected by a pink line represent a single ROV transect.

Figure 6. Live and dead *Agaricia* coral.

In conclusion, we have now completed three surveys of the Pulley Ridge area, the previous ones completed in 2007 and 2008, and will continue to do bi-annual surveys of the area to monitor coral health and changes in fish assemblages. We observed distinct habitat differences inside and outside the HAPC. With the exception of one dive to the west of the HAPC, areas outside the protected area are comprised of more carbonate rock in the form of outcrops and pavement while areas inside the HAPC are characterized by rock rubble with hermatypic corals and higher fish diversity. Sand tilefish mounds and red grouper pits were also observed inside the HAPC. Because of those pits, red grouper was the most abundant grouper species observed inside the HAPC, while scamp was the most abundant grouper outside the HAPC. Diversity of grouper species was highest on rock rubble and moderate relief outcrops. Several observations of

fishing gear (monofilament line, longline, and fish traps) were made during the ROV dives along the entire ridge, both inside and outside the protected area.

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Literature Cited

Gulf of Mexico Fishery Management Council (GMFMC). March 2005. Essential Fish Habitat Amendment 3. Addressing essential fish habitat requirements, habitat areas of particular concern, and the adverse effects of fishing on fishery management plans of the Gulf of Mexico.

Halley, R.B., A.C. Hine, B.D. Jarrett, D.C. Twichell, D.F. Naar, G.D. Dennis, and K. Ciembronowicz. Pulley Ridge: the US's deepest hermatypic coral reef? Poster at: http://coastal.er.usgs.gov/pulley-ridge/pdf.html.

Hine, A.C., R.B. Halley, S.D. Locker, B.D. Jarrett, W.C. Jaap, D.J. Mallinson, K.T. Ciembronowicz, N.B. Ogden, B.T. Donahue, and D.F. Naar. 2008. Coral reefs, present and past, on the West Florida shelf and platform margin. In: Coral Reefs of the USA (eds. B. Riegl and R.E. Dodge). Springer. pp.127-174.

Jarrett, B.D., A.C. Hine, R.B. Halley, D.F. Naar, S.D. Locker, A.C. Neumann, D. Twichell, C. Hu, B.T. Donahue, W.C. Jaap, D. Palandro, and K. Ciembronowicz. 2005. Strange bedfellows – a deep-water hermatypic coral reef superimposed on a drowned barrier island; southern Pulley Ridge, SW Florida platform margin. Marine Geology. 214:295-307.