Steady state photosynthesis (photosynthetic induction time) from Porites astreoides colonies in St. John, US Virgin Islands from July to August of 2019

Website: https://www.bco-dmo.org/dataset/892286
Data Type: Other Field Results
Version: 1
Version Date: 2023-03-21

Project
» Collaborative Research: Pattern and process in the abundance and recruitment of Caribbean octocorals (Octocoral Community Dynamics)
» RUI: Pattern and process in four decades of change on Caribbean reefs (St John Coral Reefs)

Contributors	Affiliation	Role
Edmunds, Peter J.	California State University Northridge (CSUN)	Principal Investigator
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Abstract
These datasets represent the time to steady state photosynthesis (photosynthetic induction time) of Porites astreoides colonies classified as inside or outside of octocoral canopies. These data were used to test for the potential effect of light regimes created by octocoral canopies on the photophysiology of autotrophic taxa within the understories of octocoral forests. Additionally, these datasets contain information on the octocoral community surrounding each P. astreoides colony. Data was collected between July and August of 2019 at ~ 7.0 ± 0.5-m depth at three sites (White Point, Tektite, Cabritte Horn) in Lameshur Bay St. John, U.S. Virgin Islands. These data were collected as part of an NSF Coral Reef Time Series, Virgin Islands: Long-term coral reef community dynamics in the Virgin Islands National Park and were published in Girard and Edmunds (2023).

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Coverage

Spatial Extent: **N**:18.3154 **E**:-64.7186 **S**:18.3074 **W**:-64.7314
Temporal Extent: 2019-07-26 - 2019-08-15

Methods & Sampling

Location:
Lameshur Bay St. John, U.S. Virgin Islands at ~ 7.0 ± 0.5-m depth
Research conducted from the University of the Virgin Islands Marine Station in Lameshure Bay during July – August 2019.

Methods & Sampling:

At each site (White Point, Tektite, Cabritte Horn) corals were haphazardly selected and categorized as within "dense" or "sparse" octocoral canopies. Colonies were categorized as within dense canopies if they were shaded by at least one octocoral colony ≥ 25 cm tall when it flexed in routine oscillatory water flow. Preliminary surveys showed that colonies of Porites astreoides (urn:lsid:marinespecies.org:taxname:288889) met this criterion when the distance from the nearest tall octocoral was less than half the height of the octocoral colony. The distance between P. astreoides colonies and the nearest octocoral was measured to categorize colonies of P. astreoides as within or outside the understory habitat. A single induction curve was performed on each P. astreoides on one of 16 days during July and August 2019. Sampled colonies were > 4 cm in diameter to provide space on the colony surface for the placement of the fiber-optic probe (5 mm diameter) attached to the Diving Pulse Amplitude-Modulation (PAM) fluorometer (Heinz Walz, GmbH) that was used to measure induction time. To standardize the light environment of samples all induction curves were performed between 09:00 and 11:00 hrs on clear cloudless days. In this study actinic light from the Diving PAM was set to 896 µmol photons m-2 s-1 during the induction protocol. There was a two-minute rest period between the first saturation pulse assessing Fm and the initiation of actinic light. Once turned-on, actinic light was continuously delivered for 17 minutes with a total of 13 saturating pulses being delivered one every 1.4 minutes.

Instruments:

PVC Quadrats (1 m2)
Transect tapes
Measuring ribbons with mm graduations
Underwater Fluorometer Diving-PAM (Heinz Walz GmbH)

Data Processing Description

To quantify induction time, the time to steady state photosynthesis was measured by evaluating the performance of photosystem II (PSII) using chlorophyll fluorescence (Bradbury and Baker, 1984, 1981). Calculation of the rate of production of high energy electrons by PSII (relative electron transfer rate, rETR) at a fixed Photon Flux Density is a measure of induction time (Suggett et al., 2010). rETR was calculated by the Diving PAM using the manufacturers software:

rETR = ΔF/Fm X PAR X 0.5 X 0.0001

where ΔF is the change in fluorescence (F) resulting from the saturation pulse, Fm is the maximum fluorescence, PAR is the PFD to which the sample is exposed, 0.5 is an estimate of the quanta absorbed by PSII, and 0.001 is an absorptance constant for light at the coral surface. As neither the absorptance of light by the coral surface, nor quanta by PSII, are known for P. astreoides, this equation estimates relative ETR.

