Sessile organisms biomass on settlement tiles deployed as part of fish exclusion/exposure experiments in Coastal Costa Rica and Panama in 2024

Website: https://www.bco-dmo.org/dataset/999304
Data Type: experimental
Version: 1
Version Date: 2026-05-22

Project
» Collaborative Research: RAPID: Turning up the heat: El Nino warming effects on top-down control of Tropical Eastern Pacific reef communities (Turning up the heat)

Contributors	Affiliation	Role
Torchin, Mark E.	Smithsonian Tropical Research Institute (STRI)	Principal Investigator
Schlöder, Carmen	Smithsonian Tropical Research Institute (STRI)	Scientist
Sellers, Andrew	McGill University	Scientist
York, Amber D.	Woods Hole Oceanographic Institution (WHOI BCO-DMO)	BCO-DMO Data Manager

Abstract
This dataset contains the biomass of sessile organisms on settlement tiles deployed during fish exclusion/exposure experiments across coral reef sites in Costa Rica and Panama in 2024. See "Related Datasets" on this page for all data associated with these settlement tile experiments. Study summary: Marine ecologists have long emphasized the role of local species interactions in shaping community structure. Yet the composition of local assemblages, and the interactions that shape them are strongly modulated by regional oceanographic processes. In the Tropical Eastern Pacific, seasonal upwelling regulates nutrient supply, productivity, and thermal regimes across broad spatial scales, potentially driving large-scale variation in community structure and food-web dynamics within coral reef ecosystems. The seasonal upwelling centers along the Pacific coasts of Panama and Costa Rica therefore provide an exceptional natural laboratory to test how regional drivers influence local ecological processes in coral reef ecosystems. We quantified the bottom-up effects of upwelling on the assembly of sessile prey communities and consumer effects in Pocillopora-dominated reefs by conducting standardized four-month fish-exclusion experiments across four regions spanning >1000 km and varying markedly in exposure to seasonal upwelling. Experiments were repeated during both the dry (upwelling) and wet (non-upwelling) seasons of 2024 across 10 sites nested within 4 regions varying in exposure to seasonal upwelling. Seasonal fish exclusion experiments were installed in each site. These consisted in three treatments: (1) a ‘caged’ treatment where fish larger than 5cm are excluded using a 1” vexar mesh, (2) an ‘open’ treatment, which have no cage to limit the access of fish, and (3) a procedural control or ‘partial’ treatment which is like the caged treatments, but lack the top and bottom cage panels, allowing access of fish to sessile organisms attached to the plates, while controlling for alterations in water flow imposed by the cages. These 5 units of each of those 3 treatments are retrieved after 4 months. Each plate is weighed, and the exposed surface of each plate is photographed. We then use a grid to quantify percent cover by identifying organisms growing under 50 random points to the lowest possible taxonomic level under a dissecting microscope. We also identify all organisms growing on each plate to the lowest taxonomic level possible to quantify richness. In addition to our main experiment (caged vs. open vs. partial), we include two additional treatments to measure consumer effects on fouling assemblages during a 24-hr timespan. After the 4-month experimental period, we retrieve 10 randomly selected caged treatments. We remove the cage for each unit, then weigh and photograph the exposed faces of top and bottom plates. We then reassemble half of those units (n=5; ‘cage control’), and leave the other half without cages (n=5; cage-exposed). The ten units (5 cage control and 5 cage exposed) are placed back on the reefs and recovered after 24-hours to be photographed and measured once again. These two last treatments are not examined under dissecting microscopes. The data was collected by Carmen Schloeder and Andrew Sellers from the Smithsonian Tropical Research Institute in collaboration with Drs. Cindy Fernandez and Juan José Alvarado from the University of Costa Rica. Research interns included Maria Isabel Cordon Krumme, Diego Valladares, Luis De Gracia, and Justin Ryan.

Table of Contents

Coverage

Location: Santa Elena Bay, Costa Rica; Gulf of Papagayo, Costa Rica; Gulf of Panama; Chiriqui, Panama
Spatial Extent: **N**:10.948 **E**:-79.016 **S**:7.399 **W**:-85.866
Temporal Extent: 2024-05-01 - 2024-12-07

Dataset Description

See "Related Datasets" section for the other datasets in this study describing the sessile organisms on settlement tiles deployed during fish exclusion/exposure experiments.

Methods & Sampling

We conducted 4-month fish exclusion/exposure experiments during the upwelling (December-March) and non-upwelling seasons (July-October) of 2024 across 10 sites in Costa Rica and Panama. At each site, we deployed 35 experimental units belonging to one of five treatments: open, caged, partial, cage-control and cage-exposed. Each experimental unit consisted of two 10-cm square PVC horizontal settlement plates mounted flush with each other on a 0.4-cm thick steel threaded stud. One plate faced the surface (top-plate) while the other faced the bottom (bottom-plate). The stud was inserted through a 0.4-cm hole drilled into the middle of each plate, and fixed to a 1.3-cm diameter threaded PVC cap using two stainless-steel nuts. The threaded cap was then screwed to a PVC male adapter fixed to one end of a 20-cm length of 1.3-cm diameter PVC tubing.

