Is the Lionfish Invasion Waning? Evidence from the Bahamas

¿Está Disminuyendo la Invasión del Pez León? Evidencia de las Bahamas

Est l'Invasion de Lionfish en Déclin? Preuve des Bahamas

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KEY WORDS: Population time series, causes of population decline

EXTENDED ABSTRACT

During the early 2000s, Pacific Red Lionfish (*Pterois volitans*) and Devil Firefish (*P. miles*) spread rapidly throughout the greater Caribbean region. In 2004, invasive lionfish reached the Bahamas, where local populations grew exponentially (Claydon et al. 2008, Albins and Hixon 2013), reaching levels of about 400 lionfish per ha on continuous reef (Green and Côté 2009) and a phenomenal 8 lionfish per m^2 on patch reefs (Benkwitt 2013). This rapid increase in the population size of the invader was accompanied by extreme declines in the abundance of small native reefs fishes (Albins and Hixon 2008, Green et al. 2012, Albins 2013, 2015, Benkwitt 2015, Ingeman and Webster 2015). A voracious predator of small fish, invasive lionfish were rapidly converting native fish biomass to lionfish biomass.

By about 2009, there was evidence that lionfish populations in the Bahamas were starting to level-off (Green et al. 2012), followed by anecdotal reports of population declines Having studied lionfish since their first appearance in 2005 in the Exuma Cays chain of the central Bahamas near Lee Stocking Island, we examined our fish survey data from 2005 through 2015 to determine patterns of lionfish abundance over the first decade of the invasion. Importantly, no lionfish derbies or fisheries occured in this remote region. We surveyed reef-resident fishes at three spatial scales:

i) Small patch reefs,
ii) Medium-sized patch reefs, and
iii) Large reefs.

Small reefs included 32 small (ca.6 m^2) natural patch reefs (Hixon and Carr 1997), as well as 16 cubic-meter concrete-block artificial reefs (Carr and Hixon 1997). These small reefs were arranged in a matrix on a sand and seagrass flat 3 - 6 m deep on the Great Bahama Bank, with 200 m between adjacent reefs and at least 1 km to the nearest large reef. As these reefs were used in various field experiments during summer recruitment seasons, for this analysis we used only annual censuses that were conducted before any manipulations each year, which allowed time for recovery of resident fish communities. Six medium-sized patch reefs that ranged from 6 to 23 m^2 (averaging 10 m^2) were censused annually without manipulation. These reefs, ranging in depth from 2 to 4 m on sand and hardpan seafloors, were not well-isolated compared to the small reefs, and thus exhibited more dynamic fish densities. All resident reef fishes were censused on both the small and medium-sized reefs. At the largest scale, ten reefs 1400 to 4000 m^2 were surveyed before and after a long-term lionfish manipulation experiment (Albins 2015). Fish were censused on each reef in 400 m^2 survey areas (two 10 ´ 10 m plots and four 2 ´ 25 m^2 transects). For this analysis, we compared fish surveys that were conducted in 2009 before any lionfish manipulations and in 2015, five years after the experiment of Albins (2015) was completed. Lionfish were never manipulated on one of these large reefs, so we examined a complete time series from 2009 to 2015.

At all three spatial scales examined, there was a uniformly clear pattern of lionfish densities peaking between 2009 and 2011, and subsequently declining, with 2015 showing the lowest densities since lionfish population growth first accelerated (Figure 1). In contrast, the densities of one of the largest native predator on these reefs, Nassau Grouper (*Epinephelus striatus*), typically showed no trend, and certainly did not exhibit any increases that could have accounted for the decline in lionfish abundance (Figure 1).

At present, these patterns raise more questions than they answer. First, are these declines occurring elsewhere? Second, are these declines temporary or permanent? Third, given that few people inhabit this region and neither lionfish derbies nor lionfish fisheries were responsible, what caused these declines? Given the lack of substantial abiotic disturbances during this period (hurricanes notwithstanding), possible factors that naturally could reduce lionfish abundance include some combination of:

i) Competition for food, which could ultimately affect fecundity (as shown by Benkwitt's [2013] experimental evidence of density-dependent growth),
ii) Poor larval survival, although the larval life of lionfish is virtually unknown;
iii) Predation, with cannibalism being more likely than predation by native predators, and/or
iv) Parasitism or disease (although lionfish are relatively parasite-free [Sikkel et al. 2014]).

