

Sessile organism richness 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/999310>

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
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Abstract

This dataset contains the richness 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. 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.

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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: 2024-04-08 - 2024-12-08

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.

This dataset reports all taxa observed growing on settlement tiles. These include named taxa (e.g. Polysiphonia), as well as functional groups/codes (e.g. BAM, Ecto 1). See supplemental category_list.csv for more details about categories. The point-intercept method was NOT used to build these list of taxa. The settlement tiles were examined visually to list all taxa found on a given settlement tile. Information regarding the settlement tile's assigned treatment, region, site, and deployment date are also included.

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

Note: The primary form of this dataset under "Data Files" is the data table in long format (row per identification). The same data in an additional (wide format - row per plate, columns per plate) is provided as supplemental file.

- Loaded richness.csv as table 999310_v1_settlement-tile_richness (CSV, comma-delimited), treating "", "NA", "nd", and "NaN" as missing values
- Applied find/replace on depth column to strip trailing "m" unit suffix so it can be typed as numeric. Units are described in "Parameters" section.
- Converted Date column from Excel serial number format to ISO date format (%Y-%m-%d)
- Set column types: Date as date, lat/lon/depth/Biomass as number, and Region, Sea, Season, Site, Observer, Plate, Treatment, Type, and Taxon_obs_1 through Taxon_obs_53 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 BCO-DMO metadata (descriptions, standard name IDs, supplied units) to all columns including lat, lon, depth (primary parameters), Date, Observer, Plate, Region, Sea, Season, Site, Treatment, Type, Biomass, and Taxon_obs_1 through Taxon_obs_53
- Duplicated table to create a wide-format copy named 999310_v1_settlement-tile_richness_wide-format in order to have the main form of this dataset be longform (one column for taxon observation number on the plate and one column for the category identified. The wide format maintains the Taxon_obs_1,...,Taxon_obs_53 columns (a column per the max number of IDs on any plate).
- Unpivoted columns Taxon_obs_1 through Taxon_obs_53 in the original (long-format) table into two new columns: Taxon_obs_num (integer, the observation number) and category (string, the taxon value)
- Filtered rows in the long-format table to retain only rows where category is not null, removing empty taxon observation rows that are unnecessary in long format; all plate IDs are retained since all Taxon_obs_1 values were populated prior to unpivoting. All plate IDs are reported in rows of both the long and wide form tables.
- Updated BCO-DMO metadata on the long-format table for all columns including the newly created Taxon_obs_num and category columns; lon marked as primary parameter
- Output two tables: 999310_v1_settlement-tile_richness.csv (long format, 13,244 rows) and 999310_v1_settlement-tile_richness_wide-format.csv (wide format, 577 rows)

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

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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.

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Parameters

Parameter	Description	Units
Region	Region where the experimental site is located. These include Santa Elena (SE) and Papagayo (PP) in Costa Rica, and Gulf of Chiriqui (GC) and Gulf of Panama (GP) in Panama.	unitless
Site	Site where the experiments were performed.	unitless
lat	Latitude of experimental site	decimal degrees
lon	Longitude of experimental site	decimal degrees
depth	Depth of experimental site	meters (m)
Plate	Identifying code for settlement tile	unitless
Treatment	Treatment assigned to settlement tile: partial, open, and caged.	unitless
Season	Season when experiments were performed: dry or wet	unitless
Biomass	Biomass of settlement tile after 4 months	grams (g)
Date	Date when settlement tiles were retrieved	unitless
Sea	Season and year when experiments were performed. Dry 2024 (u24) and wet 2024 (nu24).	unitless
Type	Orientation of settlement tile (top or bottom facing).	unitless
Observer	Initials of person analyzing settlement plate	unitless
Taxon_obs_num	Sequential number of the observed taxa on the settlement plate during visual examination. The identifier is unique per settlement plate. The first observation on the plate is Taxon_obs_num 1, the second one is 2, and so on.	count
category	Category code for the taxon or category observed at the grid_point_id location (e.g., named taxa such as Polysiphonia, functional groups/codes such as “BAM”, “Ecto 1”, and “Bare” where no organism was present). See the supplemental file category_list.csv for more information about the categories.	unitless

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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".

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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.

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Funding

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

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