To generate an induction time from Diving PAM rETR measurements the time to steady state photosynthesis (induction time) was taken as the intersection on the abscissa of two straight lines, one calculated using least squares linear regression of the first three points on the rETR curve, and the second representing the mean rETR of the last three points of the curve. This calculation was performed in Microsoft® Excel® for Microsoft 365 MSO (Version 2212 Build 16.0.15928.20196) by using the =Linest() function to generate a linear equation (y = mx + b) from the first three induction data points such that x is time (min) and y is rETR. Then solving for x (time) by using the mean of the last three rETR points as the rETR value (y).

BCO-DMO Data Manager Processing Notes:

* Source file "St.John_Porites Astreoides Induction Time and Octocorals.csv" imported into the BCO-DMO data system
* Column names adjusted to conform to BCO-DMO naming conventions designed to support broad re-use by a variety of research tools and scripting languages. [Only numbers, letters, and underscores. Can not start with a number]
* lat and lon added to the data from a site list.
* Columns Mean_Octocoral_Height, Canopy_Closure_above_P_astreoides,Mean_rETR_3pts rounded to three decimal places.
* Date format converted to ISO 8601 format

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Data Files

File
photosynth_induction.csv (Comma Separated Values (.csv), 3.97 KB) MD5:5dac2e424a3171d50acd786f66c0278f Primary data table for dataset 892286.

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Supplemental Files

File
Site List filename: site_list.csv (Comma Separated Values (.csv), 192 bytes) MD5:4415feb2d663fc251a671a2a7c5cac04 Site list for all dataset related to the results publication Girard and Edmunds (2023). Parameters (column names, descriptions, and units): Site, Site name used in dataset related to Girard and Edmunds (2023),unitless lat, Site latitude,decimal degrees lon,Site longitude,decimal degrees Alternate_name, Alternate name for the site,unitless

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Related Publications

Bradbury, M., & Baker, N. R. (1981). Analysis of the slow phases of the in vivo chlorophyll fluorescence induction curve. Changes in the redox state of Photosystem II electron acceptors and fluorescence emission from Photosystems I and II. Biochimica et Biophysica Acta (BBA) - Bioenergetics, 635(3), 542–551. https://doi.org/10.1016/0005-2728(81)90113-4
Methods

Girard, J. F., & Edmunds, P. J. (2023). Effects of arborescent octocoral assemblages on the understory benthic communities of shallow Caribbean reefs. Journal of Experimental Marine Biology and Ecology, 561, 151870. https://doi.org/10.1016/j.jembe.2023.151870
Results

Heinz Walz, G. (1998) UNDERWATER FLUOROMETER submersible photosynthesis yield analyzer handbook of operation, 1st ed. Effeltrich. Accessed May 2nd, 2023 from https://www.walz.com/files/downloads/manuals/diving-pam/DIVING3EB.pdf
Methods

Suggett, D. J., Prášil, O., & Borowitzka, M. A. (Eds.). (2010). Chlorophyll a Fluorescence in Aquatic Sciences: Methods and Applications. https://doi.org/10.1007/978-90-481-9268-7
Methods

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Related Datasets

IsRelatedTo

Girard, J., Edmunds, P. J. (2023) **Benthic invertebrate abundances associated with octocoral forests in St. John, US Virgin Islands from July 2019 to Jan 2020.** Biological and Chemical Oceanography Data

Management Office (BCO-DMO). (Version 1) Version Date 2023-03-21 doi:10.26008/1912/bco-dmo.892248.1 [view at BCO-DMO]
Relationship Description: Octocoral measurements and invertebrate counts were done in the same quadrats. Therefore, the quadrat IDs correspond to each other across community & canopy data sets.

Girard, J., Edmunds, P. J. (2023) **Canopy closure values from photographs taken within octocoral forests in Lameshur Bay St. John, U.S. Virgin Islands from July 2019 to Jan 2020.** Biological and Chemical Oceanography Data Management Office (BCO-DMO). (Version 1) Version Date 2023-03-21 doi:10.26008/1912/bco-dmo.892258.1 [view at BCO-DMO]
Relationship Description: Octocoral measurements and invertebrate counts were done in the same quadrats. Therefore, the quadrat IDs correspond to each other across community & canopy data sets.

Girard, J., Edmunds, P. J. (2023) **Canopy closure values from photographs taken within octocoral forestsalong the south shore of St. John, U.S. Virgin Islands in March of 2019.** Biological and Chemical Oceanography Data Management Office (BCO-DMO). (Version 1) Version Date 2023-03-21 doi:10.26008/1912/bco-dmo.892323.1 [view at BCO-DMO]
Relationship Description: Octocoral measurements and invertebrate counts were done in the same quadrats. Therefore, the quadrat IDs correspond to each other across community & canopy data sets.

