Seawater properties at two locations in a northeast Florida estuary measured using HydroCAT CTD between July 2019 and April 2020 as part of an oyster reciprocal transplant experiment

Website: https://www.bco-dmo.org/dataset/885452
Data Type: Other Field Results
Version: 1
Version Date: 2022-12-16

Project
» Collaborative research: Quantifying the influence of nonconsumptive predator effects on prey population dynamics (Predatory NCEs and Scale)

Contributors	Affiliation	Role
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Abstract
The eastern oyster (Crassostrea virginica) is a foundation species in northeast Florida estuaries, including the Guana Tolomato Matanzas National Estuarine Research Reserve (GTMNERR), where intertidal reefs are extensive. Estuarine research to assess sustainability of oyster populations, plus various monitoring studies and oyster reef restoration projects have been undertaken, with an additional focus on testing theory regarding the effects of predation risk and local adaptation in the natural environment. To help quantify how environmental conditions (salinity, temperature, dissolved oxygen) varied over space and time between two sites in the GTM NERR, and therefore to provide physical context for the biological results of the project, a HydroCAT CTD was deployed approximately 3 meters seaward of the oyster reef at low tide for the duration of the experiment (July 2019 - April 2020). The instrument was deployed just seaward of the reef because the intertidal reefs were typically fully exposed at low tide.

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Coverage

Spatial Extent: **N**:29.77002 **E**:-81.2144 **S**:29.62923 **W**:-81.2641
Temporal Extent: 2019-07-23 - 2020-04-02

Methods & Sampling

A reciprocal transplant experiment was conducted at two sites in an estuary in NE Florida, USA that encompassed different environmental (salinity, aerial exposure) and biotic (predators) stressors. Juvenile oysters were reciprocally transplanted within and between the two locations within the Guana Tolomato

Matanzas National Estuarine Research Reserve (GTMNERR)--the Butler site at 29.77002 N, -81.2641 W, and the Pellicer site at 29.62923 N, -81.2144 W.

To obtain site-specific information on seawater properties, a SeaBird HydroCAT-EP CTD instrument was deployed just seaward of the reefs. Measurements include temperature, conductivity, pressure, salinity, and oxygen. The HydroCAT ODO by Seabird was put in the water in front of the oyster reefs for the duration of the experiment, Butler (7/23/2019 8:00 to 4/2/2020 14:45) and Pellicer (8/19/2019 10:30 to 4/2/2020 14:45). The instrument was deployed in a PVC housing with the CTD in a 2 inch PVC pipe with drilled 1/2 inch holes to allow water flow. The frame of the housing was made up of 1 inch PVC pipe with the 2 inch PVC pipe resting on the edge of the housing at a 45 degree angle so the end with the sensors was lower in the water than the top of the instrument. The housing and sensor were deployed seaward at approximately three meters from the middle of the oyster reef.

In order to secure the CTD, the housing frame was pressed into sediment with the CTD being above the sediment. At each end of the housing frame, we also attached two pieces of rope and used rebar stakes to secure the rope into the ground. Samples were taken every 15 minutes but if the CTD was out of the water the observations were discarded; for Butler this was determined as salinity less than 25 and pressure less than 1 dbar, for Pellicer it was salinity less than 15 psu and pressure less than 0.008 dbar. Throughout the experiment, the CTDs were removed from the water to download data and cleaned prior to re-deployment.

Problem report:
No conductivity on 9/20/2019 through 4/2/2020 at Butler. Similarly, no conductivity beginning 11/15/2019 through 4/2/2020 at Pellicer, but specific conductivity was still measured at both sites at those times.

Data Processing Description

The data were uploaded using the UCI version 2.0.3 software by Seabird and saved as a .csv file. All data processing took place in RStudio under R version 4.2.1. using packages lubridate (v1.8.0; Grolemund & Wickham, 2011), tidyverse (v1.3.2; Wickham et al., 2019), oce (Kelley, 2018; Kelley & Richards, 2022). The script "Hydrocat_RT.R" processes the data to take out values when the CTD was out of the water and to label the sites. The salinity was not recorded during a few deployments, so the oce package was used to calculate the salinity.

