Measurements of light intensity (PAR) underwater (19 m depth) in St. John, US Virgin Islands from 2014-2017.

Website: https://www.bco-dmo.org/dataset/739892
Data Type: Other Field Results
Version: 1
Version Date: 2018-07-13

Project
» Collaborative research: Ecology and functional biology of octocoral communities (VI Octocorals)
» RUI-LTREB Renewal: Three decades of coral reef community dynamics in St. John, USVI: 2014-2019 (RUI-LTREB)

Program
» Long Term Research in Environmental Biology (LTREB)

Contributors	Affiliation	Role
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Abstract
Light measured at depth (19 m) in Great Lameshur Bay, St. John using a cosine-corrected sensor with wiper. These data describe the core data in the manuscript and come from an Alec (brand) light sensor installed at 19 m depth.

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Coverage

Spatial Extent: **Lat**:18.314604 **Lon**:-64.725975
Temporal Extent: 2014-08-23 - 2017-07-28

Dataset Description

Measurements of light intensity (PAR) underwater (19 m depth) in St. John, US Virgin Islands from 2014-2017.

Methods & Sampling

Light was measured as the radiant energy between 400 and 700 nm wavelength (i.e., PAR, µmol quanta m-2 s-1) as Photosynthetic Photon Flux Density (PPFD). In situ light was measured using two logging meters fitted with a cosine-corrected PAR sensor and wiper (Compact LW, JFE Advantech Co., Ltd, Japan), that were deployed at ~ 19.1-m depth (height of the sensor) in Great Lameshur Bay (18° 18′ 37.04N, 63° 43′ 23.17W).

These instruments recorded downwelling PAR, and were deployed six times from 2014and 2017, from August to March and from March to August. The meters were operated in burst mode, during which they would wake up, clean the sensor with a wiper, and record a burst of multiple records before returning to sleep. The Compact LW meter is designed for oceanographic applications to 200 m depths, is fitted with a photodiode sensor, and has a stated accuracy of ± 4% (over 0–2000 µmol photons m2 s-1) and resolution of 0.1 µmol photons m2 s-1. Both meters were purchased new for this study, and were deployed individually and sequentially between field samplings with comparisons between consecutive deployments used to screen for calibration drift. One sensor was used for a combined duration of 16 months during, and the other sensor was used for 4 months, returned to the manufacturer for servicing (May 2016), and then used again for 3 months. In between deployments, sensors were inspected for abrasions that would affect calibration, and were carefully cleaned with vinegar.

Different configurations of the meter were employed to prolong battery life. In the first and second deployments (starting 21 August 2014 and 19 March 2015, respectively), a burst of 10 measurements was recorded at 0.033 Hz (i.e., every 30 s) every 1.5 h; the instrument failed during the third deployment (starting August 2015); in the fourth and fifth deployments (starting 16 March 2016 and 29 July 2016, respectively) a burst of 10 measurements was recorded at 0.033 Hz every 1.0 h; and in the sixth deployment(starting 23 February 2017) a burst of 30 measurements was recorded at 0.100 Hz (i.e.,every 10 s) every 2.0 h. The timing of bursts was not standardized to local time and, therefore, the number and timing of bursts bracketing noon (which were used to calculate transmission, described below) differed among deployments. The sampling frequency within each burst was sufficient to alleviate the bias resulting from wave-induced light flecking (Zheng et al. 2002). As a result of varying power demands of each sampling configuration, the meter did not always record for the full duration of each deployment.

Data Processing Description

In situ light data were averaged by burst, and burst means were paired with measurements of surface light at the same time to calculate the percent transmission to 1-m depth (TPAR-19). These values underestimate water column light extinction when the sun is low in the sky and light is strongly reflected from the seawater surface and, therefore, daily transmission calculations used averages of several measurements bracketing noon. At these times, the sun was approximately overhead, and mo

