Quantifying Ecological Impact of Invasive Lionfish Relative to Co-occurring Native Predators: The Influence of Habitat Heterogeneity on Per Capita Impact

Cuantificando el Impacto Ecológico del Pez León Invasivo Relativo a los Depredadores Nativos Co-ocurrentes: La Influencia de Heterogeneidad del Hábitat en el Impacto per Cápita

Quantifier L'impact Écologique du Poisson-lion Envahissant par Rapport aux Prédateurs Autochtones Co-occurrents: L'influence de Hétérogénéité de L'habitat sur L'impact par Habitant

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EXTENDED ABSTRACT

Invasive species exert profound impacts on the systems to which they are introduced. Understanding the threat posed by an invasive species is undoubtedly the first step to mitigating its impact. However, these impacts are often difficult to both forecast and quantify (Lockwood et al. 2013). Quantifying the impacts of marine invasive species is especially critical, whose study has historically lagged behind their freshwater and terrestrial counterparts (Tricarico et al. 2016). Functional response is a novel way with which to predict and quantify the impact of invasive species by comparing their feeding rates and thus their per capita impact on prey populations, relative to the native analogues with which they occur (Dick et al. 2014). Unfortunately, most experiments of this vein lack habitat heterogeneity, limiting their applicability and transferability (Jeschke et al. 2002). Lionfish are one such marine invasive species whose impacts have drawn substantial attention from researchers. However, we continue to lack a thorough understanding of their feeding and behavioural ecology across their invaded range and relative to ecologically similar native predators with which they co-occur. Therefore, we sought to better understand the impacts of lionfish in an understudied region of its invaded range, the eastern Gulf of Mexico.

We conducted comparative, feeding rate laboratory experiments with each of three species across six prey densities. Pink shrimp (*Penaeus duorarum)* sufficed as prey. Trials were conducted in a circular experimental tank, comprised of three patches of equal area but distinct habitat. Prey was replaced as they were consumed throughout the three-hour trial duration. Lionfish per capita impact was contrasted against two native species, red (*Epinephelus morio*) and graysby (*Cephalopholis cruentata*) grouper.

We sought to understand how foraging behaviour varied across:

i) Habitat
ii) Species
iii) Prey density

Red grouper demonstrated greater attack and consumption rates relative to both lionfish and graysby grouper, while lionfish and graysby grouper displayed similar feeding rates (Figure 1).

Our data is discordant with previous estimates of lionfish feeding rates. Prey consumption rates of lionfish (g prey per g predator) in our study were considerably less than consumption rates published in both prior lab and field studies conducted in both the native and invaded ranges of lionfish (Figure 2). This study suggests that the impacts of lionfish may be context-dependent, varying with abiotic and biotic conditions and across their invaded range.

This is the first laboratory study to use comparative functional response methodology to assess the impacts of lionfish versus co-occurring predators and to do so in a spatially heterogeneous arena. Field-based feeding estimates are needed to corroborate our estimates of consumption per unit biomass, both alone and in conjunction with local estimates of abundance. The results from this experiment will have practical implications for prey population

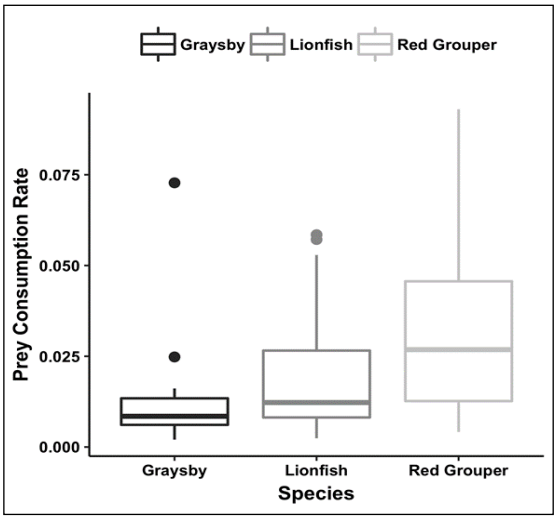

Figure 1. Mass-specific prey consumption rate (gram prey per gram predator)

dynamics in the Gulf of Mexico and beyond. Better understanding the feeding ecology and behaviour of lionfish across their invaded range is a pivotal step toward mitigating their threat and appropriately partitioning resources.

KEYWORDS: Lionfish, feeding, behaviour

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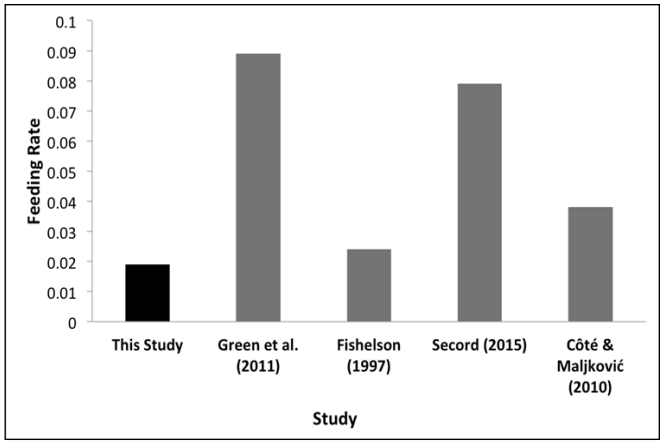

Figure 2. Mass-specific prey consumption rate (g prey per g predator) in our study relative to previous estimates