Fine-scale Dispersal of Eggs from a Nassau Grouper (*Epinephelus striatus*) Spawning Aggregation

Dispersión a Escala Fina de Huevos de un Agregación Reproductiva de Mero de Nassau (*Epinephelus striatus*)

Dispersion Fine Échelle des Oeufs à Partir d'une Frai Agrégation de Mérou Nassau (*Epinephelus striatus*)

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EXTENDED ABSTRACT

Introduction

Nassau Grouper (*Epinephelus striatus*) are large, predatory reef fish that are ecologically, economically, and culturally valuable members of Caribbean reef communities (Sadovy and Eklund 1999). Their populations have been severely depleted throughout the Caribbean, primarily due to overfishing at fish spawning aggregations (FSAs, Sadovy et al. 2008). Since 2003, the Cayman Islands Department of the Environment (DOE) and Reef Environmental Education Foundation (REEF) have spent considerable scientific, financial, and political resources to protect the spawning aggregation of Nassau Grouper off the west end of Little Cayman—the largest known aggregation of the species. The number of spawning adults has increased under protection from fishing, but the contribution of the aggregation to recruitment (young adults entering the population) is unknown.

Recruitment is highly variable in most marine fish and is thought to be the principal driver of variability in adult abundance (Miller and Kendall 2009). Hjort (1914) first showed that egg and larval survival are key to recruitment variation. Although many researchers have since refined and expanded on Hjort's hypotheses (Houde 2008), evidence has mounted that mortality of the early life-history stages largely dictates recruitment variability and deserves research into its causal mechanisms (Cushing 1975). Three key processes govern successful recruitment. Larvae must:

i) Eat enough prey,
ii) Avoid predation, and
iii) Find suitable habitat (dispersal).

These processes in turn likely depend on fine-scale and patchy distributions of eggs, prey, and predators (Bailey and Houde 1989).

Self-recruitment (Little Cayman to Little Cayman) is likely necessary for long-term viability of the population. Inter-island recruitment (Little Cayman to Grand Cayman and Cayman Brac) would aid efforts to recover Nassau Grouper populations there, as well as broaden support for protection of the Little Cayman aggregation. The frequency of successful recruitment also matters—if recruitment is only appreciable once every twelve years (as anecdotally observed), managers know protections must be in place long-term to expect any effect. Understanding the drivers of recruitment, whether early larval survival or dispersal, is important in linking changes in adult numbers to future, long-term population status. Fine-scale patterns in survival and dispersal are likely important, but have not been measured because the necessary technology has not existed until now.

Methods

To study such fine-scale processes, we developed a novel *in situ* plankton sampler, the NetCam, and used it to map the dispersal of Nassau Grouper eggs from the FSA following spawning on Feb 25, 2016. The NetCam uses a 0.5 m diameter, 500 µm mesh plankton net to concentrate and funnel plankton past two cameras that each image roughly 17 mL of water 8 times per second (Roberts et al. 2014). Standard plankton tows provide measurements of average density, integrated over the tow track. However, the NetCam allows us to calculate density of eggs and other plankton at a fine spatial scale (10s of meters), in real-time, and at different depths along a tow track (Figure 1).

In order to calculate the density of Nassau Grouper eggs from NetCam plankton images, we needed a method to reliably distinguish Nassau Grouper eggs from eggs of other fish species that spawn nearby. We found species-specific differences in egg diameter based on visual (egg size-frequency) and genetic (DNA barcoding) analysis of two collected plankton samples, and classified eggs with diameters between 0.89 - 1.10 mm as Nassau Grouper.

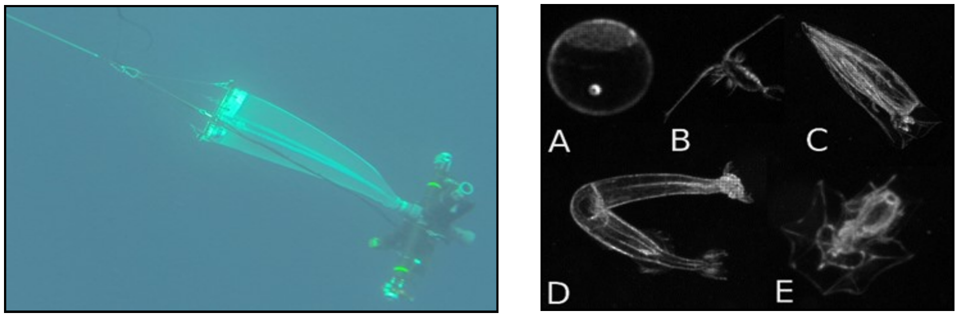

Figure 1. (Left) Underwater image of the NetCam being towed. (Right) Sample plankton images from the NetCam: A) Nassau Grouper egg, B) copepod, C) siphonophore, D) chaetognath, and E) siphonophore.

