Physical description of marine lakes: surface area, distance to ocean, tidal efficiency, depth, and stratification

Website: https://www.bco-dmo.org/dataset/768110
Data Type: Other Field Results
Version: 1
Version Date: 2019-05-13

Project
» Do Parallel Patterns Arise from Parallel Processes? (PaPaPro)

Program
» Dimensions of Biodiversity (Dimensions of Biodiversity)

Contributors	Affiliation	Role
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Abstract
Physical description of marine lakes including surface area, distance to ocean, tidal efficiency, depth, and stratification.

Table of Contents

Coverage

Spatial Extent: **N**:7.3237 **E**:134.5089 **S**:7.1506 **W**:134.3447
Temporal Extent: 2014-07-11 - 2015-07-27

Dataset Description

Physical parameters describing Palau marine lakes, 2011-2015. Reported parameters include surface area, distance to ocean, tidal efficiency, depth, and stratification.

* NOTE: The P.I.'s are using this dataset to write papers. Please contact them before using these data to make sure you are not duplicating efforts.

Methods & Sampling

Lake Bathymetry Mapping

The bathymetry of the lakes was recorded with a purpose-built lightweight, low-power echosounder unit with integrated GPS and AHRS (attitude and heading reference system), towed behind a kayak. (Data courtesy of

Herwig Stibor, Thomas Stieglitz.)

Lake Bathymetry Analysis

Raw bathymetry data were down-sampled to include one sample every 2 m distance along the survey track. Data were visually inspected and false soundings removed. In some lakes, GPS reception was partially compromised along the steep shorelines. Where required to not compromise data density, the survey track was reconstructed from field notes and AHRS data (less than 5% of data where applicable). During the bathymetry surveys, tidal water level was not recorded. Therefore, tidal water level variations were corrected for by modeling tidal water level in each lake. The water level for each lake was correlated with tidal water level measured at a reference station at CRRF or predicted tide (x-tide database), by determining tidal lag time and tidal efficiency (see below) from data previously collected concurrently in the respective lake and at this reference station. Subsequently, bathymetry data was reduced to a grid with 2m resolution by kriging of a further down-sampled subset of data using every third data point. Lake-specific variograms were applied, and contour lines and total lake volumes were calculated in a GIS. (Data courtesy of Thomas Stieglitz.)

Distance from lake to ocean & lake surface area

Lake shorelines and island coastlines were manually extracted from satellite data (Microsoft Bing). The nearest, mean and median distance of each lake to the respective island's coastline as well as lake surface area was calculated in a GIS. The perimeter was measured in meters using the 'Measure Line' tool in QGIS 3.4.

Habitable surface area for benthic organisms was estimated either as (1) a multiple of the perimeter and depth of the chemocline, i.e. assuming a cylindrical model for the lake, or (2) as the area of a frustum, i.e. a truncated cone, using the perimeter of the lake at the surface, the average length of transects, and the average angle of the transect from the vertical (estimated using the sine of maximum depth / transect length).

Tidal lag time and tidal efficiency were calculated from concurrently measured tidal water level in a lake and the adjacent ocean. The tidal lag time — the time between high tide in the adjacent ocean and high tide in the lake — was determined by least-square fit between lake and ocean tide measured using HOBO 30-foot depth Titanium water level data loggers (Part # U20-001-01-Ti). Tidal efficiency was calculated as the ratio between amplitude of ocean tide and lake tide (e.g. Ayers, JF and Vacher, HL, 1986. Hydrogeology of an Atoll Island: A Conceptual Model from a Detailed Study of a Micronesian Example. Groundwater 24(2) 185-198.). Larger tidal lag time and smaller tidal efficiency respectively indicate a less efficient hydrological connection between ocean and lake.

Error-checking: Estimates of basic dimensions (depth, distance, length, surface area) were double-checked manually for a subset of measurements by a second person using using Google Earth.

Data Processing Description

BCO-DMO Processing:
- added conventional header with dataset name, PI name, version date
- reformatted date from dd-Mon-yy to yyyy-mm-dd (ISO date format)
- replaced blanks records

[table of contents | back to top]

Data Files

File
2_lake_physical.csv (Comma Separated Values (.csv), 2.02 KB) MD5:aa24f556714c72bb1428a7f262db09e9
Primary data file for dataset ID 768110

[table of contents | back to top]

Related Publications

Ayers, J. F., & Vacher, H. L. (1986). Hydrogeology of an Atoll Island: A Conceptual Model from Detailed Study of a Micronesian Example. Ground Water, 24(2), 185–198. doi:10.1111/j.1745-6584.1986.tb00994.x
Methods

Meyerhof, M. S., Wilson, J. M., Dawson, M. N., & Michael Beman, J. (2016). Microbial community diversity, structure and assembly across oxygen gradients in meromictic marine lakes, Palau. Environmental Microbiology, 18(12), 4907–4919. doi:10.1111/1462-2920.13416
Methods

