Processed dissolved oxygen and infauna of experimental chambers and ambient sensors acquired in the shallow subtidal shore-accessible site in Bon Secour Bay, Mobile Bay, Alabama, USA between August 7-12, 2021

Website: https://www.bco-dmo.org/dataset/940735
Data Type: Other Field Results
Version: 1
Version Date: 2025-04-21

Project
» CAREER: Mechanisms of bioturbation and ecosystem engineering by benthic infauna (Bioturbation and Ecosystem Engineering)

Contributors	Affiliation	Role
Gadeken, Kara	University of South Alabama; and Dauphin Island Sea Lab (USA-DISL)	Student, Contact
Soenen, Karen	Woods Hole Oceanographic Institution (WHOI BCO-DMO)	BCO-DMO Data Manager

Abstract
This data set includes data and scripts from a field study examining the effect of diel oxygen cycling on faunal activity, and in turn sediment oxygen demand. The field experiment used in situ flow-through benthic chambers to measure oxygen consumption, as described in the methods paper Gadeken et al 2023 in L&O:Methods. The chambers were deployed and retrieved in three ~24 hour deployments in a shallow subtidal area of Bon Secour Bay in Mobile Bay, AL, in August 2021. Included in this data set are the raw data files of oxygen and temperature measurements from Onset HOBO DO loggers integrated into the benthic chamber system, annotated MATLAB scripts and workspaces detailing data processing and analysis, and faunal community data from the benthic chambers.

Table of Contents

Coverage

Location: SShallow subtidal shore-accessible site in Bon Secour Bay, Mobile Bay, AL, USA
Spatial Extent: **Lat**:30.239478 **Lon**:-87.894094
Temporal Extent: 2021-08-07 - 2021-08-12

Dataset Description

Five matlab script files (.m) are added as supplemental files to this dataset. They are for the data analysis and results/figures of the results paper. Some of these are run step-wise. Note that because Chamber 1 malfunctioned in all three deployments, the scripts regularly exclude that chamber in data processing and analyses. Users replicating these methods who have better luck with their chamber 1 will want to add in code modified from analysis of the other chambers to analyze those data.

Methods & Sampling

In brief, a custom field deployable benthic chamber system was used to collect sediment oxygen demand (SOD) data in situ from small replicate patches of sediment throughout a diel oxygen cycle. Chambers were "batch" style incubation chambers that periodically flushed the overlying water with water from the external environment to start another incubation, and SOD could be calculated from the slopes of each incubation. Upon completion of the 24 hour deployment, the chambers were extracted, oxygen data offloaded from the chamber loggers, and the faunal community in each chamber identified and counted (1mm sieve).

Data Processing Description

The data file s the compiled data for every high-quality chamber incubation among all three deployments, the product of data processing, filtration, and consolidation done in MATLAB scripts 2, 3 and 4. This sheet is used in MATLAB script 5 for data analysis. It contains the start date and time of the incubation, the elapsed time since the start of the deployment (dayfrac), the chamber number out of 5 replicate chambers, the SOD (sediment oxygen demand) in mmol m-2 d-1, the Initial DO (dissolved oxygen) of that incubation in mg L-1, the total biomass of fauna within the chamber in grams, the deployment number, and the overall study sample number.

DO data processing involved manual selection of oxygen slopes from raw oxygen data for each deployment to generate a data set of sediment oxygen demand (SOD) values. Data were compiled into a master data sheet which was then used to compare SOD with the dissolved oxygen levels at the time of the slope and the faunal community in the particular chamber.

BCO-DMO Processing Description

* Added Matlab script files as supplemental files

Problem Description

* The flush mechanism for chamber 1 malfunctioned during all three deployments of the system. This is evident by the lack of the expected sawtooth pattern in the data but worth noting here. The scripts regularly exclude that chamber in data processing and analyses. Users replicating these methods who have better luck with their chamber 1 will want to add in code modified from analysis of the other chambers to analyze those data.

[table of contents | back to top]

Data Files

File
940735_v1_depalldata.csv (Comma Separated Values (.csv), 50.06 KB) MD5:2b759d41bdfdb88d4de491a4337251ec Primary data file for dataset ID 940735, version 1

[table of contents | back to top]

Supplemental Files

File
Matlab Scripts filename: MATLABscripts/FTC_2_data_processing.m (MATLAB Programming Script (.m), 10.78 KB) MD5:025c7e4c6df84eb224f42883bded2adc

This script plots HOBO data from flow-through chamber setup (ambient and each of the 5 chambers) and calculates sediment oxygen demand (SOD). The user can select to either auto-calculate or manually calculate SOD. Whichever method is chosen, this process must be done for each of the chambers, changing variable names to append data as you go.

