

## NOTES

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### Occurrence of Juvenile Nassau Grouper, *Epinephelus striatus* (Teleostei: Serranidae), off Mona Island, Puerto Rico: Considerations of Recruitment Potential

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**ABSTRACT.**—In the wider Caribbean, the Nassau grouper (*Epinephelus striatus*) is considered a commercially important fish. However, its former abundance has declined precipitously in many areas due to overfishing. In Mona Island, Puerto Rico, its spawning aggregations have apparently disappeared; but while visual surveys were undertaken in shallow back reef habitats of the southern coast of Mona, at least 7 Nassau grouper juveniles were recorded. During 2000 and 2005, early stage juveniles were observed in seagrass dominated habitats within a 100 m radius. Despite the apparent disappearance of spawning aggregations, the presence of early stage juveniles implies that this grouper is reproducing in Mona Island either at unknown aggregation sites or during seasons other than winter (i.e., the common reproductive season). Alternatively, larvae may derive from either the western coast of Puerto Rico or eastern coast of the Dominican Republic and thereby replenish this species in waters of Mona Island. More research is needed to determine the location of spawning aggregation sites, the extent of its reproductive season, and the potential for grouper larval connectivity among nearby islands.

**KEYWORDS.**—Nassau grouper, Puerto Rico, coral reefs, grouper juvenile, Mona Island

The Nassau grouper, *Epinephelus striatus*, represents one of the most commercially important grouper species in the wider Caribbean (Sadovy and Eklund 1999)<sup>1</sup>. However, due to its life history (including especially the peculiar reproductive behavior of forming highly predictive spawning aggregations in shallow coral reefs), high site fidelity, and restricted home range displacements, it is exceptionally vulnerable to fishing (Sadovy and Eklund 1999, Sadovy and Domeier 2005). Consequently, overexploitation of the fishery has resulted in the Nassau groupers being included as an IUCN threatened species (Cornish and Eklund 2003).

Since their first discovery in The Bahamas (Smith 1972), more Nassau grouper spawning aggregation sites have been progressively documented in waters of the US Virgin Islands (Olsen and La Place 1978), Belize (Carter et al. 1994), Mexico (Aguilar-Perera and Aguilar-Dávila 1996), Cuba (Claro and Lindeman 2003), and the Cayman Islands (Whaylen et al. 2004). Notably, many aggregations at these areas show evidence of severe overfishing.

In the 20<sup>th</sup> century, the high exploitation of the once commercially important Nassau grouper (Suárez Caabro 1979) in Puerto Rico reduced the fishery status to insignificant levels (Sadovy and Eklund 1999). With the aim of protecting the remains of this species in Puerto Rican waters, efforts have been taken for identifying Nassau grouper spawning aggregation sites based upon traditional environmental knowledge gleaned through interviews with the island's experienced fishermen (Schärer et al. unpub ms).

Typically, Nassau grouper juveniles occur in association with the macroalgae *Laurencia* sp. when settling and show ontogenetic habitat shifts or displacements from macroalgae clumps to patch-reef habitats. However, juveniles are also associated with off-reef habitats, such as seagrass beds

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<sup>1</sup>Still represents a very important fishery resource in some areas of the wider Caribbean, such as The Bahamas, Cayman Islands and Belize.

(Eggleston 1995, Dahlgren and Eggleston 2001). Currently, little is known about habitat preferences of Nassau grouper juveniles off Puerto Rican waters.

The objective of this note is to record the presence of Nassau grouper juveniles and adults off Mona Island, describe aspects of juvenile distribution, and present hypotheses that may explain how this severely exploited grouper is still reproducing and recruiting on this remote island.

Mona and Monito Islands are located in the Mona Passage (18°05.0' N, 67°54.0' W), midway between the Dominican Republic and Puerto Rico (~ 70 km from western Puerto Rico, Fig. 1). The Mona Passage is considered a biogeographic filter in that it either allows or prevents certain reef fish species crossing into waters of mainland

Puerto Rico (Dennis et al. 2005). Reef fish surveys at Mona reveal a diversity of grouper species. However, these surveys reveal that the Nassau grouper is relatively elusive (Schärer et al. unpub ms). Even more elusive are its spawning aggregations, which are presumed to have disappeared from Mona Island (Sadovy and Eklund 1999, Schärer et al. unpub ms).

