Spawning Aggregations of Groupers and Snappers in Protected Marine Reserves

Many coral reef fishes, including commercially important groupers and snappers, form large aggregations at specific sites each year in which spawning is concentrated within a couple of months. These spawning aggregations may be the primary source of larvae that replenish local fish populations through larval retention and recruitment. Although the protection of spawning aggregation sites (SPAGs) is now considered imperative for sustaining fisheries and reef fish populations, many spawning aggregation sites around the Caribbean are still vulnerable to fishing. In the late 1970’s and early 1980’s unregulated fishing on grouper spawning aggregation sites throughout the U.S. Virgin Islands led to the extirpation of the Nassau grouper and brought the red hind grouper population to the verge of collapse (Olsen and LaPlace, 1978; Beets and Friedlander, 1992).

In an effort to document the dynamics of spawning aggregations and to better understand how exploitation by fishing affects these dynamics, CMES has conducted research over the past 6 years on protected and unprotected spawning aggregation sites off St. Croix, St. Thomas and Saba, Netherlands Antilles. Research centers around defining population characteristics of aggregating species, identifying and documenting morphological and behavioral changes associated with courtship and spawning, delineating migration to and movement on aggregation sites, determining connectivity of spawning adults to juveniles and non-reproductive adults across the region, and studying the biotic and abiotic components of aggregation sites and seasonality.
Scientists measure and tag fish on board research vessels. Visual surveys are conducted and video is taken by researchers on enriched Nitrox or closed circuit re-breathers.

Methodology includes estimating spawning population size using underwater visual surveys and both point counts and transects; defining population characteristics by measuring and determining sex ratios of spawning fish; defining movement with traditional external tags and hydro-acoustic tagging technology; determining connectivity across the region using mDNA and population genetics; and studying biotic and abiotic parameters of spawning sites using coral reef video transects to determine substrate composition and acoustic doppler current profilers (ADCP) to record temperature, pressure, current speed and current direction.

A portable ultrasound is used to sex fish non-invasively. Figure A shows the paired testes of a male fish, Figure B the ripe ovary of a female.
Research Contributions to Fisheries Management and Conservation

- Data collected by CMES researchers to assess a re-forming Nassau grouper spawning aggregation on the Grammanik Bank, a deep water reef south of St. Thomas, convinced the Caribbean Fisheries Management Council to close the bank seasonally each year beginning in 2005, from February through May. During that time the site also hosts spawning aggregations of yellowfin grouper (*Mycteroperca venenosa*), tiger grouper (*M. tigris*) yellowmouth grouper (*M. interstitialis*), and dog snapper (*L. jocu*; Nemeth et al., 2005; Kadison et al., 2006).

- Comparative studies of red hind (*E. guttatus*) spawning aggregations with different management regimes (year-round ban on fishing, seasonal ban on fishing and no protection) have indicated that year-round protection is much more effective in sustaining regional fish stocks than no or even seasonal protection. A spawning aggregation of red hind in the Marine Conservation District off St. Thomas has shown a dramatic rebound of both fish size and abundance after 10 years of seasonal protection and 5 additional years of year-round closure (Beets and Friedlander, 1997; Nemeth, 2005). This has resulted in an increase in the annual catch and average size of fish in the local fishery as well. On the other hand, a spawning aggregation of red hind on Lang Bank off St. Croix with an un-enforced seasonal closure and an unprotected site on the Saba Bank both show signs of an over-exploited and declining fishery (Nemeth et al., 2006a; Kadison et al., 2009). Reports and recommendations have been made to the respective fisheries management agencies to consider different management strategies.

- Recent data collected using hydro-acoustic technology has shown that large groupers caught and tagged on spawning aggregation sites can move distances of several miles a day around the area, presumably to forage or search for mates. Marine protected areas that are designated to protect spawning fish therefore should be designed to account for daily and weekly movement patterns, which for some species can be extensive.
Future Work

- Determining the connectivity of Nassau grouper across the Puerto Rican shelf: is the population self-recruiting?
- Modeling larval dispersal using oceanographic parameters to determine the evolutionary advantages of location, seasonality and periodicity of spawning aggregations
- Modeling the extent of grouper and snapper movement on an aggregation site using size and trophic level
- Determining fidelity of fish to aggregation sites: do discrete stocks of groupers and snappers exist in the eastern Caribbean?
- Identifying, characterizing and mapping additional aggregation sites of groupers, snappers, parrotfishes and other fisheries species in waters of the US Virgin islands

Partners
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**Relevant Publications**


