Grazing preferences by herbivorous fishes in The Bahamas in 2011

Website: https://www.bco-dmo.org/dataset/700177
Data Type: Other Field Results
Version: 1
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Project
» Mechanisms and Consequences of Fish Biodiversity Loss on Atlantic Coral Reefs Caused by Invasive Pacific Lionfish (BiodiversityLossEffects_lionfish)

Contributors	Affiliation	Role
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Abstract
Grazing preferences by herbivorous fishes in The Bahamas in 2011

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Coverage

Temporal Extent: 2011-07-22 - 2011-07-31

Dataset Description

Grazing behavior during assays of native herbivorous fishes in response to the presence of invasive lionfish.

For related datasets, please visit the project link listed at the top of the page.

Methods & Sampling

Methods from Kindinger and Albins (2016) "Consumptive and non-consumptive effects of an invasive marine predator on native coral-reef herbivores" doi: 10.1007/s10530-016-1268-1

To quantify NCEs of invasive lionfish on native herbivores, we observed the grazing behavior of herbivorous fishes at each of the 10 experimental reefs over 10 consecutive days in July 2011, observing paired reefs on adjacent days. Each day, we collected 20 haphazardly selected pieces of algal-covered coral rubble (0.43–0.94 m2 surface area) from a nonexperimental reef containing an extensive area of dead Acropora cervicornis coral rubble inhabited by a high density of three-spot damselfish (Stegastes planifrons). This territorial fish maintains higher standing stocks of farmed palatable seaweeds via interspecific aggression in response to intruding herbivores (Ceccarelli et al. 2001).

Each piece of algal substratum was carefully placed into a plastic bag filled with seawater, photographed out of water onboard a boat, returned to its plastic bag, and transported in a cooler of seawater to a nearby experimental reef. At high-lionfish-density reefs, we randomly assigned paired substrata to two similar, but separate microhabitats (e.g., next to a coral head, on a ledge, etc.) that differed only in the presence (\ 0.25 m away) versus absence ([3 m away) of lionfish at the time of observation. At low-lionfish-density reefs, we placed algal substrata in paired microhabitats that were similar to those used at high-lionfish-density reefs, except lionfish were always absent during observation. All replicates were therefore placed in types of microhabitats frequented by lionfish, regardless of actual lionfish presence. Overall, we observed grazing of translocated algal-covered substrata at three levels of lionfish presence: (1) low-lionfish-density reef with lionfish absent from the observed microhabitat (n = 100); (2) high-lionfish-density reef with lionfish absent from the microhabitat (n = 50); and (3) high-lionfish-density reef with lionfish present in the microhabitat (n = 50); hereafter referred to as low -absent , high -absent , and high -present treatments, respectively. These treatments were designed to provide insight on the spatial scale at which lionfish presence affects herbivorous fish behavior by allowing simultaneous comparisons of grazing behavior between (1) low- and high-lionfish-densities at the reef-scale while controlling for lionfish presence at the within-reef scale (i.e., low-absent vs. high-absent treatments) and (2) lionfish presence-absence at the within-reef scale while controlling for lionfish density at the reef-scale (i.e., high-absent vs. high-present treatments).

At each experimental reef, we monitored four of the translocated algal substrata—one pair in the morning (0900–1200) and one pair in the afternoon (1400–1600)—for 60 min each using automated underwater video cameras placed approximately 3 m away. Meanwhile, we observed the remaining 16 algal substrata with SCUBA (8 replicates per diver) one at a time for 20 min each, with observations divided evenly throughout the day (2 pairs in the morning and 2 pairs in the afternoon per diver). All observations were therefore performed during the day when the probability of lionfish predation is greatly reduced (Green et al. 2011 ; Cure et al. 2012) and all lionfish observed were inactive. We identified the species of each fish that visited these substrata, visually estimated its TL to the nearest cm, and counted the number of times it took a bite of algae. Each fish was considered to be a unique individual once it entered the diver's field of view (approximately 2 m surrounding the focal rock), and continuing until the time it left the field of view and could no longer be visually tracked. At the end of each observation period, the algal substratum was carefully returned to its plastic bag full of fresh seawater and kept underwater until all 20 replicates had been observed. We then rephotographed each replicate onboard the boat.

Grazing behavior observed at each replicate algal substratum was comprised of the following response variables: (1) visitation rate (number of fish/minute); (2) percent visitation rate (percent fish/minute); (3) bite rate (number of bites/minute); and (4) individual bite rate (number of bites per fish/minute). The percent visitation rate and individual bite rate allowed us to account for any potential differences in herbivorous fish densities between low- and high-lionfish-density reefs. Percent visitation rates were calculated by dividing the total number of fish observed grazing (per substratum) by the total number of herbivorous fish counted at each reef during the reef fish surveys conducted just prior (June 2011) to the grazing observations (July 2011). For all the herbivorous fish that grazed on each experimental substrate, the number of bites each fish took during individual grazing bouts was averaged to measure the individual bite rate. We also used the before and after photographs of each substrate to estimate the percent loss of algal cover from observed grazing. We quantified percent cover from photographs using the image processing program, ImageJ.

We analyzed the response of all herbivorous fishes that grazed on the experimental substrate by fish size class (small and large , with large encompassing the response among fishes[10 cm TL, which remained consistent regardless of further size binning into medium and large size classes). Parrotfishes accounted for 69.2 % of the herbivorous fishes that we observed grazing. Therefore, the behavioral response (same variables as above) of this fish family was also analyzed by fish size class. The remaining fish families (surgeonfishes, angelfishes, and damselfishes) were not further divided by size class, because such extensive division of each response variable would have resulted in highly zero-inflated data. The percent loss of algae from substrata was not analyzed by fish size class nor by fish family, because individual contributions of each fish to the overall algal loss could not be distinguished.