Results

We towed the NetCam for 1-5 hours post-spawning on Feb 25, 2016 and classified 49,904 images into five broad categories: Nassau Grouper eggs, fish eggs (not Nassau Grouper), copepods, chaetognaths, and gelatinous (Figure 2). We demonstrated the ability of the NetCam to observe fine-scale distributions of eggs as they disperse and drift away from the Nassau Grouper spawning aggregation, and anticipate that future deployments of this new tool will shed light on the fine-scale processes influencing recruitment success.

KEYWORDS: Nassau Grouper, spawning aggregation, egg, larvae, dispersal

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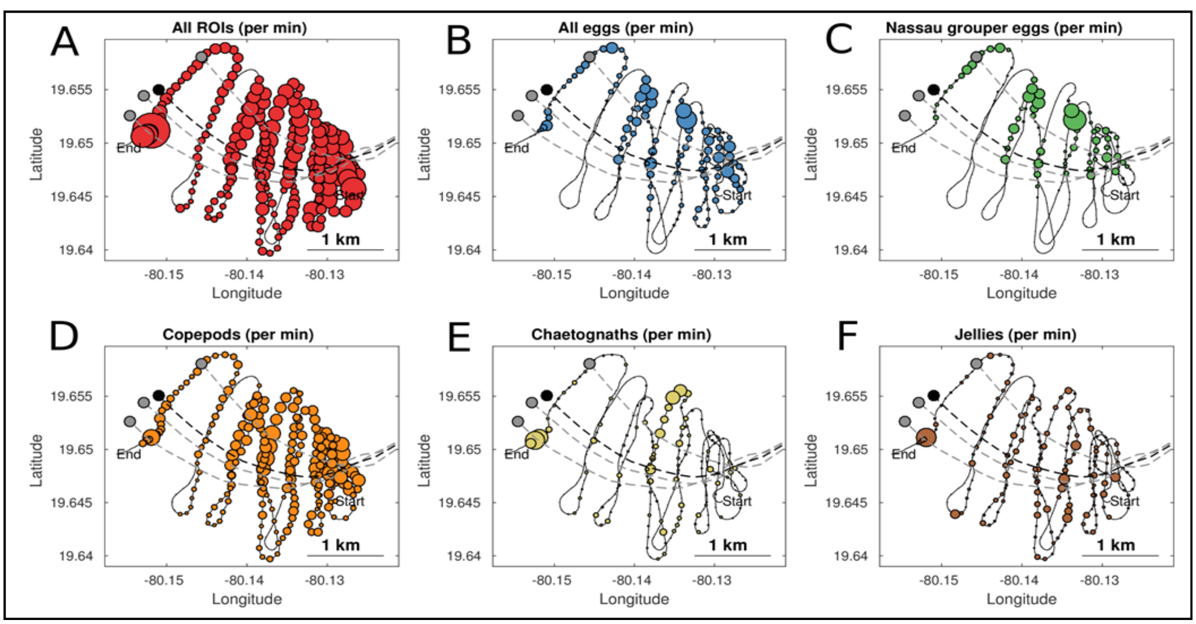

Figure 2. Preliminary counts of six categories of plankton along the NetCam tow track following Nassau Grouper spawning on February 25, 2016 (images from only 1 of 2 cameras). Three drifters (grey circles, dashed curves) deployed at the spawning site moved roughly 3 km west in the 4 hours of towing (1-5 hours after spawning). Counts (size of colored circles) from the NetCam images along our tow track (solid line) show the fine-scale dispersal of the spawn cloud through time for six plankton groups: A) all images, B) all fish eggs, C) Nassau Grouper eggs only, D) copepods, E) chaetognaths, and F) gelatinous.