Journal of Experimental Marine Biology and Ecology 446 (2013) 282–290

Contents lists available at SciVerse ScienceDirect

Journal of Experimental Marine Biology and Ecology

journal homepage: www.elsevier.com/locate/jembe

Predator effects on faunal community composition in shallow seagrass beds of The Bahamas

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ARTICLE INFO

Article history:
Received 6 March 2012
Received in revised form 31 May 2013
Accepted 3 June 2013
Available online 26 June 2013

Keywords:
Exclusion experiment
Food web
Interaction strength
Predator–prey interaction
Top-down effect
Trophic cascade

ABSTRACT

Much emphasis has been placed on predator effects that cascade through food webs. Such top-down effects seem to be most common in systems with relatively simple food chains, and rarer in species-rich systems where numerous weak interactions among species can buffer strong top-down effects. Seagrass ecosystems are typically species-rich and characterized by complex food webs, but evidence of top-down effects in these systems has been mixed. We examined effects of predatory fishes on the species richness, biomass, density, and composition of the epifaunal community in a shallow seagrass ecosystem of The Bahamas. We used exclusion experiments at two different spatial scales, and applied mesh sizes that excluded different-sized predator individuals. We found some evidence of species-level top-down effects (*i.e.*, strong interactions within a subset of the community), driving higher biomass in at least one decapod mesopredator. In contrast, community-level predator effects were rather weak, with predator size and spatial scale of experiments displaying no detectable impact on the overall epifaunal community. Multiple factors may have contributed to these patterns, including high species richness, relatively shallow water depth, small-scale spatial variation in habitat features, and the size and abundance of predators. Because of the rapid global decline of seagrasses and their associated fauna, increased knowledge of predator effects on faunal communities of seagrass beds is critical for long-term conservation efforts.

1. Introduction

Much emphasis has been placed on the cascading effects of predators in food webs (Polis et al., 2000), and strong top-down effects have been documented in many aquatic ecosystems (Strong, 1992). Often these systems are relatively simple, low-diversity, food webs with little omnivory or intraguild predation (Chase, 2000; Finke and Denno, 2005; Fox, 2007; Heck and Valentine, 2007; Polis and Strong, 1996; Shurin et al., 2002, 2006). Examples of strong top-down effects have been well documented in freshwater lentic and marine benthic systems, rocky intertidal zones and kelp forests (Estes et al., 1998; Paine, 1966; Shurin et al., 2002). Conversely, more species-rich ecosystems seem less likely to have such strong top-down effects, largely because of their inherently reticulate food webs with many weak interaction links (McCann et al., 1998; Strong, 1992).

Seagrass beds are species-rich ecosystems that provide food and shelter for numerous ecologically and economically important organisms (Beck et al., 2001; Orth et al., 1984). Evidence of predator effects on food web structure in these ecosystems has been mixed, with some studies suggesting strong (Ambrose, 1984; Douglass et al., 2007; Duffy et al., 2005; Heck et al., 2000; Hindell et al., 2000; Moksnes et al., 2008), and others weak or no top-down effects on faunal seagrass communities (Gacia et al., 1999; Hindell et al., 2001; Leber, 1985; Moore and Hovel, 2010; Summerson and Peterson, 1984; Valentine et al., 2008). Predator effects in seagrass ecosystems have been suggested to be rather weak because other factors may be more important in structuring food webs, such as landscape context (*i.e.*, the spatial position of a given patch within a larger mosaic of habitats or landscape features, Turner, 1989) or structural complexity of seagrass beds (Leber, 1985; Moore and Hovel, 2010; Orth et al., 1984; Rypel et al., 2007; Summerson and Peterson, 1984). In contrast, high local abundance of predatory fishes may override these factors and result in strong top-down effects (Hindell et al., 2001).

Predator body size range (Costa, 2009) may be another factor mediating the strength of top-down effects in seagrass systems. In terrestrial, freshwater and temperate marine ecosystems, relative predator size has been shown to play an important role in regulating prey communities (Langlois et al., 2006; Magnusson and Williams, 2009; Perez et al., 2009; Radloff and Du Toit, 2004; Rudolf, 2006; Winkler and Greve, 2004). Understanding the divergent effects of large- *versus* small-bodied predators on top-down regulation of food webs is critical as human activities (*e.g.*, overexploitation, habitat degradation) alter the size structure of marine organisms (Knowlton and Jackson, 2008; Pauly et al., 1998; Worm et al., 2006).

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http://dx.doi.org/10.1016/j.jembe.2013.06.002

Studies examining predator effects in seagrass beds have focused primarily on subtidal systems with water depths >1 m (Gacia et al., 1999; Heck et al., 2000; Hindell et al., 2000; Leber, 1985; Moore and Hovel, 2010). However, the role of predation may be rather different when predator access is constrained temporally, for instance, by water depth variation during a tidal cycle. In The Bahamas, for example, seagrass beds are common in extremely shallow, subtidal, wetlands with water depths as low as <0.1 m at low tide (Hammerschlag-Peyer and Layman, 2010; Rypel et al., 2007). In these systems, most fish predators can only forage in seagrass beds at high tide, and are restricted to deeper refuge areas, such as sink holes or mangrove-lined channels, during lower tidal levels (Hammerschlag-Peyer and Layman, 2010).

