Behavioral observations of lionfish at native Pacific and invaded Atlantic locations (Bahamas, Cayman Islands, Guam, Philippines) from 2009-2012 (Lionfish Invasion project)

Website: https://www.bco-dmo.org/dataset/3975
Data Type: Other Field Results
Version: 1
Version Date: 2013-06-26

Project
» Ecological Release and Resistance at Sea: Invasion of Atlantic Coral Reefs by Pacific Lionfish (Lionfish Invasion)

Contributors	Affiliation	Role
Hixon, Mark	Oregon State University (OSU)	Lead Principal Investigator
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Abstract
Behavioral observations of lionfish, with a focus on hunting activity throughout the day, at native Pacific (Guam and the Philippines) vs. invasive Atlantic locations (Bahamas and Caymans) to assess possible differences between ranges. Particular emphasis was placed on species hunted, time spent hunting and total numbers of kills and strikes. The investigators hypothesized that lionfish at invaded locations would have higher success at killing prey and spend less time hunting.

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Coverage

Spatial Extent: **N**:23.81761 **E**:144.800067 **S**:9.073039 **W**:-80.06091
Temporal Extent: 2009-08-07 - 2010-08-20

Dataset Description

Behavioral observations of lionfish, with a focus on hunting activity throughout the day, at native Pacific (Guam and the Philippines) vs. invasive Atlantic locations (Bahamas and Caymans) to assess possible differences between ranges. Particular emphasis was placed on species hunted, time spent hunting and total numbers of kills and strikes. The investigators hypothesized that lionfish at invaded locations would have higher success at killing prey and spend less time hunting.

Related Publications:
Cure K., Benkwitt C.E., Kindinger T.L., Pickering E.A., Pusack T.J., McIlwain J.L, Hixon M.A. (2012) Comparative behavior of red lionfish *Pterois volitans* on native Pacific versus invaded Atlantic coral reefs. Marine Ecology Progress Series. 467: 181-192. DOI: 10.3354/meps09942

Pusack, T.J., Kindinger T.L., Benkwitt C.E., Katherine, C. (submitted) Invasive red lionfish (*Pterois volitans*) grow

faster and larger in the Atlantic Ocean than in their native Pacific range. Marine Ecology Progress Series.

Methods & Sampling

This sub-project aimed to compare native vs. invasive populations of lionfish, in order to assess some of the potential factors responsible for the invasive success of lionfish in the Atlantic. Assessment in the native range included analysis of behaviour and juvenile growth patterns, at two general locations: Guam and the Philippines. Behaviour was assessed via 10-minute observations on inividual lionfish, aiming to assess different individuals and their hunting behaviour as well as interactions with other species at different times of the day. Observations were done wherever lionfish were found, and included artificial habitats, coral reefs, sandy areas and reef channels with rock/boulder habitat. Observations in the native range were then compared to those at invaded locations (Bahamas and Caymans) undertaken with identical methods by other members of the team. Data were QA/QCd by spot checking against original field data sheets.

Lengthy notes/comments extracted from dataset are below. Indicated by 'see_Note_x' in the data.

Notes in strikes_at_species column:
Strikes_at_sp_Note_1 = Not visible but around P. coelestis and wanting to feed on them
Stikes_at_sp_Note_2 = Plotosus lineatus and something not visible in the water column
Strikes_at_sp_Note_3 = Recruits pomacentrids & cardinals less than 2cm
Strikes_at_sp_Note_4 = Unidentified Apogonidae with bright yell spot on the caudal peduncle

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Notes in num_blows column:
Num_blows_Note_1 = 4 (plus 3 continuous bLings at a little sandy bay under a rock)

Notes in blows_at_species column:
Blows_at_sp_Note_1 = unidentified; not possible to view from distance
Blows_at_sp_Note_2 = Labrid small; perhaps Labroides bicolor
Blows_at_sp_Note_3 = unidentified; cannot see from distance at which observer located and water murky; only prey IDd nearby was yell and blue little fish
Blows_at_sp_Note_4 = While being cleaned by L. dimidaitus
Blows_at_sp_Note_5 = cardinalfish bright yelL margin on dorsal fin

