OCULINA CORAL BANKS OF FLORIDA: CONSERVATION AND MANAGEMENT OF A DEEP-WATER RESERVE

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INTRODUCTION
In 1975, during photographic surveys of the continental shelf using the Johnson-Sea-Link Research Submersible, scientists from Harbor Branch Oceanographic Institution discovered high relief pinnacles at depths of 70-100 m that were living coral reefs composed entirely of the ivory tree coral Oculina varicosa. Various research ensued including studies on coral growth rates, community structure of associated invertebrates and fishes, effects of upwelling, bioerosion, sediments, geology, and taxonomic studies of fish, decapods, mollusks, echinoderms, sipunculids, pycnogonids, and amphipods. During the 1970s these deep-water reefs were teeming with large populations of grouper, snapper, and amberjack. Fishing pressure from both commercial and recreational fishermen was intense, and by the early 1990s the fish populations and the coral had been severely impacted. Legislation in 2000 designated a 300 nm (1029 km²) Oculina Coral Bank Habitat Area of Particular Concern (HAPC) which prohibits use of anchors, bottom trawls, bottom longlines, dredges, fish traps and pots (Figure 1).

BANK DESCRIPTION
Coral Morphology and Distribution
A unique deep-water Oculina coral reef stretches over 90 nmi (167 km) along the shelf edge from Fort Pierce to Daytona, Florida, at depths of 70-100 m, and ranges from 32 to 68 km offshore (Avent et al., 1977; Reed, 1980; Thompson and Gilliland, 1980; Virden et al., 1996). A single species of branching scleractinian coral, Oculina varicosa Lesueur, 1820, the ivory tree coral, grows on these reefs. The reef system consists of over one hundred individual coral pinnacles, mounds, and ridges that are high relief structures, ranging from 3 to 35 m in height and 100-300 m in width (Figure 2; Reed, 1980). Each pinnacle is actually a veneer of living coral overlying a mound of sand and mud sediment, coral debris, and oolitic limestone base formed during the Holocene transgression. The reefs are termed coral banks because they are below the effective wave base and the coral lacks zooxanthellae, the algal symbiont of shallow-water reef corals.

Benthic Communities
The biodiversity of the Oculina banks is similar to shallow tropical reefs. Quantitative studies found over 20,000 individual invertebrates living among and within the branches of 42 small Oculina colonies, yielding 230 species of mollusks, 50 species of decapods, 47 species of amphipods, 21 species of echinoderms, 15 species of pycnogonids, 23 families of polychaetes, and numerous other taxa, e.g., sipunculids, nemertines, isopods, tanaids, ostracods, and copepods (Miller and Pawson, 1979;...
Reed et al., 1982; Reed and Hoskin, 1987; Reed and Mikkelsen, 1987; Child, 1998).

**Fish Communities**
The invertebrate community helps support the dense and diverse populations of fishes (>70 species). The *Oculina* banks form impression breeding grounds for commercially important populations of gag and scamp grouper; nursery grounds for juvenile snowy grouper; and feeding grounds for these and other fish including black sea bass, red grouper, speckled hind, warsaw grouper, jew fish, almaco jack, greater amberjack, red porgy, red snapper, gray snapper, little tunny, giant sunfish, manta ray, tiger shark, hammerhead shark, and scalloped hammerhead (Reed and Gilmore, 1981; Reed, 1985; Gilmore and Jones, 1992).

**Coral Growth**
Long-term growth experiments were conducted on the deep-water *Oculina* coral banks (80-m depth) using lookout diving from the *Johnson-Sea-Link* research submersibles. The growth rate of the deep-water *Oculina* coral at 80 m averaged 16.1 mm yr⁻¹ and was significantly greater compared to the growth at 6 m (11.3 mm yr⁻¹; Reed, 1981). Growth rate was significantly positively correlated with water temperature at both sites, but paradoxically the coral growth was faster in deep water where it lacks zooxanthellae.

