Dataset: Measurements of rainfall and surface light intensity (PAR) in St. John, US Virgin Islands from 2014-2017.

Project(s): 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)

Abstract: Data supporting publication through measurements of rainfall on St. John and surface light adjacent to Lameshur Bay. These data describe rainfall on the north shore of St. John as measured by R. Boulon using a manual rain gauge. For a complete list of measurements, refer to the supplemental document 'Field_names.pdf', and a full dataset description is included in the supplemental file 'Dataset_description.pdf'. The most current version of this dataset is available at: http://www.bco-dmo.org/dataset/739601

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Measurements of rainfall and surface light intensity (PAR) in St. John, US Virgin Islands from 2014-2017.

Acquisition Description: 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.

Surface light was recorded with two cosine-corrected PAR sensor (S-LIA-M003, OnsetComputer Corporation) attached to loggers (Micro Station Data Logger H21-002, OnsetComputer Corporation) recording at 0.0033 Hz (i.e., every 5 minutes). The sensors were calibrated by the manufacturers, and were mounted ~ 4-m above sea level adjacent to Great Lameshur Bay (18° 19′ 6.61N, 64° 43′ 27.73W), and ~ 0.875 km from the sensor recording in situ light. The paired surface sensors were used to ensure data integrity should one sensor fail, and the paired deployments provided a means to detect erroneous records due to sensor drift or failure. The surface sensors were downloaded, reprogrammed, and cleaned in July of each year, and have been deployed for 11 y(from 2007). Here, surface light data for 2014-2017 are presented to provide temporal concordance with the submerged sensor.

Rainfall was measured using a 20.3 cm, Standard Rain Gauge (NOAA, NationalWeather Service) that was deployed on the north shore of St. John (18° 21′ 20.95N, 64°45′ 57.53W). The gauge was used to manually record daily rainfall that was averaged by month for each sampling year.

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

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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:

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

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:

-Changed month names to be full names instead of abbreviations
-Added underscores to column names
-Combined rainfall and surface light tables from "fig 1" in paper

Project Information

Ecology and functional biology of octocoral communities

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. 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/ecs2.1646Rainfall and temperature dataCoral and macroalgae abundance and distributionDescriptions of hurricanes affecting St. John 2016 Gambrel, B. and Lasker, H.R. Marine Ecology Progress Series 546: 85–95, DOI 10.3354/meps11670Colony to colony interactionsEunicea flexuosa interactionsGorgonia ventalina asymmetryNearest 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-xoctocoral survey - densitiesoctocoral counts - photoquadrats vs. insitu surveyoctocoral literature reviewDownload 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.2015.08.006octocoral density dependenceDownload 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

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.

Deployment Information

Deployment description for Virgin Islands National Park Edmunds_VINP

Studies of corals and hermit crabs

Instrument Information

Instrument	PAR Sensor
Description	Used to determine PAR
Generic Instrument Name	LI-COR Biospherical PAR Sensor
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.