Lionfish Hunting Behavior Across Multiple Habitats: Effect of Local Lionfish Density and Implications for Native Fishes

Comportamiento de Caza del Pez León en Múltiples Hábitats: Efecto de la Densidad Local del Pez León e Implicaciones para Peces Nativas

Comportement de Chasse du Poisson-lion à Travers Plusieurs Habitats: Effet de la Densité Locale du Poisson-lion et Implications pour les Poissons Indigènes

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EXTENDED ABSTRACT

Local population density can strongly influence individual demographic rates and behavior, with important consequences for the population dynamics of a single species, as well as community-level dynamics and ecosystem processes. If there is increased intraspecific competition for food at higher densities, then predators may increase the amount of time they spend hunting and/or the distances over which they travel while hunting, which in turn may change which prey are most vulnerable to predation. These changes may be particularly important to the population dynamics of both introduced predators and their native prey, as invasive species often reach higher abundances in their invaded range compared to their native range, and invasive predators often have large effects on native prey populations (Sakai et al. 2001).

The Indo-Pacific red lionfish (*Pterois volitans*) is an invasive marine fish that has reached extremely high densities in parts of the Western Atlantic (review by Côté et al. 2013). Invasive lionfish are efficient predators that cause substantial reductions in native coral-reef fish abundance, biomass, and richness. In both their native and invaded ranges lionfish are crepuscular hunters, with peaks in foraging activity typically occurring around dawn and dusk (Cure et al. 2012). Juvenile invasive lionfish exhibit slower growth rates at higher densities (Benkwitt 2013), indicating local competition for food, but how the foraging behavior of lionfish changes at different local lionfish densities has not yet been examined. We predicted that if there is intraspecific competition for food, then at higher densities lionfish will change their foraging activity by:

i) Increasing the amount of time spent hunting and active and/or
ii) Increasing the distances over which they travel while hunting.

To test these predictions, we conducted behavioral observations of lionfish on sixteen coral patch reefs in The Bahamas. We selected reefs with a natural range of lionfish densities (1 – 16 lionfish/reef, 0.04 – 1.01 lionfish/m^2) and visited each reef at dawn, midday, and dusk. Significantly more lionfish hunted at dawn compared to dusk and midday, and significantly more lionfish also hunted at dusk compared to midday, but this relationship did not vary with lionfish density. In contrast, the proportion of lionfish active (hovering, swimming, or hunting) varied with both time of day and lionfish density (Figure 1). Regardless of lionfish density, the majority of lionfish were active at dawn and very few were active in the middle of the day. At higher densities, however, a higher proportion of lionfish were active at dusk. Lionfish exhibited predictable movements between their "home" coral patch reefs and surrounding seagrass and sand habitats. Lionfish increased their foraging movements at dawn and dusk at higher densities, with a higher proportion of lionfish feeding in habitats surrounding patch reefs (Figure 2).

These observed behavioral differences among lionfish at different densities may have implications for native prey populations. There was a peak in feeding and activity at dawn regardless of lionfish density, but at dusk lionfish were more active only at higher densities. This observation suggests that native prey species that are primarily active at dusk will be most affected by lionfish predation only in areas with high lionfish densities. At both dawn and dusk, there were increased foraging movements in habitats surrounding patch reefs at higher lionfish densities. In a follow-up study to determine whether these movements affect native prey fishes in the surrounding habitats, lionfish first depleted prey fishes on patch reefs and subsequently caused reductions in prey fishes on small structures (e.g., coral heads, conch shells, coral rubble) up to 35 m away from reefs. These results suggest that lionfish feed substantially in the habitats around coral patch reefs, especially at higher local lionfish densities, and are therefore having broader negative effects on native fish communities than previously documented.

Lionfish removals can reduce local lionfish abundances and help maintain prey populations on coral reefs (Green et al. 2014). Here, we demonstrate that at higher densities lionfish have increased activity levels at dusk and broader foraging movements at both dawn and dusk, which suggests that removals may have more benefits than previously documented. In particular, by keeping lionfish densities low, managers may reduce the local foraging range of lionfish and thus help maintain native fish communities in multiple habitats.

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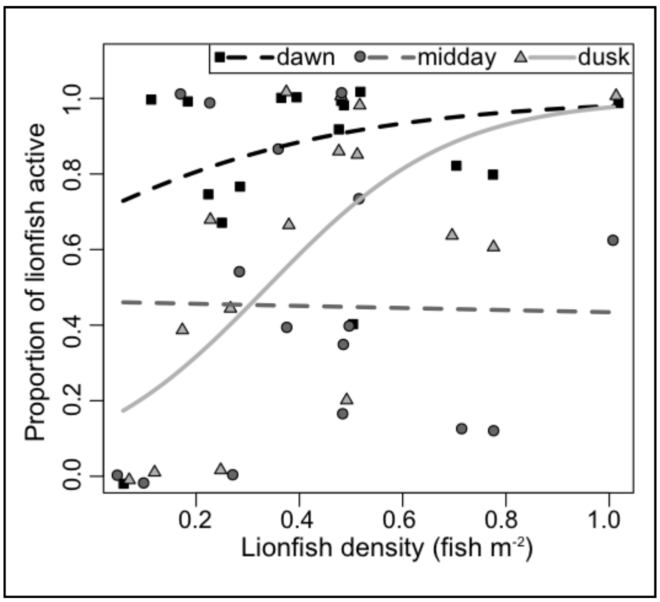

Figure 1. Proportion of lionfish that were active as a function of maximum lionfish density observed on each reef and time of day. Points represent reefs and lines are predicted probabilities based on mixed effects models (dashed lines: $p > 0.05$, solid lines: $p < 0.05$).

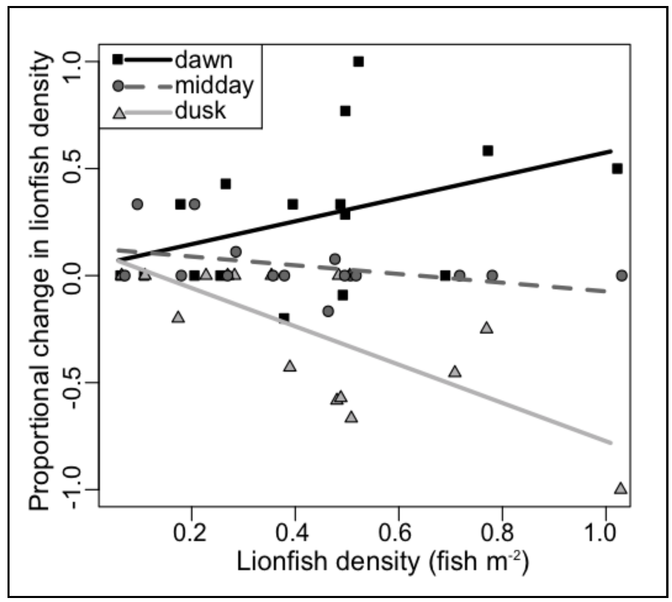

Figure 2. Proportional change in lionfish density on each reef as a function of maximum lionfish density observed on each reef and time of day. The positive change at dawn indicates lionfish arriving at the reef from surrounding habitats, and the negative change at dusk indicates lionfish departing from the reef, with no significant change occurring during midday. Points represent reefs and lines are predicted probabilities based on mixed effects models (dashed lines: $p > 0.05$, solid lines: $p < 0.05$).