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Notes in aggression_at_species column:
Aggrssn_at_Note_1 = 2 pennant bannerfish(H.chrysostomus);agression=approach w flared fins & upright spines;slight movement displaced Heniochus
Aggrssn_at_Note_2 = 2X P.antennata;flaring fins & moving to defend;1 against lrgr PTVO(27cm) that it encntrd looking for diff spot;got it out of its hole & occupied hole
Aggrssn_at_Note_3 = Parrotfish large darting by; lion reacted by flaring spines defensively

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Notes in killed_species column:
Killed_sp_Note_1 = Invert maybe;not seen;definite action under boat while upsidedown amongst algae overgrowth
Killed_sp_Note_2 = Not visible but feeding observed;must be prey small enough to not be seen at distance of observation
Killed_sp_Note_3 = Not visible but clearly lion turned around from position and ate

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Notes in aggressive_species column:
Agg_sp_Note_1 = PTVO smaller size (13) approached with flared fins trying to get a hunting spot
Agg_sp_Note_2 = PTVO smaller size approached it with flared fins and kept staring at it;no close approach but enought to cause this animal to move away and stop rest. This PTVO was observed by Brett Taylor, line 39
Agg_sp_Note_3 = Ptvo larger 37 cm; kept displacing this one from its position
Agg_sp_Note_4 = Ptvo larger 37 cm; displaced it from its position
Agg_sp_Note_5 = PTAT 10cm moved voli from its spot

Notes in location column:

Loc_Note_1 = 260 deg from mooring / 270 deg from x-mas tree / 310 deg over little mushroom
Loc_Note_2 = 10 deg from ally with mallet head on right / mallet head is 235 deg from x-mas tree
Loc_Note_3 = 80 deg to triple head (?) boundary ~10 m/past other 2 300 deg to lion ledge/ 3 fan rock
Loc_Note_4 = New head across alley from flag 290/300 to Lion ledge (closer to lion ledge)
Loc_Note_5 = Near Goniopora field;Under plate of coral at cleaning stn being cleaned by a blue&yell wrasse w straight caudal fin
Loc_Note_6 = On table Porites rus at the northernmost part of the dive; towards Love Rock; next to previous
Loc_Note_7 = On table Porites rus at the northernmost part of the dive; towards Love Rock
Loc_Note_8 = Under ledge of almost dead skirt like coral w no bumps;not P.rus;reddish color;looks like P. asteroides in Caribbn
Loc_Note_9 = Massive semi dead;under larger volitans;moved & sat next to the big guy & repositioned itself
Loc_Note_10 = On Boulder;Non Coral;undrneath & close to PTVO 32cm;ended next to big guy;at cleaning stn at branching Porites
Loc_Note_11 = At boulder;non-coral;next to Prus cleaning colony;another PTVO under it in silt

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Notes in body_orientation column:
Body_Note_1 = Upright and exposed but upon approach kept running away and tucking itself more and more until ended up in cave with only pectorals and tail seen
Body_Note_2 = Area w sm colonies of Pocillopora & recruit Chromis;vertcl position;under boat canopy;recently fallen;couldnt find lttle guy;kept envrnmnt dark & kept opening&closing space
Body_Note_3 = On top of massive boulder w somewhat live coral;horizntl position;next to darker phase volitans almost touching each other
Body_Note_4 = Under sm ledge near bottm facing wall vertically;diff place than othr times;but same head
Body_Note_5 = Upright on sandy bottom; under boulder; could be seen through a hole; right next to previous one

Data Processing Description

BCO-DMO Processing Notes:
- Changed parameter names to conform with BCO-DMO naming conventions.
- Removed apostrophes in the 'site' column. Replaced commas with semi-colons in the columns containing text.
- Added lat and lon for each site from the metadata sheet.
- Replaced blanks with 'nd' to indicate 'no data'.
- Replaced 'ICON' with 'ICON_reef' for consistency throughout dataset.
- Extracted very long notes/comments to improve visual display of the data in the browser.
- Edited notes/comments slightly to shorten length of fields.
- 27-Dec-2017: Removed embargo on dataset.