The HydroCAT-EP CTD files for each site were compiled and run through the R code "Hydrocat_RT.R" (see Supplemental Files section)

Butler site HydroCAT raw data files:

- HydroCAT-ODO-SDI12-03730256-Data-20200121T142941.csv, (time period: 2019-12-01 to 2020-01-08)
- HydroCAT-ODO-SDI12-03730256-Data-20200417T232531.csv, (time period: 2020-01-21 to 2020-03-04)
- HydroCAT-ODO-SDI12-03730258-Data-20190830T005058.csv, (time period: 2019-07-23 to 2019-08-29)
- HydroCAT-ODO-SDI12-03730258-Data-20191112T233136.csv, (time period: 2019-09-20 to 2019-11-12)
- HydroCAT-ODO-SDI12-03730258-Data-20200402T210143.csv, (time period: 2020-03-06 to 2020-04-02)

Pellicer site HydroCAT raw data files:

- HydroCAT-ODO-SDI12-03730256-Data-20191120T131243.csv, (time period: 2019-11-15 to 2019-11-20)
- HydroCAT-ODO-SDI12-03730256-Data-20191130T232934.csv, (time period: 2019-11-20 to 2019-11-30)
- HydroCAT-ODO-SDI12-03730257-Data-20190830T004554.csv, (time period: 2019-08-19 to 2019-08-29)
- HydroCAT-ODO-SDI12-03730257-Data-20191112T233512.csv, (time period: 2019-09-19 to 2019-11-12)
- HydroCAT-ODO-SDI12-03730257-Data-20200402T210448.csv, (time period: 2020-02-19 to 2020-04-20)

BCO-DMO Processing description:
- Converted dates to format (YYYY-MM-DD)
- Adjusted field/parameter names to comply with BCO-DMO naming conventions
- Added columns for "Latitude" and "Longitude" based on geospatial bounds
- Added a conventional header with dataset name, PI names, version date
- Rounded Salinity values to 2 decimal places

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Supplemental Files

File
HydroCAT CTD raw data for Butler site filename: Butler_HydroCAT_CTD_raw.zip (ZIP Archive (ZIP), 383.99 KB) MD5:de82fb225ef81e5b72483b3cd0739d76 Compressed folder of HydroCAT CTD raw data files for the Butler site. The files are inputs to the Hydrocat_RT.R processing script and are listed here with time periods of coverage: HydroCAT-ODO-SDI12-03730256-Data-20200121T142941.csv, (time period: 2019-12-01 to 2020-01-08) HydroCAT-ODO-SDI12-03730256-Data-20200417T232531.csv, (time period: 2020-01-21 to 2020-03-04) HydroCAT-ODO-SDI12-03730258-Data-20190830T005058.csv, (time period: 2019-07-23 to 2019-08-29) HydroCAT-ODO-SDI12-03730258-Data-20191112T233136.csv, (time period: 2019-09-20 to 2019-11-12) HydroCAT-ODO-SDI12-03730258-Data-20200402T210143.csv, (time period: 2020-03-06 to 2020-04-02) The headings are FrameSync, DateTime (UTC-4:00), Temperature (Celsius), Pressure (Decibar), Oxygen (mg/L), SpecConductivity (uS/cm), Date, Time (UTC-4:00)
HydroCAT CTD raw data for Pellicer site filename: Pellicer_HydroCAT_CTD_raw.zip (ZIP Archive (ZIP), 262.31 KB) MD5:01c9aa240b0dc2bd55df3bca706c0fe6 Compressed folder of HydroCAT CTD raw data files for the Butler site. The files are inputs to the Hydrocat_RT.R processing script and are listed here with time periods of coverage: HydroCAT-ODO-SDI12-03730256-Data-20191120T131243.csv, (time period: 2019-11-15 to 2019-11-20) HydroCAT-ODO-SDI12-03730256-Data-20191130T232934.csv, (time period: 2019-11-20 to 2019-11-30) HydroCAT-ODO-SDI12-03730257-Data-20190830T004554.csv, (time period: 2019-08-19 to 2019-08-29) HydroCAT-ODO-SDI12-03730257-Data-20191112T233512.csv, (time period: 2019-09-19 to 2019-11-12) HydroCAT-ODO-SDI12-03730257-Data-20200402T210448.csv, (time period: 2020-02-19 to 2020-04-20) The headings are FrameSync, DateTime (UTC-4:00), Temperature (Celsius), Pressure (Decibar), Oxygen (mg/L), SpecConductivity (uS/cm), Date, Time (UTC-4:00)
HydroCAT processing R script filename: Hydrocat_RT.R (Octet Stream, 5.11 KB) MD5:a94b77f3f36c20a1ec751afed9c15c28 This R script stitches together data from the Seabird HydroCat and then removes values for times when the logger was out of the water. Written by Adrienne Breef-Pilz (27-Oct-2022) and used for David Kimbro's reciprocal transplant experiment.

