3.3. Pulley Ridge, Gulf of Mexico, USA

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Pulley Ridge, located in the Gulf of Mexico, lies about 250 km west of the Florida coast and extends from north to south along the southwestern Florida platform at depths of 60–90 m for nearly 300 km (Figure 1; Hine et al. 2008). Only the southernmost 34 km of Pulley Ridge, referred to as southern Pulley Ridge, supports MCEs (Figure 2; Cross et al. 2005, Reed et al. 2014, 2015). Southern Pulley Ridge is about 160 km² in size (Cross et al. 2005, Culter et al. 2006) with 10 m relief and represents a drowned barrier island from the last glacial period. Pulley Ridge is the deepest known light-dependent coral reef ecosystem off the continental United States (Halley et al. 2003).

Seismic maps indicate that drowned shoreline ridge complexes and pinnacles extend west of Pulley Ridge to depths of 100–150 m, suggesting the potential for other MCE habitat in the region (Ballard and Uchupi 1970, Holmes 1981, Phillips et al. 1990). In 2015, an additional 321 km² of MCE habitat adjacent to southern Pulley Ridge was documented (Reed et al. 2015). An analysis of the total area of mesophotic depth habitat at depths of 30–150 m indicates that the northern Gulf of Mexico region (Figure 1; 178,867 km²) has an order of magnitude area greater for potential MCEs than either the U.S. Caribbean or the Main Hawaiian Islands (Locker et al. 2010).

Coral growth is supported by the Loop Current, the prevailing western boundary current in the Gulf of Mexico, which provides warm, clear, nutrient-poor waters to Pulley Ridge (Jarrett et al. 2005). This current separates the clear, oligotrophic, outer-shelf waters from cooler, higher nutrient, interior-shelf waters (Hine et al. 2008). Seafloor light measured at southern Pulley Ridge (65–70 m) is only 1–2 per cent (5–30 μ E m⁻²s⁻¹) of available surface light, which is 5 per cent of the light typically available to shallow-water reefs (Jarrett et al. 2005).

Recent surveys of Pulley Ridge in 2012–2014 (Reed et al. 2014, 2015) show that the reef habitat supports a biologically diverse and dense community that is dominated by macroalgae (53.8 per cent cover), including plates of crustose coralline algae, *Peyssonnelia* spp., and the green alga *Anadyomene menziesii*; 1.6 per cent cover of sponges (102 taxa); and 1.3 per cent cover of hard coral. A total of 216 benthic macrobiota taxa have been identified from Pulley Ridge, including 14 Scleractinia, 15 Octocorallia (gorgonacea), and four Antipatharia (black corals; Figure 3). The scleractinian hard corals are dominated by the plate corals *Agaricia* sp., *A. fragilis, A. lamarcki/grahamae, Helioseris cucullata* and plate-forms of *Montastraea cavernosa*.

Previous surveys indicate that there has been a significant loss of coral cover on Pulley Ridge over the past 10 years. In 2003, the mean coral cover at southern Pulley Ridge was 11.9 per cent, with a maximum of 23.2 per cent in the central region of the ridge; and platy corals were up to 50 cm in diameter with coral cover as high as 60 per cent (Halley et al. 2003, Jarrett et al. 2005, Hine et al. 2008). By 2013, the



Figure 1. Map of U.S. Gulf of Mexico showing extent of mesophotic depth habitat (darker 30 m to 150 m depth contours) and major mesophotic reefs (boxes). Mesophotic depth marine reserves include marine protected areas (MPA), Habitat Areas of Particular Concern (HAPC), and National Marine Sanctuaries (NMS).