In situ light data were averaged by burst, and burst means were paired with measurements of surface light at the same time to calculate the percent transmission to 1-m depth (TPAR-19). These values underestimate water column light extinction when the sun is low in the sky and light is strongly reflected from the seawater surface and, therefore, daily transmission calculations used averages of several measurements bracketing noon. At these times, the sun was approximately overhead, and most light entered the water rather than being reflected. In the first and second deployments, TPAR-19 was based on measurements at 10:30 hrs, 12:00 hrs and 13:30 hrs; in the fourth deployment, TPAR-19 was based on measurements at 11:00 hrs, 12:00 hrs, and 13:00hrs; in the fifth deployment, TPAR-19 was based on measurements at 11:45 hrs, 12:45 hrs and 13:45 hrs; and in the sixth deployment, TPAR-19 was based on measurements at11:00 hrs and 13:00 hrs. Daily TPAR-19 values were summarized by month as the maximum, minimum, mean, and SE, and their frequency distributions explored by season. Light intensities at 19.1-m depth were also used to calculate the diffuse attenuation coefficient for PAR (Kd-PAR) using the equation representing the Beer-Lambert Law:

$$Ed(Z) = Ed(O-)\, e^{-Kd \times Z}$$

where Ed(Z) is the downwelling irradiance at Z m depth, Ed(O-) is downwelling irradiance just below the surface of the seawater, and Kd is the diffuse attenuation coefficient for downwelling irradiance. Ed(O-) was approximated from surface PPFD, which shows ~96 percent transmission through the air-sea interface when sun altitudes are high (greater than 46 deg) and wind speeds are low (less than 5 m s-1) (Gregg and Carder 1990). This method of calculating Kd is prone to larger variance that the more standard regression approach using downwelling irradiances measured in quick succession at multiple depths (Kirk 2011),but it allows a time-series of Kd values to be obtained using modest equipment resources. Calculations of the possible magnitude of this variance suggested Kd would vary +/- 5 percent if Ed(Z) varied +/- 10 percent. Assuming seawater in Great Lameshur Bay is vertically homogeneous with regard to the factors affecting downwelling irradiance, Kd-PAR can be used to calculate PPFD by depth, although assigning causation to variation in Kd-PAR is problematic due to its summative origin in the scatter and absorption of water, dissolved pigments, photosynthetic biota, and inanimate particulate matter (Kirk 2011). Surface light was integrated over each day after excluding values less than 3 µmol quanta m-2 s-1 (i.e.,effectively darkness), and averaged by month to characterize the daily availability ofPAR (mol quanta m-2 s-1). Finally, to evaluate the biological implications of

Kd-PAR for St.John, equivalent values for seawater were compiled from the literature.

The objective of this paper is to describe the underwater light environment on a coral reef over scales of time that have relevance to understanding biological processes mediating coral reef community dynamics. While it is beyond the scope of this study to comprehensively explore such effects, or to develop a bio-physical model with which they can be integrated, it is valuable to a consider a simple case in which variation in underwater light intensity could affect reef corals. We develop this case to consider the effects of light on the energetic status of a symbiotic coral through the balance between gross photosynthesis and aerobic respiration as described in one study using the common Caribbean coral Porites porites from 10-m depth on the fore reef of DiscoveryBay, Jamaica (Edmunds 1986). We present the outcome of these calculations, which use published values for aerobic respiration and the hyperbolic tangent function relating light intensity to gross photosynthesis, with the present study generating the light intensities inserted into this function. Daily gross photosynthesis for P. porites was equated to the 24 h aerobic respiratory demand (Edmunds and Davies 1986), and with a currency of Joules, gross photosynthesis was calculated using the hyperbolic tangent describing photosynthesis as a function of light intensity (with 5-min resolution), and dark aerobic respiration over 24 h (see Table 2 in Edmunds and Davies 1986). In situ daily light was calculated as 12 h sine curves with a maximum irradiance corresponding to the maximum surface irradiance attenuated using Kd (determined empirically in the present study) to the value at 10-m depth. With this method, the quotient p12h grosss/R 24h provides a rough indication of the capacity for photosynthesis by endosymbiotic Symbiodinium algae to meet the daily energy requirements of aerobic respiration; values greather than or equal to 1 suggest energy surplus to the daily needs might be produced. While use of the quotient p12h grosss/R 24h to evaluate the energetic status of corals has important limitations, and has been superseded by more sophisticated and accurate approaches(Lesser 2013), in the present case it served as an effective measure of the relative impacts of differing light regimes on coral energetics.