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Related Publications

Grolemund, G., & Wickham, H. (2011). Dates and Times Made Easy with lubridate. Journal of Statistical Software, 40(3). https://doi.org/10.18637/jss.v040.i03
Software

Kelley, D. & Richards, C. (2022). oce: Analysis of Oceanographic Data. R package version 1.7-10, https://dankelley.github.io/oce/
Software

Kelley, D. E. (2018). Oceanographic Analysis with R. https://doi.org/10.1007/978-1-4939-8844-0
Software

Kimbro, D. L., White, J. W., Breef-Pilz, A., Peckham, N., Noble, A., & Chaney, C. (2022). Evidence for local adaptation of oysters to a within-estuary gradient in predation pressure weakens with ontogeny. Journal of Experimental Marine Biology and Ecology, 555, 151784. https://doi.org/10.1016/j.jembe.2022.151784

Results

R Core Team (2022). R: A language and environment for statistical computing. R v4.2.1 (June 2022). R Foundation for Statistical Computing, Vienna, Austria. URL https://www.R-project.org/
Software

Rinker, T.W. & Kurkiewicz, D. (2018). pacman: Package Management for R. v0.5.0, http://github.com/trinker/pacman
Software

Wilson, D., Koch, C., Dutton, A., Bennett, S. (2017, May 25) Long-Term Water Quality Monitoring Deployments with the Sea-Bird HydroCAT-EP. https://www.seabird.com/technical-papers/hydroCAT-EP-case-study
Methods

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Related Datasets

IsRelatedTo

Kimbro, D. L., White, J. (2022) **(DRAFT) Tidal inundation results from oyster reciprocal transplant experiment.** Biological and Chemical Oceanography Data Management Office (BCO-DMO). (Version 1) Version Date 2022-10-16 http://lod.bco-dmo.org/id/dataset/882626 [view at BCO-DMO]

Kimbro, D. L., White, J. (2022) **(DRAFT) Water salinity and temperature data from oyster reciprocal transplant experiment.** Biological and Chemical Oceanography Data Management Office (BCO-DMO). (Version 1) Version Date 2022-10-16 http://lod.bco-dmo.org/id/dataset/882657 [view at BCO-DMO]

Kimbro, D. L., White, J. (2022) **Individual oyster results from an oyster reciprocal transplant experiment conducted at two sites in an estuary in NE Florida between August 2019 and May 2020.** Biological and Chemical Oceanography Data Management Office (BCO-DMO). (Version 1) Version Date 2022-10-14 http://lod.bco-dmo.org/id/dataset/880691 [view at BCO-DMO]

Kimbro, D. L., White, J. (2022) **Predator size and abundance data from oyster reefs in a northeast Florida estuary collected between April and August 2019 as part of an oyster reciprocal transplant experiment.** Biological and Chemical Oceanography Data Management Office (BCO-DMO). (Version 1) Version Date 2022-12-13 http://lod.bco-dmo.org/id/dataset/882641 [view at BCO-DMO]

Kimbro, D. L., White, J. (2022) **Survival and growth data from an oyster reciprocal transplant experiment conducted at two sites in an estuary in northeast Florida between August 2019 and May 2020.** Biological and Chemical Oceanography Data Management Office (BCO-DMO). (Version 1) Version Date 2022-10-16 http://lod.bco-dmo.org/id/dataset/882606 [view at BCO-DMO]

Kimbro, D. L., White, J. (2022) **Water flow data from oyster reciprocal transplant experiment conducted at two sites in an estuary in NE Florida between July 2019 and April 2020.** Biological and Chemical Oceanography Data Management Office (BCO-DMO). (Version 1) Version Date 2022-10-16 http://lod.bco-dmo.org/id/dataset/882674 [view at BCO-DMO]

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Parameters

Parameter	Description	Units
Latitude	Latitude of CTD deployment	decimal degrees
Longitude	Longitude of CTD deployment	decimal degrees
Site	Reef site (either Butler or Pellicer)	unitless
DateTime	DateTime of CTD measurement	unitless
Temp	Temperature	degrees Celsius
Cond	Conductivity	microSiemens per centimeter (uS/cm)
Pressure	Pressure	decibar
Oxygen	Dissolved oxygen from optical sensor	milligrams per liter (mg/L)
Salinity	Salinity	practical salinity units (PSU)
SpCond	Specific conductivity	microSiemens per centimeter (uS/cm)

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Instruments

Dataset-specific Instrument Name	SeaBird HydroCAT-EP CTD
Generic Instrument Name	CTD - fixed
Generic Instrument Description	A reusable instrument that always simultaneously measures conductivity and temperature (for salinity) and pressure (for depth). This term applies to CTDs that are fixed and do not measure by profiling through the water column. For profiling CTDs, see https://www.bco-dmo.org/instrument/417.