During visual surveys for reef fishes at Mona and Monito in 2000 and 2005, at least 7 Nassau grouper juveniles were found in shallow seagrass and rubble habitats (formed by emergent coral reefs of southern Mona Island) within the reef lagoon. All 7 juveniles were observed within 200 m of one another even though sightings were 5 years apart (Figure 1, Table 1). Out of a total of 330 transects (covering 19,800 m<sup>2</sup>)

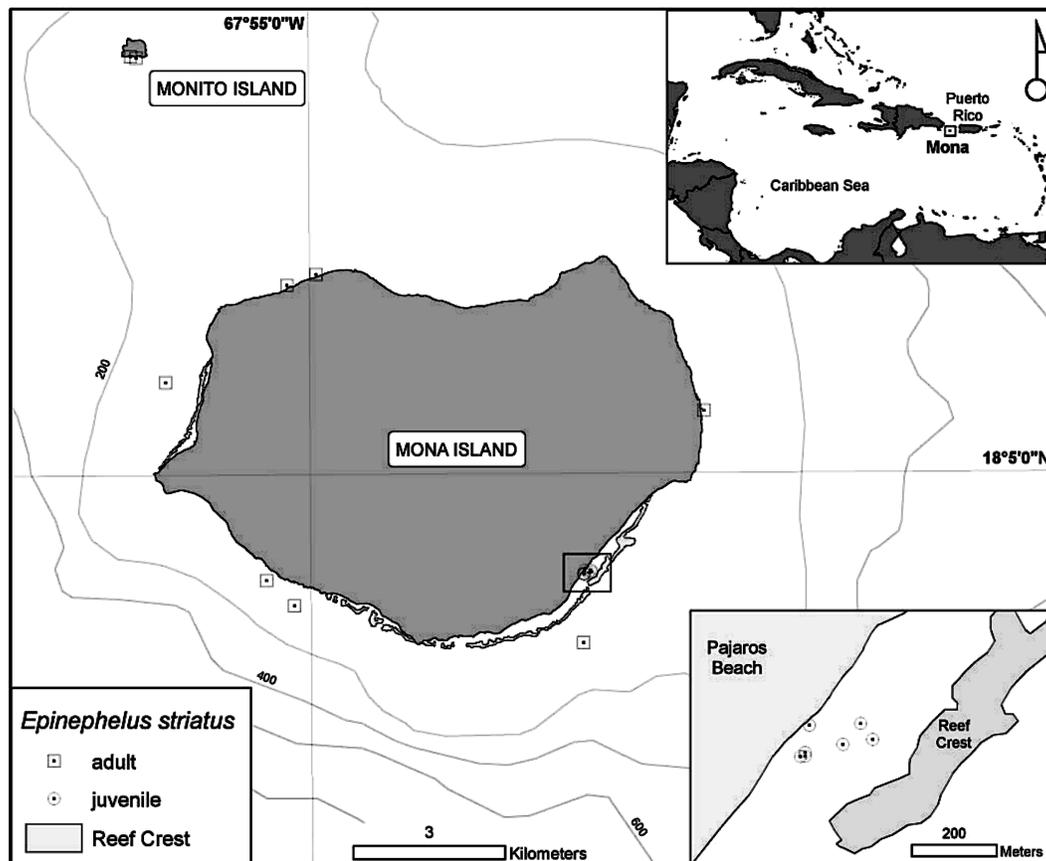


FIG. 1. Map of Mona and Monito Islands, western Puerto Rico, showing the sites where juvenile and adult Nassau grouper were sighted during underwater surveys.

