Oceanographic Patterns Associated with Nassau grouper Aggregation Spawn Timing: Shifts in Surface Currents on the Nights of Peak Spawning

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ABSTRACT

There is virtually nothing known about the fate of fish larvae born on spawning aggregations from the time of spawning to settlement, yet the location of the aggregation site must be important in determining their fate. While aggregations always form in the same place and at the same time in part to assure a large number of adults will congregate for spawning, oceanographic patterns of dispersal and retention of the larvae may provide a driving force for the selection of specific spawning locations. During the winters of 2008 and 2009 we deployed Surface Velocity Profile drifters at the Nassau grouper spawning aggregation site on Little Cayman Island, BWI. A single drifter was deployed each night, then recovered 12 hours later in order to determine trajectory paths off the aggregation. In contrast to the path taken on nights prior to spawning, in both years the drifters released on the night of peak spawning showed substantial eddy formation near the aggregation site. This repeated pattern suggests an oceanographic-based "importance of place" for the aggregation site that may result in local recruitment. This would mean that local aggregations of fish are directly responsible for the long-term survival of local populations. This gives substantial credence to the need to identify and protect specific locations because they are unique and critical to the long-term survival of the many species that aggregate there.

KEY WORDS: Nassau grouper, aggregation, spawning, dispersal, satellite drifters

Patrones Oceanográficos Asociados a las Agrupaciones de Desove del Mero de Nassau: Cambios en las Corrientes de Superficie en las Noches de Mayor Desove

PALABRAS CLAVE: Mero de Nassau, agruapiones, desove,corrientes de superficie

Les Modes Océanographiques Associés aux Aggregations de Frai de Mérou de Nassau: Les Changements dans les Courants de Surface sur les Nuits du Frai Maximal

MOTS CLÉS: Mérou de Nassau, aggregations, frai, courants de surface

INTRODUCTION

The Nassau grouper (*Epinephelus striatus*) is listed as endangered by the International Union for the Conservation of Nature and Natural Resources (IUCN, www.redlist.org), having been decimated throughout its range; the number of known Nassau aggregation sites has been reduced by over 60% (De Mitcheson et al. 2008, Sala et al. 2001) and populations continue to decline. Nassau grouper aggregate to spawn in large groups (Colin 1992, Smith 1972), where they are particularly vulnerable to fishing; intense harvest at spawning aggregations is the primary cause for the precipitous decline of this species. This vulnerability to overexploitation is evident in the Cayman Islands (Whaylen et al. 2004), where over 90% of the Nassau grouper harvest in the Cayman Islands has historically come from fishing spawning aggregations.

While the west-end Little Cayman spawning aggregation site is now home to one of the largest fully-protected Nassau spawning aggregations, the 8-year harvest ban expires at the 2011 pending a review as to whether further protections are needed. One of the critical questions associated with the persistence of any population, including Nassau grouper, are recruitment rates and the sources of that recruitment. For aggregating species like the Nassau grouper, this begs the question, "Why do Nassau grouper aggregate where they do?" We used Surface Velocity Profile (SVP) drifters to map current patterns around the west end, Little Cayman Nassau grouper spawning aggregation site, with the aim of understanding how important the local aggregation site, and the local Nassau grouper population, is to local recruitment.

METHODS

Site Description

The geomorphology Cayman aggregation sites, including our end, Little Cayman site, are described by Kobara and Heyman (2008). With the exception of the fact that the aggregation sites in the Cayman Islands are located on both the windward (3) and leeward (2) sides of the

islands, all five are located on convex points (reef promontories) of similar slope and inflection angle, within 50m of the shelf edge and at 25 - 45 m depth. These shared traits indicate that specific locations are being selected.

Drifter Deployment and Tracking

For multiple nights in 2008 and 2009, both prior to and proceeding spawning, we released SVP drifters over the West End Little Cayman spawning aggregation site. The release was done at approximately 6 pm each evening (Figure 1, panel A) immediately following our daily dusk site survey, the drifter floated for approximately 12 hours, and was then recovered (Figure 1, panel B) for future use. Reproductive activity was evaluated each night during the dusk survey.

Drifters report on average six times per hour, providing high-resolution profiles of surface current patterns — this data rate also facilitates relocation and recovery of drifters. Drifter positions were plotted using ArcGIS™ with basemap and bathymetry shape files provided by the Government of the Cayman Islands.

RESULTS

We successfully deployed and recovered SVP drifters for the five nights leading up to the major spawning night, plus the major night of spawning in 2008, while in 2009 we deployed drifters for the two nights leading up to spawning, the night of peak spawning, and two days following the major spawning night. On nights leading up to spawning, drifters took a linear to curvilinear path during their 12 hour deployment, while on the major night of spawning drifters looped back on themselves, indicating eddy formation in oceanographic currents over the spawning site (Figure 1, panel C).