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Project Information

Collaborative research: Quantifying the influence of nonconsumptive predator effects on prey population dynamics (Predatory NCEs and Scale)

Coverage: Sub-tropical estuarine waters (29.67,-81.21)

NSF Award Abstract:
Predators can affect populations of their prey in two ways: by consuming them ("consumptive effects" or "CE"s), or by causing the prey to change behavior to avoid contact with the predator. For example, prey often spend less time feeding and more time watching out for predators, which comes with the cost of lower food intake and thus slower growth. Such "non-consumptive effects" (NCEs) have been described for a wide range of terrestrial and marine prey species, from elk to clams, but mostly in short-term (< 1 month) experiments. These prior results suggest that in some cases, the behavioral changes (NCEs) have a bigger effect on prey populations than consumption by predators (CEs). However, those short-term, controlled experiments may artificially inflate the perceived importance of NCEs. Over longer time periods, prey may adapt or become acclimated to predation risk, and NCEs may become less important. Additionally, environmental variability (e.g., differences in the availability of the prey's food between study sites) may have a bigger effect on prey populations than NCEs do. This project will use a combination of short- (months) and long-term (years) field experiments and mathematical models to evaluate the role of NCEs on Florida oyster reefs. The prey species in

this study is the eastern oyster, an important marine resource in the southeast US for harvesting and habitat creation; the main oyster predator is a mud crab. In this study, results from mathematical models of oyster populations will be compared to experimental data from the field to see whether including NCEs in the model leads to better model predictions. Better understanding of NCEs in oysters should improve management of that important marine resource. Furthermore, the mathematical model will be used to develop broader, generalizable conclusions about the importance of NCEs that could be applied to other important prey species. This project will provide data useful for oyster resource management, will support public education regarding the ecological importance of NCEs, and will enhance the scientific engagement of underrepresented groups in the study region. The project will support a partnership with the Guana Tolomato Matanzas National Estuarine Research Reserve in Florida, including data sharing, sponsoring an oyster management symposium, and funding the development of multimedia scientific outreach materials at the reserve that will be used by a large and diverse population of K-12 students in the surrounding community. The project will train a postdoctoral researcher, two graduate students, two undergraduate students, and research results will be disseminated by those students and the principal investigators at scientific conferences, in journal publications, and in online content through an ongoing partnership with a Florida public television station.

Predators can alter prey population dynamics by causing fear-based shifts in prey traits (nonconsumptive effect, NCE). The importance of NCEs for prey populations - relative to direct consumption by predators (consumptive effects, CEs) - remains uncertain, particularly because short-term studies of NCEs cannot estimate their effect over multiple prey generations. This project addresses that knowledge gap by combining short- and long-term field experiments with population models to investigate the importance of NCEs on oyster population dynamics in a Florida estuary. The central question is whether accounting for NCEs improves the ability to predict long-term trends in oyster population abundance. Several types of NCEs are present in this system: exposure to water-containing predator odors reduces oyster larval recruitment and causes juvenile oysters to increase shell thickness, reducing their somatic growth. In addition to CEs and NCEs, environmental gradients in stress, food, and propagule delivery are also present in this system. Those environmental factors can have strong effects on post-settlement survivorship, growth, and recruitment of oysters, so the relative importance of predator CEs and NCEs may vary along those spatial gradients as well. This project will consist of four components. (1) A series of short-term field experiments to test how NCEs vary with predator density and environmental variables, and whether one of the NCEs (increased shell thickness) actually reduces vulnerability to predators. (2) A population model, parameterized using experimental results; model simulations will quantify how the relative importance of NCEs should vary over time, space, and environmental gradients. (3) A longer-term (3.5 year) field experiment; the results from this experiment will be compared to model predictions to test whether accounting for NCEs improves predictions of long-term variation in oyster population dynamics. (4) A general form of the model will be developed to broadly investigate the effect of NCEs on non-equilibrium, transient population dynamics. By combining models and field experiments, this project will bridge the gap between the theoretical understanding of how NCEs affect population dynamics and empirical tests of that theory, advancing the field towards the goal of predicting how multiple interacting factors structure communities.

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Funding

Funding Source	Award
NSF Division of Ocean Sciences (NSF OCE)	OCE-1736943
NSF Division of Ocean Sciences (NSF OCE)	OCE-1820540

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