Treatments included:
(1) a ‘caged’ treatment where fish larger than 5cm were excluded using a 1” vexar mesh.
(2) an ‘open’ treatment, which had no cage to limit the access of fish
(3) a procedural control or ‘partial’ treatment which was like the caged treatments, but lacked the top and bottom cage panels, allowing access of fish to sessile organisms attached to the plates, while controlling for alterations in water flow imposed by the cages.

These 5 units of each of those 3 treatments were retrieved after 4 months. Each plate was weighed, and the exposed surface of each plate was photographed. We then used a grid to quantify percent cover by identifying organisms growing under 50 random points to the lowest possible taxonomic level under a dissecting microscope. We also identified all organisms growing on each plate to the lowest taxonomic level possible to quantify richness.

In addition to our main experiment (caged vs. open vs. partial), we included two additional treatments to measure consumer effects on fouling assemblages during a 24-hr time-span. After the 4-month experimental period, we retrieved 10 randomly selected caged treatments. We removed the cage for each unit, then weighed and photographed the exposed faces of top and bottom plates. We then reassembled half of those units (n=5; ‘cage control’), and left the other half without cages (n=5; cage-exposed). The ten units (5 cage control and 5 cage exposed) were placed back on the reefs and recovered after 24-hours to be photographed and measured once again. These treatments were not examined under dissecting microscopes.

This dataset reports the biomass of each settlement tile. The wet weight of each settlement tile was measured in grams using a digital scale following retrieval at the end of each experimental period.

Additional location description: The experiments were installed in coral reefs dominated by Pocillopora sp. coral at a depth of about 5m. We focused on 4 regions: Santa Elena Bay and Gulf of Papagayo in Costa Rica, and

the Gulfs of Panama and Chiriqui in the Republic of Panama.

Data Processing Description

The data was entered manually into spreadsheets. No software was used in this process.

BCO-DMO Processing Description

Main data table:
- Loaded biomass.csv into table "999304_v1_settlement-tile_biomass" with missing values defined as "", "nd", "NA", and "NaN"
- Converted column date from Excel serial number format to ISO date format (%Y-%m-%d)
- Stripped trailing "m" character from depth column values using find/replace so column could be typed as numeric. Units are noted in metadata "Parameters" section.
- Set column types: bmass1, bmass2, depth, lat, lon as number; date as date (%Y-%m-%d); country, plate, region, season, site, topBottom, treatment as string
- Corrected longitude values that were positive: any lon > 0 was multiplied by -1, as all values in this area should be negative
- Applied metadata updates to all columns including standard name IDs, descriptions, units, and primary parameter designations for lat, lon, and depth
- Replaced abbreviated country codes with full names: "CR" replaced with "Costa Rica" and "PAN" replaced with "Panama", as described in column metadata
- Output final table to 999304_v1_settlement-tile_biomass.csv

Supplemental file: category_list.csv
BCO-DMO data manager (Amber York) and data submitter (Andrew Sellers) collaboratively made the supplemental category list from the unique category codes used in the settlement tile datasets and corrected any typos in taxon names used. Any associated taxon names in the list were matched to registered names at the World Register of Marine Species (WoRMs) on March 2, 2026 and associated taxon Ids were included in the supplemental category list. Some name matches were ambiguous (could match more than one organism) so the data submitter Andrew modified the list to clarify which taxon name and ID each was.

Problem Description

No problems or issues to report

[table of contents | back to top]

Related Datasets

IsRelatedTo

Torchin, M. E., Sellers, A., Schlöder, C. (2026) **Sessile invertebrate point-intercept identifications (used for relative abundance) on settlement tiles deployed as part of fish exclusion/exposure experiments in Coastal Costa Rica and Panama in 2024.** Biological and Chemical Oceanography Data Management Office (BCO-DMO). (Version 1) Version Date 2026-05-22 http://lod.bco-dmo.org/id/dataset/999307 [view at BCO-DMO]
Relationship Description: These related datasets describe the sessile organisms on settlement tiles deployed during fish exclusion/exposure experiments across coral reef sites in Costa Rica and Panama in 2024.

Torchin, M. E., Sellers, A., Schlöder, C. (2026) **Sessile organism richness on settlement tiles deployed as part of fish exclusion/exposure experiments in Coastal Costa Rica and Panama in 2024.** Biological and Chemical Oceanography Data Management Office (BCO-DMO). (Version 1) Version Date 2026-05-22 http://lod.bco-dmo.org/id/dataset/999310 [view at BCO-DMO]
Relationship Description: These related datasets describe the sessile organisms on settlement tiles deployed during fish exclusion/exposure experiments across coral reef sites in Costa Rica and Panama in 2024.