Figure 2. Multibeam map of the Pulley Ridge MCE in the U.S. Gulf of Mexico, the deepest known photosynthetic reef in U.S. continental waters. Pulley Ridge South (60–70 m depth) is a submerged intact barrier island. Pulley Ridge Basin and West Pulley Ridge are deeper geological features (80–90 m depth), which also provide MCE habitat. Yellow box= Pulley Ridge Habitat Area of Particular Concern, 346 km² (Multibeam Bathymetry Survey data, University of South Florida).

average hard coral cover was 0.85 per cent, with a maximum of 5.6 per cent, which is a 92.8 per cent loss of coral cover in a decade (Reed et al. 2014). In 2014, additional surveys to the west of southern Pulley Ridge, in an area known as the Pulley Ridge Central Basin, discovered a new coral area with the densest cover of mesophotic *Agaricia* corals known in the Gulf of Mexico (2.6–4.98 per cent cover with an average coral density of 5.6–16.8 colonies per m²; Figure 2). This new area is unprotected and outside of the Pulley Ridge marine protected area (Reed et al. 2015). On a positive note, a large number of these corals are relatively new recruits: 47.7 per cent are less than 5 cm in diameter, and 35.4 per cent are 5–9 cm. So it appears that the coral is growing back from the dieoff that occurred after 2003. A total of 78 fish taxa were identified in Pulley Ridge in 2012 and 2013 (Reed et al. 2014). The most common species included chalk bass, bicolour damselfish and cherubfish. Fifteen species of commercially- and recreationally-important grouper and snapper species were found (681 individuals in total), with the dominant species being vermilion snapper, black grouper, graysby, mutton snapper, red grouper and scamp. On southern Pulley Ridge, red groupers have excavated over 155,000 burrow pits from 5 m to over 15 m in diameter and 1–2 m in depth. Most active burrows have one adult red grouper with a total length of 50 cm or greater. The burrows provide habitat and act as oases for many small reef fish, but unfortunately most of the burrows seen in 2013 and 2014 had from several to 60 invasive lionfish per burrow (Reed et al. 2014; see Chapter 6).



Figure 3. Habitat and biota of Pulley Ridge MCE in the U.S. Gulf of Mexico. (a) *Helioseris cucullata*, depth 74 m. (b) *Agaricia grahamae*, depth 82.5 m. (c) *Swiftia exserta* (octocoral with lionfish Pterois volitans), depth 79 m. (d) *Peyssonnelia* sp. (crustose coralline algae) and *Halimeda copiosa* (green algae), depth 80 m. (e) *Geodia neptuni* (sponge) and *Anadyomene menziesii* (green algae), depth 73 m. (f) *Epinephelus morio* (60 cm red grouper) guarding its burrow, depth 80 m, laser scale is 10 cm (photos Reed et al. 2015).

In the 2003 the corals generally appeared to be healthy, with little evidence of coral bleaching or disease (Jarrett et al. 2005, Hine et al. 2008). In 2014, a total of 7,329 individual plate corals (*Agaricia* spp. and *Helioseris cucullata*) were counted from the transect photos, of which 247 were noted to be bleached, partially bleached, totally bleached, partly dead, recently dead or diseased; resulting in 4 per cent morbidity of the total population measured (Reed et al. 2015). Bleaching (partial to total) ranged from 0 to 11.5 per cent per km² block.

The Gulf of Mexico Fishery Management Council (GMFMC) expressed concern over ongoing damage by fishing operations to Pulley Ridge habitat, and in 2005 designated Pulley Ridge a Habitat Area of Particular Concern (HAPC; criteria for HAPCs include ecosystem services provided by the habitat, sensitivity to human impact, development stressors and rarity of habitat type). This 346 km² marine protected area is also considered essential habitat for coral and fish. Fishing restrictions within the Pulley Ridge HAPC include prohibition of bottom-tending gear, such as bottom trawls, bottom longline, buoy gear, pot or trap and bottom anchoring by fishing vessels (GMFMC 2005). In 2014, a proposal was submitted to the GMFMC to extend the Pulley Ridge HAPC boundaries to include the newly discovered MCE habitat (321 km²) in the Pulley Ridge Central Basin and West Pulley Ridge.