Fate data for corals sampled at the U.S. Virgin Islands from April 2022 to April 2023

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Project
» A multi-scale approach to predicting infectious multi-host disease spread in marine benthic communities
(Multi-scale multi-host disease spread)

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Abstract
These data summarize the fates of sampled corals from a stony coral tissue loss disease (SCTLD) outbreak in the U.S. Virgin Islands (USVI). In January of 2019, a coral disease outbreak consistent with the gross morphology case description for Stony Coral Tissue Loss Disease (SCTLD) was observed off the south shore of St. Thomas, USVI. Approximately one year later, the disease was observed on the western reefs of St. John, and approximately 1.5 years later, the disease was observed off the south shore of St. Croix. Our interdisciplinary research team of ecologists, connectivity and disease modelers, microbiologists, and coral immunologists are using colony fate-tracking, molecular and microscopy approaches, as well as modeling of disease reservoirs and dispersal to better understand characteristics of this outbreak. A sampling mission occurred March 28 to April 15, 2022 to mark and collect samples from diseased and healthy corals at four sites: Coral Bay and South Haulover in St. John and Cane Bay and Buck Island in St. Croix. 233 stony coral colonies were tagged for sampling and tagging consisted of hammering a uniquely numbered cattle tag into adjacent dead substrate with a masonry nail. Samples were taken from all tagged corals, which included colonies of the species Acropora cervicornis, Agaricia agaricites, Colpophyllia natans, Diploria labyrinthifornis, Montastraea cavernosa, Orbicella annularis, Porites astreoides. Monitoring surveys were conducted approximately 6 months and 1 year post-sampling when sampled corals were relocated and their current health status was recorded. This dataset includes the health status of each coral at the time of sampling in March/April 2022, and its health characteristics in the Fall of 2022 and Spring of 2023 if it was found.

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Coverage

Location: United States Virgin Islands
Spatial Extent: **N**:18.34465 **E**:-64.607 **S**:17.77335 **W**:-64.8148
Temporal Extent: 2022-04-05 - 2023-04-13

Methods & Sampling

Sampling:
Daily trips were made to the sampling sites using small boats. Start and end dates of field missions:
March 28 - April 17, 2022
September 1 -& October 4, 2022
February 21 - April 13, 2023

Both apparently healthy and actively diseased colonies of *Agaricia agaricites* (14 diseased, 27 healthy), *Acropora cervicornis* (6 healthy), *Colpophyllia natans* (19 diseased, 20 healthy), *Diploria labyrinthiformis* (7 diseased, 19 healthy), *Montastraea cavernosa* (18 diseased, 20 healthy), *Orbicella annularis* (18 diseased, 24 healthy), *Porites astreoides* (8 diseased, 32 healthy) were sampled for various analyses. All work was completed by divers on SCUBA. Each sampled colony was marked for relocation by hammering a numbered cattle tag into the adjacent dead substrate and then photographed from above. Then, using either a hammer and chisel or underwater Nemo drill with a diamond tipped hole saw (no anvil), coral fragments approximately 4 x 4 centimeters (cm) were collected from each colony. Three fragments were collected from apparently healthy corals (HH), and six fragments from diseased corals, including three fragments immediately adjacent to the lesion boundary (DD) and three fragments from apparently healthy tissue (HD). All fragments were placed into individually labeled whirlpacks and transported to the surface. Sample scar edges on the sampled colonies were sealed with natural clay. Corals were rephotographed before and after sealing with the clay. Marked colonies were mapped using a camera time-paired to a GPS on a float that was towed above by the sampler. Once at the surface, one fragment from each sample type (HH, HD, DD) was processed for microbial analyses, gene expression, TEM, and histopathology (separate data sets).

Monitoring:
Using maps created using the GPS-paired images, divers on SCUBA relocated colonies, if possible. Colonies that were found were rephotographed, and the following was recorded: size estimates (length, width, and height), percent of the colony showing old mortality (defined as calyx degradation and algal recruitment), percent of the colony showing recent mortality (defined as bright white exposed skeleton with no algal recruitment), percent of living tissue that was bleached or paled, and disease identification (if applicable). Colony ID was confirmed by comparing monitoring photos to photos of the colony at sampling. All tissue was sampled from 15 of the 233 sampled colonies, and therefore these corals were not reassessed. At six months post-sampling, 159 corals were found, photographed, and monitored for health status. At one year post-sampling, 146 corals were found, photographed, and monitored for health status.