Data is not imported through the code, since some format changes must be made and it is easier to do so through the Matlab file importer tool. It is advised that users run the script in sections demarcated within the script to check proper functioning of code and array format. Once the data files have been imported to the workspace, the sections, in order, perform the following:

FORMAT CHAMBER DATA - separates chamber and ambient HOBO DO logger data files into separate Date&Time, Dissolved Oxygen, Elapsed Time, and Temperature vectors

Plotting - below sections perform identical functions as in FTC_1_viewdata script, necessary for point selection if using manual calculate method

PLOT AMBIENT DO DATA (CHANGE SUNRISE/SUNSET INDICES IF NEEDED)
PLOT FTC_LOG DATA AS VERTICAL LINES
PLOT SELECT CHAMBER DO DATA OVER AMBIENT DO DATA AND REFORMAT DandT
ADD LEGEND

SOD AUTO-CALCULATE – this section extracts DO slopes and auto-calculates SOD using supplied information about the chamber system incubation interval. Annotation about what variables need to be modified for correct functioning of the section is provided in the script. Note that this method of SOD calculation is not discerning but it is fast.

SOD MANUAL CALCULATE – This section allows you to manually select points and calculate slope and SOD data. To do this, you must have generated a plot with the data using the plotting sections above. Execute each section individually following the steps. Make sure you select the correct cell to write data in Step 4, or run Prep Step to reset "Row" to selected value if starting from beginning of trial.

File

Matlab Scripts

filename: MATLABscripts/FTC_5_data_analysis.m

(MATLAB Programming Script (.m), 16.85 KB)
MD5:44bf755e5938d0dc6872d78dc3c59af3

Script for consolidated data analysis using three tables from each deployment. Sections should be run independently.

Made a table called DepAllData that contains the combined data tables from all of the deployments. Added a column to the table denoting a sample number. Samples numbered in ascending deployment and chamber order. All incubations from the same chamber in the same deployment have the same sample number. Also added a column with biomass, standardized to individuals per meter squared, for each row. The biomass is the same for each incubation from a given chamber in a given deployment.

Regressions
PLOT ALL INITIAL DO VS SOD – pulls data from all deployments to plot initial DO vs SOD as scatterplot, colorized by biomass
Compute Linear regression for each chamber, put plotting data into table – the resulting table named regr_table will be referenced for calculated values to plot regression lines
Plot regressions on top of scatter – uses points in regr_table to plot regression lines for each chamber, colorized by biomass

PLOT SLOPES VS FAUNAL BIOMASS – plots a regression of initial DO/SOD slopes against biomass of fauna in the chambers
PLOT SLOPES VS BIOMASS OF CERTAIN FAUNAL TAXA (CHANGE TAXON IN VARIABLES) - plots a regression of initial DO/SOD slopes against biomass of a specified faunal taxon. Taxon must be referenced from the InfaunaAndSOD_Agg table.
PLOT SLOPES VS FAUNAL ABUNDANCE – similar to above, plots a regression of initial DO/SOD slopes against biomass of fauna in the chambers
PLOT SLOPES VS ABUNDANCE OF CERTAIN FAUNAL TAXA (CHANGE TAXON IN VARIABLES) – similar to above, plots a regression of initial DO/SOD slopes against abundance of a specified faunal taxon
REGRESSIONS OF SOD WITH DO AND FAUNAL BIOMASS AS PREDICTORS – simple regressions of each and multiple regression testing interactions
LINEAR MIXED MODEL WITH ALL DATA – uses all data to run a linear mixed model and perform a likelihood ratio test to examine effects of Initial DO and faunal biomass on the model

Smoothing Analysis
These code sections perform the smoothing analysis that shows the amount of sub-diel variability in the SOD data. Iterative smoothing fit lines are generated for each of the chambers in each of the deployments and the residual sum of squares calculated, and then the RSS is plotted with changing smoothing span size.