Girard, J., Edmunds, P. J. (2023) **Light intensity (lux) of downwelling light upon the benthos along differing conditions of octocoral canopy formation in East Cabritte, in Grootpan Bay, St. John U.S. Virgin Islands in March of 2019.** Biological and Chemical Oceanography Data Management Office (BCO-DMO). (Version 1) Version Date 2023-03-21 doi:10.26008/1912/bco-dmo.892300.1 [view at BCO-DMO]
Relationship Description: Octocoral measurements and invertebrate counts were done in the same quadrats. Therefore, the quadrat IDs correspond to each other across community & canopy data sets.

Girard, J., Edmunds, P. J. (2023) **Light intensity (lux) of downwelling light upon the benthos along differing conditions of octocoral canopy formation in Lameshur Bay St. John, U.S. Virgin Islands in March of 2019.** Biological and Chemical Oceanography Data Management Office (BCO-DMO). (Version 1) Version Date 2023-03-21 doi:10.26008/1912/bco-dmo.892272.1 [view at BCO-DMO]
Relationship Description: Octocoral measurements and invertebrate counts were done in the same quadrats. Therefore, the quadrat IDs correspond to each other across community & canopy data sets.

Girard, J., Edmunds, P. J. (2023) **Octocoral canopy metrics (mean height, density, and closure) in St. John, US Virgin Islands in March of 2019.** Biological and Chemical Oceanography Data Management Office (BCO-DMO). (Version 1) Version Date 2023-03-21 doi:10.26008/1912/bco-dmo.892293.1 [view at BCO-DMO]
Relationship Description: Octocoral measurements and invertebrate counts were done in the same quadrats. Therefore, the quadrat IDs correspond to each other across community & canopy data sets.

Girard, J., Edmunds, P. J. (2023) **Octocoral height, density, and genera from in situ observations within octocoral forests in Lameshur Bay St. John, U.S. Virgin Islands from July 2019 to Jan 2020.** Biological and Chemical Oceanography Data Management Office (BCO-DMO). (Version 1) Version Date 2023-03-21 doi:10.26008/1912/bco-dmo.892265.1 [view at BCO-DMO]
Relationship Description: Octocoral measurements and invertebrate counts were done in the same quadrats. Therefore, the quadrat IDs correspond to each other across community & canopy data sets.

Girard, J., Edmunds, P. J. (2023) **Pulse Amplitude Modulation (PAM) fluorometer measurements from Porites astreoides colonies in St. John, US Virgin Islands from July to August of 2019.** Biological and Chemical Oceanography Data Management Office (BCO-DMO). (Version 1) Version Date 2023-03-21 doi:10.26008/1912/bco-dmo.892279.1 [view at BCO-DMO]
Relationship Description: Octocoral measurements and invertebrate counts were done in the same quadrats. Therefore, the quadrat IDs correspond to each other across community & canopy data sets.

Girard, J., Edmunds, P. J. (2023) **Simultaneous light intensity measurements from a HOBO light intensity logger and a cosine-corrected PAR sensor in Lameshur Bay, St. John, U.S. Virgin Islands in January of 2021.** Biological and Chemical Oceanography Data Management Office (BCO-DMO). (Version 1) Version Date 2023-03-21 doi:10.26008/1912/bco-dmo.892308.1 [view at BCO-DMO]
Relationship Description: Octocoral measurements and invertebrate counts were done in the same quadrats. Therefore, the quadrat IDs correspond to each other across community & canopy data sets.

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Parameters

Parameter	Description	Units
Date	Date of sampling in ISO 8601 format	unitless
Site	Name of study site	unitless
lat	site latitude	decimal degrees
lon	site longitude	decmal degrees
Coral_ID	Number given, in sequence, to a Porites astreoides individual measured at a site	unitless
Canopy_Classification	Defines the P. astreoides individual as "in" or "out" of the octocoral canopy	unitless
Depth	Depth under the ocean surface of the P. astreoides individual being measured	meters (m)
Mean_Octocoral_Height	Average octocoral height in a m2 quadrat with the measured P. astreoides individual at its center	millimeters (mm)
Density_of_Octocorals	Density of octocorals in a m2 quadrat with the measured P. astreoides individual at its center	individuals/m-2
Canopy_Closure_above_P_astreoides	Canopy Closure above Porites astreoides colony. Proportion of the sky closed by the octocoral canopy as determined by the number of points out of 300 superimposed on a photograph taken facing up from the colony that fell on octocoral branches.	unitless
Start_Time_PAM_Induction_Curve	Time of the start of the PAM induction curve protocol (Local Time, Atlantic Standard Time, GMT -4) in ISO 8601 format.	unitless
Induction_Time	Estimated time to steady state Photosynthesis (min) (Induction Time). Quantification of steady state photosynthesis of Porites astreoides sampled	minutes
Max_rETR	Maximum relative Electron Transport Rate reported by the diving PAM during induction protocol	Micromoles of electrons per square metre per second (umol m-2 s-1)
Mean_rETR_3pts	Mean relative Electron Transport Rate of the last three points reported by the diving PAM during the induction protocol."	Micromoles of electrons per square metre per second (umol m-2 s-1)