**Human Impacts**
Extensive areas of dead coral rubble are present throughout the *Oculina* bank system, but the exact cause(s) is yet unknown. Impact has certainly been the result of commercial and sport fishing. The benthic commercial fisheries in this region use dredges for scallop; bottom trawls for royal red shrimp and rock shrimp; and bottom longlines for grouper, snapper, and shark. The banks are at the edge of the Gulf Stream, so bottom hook and line fishing requires heavy weights which damage the coral. Early in the 1970s the *Oculina* banks were teaming with large populations of snapper and grouper. By late 1980s both commercial and recreational fisheries had taken a toll on the fish populations, especially grouper and snapper, and the coral had been impacted. Other hypotheses may account for some of the damaged reef areas. Natural episodic coral die-off, such as occurs with the shallow-water *Acropora* species, may be an unknown factor on the deep-water coral banks. Do fungi and other pathogens that attack shallow-water reef corals also affect deep-water ahermatypic coral species? These questions remain unanswered.

**PROTECTION AND MANAGEMENT**

**Federal and State Regulations**
In the United States, corals and coral reefs are protected and regulated by various federal and state legislation. The State of Florida has jurisdictional limit of 3 miles in the Atlantic Ocean and it bans the taking, destroying or selling of scleractinian corals. Beyond the 3-mile limit, the federal waters are regulated by the Minerals Management Service through the Outer Continental Shelf Lands Act of 1978. This requires permits for damaging or injuring corals by mineral, oil, or gas lessees. Some reef areas that are National Marine Sanctuaries are protected by the Fishery Conservation and Management Act.

Fisheries in the region of the *Oculina* banks are managed through the South Atlantic Fishery Management Council’s Fishery Management Plans (FMPs), as approved and implemented by the National Marine Fisheries Service (NMFS). The FMPs are implemented under the authority of the Magnuson-Stevens Fishery Conservation and Management Act by regulations 50 CFR part 622. The Magnuson-Stevens Act, as amended by the Sustainable Fisheries Act, requires the Fishery Management Councils to describe and identify essential fish habitats (EFH) in all FMPs, including identification of adverse impacts from both fishing and non-fishing activities. Also created are several EFH-HAPCs which are habitat areas of particular concern that are not only important to fish species, but are also considered critical for fish reproduction and growth to maturity.

**Oculina Bank HAPC**
The deep-water *Oculina* banks were nominated in 1980 by the author as a Habitat Area of Particular Concern (HAPC) within the Fishery Management Plan for Coral and Coral Reefs. In 1984, a 92 nmi² (315 km²) portion was designated the *Oculina* Bank HAPC (Federal Register 49 FR 29607, July 1984). In 1994, the Fishery Management Council banned fishing for grouper and snapper within the *Oculina* Bank HAPC in order to evaluate the benefits of marine reserves. This ban on grouper and snapper fishing will be reevaluated in 2004. Legislation was adopted in 2000 (Federal Register 50 CFR part 622, vol. 65, no. 115, June 2000) to expand the *Oculina* Bank HAPC to encompass approximately 300 nmi² (1029 km²) of shelf-edge habitat. The following restrictions apply to the expanded *Oculina* Bank HAPC: no person may (i) use a bottom longline, bottom trawl, dredge, pot, or trap; (ii) if aboard a fishing vessel, anchor, use an anchor and chain, or use a grapple and chain; (iii) fish for rock shrimp or possess rock shrimp in or from the area.

**Enforcement**
Stringent surveillance and enforcement is not likely to be 100% for this deep-water reserve or any that is so remote from coastal areas. However, random surveillance by various means such as spotter planes along with the occasional helicopter and enforcement vessel may impact the major offenders. Required use of vessel identification systems is also gaining acceptance. Education regarding the importance and delicate nature of these rich resources is important for both the commercial and recreational fishermen. This will lead to better self-regulation and surveillance by the fishing
Although large scale commercial fisheries' impacts could be devastating, the small repetitive impacts from the uninformed recreational fishermen may also have long-term consequences to the health of the reefs. It is also important to educate the enforcement personnel so they have a better understanding what they are protecting and why. By bringing knowledge of these deep-water coral banks to the public and the fishing community though videos, photos, and education will we gain their acceptance for the need of protection for these unseen resources.

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