BCO-DMO Data Processing Notes:

-Combined all light intensity year tables from "fig 1" from paper
-Reformatted date to yyyy-mm-dd
-Changed first column name from day to date
-Replaced spaces in column names with underscores
-Replaced blank cells with nd
-Added ISO DateTime column

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Data Files

File
light_intensity.csv (Comma Separated Values (.csv), 752.44 KB) MD5:a0a8218ca48799593b14c3627d5e6cee Primary data file for dataset ID 739892

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Related Publications

Bramanti, L., Boulon, R., Tsounis, G., & Edmunds, P. J. (2018). Measurements of light intensity (PAR) underwater (19 m depth) and on the surface, as well as rainfall data from St. John, US Virgin Islands from 2014-2017. Woods Hole Open Access Server (WHOAS) at the MBLWHOI Library. doi:10.1575/1912/10478
Collection-level Data DOI

Edmunds, P. J., Tsounis, G., Boulon, R., & Bramanti, L. (2018). Long-term variation in light intensity on a coral reef. Coral Reefs, 37(3), 955–965. https://doi.org/10.1007/s00338-018-1721-y
Results

,
Methods

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Parameters

Parameter	Description	Units
Date	Day of measurment; yyyy-mm-dd	unitless
Time	Time of measurement; hh:mm:ss	unitless
Burst_average	Underwater light; averaged within burst that the sensor was on	umol photons per square meter per second
Surface	Surface light	umol photons per square meter per second
Transmission	TPAR-19 is the percent surface light reaching to 19 meters depth.	percent
Noon_percent	Mean TPAR-19 over noon hours using 2-3 records around noon. Values at night and late/early in the day (between about 17:00 and 07:00 the next day) are unlikely to be meaninghful due to the low values recorded.	percent
Kd_PAR	Kd PAR calculated according to equations and assumptions in paper (DOI: 10.1007/s00338-018-1721-y). Values at night and late/early in the day (between about 17:00 and 07:00 the next day) are unlikely to be meaninghful due to the low values recorded.	umol photons per square meter per second
Noon_Kd	Mean Kd-PAR over noon hours using 2-3 records around noon.	umol photons per square meter per second
ISO_DateTime_UTC	UTC DateTime; ISO formatted	unitless

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Instruments

Dataset-specific Instrument Name	PAR Sensor
Generic Instrument Name	LI-COR Biospherical PAR Sensor
Dataset-specific Description	Used to determine PAR
Generic Instrument Description	The LI-COR Biospherical PAR Sensor is used to measure Photosynthetically Available Radiation (PAR) in the water column. This instrument designation is used when specific make and model are not known.

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Deployments

Edmunds_VINP

Website	https://www.bco-dmo.org/deployment/523357
Platform	Virgin Islands National Park
Start Date	1987-01-01
End Date	2016-09-01
Description	Studies of corals and hermit crabs

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Project Information

Collaborative research: Ecology and functional biology of octocoral communities (VI Octocorals)

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

Coverage: St. John, US Virgin Islands: 18.3185, 64.7242

The recent past has not been good for coral reefs, and journals have been filled with examples of declining coral cover, crashing fish populations, rising cover of macroalgae, and a future potentially filled with slime. However, reefs are more than the corals and fishes for which they are known best, and their biodiversity is affected strongly by other groups of organisms. The non-coral fauna of reefs is being neglected in the rush to evaluate the loss of corals and fishes, and this project will add on to an on-going long term ecological study by studying soft corals. This project will be focused on the ecology of soft corals on reefs in St. John, USVI to understand the Past, Present and the Future community structure of soft corals in a changing world. For the Past, the principal investigators will complete a retrospective analysis of octocoral abundance in St. John between 1992 and the present, as well as Caribbean-wide since the 1960's. For the Present, they will: (i) evaluate spatio-temporal changes between soft corals and corals, (ii) test for the role of competition with macroalgae and between soft corals and corals as processes driving the rising abundance of soft corals, and (iii) explore the role of soft corals as "animal forests" in modifying physical conditions beneath their canopy, thereby modulating recruitment dynamics. For the Future the project will conduct demographic analyses on key soft corals to evaluate annual variation in population processes and project populations into a future impacted by global climate change.

This project was funded to provide and independent "overlay" to the ongoing LTREB award (DEB-1350146, co-

funded by OCE, PI Edmunds) focused on the long-term dynamics of coral reefs in St. John.