The following sections must be run for each chamber in each deployment in succession to build a table, rsstable, that is referenced to plot all patterns of changing RSS with increasing span size.
SELECT DEPLOYMENT FOR ANALYSIS – this must be done to select data from a specific deployment
SELECT CHAMBER AND EXTRACT DATA - selects one chamber for smoothing fit analysis
PLOT SINGLE CHAMBER – plots to observe variability in raw data
DETREND DATA, GENERATE TEST FITLINE AND PLOT – detrending is done by subtracting the SOD sample mean from each SOD measurement
GENERATES ITERATIVE FIT LINES OF SHRINKING WINDOW SIZE – only does this for the selected chamber. This process must be done with each chamber in each deployment.
PLOT ITERATIVE TREND – plots trendline generated in previous step. The plot is the residual sum of squares calculated for each span size.
SAVE VALUES IN STRUCTURE – saves calculated residuals to a table, restable, and calculates RSS values with changing span size and saves to a table, rsstable

The following sections extract information from the calculated trendlines and plots them against potentially informative parameters.
PLOT ALL RESIDUAL SUM OF SQUARES TRENDS – plots the RSS trends with increasing span size from every chamber together on the same plot.
Extract asymptote (avg RSS of span size over 20)
Plot asymptote over biomass
Calculate normalized residual sum of squares (RSS/maxRSS)
Plot normalized RSS with span size
Extract initial slope of normalized data (over first four span sizes, or up to span 7)
Plot normalized initial slope over biomass

File

Matlab Scripts

filename: MATLABscripts/FTC_1_viewdata.m

(MATLAB Programming Script (.m), 5.00 KB)
MD5:370f53b7784a317727f45450ee1929df

Script to view flow-through chamber data and relevant environmental parameters. Data is not imported through the code, since some format changes must be made and it is easier to do so through the Matlab file importer tool. It is advised that users run the script in sections demarcated within the script to check proper functioning of code and array format. Once the data files have been imported to the workspace, the sections, in order, perform the following:

FORMAT CHAMBER & AMBIENT DATA – separates chamber and ambient HOBO DO logger data files into separate Date&Time, Dissolved Oxygen, and Temperature variables

Plotting data from deployments

PLOT AMBIENT DO DATA FOR DEPLOYMENTS (CHANGE SUNRISE/SUNSET INDICES IF NEEDED) – creates a plot of the data for initial viewing and inspection for patterns. The sunrise/sunset indices must be directly input to create a shaded box on the plot denoting nighttime hours.

PLOT SELECT CHAMBER DO DATA OVER AMBIENT DO DATA AND REFORMAT DandT – this is useful for looking more closely to see if the DO data for a given chamber more or less follows the ambient DO. If the chamber DO after flushing does not match the ambient DO, there is likely an issue with the chamber not flushing sufficiently.

PLOT AMBIENT TEMP DATA (IF NEEDED) – run this directly after the previous section to plot temperature measured by the ambient HOBO DO logger on the right axis of the same plot.

PLOT CHAMBER TEMP DATA (IF NEEDED) – same as above but for the chamber HOBO DO logger

PLOT FTC_LOG DATA AS VERTICAL LINES – adds vertical lines denoting each time the chamber system flushed the overlying water in the chamber. Helpful for checking for sawtooth pattern more easily.

ADD LEGEND – adds a legend for all of the added elements

Matlab Scripts

filename: MATLABscripts/FTC_3_data_filtration.m

(MATLAB Programming Script (.m), 11.36 KB)
MD5:12798715bdab701a03efb6def792ed55

This script takes the output from the previous script (FTC_2_data_processing) and filters out SOD data according to certain thresholds - lower limit of oxygen depletion as percent dissolved oxygen, lower useable time limit, a positive slope, and r-squared value.

IMPORT AND FORMAT CHAMBER AND AMBIENT DATA – same function as previous scripts

Following sections must be run sequentially for each chamber, changing variable names each time through for each chamber.

PULL ALL CHAMBER DATA – change which chamber you are analyzing here, and pull data into variables

FILTER CHAMBER DATA BY THRESHOLDS – filters SOD incubations by the above stated criteria, saves indices of incubations that “succeed” on each of the criteria, and assembles into vector of indices for incubations that succeeded on all criteria.

SUBSET CHAMBER DATA THAT MEET THRESHOLD – finds corresponding incubation start times and SOD values for all incubations that met all filter criteria

PULL INDICES OF THRESHOLDED DATA FROM EACH OF THE CHAMBERS – shuttles extracted data into variables named for each chamber. Must change variable suffix for the corresponding chamber here to avoid overwriting.