DISCUSSION

Our results show that spawning is occurring on nights where current patterns change in proximity to the aggregation site. Such changes indicate that there may be something important about this location, and this time, for the successful reproduction in Nassau grouper. This importance is likely not limited to Nassau grouper, either, as Whaylen et al. (2006) list at least 20 other species that exhibit reproductive activity at the same time at the west end Little Cayman aggregation site.

It should be noted that SVP drifters are not fish larvae, although they likely well represent passive dispersal of initial reproductive products. Within the context of local retention (self-recruitment), the early onset of larval behavior is a critical feature (Cowen et al. 2006). The presence of larval swimming behavior as early as 3 - 5 days post-spawning can result in substantial retention for pelagic spawning fish, with dispersal restricted to distances of just 10km or less (Cowen et al. 2006, Paris and Cowen 2004). Fertilized Nassau grouper eggs hatch within 30 hours at 25C, the temperatures found around the Cayman Islands during spawning, have pigmented eyes within 40 hours, and are feeding within 60 hours (Tucker et al. 1991).

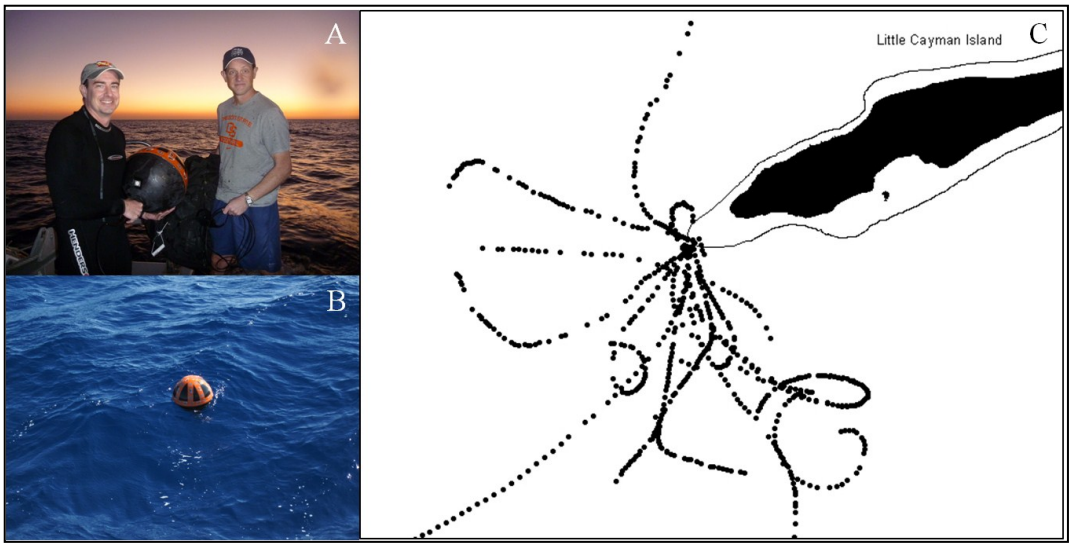

Figure 1. Drifter release, recovery, and tracking from the West End, Little Cayman Nassau grouper spawning aggregation site. (A) REEF Grouper Moon crew prepare to deploy a Surface Velocity Profile Drifter over the West End site, having just completed an in-water survey of Nassau grouper reproductive activity. (B) The SVP drifters were recovered each morning for re-use. High-visibility markings, combined with accurate position information (obtained very 10 min) allowed almost 100 recovery success. (C) Composite of all 12hr drifter tracks for 2008 and 2009. Linear to curvilinear tracks are all from non-spawning nights, while looping patterns form on spawning nights. Dashed arrow represents SVP drifter track on peak spawning night in 2008, solid arrow indicates same track in 2009.

This ontogeny indicates that larval Nassau grouper are equipped to take advantage of the eddy formation that occurs on nights of spawning, which could keep them close to the shores of Little Cayman Island and set up a self-seeding population.

Cowen et al. (2006) hypothesized that ecologically-relevant (source-sink) dispersal distances in the central Caribbean would be > 100 km. Given that there are no known healthy Nassau grouper aggregations within 100km of the west end Little Cayman aggregation site, self-recruitment of Little Cayman-spawned larvae back to Little Cayman is one of the only ways in which the Little Cayman Nassau grouper population might continue to persist.

Overall, Nassau grouper appear to cue in on local currents when choosing when to spawn, likely as a mechanism for local retention of their offspring. Whether actual local recruitment occurs will need to be answered with parentage genetics. Given that the west end, Little Cayman Nassau grouper spawning aggregation is the last healthy aggregation around for over 100 km, a precaution-ary approach would dictate that maintaining a healthy stock of adult Nassau grouper on Little Cayman Island, and an undisturbed spawning aggregation, is critical to the long term viability of Nassau grouper populations in the Cayman Islands.

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