[table of contents | back to top]

Parameters

Parameter	Description	Units
plate	ID number for individual settlement tiles	unitless
country	Country where experiment was carried out: Panama or Costa Rica	unitless
region	Region where experiments were performed	unitless
site	Sites where experiments were performed	unitless
season	season when experiment took place (nu=wet, u=dry)	unitless
date	date when experiment took place	unitless
topBottom	Top facing or bottom facing settlement panel	unitless
treatment	Type of treatment: open, cage, partial, cage exposure, cage control	unitless
bmass1	Weight of sessile assemblage (after subtraction from the weight of the panel).	grams (g)
bmass2	Weight of sessile assemblage after exposure experiment: only applies for cage exposure and cage control treatments. Weight reported after subtraction from the weight of the panel.	grams (g)
lat	Latitude of experimental site	decimal degrees
lon	Longitude of experimental site	decimal degrees
depth	Depth of experimental site	meters (m)

[table of contents | back to top]

Instruments

Dataset-specific Instrument Name	Dissecting microscopes
Generic Instrument Name	Microscope - Optical
Generic Instrument Description	Instruments that generate enlarged images of samples using the phenomena of reflection and absorption of visible light. Includes conventional and inverted instruments. Also called a "light microscope".

[table of contents | back to top]

Project Information

Collaborative Research: RAPID: Turning up the heat: El Nino warming effects on top-down control of Tropical Eastern Pacific reef communities (Turning up the heat)

Coverage: Panama and Costa Rica

NSF Award Abstract:

Species interactions are key drivers shaping marine biodiversity. Recent marine studies demonstrate that predation can be stronger at lower latitudes where water temperatures are higher. With a changing climate, it is important to resolve how environmental forces intensify or moderate consumer interactions and change the distribution and abundance of marine species. Researchers are employing a rapid research response to measure how an extreme event, the 2023-2024 El Niño, will alter consumer interactions on Tropical Eastern Pacific (TEP) coral reefs. Following up on two consecutive years of experimental data during non-El Niño conditions, they will be able to compare how an extreme event and increased ocean temperatures alter predation and herbivory rates and how this in turn influences marine biodiversity and potential invasion by non-native species. The project builds international research and education by training early-career researchers in marine science including those from under-represented groups. The project develops partnerships and fosters collaboration through an international network, which facilitates shared and integrated marine biosecurity solutions across the Americas, informing management of invasive marine species.

Growing evidence suggests that the intensity of interspecific interactions increases at low latitudes. Recent studies along both coasts of the Americas indicate that the strength of consumer effects across latitude increases with temperature, consistent with the metabolic theory of ecology. The hypothesized impact of ocean warming on future trends in top-down control of marine communities predicts that increasing ocean temperatures will increase top-down control by consumers, but the extent to which this will occur in the tropics remains uncertain. The strong spatial and seasonal variation in upwelling that affect both temperature and nutrients in the Tropical Eastern Pacific (TEP) make it an ideal region to test how changes in environmental conditions influence trophic interactions and marine community dynamics. For the past two years, researchers conducted consumer exclusion experiments on sessile marine invertebrate communities at ten coral reef sites, distributed along a gradient of upwelling activity in Panama and Costa Rica. By comparing replicated caged (predator exclusion) and open settlement panels at each site along this gradient, this experiment examines the role of temperature and productivity on top-down control by consumers. Here, researchers are extending the duration of this work to utilize the current El Niño as a natural experiment to measure how this extreme event will alter consumer interactions on TEP reefs. The El Niño event forecasted for 2023-2024 (NOAA 2023) is predicted to (a) cause extreme increases in water temperature and (b) alter the intensity and duration of upwelling events. Using two complementary experiments to sequentially test the strength of consumer interactions, (a) 4-month predator exclusions and (b) short-term predator exposure experiments, the project tests the hypothesis that increased temperature and decreased upwelling activity linked to El Niño will increase consumer effects in the TEP. Repeating previous experiments during the current El Niño, provides a comparison for how changing temperature and productivity regimes influence consumer effects on the reef communities. By focusing these experiments in a thermally dynamic region of the tropics, this research directly tests for temperature regulation of top-down processes without the confounds of latitude, while also examining the bottom-up consequences of declining productivity due to weakened upwelling activity.

This award reflects NSF's statutory mission and has been deemed worthy of support through evaluation using the Foundation's intellectual merit and broader impacts review criteria.

[table of contents | back to top]

Funding

Funding Source	Award
NSF Division of Ocean Sciences (NSF OCE)	OCE-2350541

[table of contents | back to top]