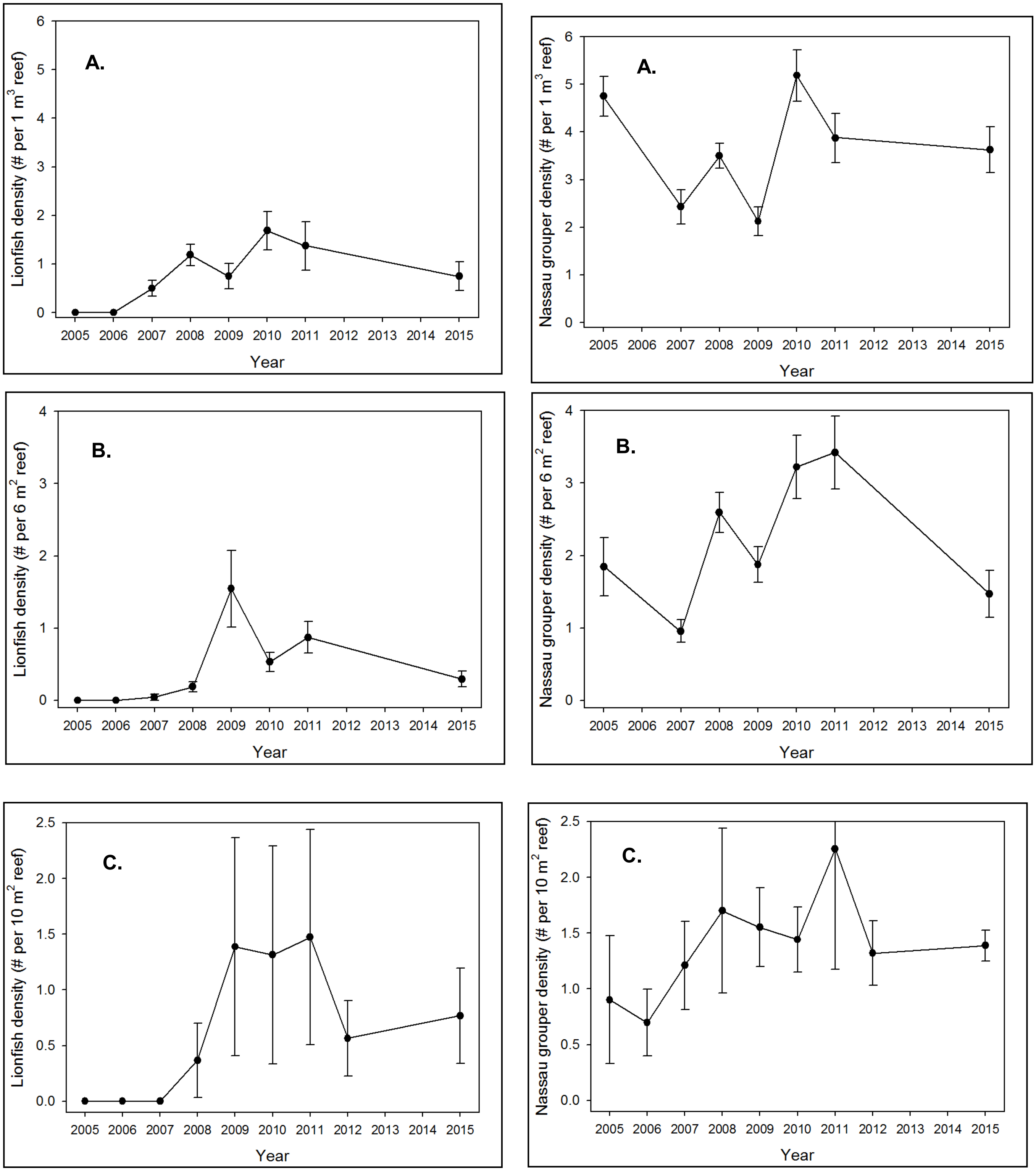

Figure 1. Time series of densities (mean ± SEM) of invasive Red Lionfish (left column) and native Nassau Grouper (right column) on reefs of different sizes in the Exuma Cays near Lee Stocking Island, Bahamas:

(A) 16 small artificial reefs,
(B) 32 small natural patch reefs,
(C) 6 medium-size patch reefs

Note that units vary between reef types to match the spatial scale of observation.

