

Processes Affecting the Emigration of Reef Fishes from Reserve Areas: Ontogenetic Migrations and Habitat Requirements of Haemulid Fishes

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ABSTRACT

Marine Fisheries Reserves (MFRs) are a potentially valuable and increasingly popular tool for managing reef fisheries. In theory, MFRs should, in part, offset loss to the fishery due to closure with increased catch rates around the borders due to emigration of fishes from the reserve. Many reef fishes, exemplified by the white grunt (*Haemulidae*), undergo ontogenetic migrations from inshore nursery areas to deeper offshore habitats, a process that could result in emigration from a MFR. In grunts, these migrations appear to be linked to habitat shifts and are to some degree related to fish size. Thus, the distances and directions travelled during any shift will be related to the distribution and availability of the required habitats.

Fishery resources in the Caribbean region are becoming increasingly overfished. Marine fishery reserves are being viewed with increasing interest as a possible, if not necessary, management tool. This is motivated by two factors. The first is the failure of standard management approaches to control the rate of exploitation either through poor or complete lack of implementation or through lack of enforcement. The second factor is the realization that protected areas, for a variety of reasons (*e.g.*, buffers against failure, controls against which to assess the effects of fishing), ought to be a basic part of resource management apart from any other strategies used.

The extent of fish movement and migration is critical to the success of any marine fishery reserve. In particular, it has been hypothesized that reserve areas will export juveniles and adults to surrounding areas, thus resulting in increased catches adjacent to the reserve that will help offset the loss of traditional fishing areas. Past studies of reef fish migration have relied extensively on simple mark-recapture methods, which at best yield minimum estimates of movement and give little understanding of the underlying factors controlling the timing, rate, pathway and distance of fish migration. Habitat is known to be one of the most

important factors determining coral reef fish distribution. We argue that habitat distribution and changes in habitat requirements are equally important in controlling timing and extent of ontogenetic migration.

The processes affecting reef fish movement are being studied using as a model the white grunt, *Haemulon plumieri* (Lacépède). Three juvenile stages, plus one transition stage and adult stage have been identified for the white grunt, based on habitat utilization, behavior, and diet. Juveniles are found on the reef in large daytime resting schools. At the transition stage, grunts occur in smaller groups and wander over a broader range of reef. Adults are often solitary and appear to be resident, roaming over a maximum of few 100 meters when resident on a large reef.

Size distributions collected across the insular shelf of southwest Puerto Rico using standardized methods show that juveniles are found only inshore and that adults are distributed at all locations. There is a distinct transition point between inshore and offshore size-distributions that occurs at about the size of maturity. We suggest that these size-distribution patterns across a shelf arise from the distribution of critical habitat, and that the latter controls the distance travelled in any stage/habitat shift. Juvenile habitats exist only in shallow water near sea grass beds; the habitats for the first three stages are often in close proximity. Off La Parguera, Puerto Rico suitable adult habitat extends from inshore reefs to the shelf edge and adults are found throughout the area. It is hypothesized that at about the time of sexual maturation, grunts redistribute themselves, perhaps in a single step, over this available adult habitat. Thus, at this time, fish could stay at the reef at which they resided as juveniles or migrate as far as the shelf edge reef 12 km offshore. In contrast, off Key Largo in the Florida Keys, no adult habitat exists near shore and all fish at this time migrate 8-12 km to patch reefs near the shelf edge.

This has several implications for the study of fish movements and the design of a marine fishery reserve. The actual degree of movement recorded, in terms of distance travelled, will depend upon the distribution of habitat, the width of the shelf, and the life stage studied. In islands where the shelf is but a few tenths of a kilometer wide, all movements recorded will be short because all areas will be in close proximity, regardless of the distribution of habitat. With the white grunt, almost all of the movement incurred during ontogenetic migration occurs over the short period during the transition from juvenile to adult. Thus, studies of only adult movements would grossly underestimate the potential for dispersal. The design of reserve areas must consider the range of habitat requirements and habitat distribution if all life stages are to be protected.