Instrument Details:
Corals were tagged with 2½ inch masonry nails and plastic cattle tags with unique IDs. Coral and sample-specific images were recorded with Olympus Tough TG-6 cameras in Olympus underwater housings. Either Milwaukee 3lb sledges and ¾ inch mason chisels or Nemo underwater drills with 1½ inch diamond hole saws (anvil removed) were used to collect fragments.

Data Processing Description

Each coral was assigned a representative health state at the monitoring period (either apparently healthy, diseased, or other health impairment) to fate track colonies and compare fates among the sampling health states.

BCO-DMO Processing Description

- Imported original file "PREDICT_USVIShallowFateTracking_toupload.csv" into the BCO-DMO system.
- Marked "NA" as a missing data value (missing data are empty/blank in the final CSV file).

- Changed format of dates to YYYY-MM-DD.
- Renamed fields to comply with BCO-DMO naming conventions.
- Saved the final file as "986534_v1_usvi_fate_tracking.csv".

Problem Description

Not all corals could be relocated to determine their fates.

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Parameters

Parameter	Description	Units
Date_Sampling	Date sample was collected	unitless
Site	Site name where sample was collected from	unitless
Species	Species of coral	unitless
Tag	ID of the tag associated with the coral	unitless
Latitude	Approximate latitude of coral in decimal degrees	decimal degrees
Longitude	Approximate longitude of coral in decimal degrees	decimal degrees
SamplingHealthState	Health state of coral at the time of sampling in 2023, either stony coral tissue loss disease (SCTLD)-affected or diseased	unitless
Date_SixMonths	Date of six months post-sampling monitoring survey	unitless
HealthState_SixMonths	Health state of coral during monitoring survey	unitless
Length_SixMonths	Maximum length of the whole coral colony (includes area of old/recent mortality) measured in centimeters	centimeters (cm)
Width_SixMonths	Maximum width (perpendicular to length) of the whole coral colony (includes area of old/recent mortality) measured in centimeters	centimeters (cm)
Height_SixMonths	Maximum height of the whole coral colony (includes area of old/recent mortality) measured in centimeters	centimeters (cm)
Pcnt_Old_SixMonths	Percent of colony that is old mortality (TCRMP definition: algal recruitment and degradation of corallite structure)	percent (%)

Pcnt_Rec_SixMonths	Percent of colony that has recent mortality (TCRMP definition: bare skeleton and no degradation of corallite structure)	percent (%)
Pcnt_Bl_SixMonths	Percent of the living tissue that is visibly bleached	percent (%)
Pcnt_Pale_SixMonths	Percent of the living tissue that is visibly paling	percent (%)
Date_OneYear	Date of one year post-sampling monitoring survey	unitless
HealthState_OneYear	Health state of coral during monitoring survey	unitless
Length_OneYear	Maximum length of the whole coral colony (includes area of old/recent mortality) measured in centimeters	centimeters (cm)
Width_OneYear	Maximum width (perpendicular to length) of the whole coral colony (includes area of old/recent mortality) measured in centimeters	centimeters (cm)
Height_OneYear	Maximum height of the whole coral colony (includes area of old/recent mortality) measured in centimeters	centimeters (cm)
Pcnt_Old_OneYear	Percent of colony that is old mortality (TCRMP definition: algal recruitment and degradation of corallite structure)	percent (%)
Pcnt_Rec_OneYear	Percent of colony that has recent mortality (TCRMP definition: bare skeleton and no degradation of corallite structure)	percent (%)
Pcnt_Bl_OneYear	Percent of the living tissue that is visibly bleached	percent (%)
Pcnt_Pale_OneYear	Percent of the living tissue that is visibly paling	percent (%)

Instruments

Dataset-specific Instrument Name	plastic cattle tags
Generic Instrument Name	labeling tag
Dataset-specific Description	Corals were tagged with 2 ½" masonry nails and plastic cattle tags with unique IDs.
Generic Instrument Description	Passive devices attached to captured organisms to specifically identify them when recaptured after release.