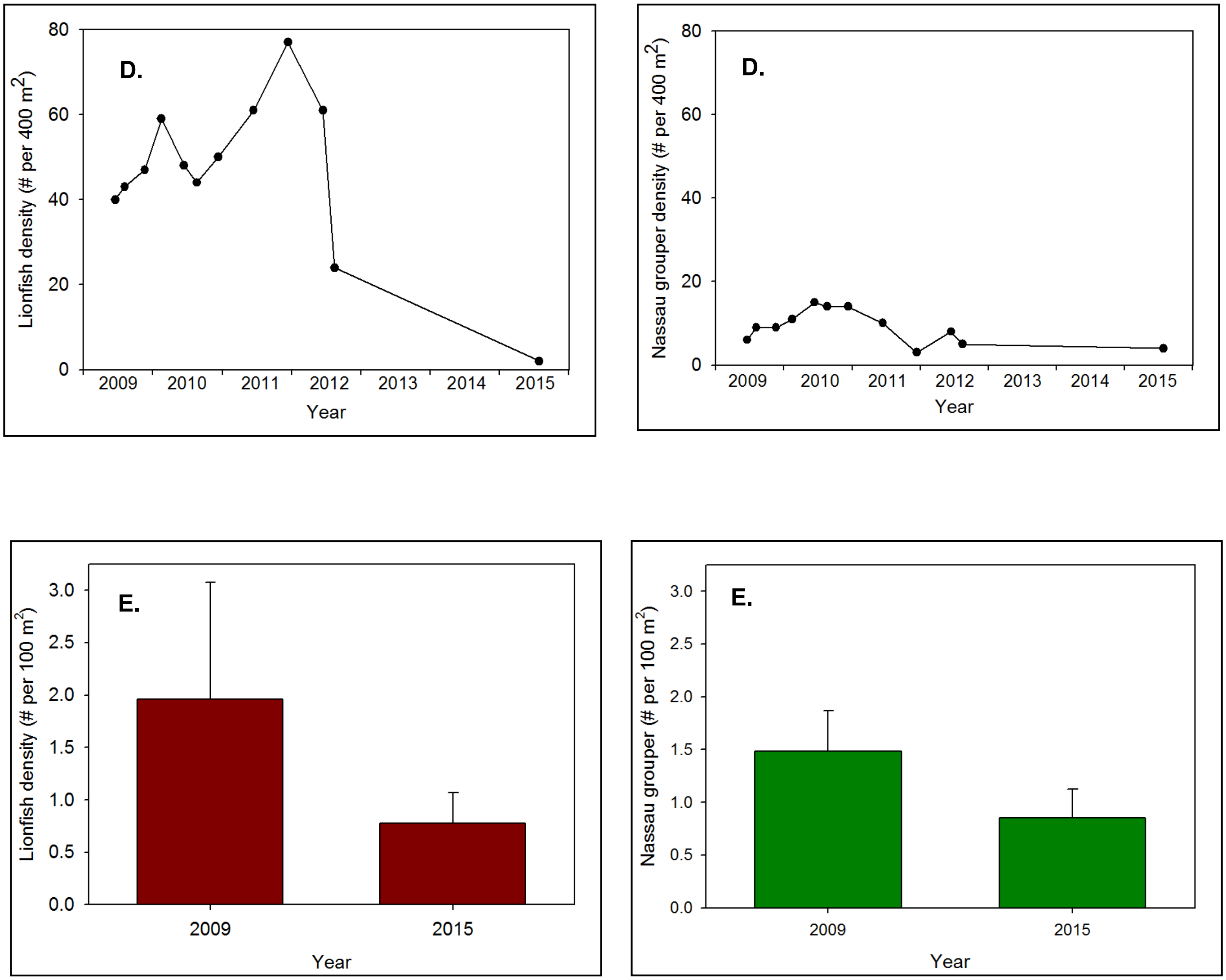

Figure 1. Time series of densities (mean ± SEM) of invasive Red Lionfish (left column) and native Nassau Grouper (right column) on reefs of different sizes in the Exuma Cays near Lee Stocking Island, Bahamas:

(D) single large reef
(E) 10 large reefs comparing two years.

Note that units vary between reef types to match the spatial scale of observation.

Importantly, given the preliminary nature of these patterns, management efforts to control the lionfish invasion should continue in earnest. Clearly, additional studies of these phenomena are warranted to determine whether or not the invaded ecosystem is starting to develop some form of biotic resistance to the invasion.

NOTE: We request that anyone who has noticed declines in lionfish densities (in regions where there have been no derbies or targeted fisheries) please contact Mark Hixon (hixonm@hawaii.edu). Thank you.

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