We examined predator effects on the seagrass epifaunal community in a shallow Bahamian wetland system. We employed exclusion experiments at two different spatial scales, and utilized mesh sizes that excluded different-sized predator individuals, to investigate how predatory fishes affected species richness, biomass and density, and community composition of the epifaunal community. Given the high abundance of predatory fishes, especially schoolmaster (*Lutjanus apodus*) and gray snapper (*Lutjanus griseus*), in this study system, we hypothesized strong predator effects on the epifaunal community. Furthermore, because these predators have been observed to shift their diet through ontogeny (Hammerschlag et al., 2010; Hammerschlag-Peyer and Layman, 2012; Starck and Schroeder, 1971), we also expected to see divergent responses between the two exclusion treatments.

2. Materials and methods

We examined effects of predatory fishes using exclusion experiments at two spatial (and temporal) scales: 1) “small-scale” (0.77 m^2 treatment area, 34 days, Figs. 1A), and 2) “medium-scale” (19.6 m^2 treatment area, 77 days, Fig. 1B). Both manipulations were conducted in the subtidal region of seagrass beds in Jungle Creek (26°21′36″N, 77°00′58″W), a seagrass- and mangrove-dominated tidal wetland, locally called “tidal creek” on the east side of Abaco Island, Bahamas. Jungle Creek is lined by mangroves (predominantly *Rhizophora mangle*) and the most prevalent benthic habitat types are seagrass beds (primarily *Thalassia testudinum*), submerged mangrove prop roots and sand flats. The system has a semi-diurnal tidal regime and mean daily tidal amplitude of ~0.8 m. Most of the seagrass areas have low tide depths <0.1 m. Consequently, fish predators were only able to access the seagrass beds twice daily for ~3–4 h around high tide (depending on individual body size), and were restricted to deeper refuge areas, such as mangrove-lined channels, during lower tidal levels (Hammerschlag-Peyer and Layman, 2010).

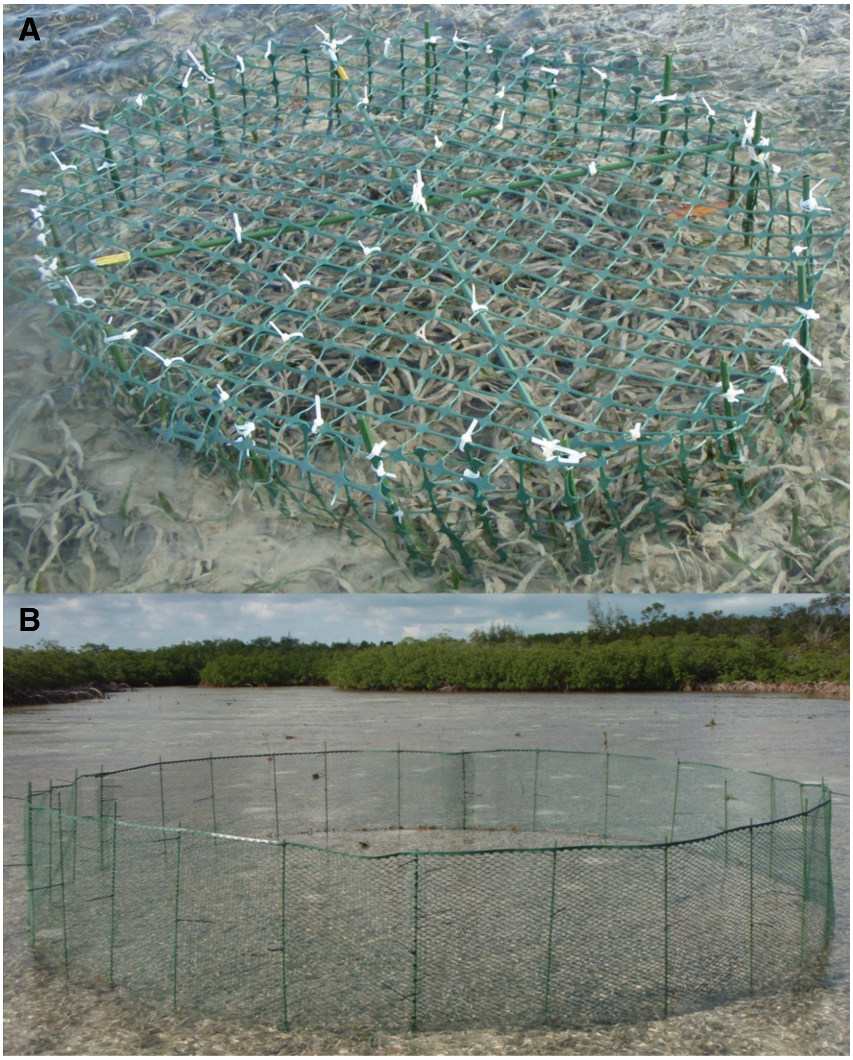

Fig. 1. Pictures of the A) large-predator (LPE) and B) small-and-large-predator (SPE + LPE) exclusion treatments of the small-scale and medium-scale experiment, respectively. Exclusion “cage” dimensions: A) 1.16 × 0.85 × 0.3 m (length × width × height), and B) 5 × 1.2 m (diameter × height). Treatment “cages” in the small-scale experiment were covered because height of cage was lower than water depth at high tide.