Dataset-specific Instrument Name	Milwaukee 3lb sledges and ¾ in mason chisels or Nemo underwater drills
Generic Instrument Name	Manual Biota Sampler
Dataset-specific Description	Either Milwaukee 3lb sledges and ¾ in mason chisels or Nemo underwater drills with 1 ½" diamond hole saws (anvil removed) were used to collect fragments.
Generic Instrument Description	"Manual Biota Sampler" indicates that a sample was collected in situ by a person, possibly using a hand-held collection device such as a jar, a net, or their hands. This term could also refer to a simple tool like a hammer, saw, or other hand-held tool.

Dataset-specific Instrument Name	SCUBA
Generic Instrument Name	Self-Contained Underwater Breathing Apparatus
Dataset-specific Description	All work was completed by divers on SCUBA.
Generic Instrument Description	The self-contained underwater breathing apparatus or scuba diving system is the result of technological developments and innovations that began almost 300 years ago. Scuba diving is the most extensively used system for breathing underwater by recreational divers throughout the world and in various forms is also widely used to perform underwater work for military, scientific, and commercial purposes. Reference: https://oceanexplorer.noaa.gov/technology/technical/technical.html

Dataset-specific Instrument Name	Olympus Tough TG-6 cameras in Olympus underwater housings
Generic Instrument Name	Underwater Camera
Dataset-specific Description	Coral and sample specific images were recorded with Olympus Tough TG-6 cameras in Olympus underwater housings.
Generic Instrument Description	All types of photographic equipment that may be deployed underwater including stills, video, film and digital systems.

Project Information

A multi-scale approach to predicting infectious multi-host disease spread in marine benthic communities (Multi-scale multi-host disease spread)

Coverage: United States Virgin Islands

NSF Award Abstract:
Marine diseases have devastating impacts on ocean ecosystems and this work will directly examine the framework for understanding disease transmission in the ocean. A team of ecologists, ocean connectivity and disease modelers, microbiologists, and coral immunologists (from the University of Virgin Islands (UVI), Louisiana State University (LSU), Rice University, University of Texas-Arlington and the Woods Hole

Oceanographic Institution) will develop a model that predicts transmission of a devastating Caribbean coral disease that has the potential to impact the economic value of coral reefs, including those located in the U.S. This project will support multidisciplinary field and laboratory research experiences of graduate students at multiple minority-serving institutions, and will provide undergraduate students with hands-on training in modeling, ecological and molecular analysis techniques. UVI and LSU are in EPSCoR jurisdictions and have diverse student bodies, including numerous under-represented minority (URM) students. The research team will collaboratively provide URM students with research experiences in STEM fields. Project findings will be broadly communicated through virtual public programming, and through the Virgin Islands Coral Disease Advisory Committee with updates on the vicoraldisease.org website. A coral disease response workshop for the U.S. Virgin Islands will also be held, in which project results will be presented and used to support disease response planning.

Over the last four decades, marine diseases have decimated ecosystem engineers in marine coastal ecosystems, including the rocky intertidal, seagrasses and coral reefs. The pathogens driving these diseases have frequently been challenging to isolate, characterize and confirm, in part because they affect multiple host species and can spread by ocean currents, as well as through individual contact. Here, we propose a multi-scale epidemic model for studying marine disease that addresses both within-host and within-patch disease dynamics, and explicitly acknowledges the dispersal of pathogens between populations. Our interdisciplinary research team of ecologists, connectivity and disease modelers, microbiologists, and coral immunologists will integrate the largest set of predictors of marine disease spread to date: individual host species traits that allow for disease resistance or susceptibility, local transmission within communities that may have unique community structure, and hydrodynamic connectivity among susceptible communities. Modeling will be supported with rich data sets of within- and among-patch population characteristics and disease dynamics as well as molecular data on species-level disease responses. This project will advance knowledge of infectious diseases by integrating multidimensional scales and differential host susceptibilities into existing epidemiological models. This model will particularly advance the framework for studying marine diseases and has the potential to elucidate the transmission properties of a devastating Caribbean coral disease (stony coral tissue loss disease) that fits the most confounding and notorious hallmarks of marine diseases: infection of multiple hosts by an elusive pathogen.

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.

Funding

Funding Source	Award
NSF Division of Ocean Sciences (NSF OCE)	OCE-2109622