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Instruments

Dataset-specific Instrument Name	Underwater Fluorometer Diving-PAM (Heinz Walz GmbH)
Generic Instrument Name	Fluorometer
Generic Instrument Description	A fluorometer or fluorimeter is a device used to measure parameters of fluorescence: its intensity and wavelength distribution of emission spectrum after excitation by a certain spectrum of light. The instrument is designed to measure the amount of stimulated electromagnetic radiation produced by pulses of electromagnetic radiation emitted into a water sample or in situ.

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Project Information

Collaborative Research: Pattern and process in the abundance and recruitment of Caribbean octocorals (Octocoral Community Dynamics)

Coverage: St. John, US Virgin Islands

NSF Award Abstract:
Coral reefs are exposed to a diversity of natural and anthropogenic disturbances, and the consequences for ecosystem degradation have been widely publicized. However, the reported changes have been biased towards fishes and stony corals, and for Caribbean reefs, the most notable example of this bias are octocorals ("soft corals"). Although they are abundant and dominate many Caribbean reefs, they are rarely included in studies due to the difficulty of both identifying them and in quantifying their abundances. In some places there is compelling evidence that soft corals have increased in abundance, even while stony corals have become less common. This suggests that soft corals are more resilient than stony corals to the wide diversity of disturbances that have been impacting coral corals. The best coral reefs on which to study these changes are those that have been studied for decades and can provide a decadal context to more recent events, and in this regard the reefs of St. John, US Virgin Islands are unique. Stony corals on the reefs have been studied since 1987, and the soft corals from 2014. This provides unrivalled platform to evaluate patterns of octocoral abundance and recruitment; identify the patterns of change that are occurring on these reefs, and identify the processes responsible for the resilience of octocoral populations. The project will extend soft coral monitoring from 4 years to 8 years, and within this framework will examine the roles of baby corals, and their response to seafloor roughness, seawater flow, and seaweed, in determining the success of soft corals. The work will also assess whether the destructive effects of Hurricanes Irma and Maria have modified the pattern of change. In concert with these efforts the project will be closely integrated with local high schools at which the investigators will host marine biology clubs and provide independent study opportunities for their students and teachers. Unique training opportunities will be provided to undergraduate and graduate students, as well as a postdoctoral researcher, all of whom will study and work in St. John, and the investigators will train coral reef researchers to identify the species of soft corals through a hands-on workshop to be conducted in the Florida Keys.

Understanding how changing environmental conditions will affect the community structure of major biomes is the ecological objective defining the 21st century. The holistic effects of these conditions on coral reefs will be studied on shallow reefs within the Virgin Islands National Park in St. John, US Virgin Islands, which is the site of one of the longest-running, long-term studies of coral reef community dynamics in the region. With NSF-LTREB support, the investigators have been studying long-term changes in stony coral communities in this location since 1987, and in 2014 NSF-OCE support was used to build an octocoral "overlay" to this decadal perspective. The present project extends from this unique history, which has been punctuated by the effects of Hurricanes Irma and Maria, to place octocoral synecology in a decadal context, and the investigators exploit a rich suite of legacy data to better understand the present and immediate future of Caribbean coral reefs. This four-year project will advance on two concurrent fronts: first, to extend time-series analyses of octocoral communities from four to eight years to characterize the pattern and pace of change in community structure, and second, to conduct a program of hypothesis-driven experiments focused on octocoral settlement that will uncover the mechanisms allowing octocorals to more effectively colonize substrata than scleractinian corals on present day reefs. Specifically, the investigators will conduct mensurative and manipulative experiments addressing four hypotheses focusing on the roles of: (1) habitat complexity in distinguishing between octocoral and scleractinian recruitment niches, (2) the recruitment niche in mediating post-settlement success, (3) competition in algal turf and macroalgae in determining the success of octocoral and scleractian recruits, and (4) role of octocoral canopies in modulating the flux of particles and larvae to the seafloor beneath. The results of this study will be integrated to evaluate the factors driving higher ecological resilience of octocorals versus scleractinians on present-day Caribbean reefs.