TABLE 1. Juveniles and adults of Nassau grouper off Mona and Monito Islands, western Puerto Rico. TL = total length, m = meters.

| Size (TL, mm) | Life stage | Depth (m) | Month    | Year |
|---------------|------------|-----------|----------|------|
| 100           | Juvenile   | <2        | October  | 2000 |
| 110           | Juvenile   | <2        | October  | 2000 |
| 120           | Juvenile   | <2        | October  | 2000 |
| 60            | Juvenile   | <2        | August   | 2005 |
| 80            | Juvenile   | <2        | August   | 2005 |
| 70            | Juvenile   | <2        | August   | 2005 |
| 80            | Juvenile   | <2        | August   | 2005 |
| 450           | Adult      | 20        | December | 2004 |
| 550           | Adult      | 23        | December | 2004 |
| 500           | Adult      | 30        | December | 2004 |
| 550           | Adult      | 30        | December | 2004 |
| 450           | Adult      | 14        | October  | 2005 |
| 400           | Adult      | 16        | October  | 2005 |
| 500           | Adult      | 22        | October  | 2005 |
| 550           | Adult      | 19        | November | 2005 |
| 490           | Adult      | 15        | December | 2005 |

in shallow backreef habitats throughout Mona Island conducted in 2005, juvenile *E. striatus* (4 individuals) were present in only 2 adjacent transects off Pajaros Beach. These 4 individuals, observed in August 2005, ranged from 60 to 80 mm in total length (TL, see Table 1); this suggests that they may have come from the previous winter spawning events (November to January).

In winter 2004, during surveys for grouper spawning aggregations, 2 adult Nassau groupers were found in coral reefs off southern Mona. These individuals showed no evidence of the distended abdomens which characterize ripeness and readiness to spawn. During this same period, 2 adults displaying a bicolor phase were found at 30 m depth off the southern coast of Monito Island; a bicolor phase is indicative of reproductive activity and spawning (Sadovy and Eklund 1999). Another 5 individuals were observed during fish surveys conducted in 2005 (Table 1).

In The Bahamas, Nassau grouper juveniles were categorized by Eggleston (1995) as post-settlement fish (25 to 35 mm TL), early juveniles (60 to 150 mm TL) and (3) larger juveniles (>150 mm TL), with early juveniles showing a disproportionately high association with the macroalgae

*Laurencia* sp. and other microhabitats (e.g. seagrass, corals) used according to availability (Dahlgren and Eggleston 2001). In Mona, the early juveniles sighted were found at the edge of a seagrass patch, under rocks surrounded by seagrass, a tire, and in a dissolution hole in shallow bedrock.

Despite the apparent disappearance of Nassau grouper spawning aggregations off Mona Island, the presence of early juveniles implies this grouper is reproducing either by (1) forming spawning aggregations at unknown sites, (2) mating in smaller groups (i.e., paired individuals), (3) building aggregations during a different reproductive season than that commonly known for this species (i.e., other than winter), or (4) larvae coming from nearby islands (i.e., western Puerto Rico or eastern Dominican Republic). Regarding (1), it is possible that Nassau groupers no longer use traditional aggregation sites (i.e., those historically known by fishermen) in favor of relatively less known, and therefore more secure, sites. Concerning (2), Nassau grouper mating may occur outside spawning aggregations, as is the case for certain other grouper species (Sadovy et al. 1992; Sadovy and Colin 1995). Regarding (3), Erdman (1976) found ripe Nassau groupers during March in other areas off Puerto Rico. Nonetheless, it is notable that sizes of observed Nassau grouper early juveniles coincide with a winter spawning time. Finally, concerning (4), a mean larval period of 41.6 days (Colin et al. 1997) and a travel distance of 70 km may support the hypothesis that some ecological connectivity derived from nearby islands, such as western Puerto Rico or eastern Dominican Republic, may supply Nassau grouper larvae to Mona Island. On this point, it is perhaps significant that grouper larvae are able to disperse and ingress as postlarvae onto habitats such as inlets (Keener et al. 1988). Recent studies on fish larvae connectivity in the western Atlantic support the assertion that larvae of snapper and groupers are able to disperse distances of ecologically relevant magnitude on a scale of 10 to 100 kilometers (Cowen et al. 2006; Paris et al. 2006).

Substantial research is still needed to determine the location of Nassau grouper spawning aggregation grounds, the extent of its reproductive season in Mona Island, and the possibility of a certain degree of ecological connectivity of larvae derived from nearby islands. A viable alternative to determine direct adult displacements to find new aggregation sites in Mona Island would involve using pop-up satellite tags.

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