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Data Files

File	
comp_lionfish_behavior.csv	(Comma Separated Values (.csv), 308.29 KB) MD5:f91d905dfca7ea69d81d58d5dee89d63
Primary data file for dataset ID 3975	

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Parameters

Parameter	Description	Units
basin	Atlantic or Pacific Ocean.	text

region	Region sampled.	text
site	Name of the reef site.	text
lat	Latitude of the reef site.	decimal degrees
lon	Longitude of the reef site.	decimal degrees
date	Date in which observation was taken in mm/dd/YYYY format.	unitless
month	2-digit month when observation was made.	mm (01 to 12)
day	2-digit day of month when observation was made.	dd (01 to 31)
year	4-digit year when observation was made in YYYY format.	unitless
time_sunrise	Time (local) of sunrise at region sampled.	HH:MM
time_sunset	Time (local) of sunset at region sampled.	HH:MM
method	Description of method use for observation (snorkel or scuba).	text
time_start	Time of day when 10-minute observation started.	HH:MM
time_start_adjusted	Time in hours and minutes between observation start and sunset at each site (i.e. time_start_adjusted = time_sunset - time_start)	HH:MM
size_est	Size in cm; estimated visually.	cm
size_class	Classes in 5 cm increments for posterior analyses.	cm
weather	Description of weather/cloud-cover.C = clear 0-25%PC = partly cloudy 25-75%O = overcast >75%	text
current_strength	Description of current strength.low = diver barely kicking to maintain position.medium = periodic kicking required by diver to maintain position.high = constant kicking by diver required to maintain position.	text
tagged	Describes whether or not elastomer tag was present on observed lionfish.	yes/no
fish_id	Identifies individuals when they were tagged according to a numbered record.	code
num_spines_clipped	Numbers for the dorsal spines which were clipped on tagged individuals (e.g. 3;10 means spines # 3 and 10 were clipped). NC stands for not clipped.	text or numbers
fish_tag_code	Describes combination of letters used to identify elsatomer tag placement along body (e.g. L-GM means tag is on the left side; green color in the mid region).	text or numbers
habitat	Desciption of the habitat.Artificial = wrecks, tires, logs, piers, any kind of man-made or associated habitat.Coral = continuous reef or coral patch.Sand/rubble = sandy or coarse rubble area.Sponge = sponge gardens.Rock/boulder/cave = large rocks and boulders especially along channels. Seagrass = seagrass beds.	text
resting_time	Total proportion of 10 minute observation lionfish spent resting (0).	proportion
min_activity_time	Total proportion of 10 minute observation lionfish spent in minimal activity (1).	proportion
active_time	Total proportion of 10 minute observation that lionfish was active (2).	proportion

passive_hunt_time	Total proportion of 10 minute observation that lionfish spent passively hunting (3).	proportion
very_active_hunt_time	Total proportion of 10 minute observation that lionfish was hunting/very active (4).	proportion
avg_activity	Weighted average of proportions of time spent in all observed activities during each 10-minute observation. avg_activity = [(0*resting_time)+(1*min_activity_time)+(2*active_time)+ (3*passive_hunt_time)+(4*very_active_hunt_time)]/5	proportion
total_hunting_time	Sum of proportion of time spent hunting (passive hunting + active hunting).	proportion
num_of_strikes	Total number of strikes by lionfish against prey.	integer
strikes_at_species	Identification of species or taxa striked against by lionfish for each strike.	code/text
num_blows	Total number of blows against prey.	integer
blows_at_species	Identification of species or taxa blown against by lionfish.	code/text
num_aggressions	Total number of aggressions by lionfish against other species.	integer
aggression_at_species	Identification of species or taxa aggresive towards lionfish.	code/text
num_kills	Total number of kills.	integer
killed_species	Identification of species or taxa killed by lionfish.	code/text
prey_size	Estimate of prey size (cm) when a kill occurred.	cm
num_aggression_against_PTVO	Total number of aggressions by other species against lionfish.	integer
aggressive_species	Identification of species or taxa aggresive towards lionfish.	code/text
location	Description of specific area where lionfish was found at study site.	text
body_orientation	Description of specific body position of lionfish during the observation period.	text
person	Initials of person who observed lionfish.	text
notes	Data entry related or QA/AC related notes or notes about a particular observation. NONE or nd if no notes associated with observation.	text

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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.

Cayman_Reef_Surveys_10-11

Website	https://www.bco-dmo.org/deployment/59048
Platform	Cayman_Islands
Start Date	2010-06-14
End Date	2011-08-29
Description	Coral reefs were surveyed/studied near the Cayman Islands during the summers of 2010 and 2011 as part of 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).

Guam_Reef_Surveys_09-10

Website	https://www.bco-dmo.org/deployment/59049
Platform	shoreside Guam
Start Date	2009-09-24
End Date	2010-03-19
Description	Coral reefs were surveyed/studied near Guam from 2009 to 2010 as part of the project "Ecological Release and Resistance at Sea: Invasion of Atlantic Coral Reefs by Pacific Lionfish" (NSF OCE-0851162).