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.

RUI: Pattern and process in four decades of change on Caribbean reefs (St John Coral Reefs)

Website: http://coralreefs.csun.edu/

Coverage: United States Virgin Islands, St. John: 18.318, -64.7253

NSF Award Abstract:
The coral reef crisis refers to the high rates of death affecting tropical reef-building corals throughout the world, and the strong likelihood that coral reefs will become functionally extinct within the current century. Knowledge of these trends comes from the monitoring of coral reefs to evaluate their health over time, with the most informative projects providing high-resolution information extending over decades. Such projects describe both how reefs are changing, and answer questions addressing the causes of the changes and the form in which reefs will persist in the future. This project focuses on coral reefs in United States waters, specifically around St. John in the US Virgin Islands. These reefs are protected within the Virgin Islands National Park, and have been studied more consistently and in greater detail than most reefs anywhere in the world. Building from 33 years of research, this project extends monitoring of these habitats by another five years, and uses the emerging base of knowledge, and the biological laboratory created by the reefs of St. John, to address the causes and consequences of the bottleneck preventing baby corals from repopulating the reefs. The work is accomplished with annual expeditions, staffed by faculty, graduate students, undergraduates, and teachers, coupled with analyses of samples at California State University, Northridge, and Florida State University, Tallahassee. The students and teachers assist with the research goals at the center of this project, but also engage in independent study and integrate with the rich and diverse societal context and natural history of the Caribbean. The scope of the science agenda extends to schools in California, where students are introduced to the roles played by marine animals in ecosystem health, concepts of long-term change in the biological world, and the role of science engagement in promoting positive environmental outcomes. In addition to generating a wide spectrum of project deliverables focusing on scientific discovery, the project promotes STEM careers and train globally aware scientists and educators capable of supporting the science agenda of the United States in the 21st Century.

This project leverages one of the longest time-series analyses of Caribbean coral reefs to extend the time-series from 33 to 38 years, and it tests hypotheses addressing the causes and consequences of changing coral reef community structure. The project focuses on reefs within the Virgin Islands National Park (VINP) and along the shore of St. John, US Virgin Islands, and is integrated with stakeholders working in conservation (VINP) and local academia (University of the Virgin Islands). Beginning in 1987, the project has addressed detail-oriented analyses within a small spatial area that complements the large-scale analyses conducted by the VINP. The results of these efforts create an unrivaled context within which ecologically relevant hypotheses can be tested to elucidate mechanisms driving ecological change. Building from image- and survey- based analyses, 33 years of data reveal the extent to which these reefs have transitioned to a low-abundance coral state, and the importance of the bottleneck preventing coral recruits from contributing to adult size classes. The intellectual merits of this project leverage these discoveries to address eight hypotheses: (H1) long-term changes are defining a cryptic regime change, with the low coral abundance reinforced by, (H2) enhanced community resilience, (H3) low post-settlement success, (H4) negative effects of peyssonnelid algal crusts (PAC) on juvenile corals, (H5) inability of juvenile corals to match their phenotypes to future conditions, (H6) impaired population growth caused by reduced genetic diversity, (H7) the premium placed on PAC-free halos around Diadema sea urchins for coral recruitment, and (H8) biotic homogenization occurring on a landscape-scale.

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.

Related Projects:

- Affiliated with MCR-LTER - https://www.bco-dmo.org/project/2222
- Serves as a new project that builds on NSF DEB-1350146 - RUI-LTREB Renewal: Three decades of coral reef community dynamics in St. John, USVI: 2014-2019 - https://www.bco-dmo.org/project/734983
- Overlaps with OCE 17-56678 (which focuses on soft corals with H. Lasker) - Collaborative Research: Pattern and process in the abundance and recruitment of Caribbean octocorals - https://www.bco-dmo.org/project/752508
- LTREB Long-term coral reef community dynamics in St. John, USVI: 1987-2019 - https://www.bco-dmo.org/project/2272
- RUI: Pattern and process in four decades of change on Caribbean reefs - https://www.bco-dmo.org/project/835192
- RAPID: Hurricane Irma: Effects of repeated severe storms on shallow Caribbean reefs and their changing ecological resilience - https://www.bco-dmo.org/project/722163

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Funding

Funding Source	Award
NSF Division of Ocean Sciences (NSF OCE)	OCE-1756678
NSF Division of Ocean Sciences (NSF OCE)	OCE-2019992

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