[table of contents | back to top]

Parameters

Parameter	Description	Units
lake	common name for lake	unitless
lake_code	3-letter code for sampled lake name	unitless
volume_m3	estimated volume of the lake (m3)	meters^3
surface_area_m2	Surface area of the lake (m2).	meters^2
distance_to_ocean_min_m	Minimum distance from a lake's edge to the surrounding lagoon (m)	meters
distance_to_ocean_mean_m	Mean distance from a lake's edge to the surrounding lagoon (m).	meters
distance_to_ocean_median_m	Median distance from a lake's edge to the surrounding lagoon (m).	meters
tidal_efficiency	the ratio between amplitude of ocean tide and lake tide.	unitless
mean_transect_length_m	average of distance_trans for the lake from https://www.bco-dmo.org/dataset/541181	meters
max_actual_depth_m	maximum depth_m for the lake from https://www.bco-dmo.org/dataset/541181	meters
perimeter_m	circumference of lake (m).	meters
habitable_surface_area_cylinder	An estimate of the area of the benthic zone above the chemocline; based on the model of lake shape as a cylinder.	meters^2
habitable_surface_area_frustum	An estimate of the area of the benthic zone above the chemocline; based on the model of lake shape as a truncated cone.	meters^2
stratified	whether a lake is vertically stratified (1) or holomictic (0)	unitless
tidal_lag_time_minutes	the time between high tide in the adjacent ocean and high tide in the lake	minutes

[table of contents | back to top]

Instruments

Dataset-specific Instrument Name	HOBO 30-foot depth Titanium water level data loggers (Part # U20-001-01-Ti)
Generic Instrument Name	Data Logger
Dataset-specific Description	Used to determine tidal lag time, the time between high tide in the adjacent ocean and high tide in the lake.
Generic Instrument Description	Electronic devices that record data over time or in relation to location either with a built-in instrument or sensor or via external instruments and sensors.

[table of contents | back to top]

Deployments

Palau_lakes

Website	https://www.bco-dmo.org/deployment/542180
Platform	Small boats - CRRF
Start Date	2010-08-21
End Date	2016-06-14
Description	Palau marine lakes

[table of contents | back to top]

Project Information

Do Parallel Patterns Arise from Parallel Processes? (PaPaPro)

Website: http://marinelakes.ucmerced.edu/

Coverage: Western Pacific; Palau; Indonesia (West Papua)

This project will survey the taxonomic, genetic, and functional diversity of the organisms found in marine lakes, and investigate the processes that cause gains and losses in this biodiversity. Marine lakes formed as melting ice sheets raised sea level after the last glacial maximum and flooded hundreds of inland valleys around the world. Inoculated with marine life from the surrounding sea and then isolated to varying degrees for the next 6,000 to 15,000 years, these marine lakes provide multiple, independent examples of how environments and interactions between species can drive extinction and speciation. Researchers will survey the microbes, algae, invertebrates, and fishes present in 40 marine lakes in Palau and Papua, and study how diversity has changed over time by retrieving the remains of organisms preserved in sediments on the lake bottoms. The project will test whether the number of species, the diversity of functional roles played by organisms, and the genetic diversity within species increase and decrease in parallel; whether certain species can greatly curtail diversity by changing the environment; whether the size of a lake determines its biodiversity; and whether the processes that control diversity in marine organisms are similar to those that operate on land.

Because biodiversity underlies the ecosystem services on which society depends, society has a great interest in understanding the processes that generate and retain biodiversity in nature. This project will also help conserve areas of economic importance. Marine lakes in the study region are important for tourism, and researchers will work closely with governmental and non-governmental conservation and education groups and with diving and tourism businesses to raise awareness of the value and threats to marine lakes in Indonesia and Palau.

[table of contents | back to top]

Program Information

Dimensions of Biodiversity (Dimensions of Biodiversity)

Website: http://www.nsf.gov/funding/pgm_summ.jsp?pims_id=503446

Coverage: global

(adapted from the NSF Synopsis of Program)
Dimensions of Biodiversity is a program solicitation from the NSF Directorate for Biological Sciences. FY 2010 was year one of the program. [MORE from NSF]

The NSF Dimensions of Biodiversity program seeks to characterize biodiversity on Earth by using integrative, innovative approaches to fill rapidly the most substantial gaps in our understanding. The program will take a broad view of biodiversity, and in its initial phase will focus on the integration of genetic, taxonomic, and functional dimensions of biodiversity. Project investigators are encouraged to integrate these three dimensions to understand the interactions and feedbacks among them. While this focus complements several core NSF programs, it differs by requiring that multiple dimensions of biodiversity be addressed simultaneously, to understand the roles of biodiversity in critical ecological and evolutionary processes.

[table of contents | back to top]

Funding

Funding Source	Award
NSF Division of Ocean Sciences (NSF OCE)	OCE-1241255

[table of contents | back to top]