ONCE THRESHOLDED VALUES HAVE BEEN FOUND,… - rewrites variables to placeholder variable for plotting

PLOT AMBIENT DO AND SOD OVER TIME (CAN ALSO PLOT CHAMBER DO IF NEEDED) – plots ambient DO and only those SOD values that met all filter criteria. Note sunset and sunrise indices may need changing.

EXTRACTS AND PLOTS SYMBOLS FOR EXCLUDED SOD VALUES – symbol types are differentiated by which filter criteria were failed for a given incubation.

FIND MEAN OF SOD AT EACH TIMEPOINT (AND STD DEV AND n) – averages and finds variance and sample size of SOD across chambers at each incubation timepoint. Because of filter criteria some timepoints may have few or no data to average.

EXTRACT INITIAL DO DATA – Finds and extracts the initial DO values for all the incubations that met the filter criteria. Must be done for each chamber. The resulting variable, InitialDO_used, will be used in the next script FTC_4_data_consolidation

File	
Matlab Scripts filename: MATLABscripts/FTC_4_data_consolidation.m	(MATLAB Programming Script (.m), 2.77 KB) MD5:d52ba5e566e832e216dbaf09aa0604c5
This script reorganizes and consolidates sediment oxygen demand (SOD) and Ambient data from a given deployment into separate tables named for the associated deployment. Must be run for each deployment separately. MAKE AMBIENT TABLE – makes a new table for ambient HOBO DO data with each row a DO measurement and the columns the date and time in matlab datetime format (DandT), the elapsed time from the start of the deployment (dayfrac), the raw DO measurement (DO), a DO value after smoothing with a moving average (DOsmoothed), and the temperature (Temp) MAKE SOD VALUES TABLE – compiles filtered SOD values from all chambers in a given deployment into a single table. Remember to change the deployment number in the table name when running for each deployment. MAKE MEAN, STDEV AND NUMBER OF VALUES TABLE – makes separate table with SOD average for each timepoint and variance and sample size data Once generated, transfer these tables (ambient, data and summary) into a separate workspace with all the consolidated data from all deployments and save the workspace. This workspace and these tables will be used in the next script, FTC_5_data_analysis.	

[table of contents | back to top]

Related Publications

Gadeken, K. J., Lockridge, G., & Dorgan, K. M. (2023). An in situ benthic chamber system for improved temporal and spatial resolution measurement of sediment oxygen demand. Limnology and Oceanography: Methods, 21(11), 645–655. Portico. https://doi.org/10.1002/lom3.10571
Results

[table of contents | back to top]

Related Datasets

IsDerivedFrom

Gadeken, K. (2025) **In situ dissolved oxygen of experimental chambers and ambient sensors acquired in the shallow subtidal shore-accessible site in Bon Secour Bay, Mobile Bay, Alabama, USA between August 7-12, 2021.** Biological and Chemical Oceanography Data Management Office (BCO-DMO). (Version 1) Version Date 2025-04-23 doi:10.26008/1912/bco-dmo.941205.1 [view at BCO-DMO]
Relationship Description: Raw dissolved oxygen data from ambient and chamber dissolved oxygen loggers

Gadeken, K. (2025) **In situ infauna abundance and biomass of experimental sediment chambers acquired in the shallow subtidal shore-accessible site in Bon Secour Bay, Mobile Bay, Alabama, USA between August 7-12, 2021.** Biological and Chemical Oceanography Data Management Office (BCO-DMO). (Version 1) Version Date 2025-04-23 doi:10.26008/1912/bco-dmo.941067.1 [view at BCO-DMO]
Relationship Description: Infauna abundance and biomass data per chamber and deployment.