We fitted LMMs using a similar procedure as the one described above to account for the nested design of the fish grazing surveys when comparing grazing behavior of herbivorous fish among lionfish treatments. Random effects consisted of paired microhabitats nested within paired reefs. In addition to lionfish treatment (lowabsent, high-absent, and high-present), all full models included the initial algal percent cover (algae) of each replicate substratumas a fixed factor in order to account for any influence this parameter could have on grazing behavior, as well as an algae 9 lionfish interaction. With the exception of the model of percent loss in algal cover, we log-transformed all rate response variables and allowed variances to differ among reefs with weighted terms to meet all assumptions of normality, homogeneity, and independence. When lionfish treatment was significant in the model based on LRTs, we performed multiple comparisons of the response at

every combination of lionfish treatments using Tukey’s Honestly Significant Difference (HSD) method. All statistical analyses of both reef fish surveys and fish grazing observations were conducted using the statistical software R (R Core Team 2014) with the associated packages, nlme (Pinheiro et al. 2014) and multcomp (Hothorn et al. 2008).

Data Processing Description

BCO-DMO Processing Notes:

- reformatted column names to comply with BCO-DMO standards
- reformatted dates
- nd used to fill blank cells

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Data Files

File
grazingAssays.csv (Comma Separated Values (.csv), 88.99 KB) MD5:efa536dc0f3583f68431ba2e3ad3bf96 Primary data file for dataset ID 700177

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Related Publications

Kindinger, T. L., & Albins, M. A. (2016). Consumptive and non-consumptive effects of an invasive marine predator on native coral-reef herbivores. Biological Invasions, 19(1), 131–146. doi:10.1007/s10530-016-1268-1
Methods

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Parameters

Parameter	Description	Units
date	Date of observation; YYYY/MM/DD	unitless
site	Name of study site (reef)	unitless
site_treatment	Lionfish treatment of site (reef): Low-lionfish-density reef or High-lionfish-density reef	unitless
replicate_number	Replicate number; replicates = algal-covered substrata placed in study site	unitless
replicate_pair	Replicate pairs	unitless
observation_time	Length of observation	minutes
micro_treatment	Lionfish treatment of microhabitat where substrate was placed/observed: lionfish were absent or present during observation	unitless
algae_initial	Initial amount of algae covering substrate	centimeters squared
algae_pcntCoverChange	Change in percent cover of algae quantified from before vs. after photos of substrate	percent
family	Family of fish	unitless
species	Species of fish: species codes are first two letters of genus and species (see species key)	unitless
fish_size	Total body length of fish	centimeters
bite_number	Number of bites fish took of algae from substrata during observation	count

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Deployments

LSI_Reef_Surveys_09-12

Website	https://www.bco-dmo.org/deployment/59019
Platform	Tropical Marine Lab at Lee Stocking Island
Start Date	2009-05-30
End Date	2012-08-18
Description	Locations of coral reef survey dives and sightings, or collections of the invasive red lionfish, Pterois volitans, near Lee Stocking Island, Bahamas for the projects "Ecological Release and Resistance at Sea: Invasion of Atlantic Coral Reefs by Pacific Lionfish" and "Mechanisms and Consequences of Fish Biodiversity Loss on Atlantic Coral Reefs Caused by Invasive Pacific Lionfish" (NSF OCE-0851162 & OCE-1233027). All dives were made from various small vessels (17' to 24' l.o.a., 40 to 275 HP outboard motors, 1 to 7 GRT). Vessel names include, Sampson, Orca, Potcake, Lusca, Lucaya, Zardoz, Parker, and Nuwanda.

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Project Information

Mechanisms and Consequences of Fish Biodiversity Loss on Atlantic Coral Reefs Caused by Invasive Pacific Lionfish (BiodiversityLossEffects_lionfish)

Website: http://hixon.science.oregonstate.edu/content/highlight-lionfish-invasion

Coverage: Three Bahamian sites: 24.8318, -076.3299; 23.8562, -076.2250; 23.7727, -076.1071; Caribbean Netherlands: 12.1599, -068.2820

The Pacific red lionfish (Pterois volitans), a popular aquarium fish, was introduced to the Atlantic Ocean in the vicinity of Florida in the late 20th century. Voraciously consuming small native coral-reef fishes, including the juveniles of fisheries and ecologically important species, the invader has undergone a population explosion that now ranges from the U.S. southeastern seaboard to the Gulf of Mexico and across the greater Caribbean region. The PI's past research determined that invasive lionfish (1) have escaped their natural enemies in the Pacific (lionfish are much less abundant in their native range); (2) are not yet controlled by Atlantic predators, competitors, or parasites; (3) have strong negative effects on populations of native Atlantic fishes; and (4) locally reduce the diversity (number of species) of native fishes. The lionfish invasion has been recognized as one of the major conservation threats worldwide.

The Bahamas support the highest abundances of invasive lionfish globally. This system thus provides an unprecedented opportunity to understand the direct and indirect effects of a major invader on a diverse community, as well as the underlying causative mechanisms. The PI will focus on five related questions: (1) How does long-term predation by lionfish alter the structure of native reef-fish communities? (2) How does lionfish predation destabilize native prey population dynamics, possibly causing local extinctions? (3) Is there a lionfish-herbivore-seaweed trophic cascade on invaded reefs? (4) How do lionfish modify cleaning mutualisms on invaded reefs? (5) Are lionfish reaching densities where natural population limits are evident?

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Funding

Funding Source	Award
NSF Division of Ocean Sciences (NSF OCE)	OCE-1233027

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