Note: This project is closely associated with the project "RAPID: Resilience of Caribbean octocorals following Hurricanes Irma and Maria". See: https://www.bco-dmo.org/project/749653.

The following publications and data resulted from this project:
2017 Tsounis, G., and P. J. Edmunds. Three decades of coral reef community dynamics in St. John, USVI: a contrast of scleractinians and octocorals. Ecosphere 8(1):e01646. DOI: 10.1002/ecs2.1646
Rainfall and temperature data
Coral and macroalgae abundance and distribution
Descriptions of hurricanes affecting St. John

2016 Gambrel, B. and Lasker, H.R. Marine Ecology Progress Series 546: 85–95, DOI: 10.3354/meps11670
Colony to colony interactions
Eunicea flexuosa interactions
Gorgonia ventalina asymmetry
Nearest neighbor surveys

2015 Lenz EA, Bramanti L, Lasker HR, Edmunds PJ. Long-term variation of octocoral populations in St. John, US Virgin Islands. Coral Reefs DOI 10.1007/s00338-015-1315-x
octocoral survey - densities
octocoral counts - photoquadrats vs. insitu survey
octocoral literature review
Download complete data for this publication (Excel file)

2015 Privitera-Johnson, K., et al., Density-associated recruitment in octocoral communities in St. John, US Virgin Islands, J.Exp. Mar. Biol. Ecol. DOI: 10.1016/j.jembe.2015.08.006
octocoral density dependence
Download complete data for this publication (Excel file)

Other datasets related to this project:
octocoral transects - adult colony height

RUI-LTREB Renewal: Three decades of coral reef community dynamics in St. John, USVI: 2014-2019 (RUI-LTREB)

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

Coverage: USVI

Describing how ecosystems like coral reefs are changing is at the forefront of efforts to evaluate the biological consequences of global climate change and ocean acidification. Coral reefs have become the poster child of these efforts. Amid concern that they could become ecologically extinct within a century, describing what has been lost, what is left, and what is at risk, is of paramount importance. This project exploits an unrivalled legacy of information beginning in 1987 to evaluate the form in which reefs will persist, and the extent to which they will be able to resist further onslaughts of environmental challenges. This long-term project continues a 27-year study of Caribbean coral reefs. The diverse data collected will allow the investigators to determine the roles of local and global disturbances in reef degradation. The data will also reveal the structure and function of reefs in a future with more human disturbances, when corals may no longer dominate tropical reefs.

The broad societal impacts of this project include advancing understanding of an ecosystem that has long been held emblematic of the beauty, diversity, and delicacy of the biological world. Proposed research will expose new generations of undergraduate and graduate students to natural history and the quantitative assessment of the ways in which our planet is changing. This training will lead to a more profound understanding of contemporary ecology at the same time that it promotes excellence in STEM careers and supports technology infrastructure in the United States. Partnerships will be established between universities and high schools to bring university faculty and students in contact with k-12 educators and their students, allow teachers to carry out research in inspiring coral reef locations, and motivate children to pursue STEM careers. Open access to decades of legacy data will stimulate further research and teaching.

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Program Information

Long Term Research in Environmental Biology (LTREB)

Website: https://www.nsf.gov/funding/opportunities/ltreb-long-term-research-environmental-biology

Long Term Research in Environmental Biology (LTREB)

Supports research for a period of 10 years or longer to generate an extended time series of data with a focus on evolutionary biology, ecology and ecosystem science.

Synopsis
The Long Term Research in Environmental Biology (LTREB) Program supports the generation of extended time series of data to address important questions in evolutionary biology, ecology, and ecosystem science. Research areas include, but are not limited to, the effects of natural selection or other evolutionary processes on populations, communities, or ecosystems; the effects of interspecific interactions that vary over time and space; population or community dynamics for organisms that have extended life spans and long turnover times; feedbacks between ecological and evolutionary processes; pools of materials such as nutrients in soils that turn over at intermediate to longer time scales; and external forcing functions such as climatic cycles that operate over long return intervals.

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Funding

Funding Source	Award
NSF Division of Ocean Sciences (NSF OCE)	OCE-1332915
NSF Division of Environmental Biology (NSF DEB)	DEB-1350146

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