[table of contents | back to top]

Parameters

Parameter	Description	Units
Latitude	Latitude of approximate sampling location, south is negative	decimal degrees
Longitude	Longitude of approximate sampling location, west is negative	decimal degrees
StartTime	StartTime of incubation in Central Standard Time (CST)	unitless
dayfrac	Proportion of a day after start of deployment at which that data point was collected. Start was 11AM for all three deployments.	unitless
Chamber	Number of chamber in the deployment, out of 5 replicate chambers	unitless
SOD	Sediment Oxygen Demand, the rate of oxygen flux across the sediment-water interface	millimoles per square meter per day (mmol m-2 d-1)
InitialDO	Dissolved oxygen concentration at the beginning of the incubation	milligrams per liter (mg L-1)
biomass	Biomass for the chamber area of 0.17 per square meters (not yet standardized to m-2)	grams (g)
deployment	Deployment number (1-3)	unitless
sample	Replicate sample out of all chambers in all deployments, numbered in ascending deployment and chamber order	unitless

[table of contents | back to top]

Instruments

Dataset-specific Instrument Name	
Generic Instrument Name	benthic incubation chamber
Dataset-specific Description	This project used a custom built field deployable benthic chamber system. Construction and functioning of the system are outlined in Gadeken et al 2023 L&O:Methods.
Generic Instrument Description	A device that isolates a portion of seabed plus overlying water from its surroundings. Either returns the entire system to the surface or incorporates sampling devices and/or in-situ sensors.

Dataset-specific Instrument Name	Onset HOBO DO loggers (U26-001)
Generic Instrument Name	Onset HOBO U26-001 Dissolved Oxygen Data Logger
Generic Instrument Description	A dissolved oxygen sensor, temperature sensor, and integrated data logger. The HOBO U26-001 can be used in freshwater and saltwater conditions, and outputs dissolved oxygen (mg/L) and temperature (degC) measurements.

[table of contents | back to top]

Project Information

CAREER: Mechanisms of bioturbation and ecosystem engineering by benthic infauna (Bioturbation and Ecosystem Engineering)

Coverage: Dauphin Island Sea Lab, Dauphin Island, AL

NSF Award Abstract:
Marine sediments are important habitats for abundant and diverse communities of organisms that are important as food sources for higher trophic levels, including commercially important species. Through burrowing, constructing tubes, and feeding on sediments, these animals modify their physical and chemical environments to such an extent that they are considered ecosystem engineers. Bioturbation, the mixing of sediments by animals, is important in regenerating nutrients and transporting pollutants and carbon bound to mineral grains. Despite its importance, our ability to predict bioturbation rates and patterns from the community structure is poor, largely due to a lack of understanding of the mechanisms by which animals mix sediments. This project builds on earlier work showing that animals extend burrows through muddy sediments by fracture to test the hypothesis that the mechanical properties of sediments that affect burrowing mechanics also affect sediment mixing. More broadly, this project examines the relative contributions of (i) the functional roles of the organisms in the community, (ii) the mechanical properties of sediments, and (iii) factors that might increase or decrease animal activity such as temperature and food availability to bioturbation rates. Burrowing animals modify the physical properties of sediments, and this project quantifies these changes and tests the hypothesis that these changes are ecologically important and affect community succession following a disturbance. In addition to this scientific broader impact, this project involves development of instrumentation to measure sediment properties and includes a substantial education plan to introduce graduate, undergraduate, and middle school students to the important role that technology plays in marine science.

Through burrowing and feeding activities, benthic infauna mix sediments and modify their physical environments. Bioturbation gates the burial of organic matter, enhances nutrient regeneration, and smears the paleontological and stratigraphic record. However, current understanding of the mechanisms by which infaunal activities mix sediments is insufficient to predict the impacts of changes in infaunal community structure on important sediment ecosystem functions driven by bioturbation. This project tests specific hypotheses relating infaunal communities, bioturbation, and geotechnical properties with the ultimate goal of understanding the dynamic changes and potential feedbacks between infauna and their physical environments. This project integrates field and lab experiments to assess the relative importance of infaunal community structure and activities to bioturbation rates. Additionally, this project builds on recent work showing that muddy sediments are elastic gels through which worms extend burrows by fracture to propose that geotechnical properties of sediments mediate bioturbation by governing the release of particles from the sediment matrix during burrow extension. Finite element modeling determines how the release of particles by fracture during burrowing depends on the fracture toughness (cohesion) and stiffness (compaction) of sediments and complements laboratory experiments characterizing the impact of geotechnical properties on burrowing behaviors. The proposed research also aims to determine whether impacts of infauna on geotechnical properties are ecologically important. Changes in infaunal communities and geotechnical properties following an experimental physical disturbance address the hypothesis that ecosystem engineering of bulk sediment properties facilitates succession.

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.

[table of contents | back to top]

Funding

Funding Source	Award
NSF Division of Ocean Sciences (NSF OCE)	OCE-1844910

[table of contents | back to top]