Invasive Lionfish: Threats and Solutions

La Invasión del Pez León: Amenazas y Soluciones

L'invasion de Lionfish: les Menaces et les Solutions

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EXTENDED ABSTRACT

Pacific red lionfish (*Pterois volitans*) have now spread throughout the Gulf of Mexico and the greater Caribbean region. Invasive lionfish are voracious and generalized predators of dozens of small fish species (Albins and Hixon 2008), including the juveniles of important fishery species, and are seafloor habitat generalists, occupying any available structure that provides shelter. Consequently, lionfish are known to have strong negative effects on the abundance of native reef fishes, including documented local extinctions (Albins 2015). Even low densities of lionfish negatively affect recruitment of native reef fishes (Benkwitt 2015). Especially affected species, including gobies (e.g., *Coryphopterus glaucofraenum*) and basslets (e.g., *Gramma loreto*), experience intense, density-independent mortality in the presence of lionfish compared to the effects of native predators. There is concern that overconsumption of herbivorous fishes by lionfish may worsen ongoing phase shifts from coral-dominated to algal-covered reefs (review by Albins and Hixon 2013).

The invaded ecosystem has offered little biotic resistance to the invader. Aggressively territorial threespot damselfish (*Stegastes planifrons*) ignore them (Kindinger 2015), and lionfish *in situ* grow more rapidly and appear to outcompete a similar-sized native piscivore, the coney grouper (*Cephalopholis fulva*) (Albins 2013). Invasive lionfish have low parasite loads compared to ecologically similar native fishes on the same reefs and to lionfish in the Pacific. Lionfish are also largely immune to substantial predation from large grouper and sharks due to their unusual and cryptic appearance, and especially, their venomous spines. The sole source of biotic resistance identified thus far has been that, by swarming at locally high densities, Nassau grouper (*Epinephelus striatus*) apparently interfere with the slow-stalking predatory behavior of lionfish, a form of amensalism (a "zero-negative" interaction). This phenomenon may explain reported negative correlations between lionfish and grouper densities, yet lionfish so displaced from reefs may target prey fish in surrounding seagrass beds. Unfortunately, groupers are severely overfished throughout most of the invaded range. As a highly successful mesopredator, invasive lionfish now dominate the interaction web of native coral-reef fishes (Figure 1).

Because of the high predatory, growth, survival, and reproductive efficiency of invasive lionfish, combined with the low level of biotic resistance provided by the native ecosystem, lionfish reach much higher densities in the invaded range than in their native Pacific range. The only density dependence thus far detected in the demographic rates of invasive lionfish is somatic growth (Benkwitt 2013). No density dependence in recruitment or survival has thus far been documented.

The primary management approaches to address the invasion have been lionfish derbies and targeted fisheries. Derbies have been successful in reducing the local abundance of lionfish. The commercial fisheries approach will be most successful if invasive lionfish become a popular and valuable "conservation dish," especially at expensive restaurants ("Save the reef, eat a lionfish"). Reports that lionfish are ciguatoxic should be reexamined to ensure that only cooked flesh is tested because spine venom precursors in uncooked flesh can provide false positive tests for ciguatera (Wilcox and Hixon 2015).

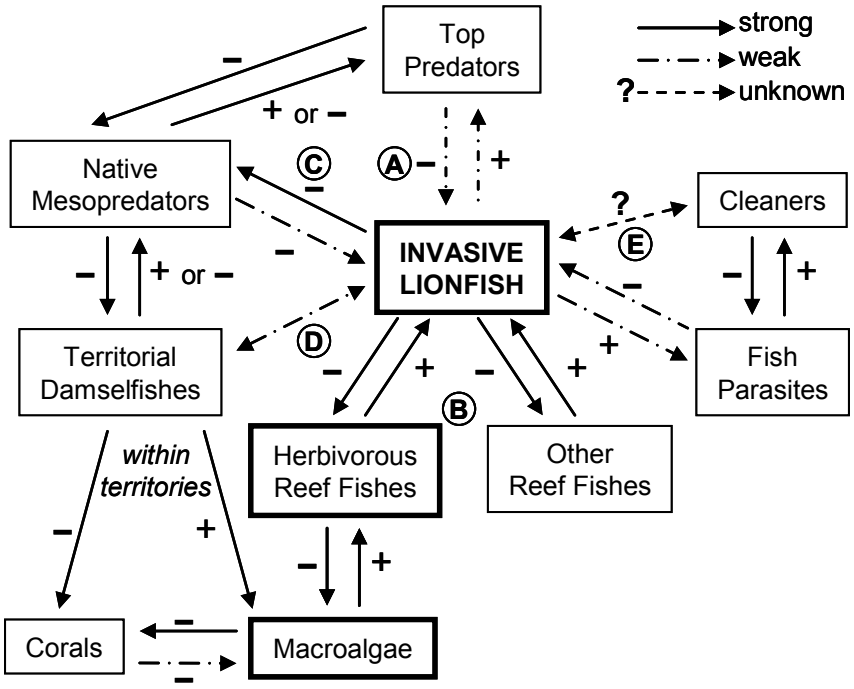

Figure 1. Simplified western Atlantic coral-reef interaction web, illustrating both previously documented and unknown interactions and effects of invasive Pacific lionfish. Effects labeled by circled letters are the focus of our field research. Predation (including parasitism) is a −/+ interaction, competition is a −/− interaction, and "+ or −" interactions may involve predation and/or competition. Indirect interactions (not shown) are mediated through direct interactions (e.g., lionfish eat herbivorous fishes, which may indirectly benefit macroalgae to the detriment of corals). The three boxes with bold borders indicate a possible trophic cascade caused by lionfish on invaded coral reefs (i.e., increases in lionfish cause decreases in herbivorous fishes, which in turn, cause increases in macroalgae).

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NOTE: All publications by the Hixon lab on the lionfish invasion can be downloaded for academic use at: http://hixon.science.oregonstate.edu/content/highlight-lionfish-invasion