Philippines_Reef_Surveys_10-11

Website	https://www.bco-dmo.org/deployment/59050
Platform	shoreside Philippines
Start Date	2010-06-29
End Date	2010-07-16
Description	Coral reefs were surveyed/studied near the Philippines during June and July 2010 and August 2011 as part of the project "Ecological Release and Resistance at Sea: Invasion of Atlantic Coral Reefs by Pacific Lionfish" (NSF OCE-0851162).

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Project Information

Ecological Release and Resistance at Sea: Invasion of Atlantic Coral Reefs by Pacific Lionfish (Lionfish Invasion)

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

Coverage: Bahamas; Cayman Islands; Mariana Islands; Philippines

Invasive species are increasingly introduced by human activities to new regions of the world where those species have never existed previously. In the absence of natural enemies (predators, competitors, and diseases) from their homeland, invasives may have strong negative effects on invaded ecosystems, especially systems with fewer species ("ecological release"), and may even drive native species extinct. However, if native natural enemies can somehow control the invaders ("ecological resistance"), then ecological disruption can be prevented or at least moderated. Most of the many invasive species in the sea have been seaweeds and invertebrates, and the few documented invasive marine fishes have not caused major problems. However, this

situation has recently changed in a stunning and ominous way. In the early 1990s, lionfish (*Pterois volitans*) from the Pacific Ocean were accidentally or intentionally released from aquaria to the ocean in the vicinity of Florida. Camouflaged by shape and color, protected by venomous spines, consuming native coral-reef fishes voraciously, and reproducing rapidly, lionfish have subsequently undergone a population explosion. They now range from the mid-Atlantic coast of the US to the Caribbean, including the Bahamas. Native Atlantic fishes have never before encountered this spiny, stealthy, efficient predator and seldom take evasive action. In fact, the investigator has documented that a single lionfish is capable of reducing the abundance of small fish on a small coral patch reef by nearly 80% in just 5 weeks. There is great concern that invasive lionfish may severely reduce the abundance of native coral-reef fishes important as food for humans (e.g., grouper and snapper in their juvenile stages) as well as species that normally maintain the integrity of coral reefs (e.g., grazing parrotfishes that can prevent seaweeds from smothering corals). There are far more species of coral-reef fish in the Pacific than the Atlantic, so this invasion may represent a case of extreme ecological release with minor ecological resistance. Dr. Hixon and colleagues will study the mechanisms of ecological release in lionfish, as well as examine potential sources of ecological resistance in the heavily invaded Bahamas. Because very little is known about the ecology and behavior of lionfish in their native Pacific range, he will also conduct comparative studies in both oceans, which may provide clues regarding the extreme success of this invasion. In the Bahamas, the investigator will document the direct and indirect effects on native species of the ecological release of lionfish, both as a predator and as a competitor. These studies will be conducted at various scales of time and space, from short-term experiments on small patch reefs, to long-term experiments and observations on large reefs. Whereas direct effects involve mostly changes in the abundance of native species, indirect effects can be highly variable. For example, lionfish may actually indirectly benefit some native species by either consuming or outcompeting the competitors of those natives. The project will explore possible ecological resistance to the invasion by determining whether any native Bahamian species are effective natural enemies of lionfish, including predators, parasites, and competitors of both juvenile and adult lionfish. Comparative studies of natural enemies, as well as lionfish ecology and behavior, in both the Atlantic and the Pacific may provide clues regarding the explosive spread of lionfish in the Atlantic.

Regarding broader impacts, this basic research will provide information valuable to coral-reef and fisheries managers fighting the lionfish invasion in the US, the Bahamas, and the greater Caribbean, especially if sources of native ecological resistance are identified. The study will fund the PhD research of U.S. graduate students, as well as involve assistance and participation by a broad variety of undergraduates and reef/fisheries managers, including women, minorities, native Bahamians, and native Pacific islanders. Participation in this project will promote education in marine ecology and conservation biology directly via Dr. Hixon's and graduate students' teaching and outreach activities, and indirectly via the experiences of undergraduate field assistants and various associates.

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Funding

Funding Source	Award
NSF Division of Ocean Sciences (NSF OCE)	OCE-0851162

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