Continuously monitored water quality measurements from five salt marsh ponds in New Jersey, USA from Apr 2023 to Jun 2024

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Project
» Sediment transport and water quality in watersheds and coastlines of the United States (SMIIL Water Quality)

Contributors	Affiliation	Role
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Abstract
This dataset consists of 10-minute resolution measurements of temperature, salinity, depth, dissolved oxygen concentration, and pH collected from five salt ponds in a tidal salt marsh within the Seven Mile Island Innovation Laboratory (SMIIL), located landward of Seven Mile Island in Cape May County, New Jersey. The ponds were selected based on aerial imagery from the New Jersey Office of Geographic Information Systems (NJOGIS) and in situ physical inspection to identify ponds spanning a range of sizes (150-19,000 m2), ages (40-100+ years), and instrumentable depths (0.5-1.5 m). Data from each salt pond was collected using four Onset Computer Corp. HOBO data loggers that measured pressure, temperature, conductivity/salinity, dissolved oxygen, and pH. Each of the four sensors measured temperature, with the finalized temperature data reflecting the median of the four sensors in each pond. An additional HOBO pressure sensor was deployed in a central location recording air temperature and barometric pressure. Sensors were cleaned, calibrated, and redeployed every 4-16 weeks, and discrete dissolved oxygen and carbonate chemistry samples were collected for sensor validation at the beginning and end of each deployment (see discrete sample dataset, also in this project). This dataset presents quality controlled data from each of the five ponds across five deployments, covering a period from April 2023 to June 2024.

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Coverage

Location: Salt marsh ponds of Seven Mile Island Innovation Laboratory, Cape May County, New Jersey (39.072 N, 74.778 W)
Spatial Extent: **N**:39.089925 **E**:-74.749486 **S**:39.058951 **W**:-74.79892
Temporal Extent: 2023-04-19 - 2024-06-03

Methods & Sampling

Continuous water-quality monitoring was conducted in five salt marsh ponds (mean water depths < 1m) located within SMIIL from April 2023–June 2024. Water quality sensors were mounted approximately 6 inches above the bottom of the pond to a fixed pole. Each pond was equipped with internally logging HOBO sensors (Onset Computer Corp.) that measured pressure, conductivity/salinity, dissolved oxygen (DO), and pH. Temperature was also recorded by each of the sensors, and temperature data provided here reflects the median of the four sensors in each pond. An additional HOBO pressure sensor, deployed at a central location within SMIIL, recorded air temperature and barometric pressure. During maintenance trips every 4-16 weeks, sensors were retrieved, cleaned, recalibrated (DO and pH only) and redeployed in their pond for a total of five deployments. Data files from each sensor were downloaded during each maintenance visit. Discrete surface-water samples for DO, dissolved inorganic carbon (DIC), and total alkalinity (TA) measurements were also collected during maintenance visits and used to validate DO and pH time series data (see discrete sample dataset, also in this project).

Data Processing Description

All deployments were merged into a continuous time series and retimed to 10-minute bins to resolve offsets and irregular sampling times. Quality control procedures were based on protocols adapted from the U.S. Integrated Ocean Observing System (IOOS) Quality Assurance/Quality Control of Real-Time Oceanographic Data (QARTOD) recommendations (IOOS, 2018; Palevsky et al., 2023; Chua et al. related dataset in this project). All data was processed through a combination of manual and automated quality checks.

As the first quality control check, the depth time series for each pond was manually inspected with "human-in-the-loop" (HITL) annotations to identify and document bad data. The initial depth time series was calculated using two HOBO water level loggers: one measuring the pressure in each pond, and the other measuring the barometric pressure in the area. The difference between the two sensors was used to calculate sensor depth in the HOBOware software package. Points flagged for review were compared to service trip logs in order to diagnose the reason for bad data (e.g., periods where sensors were not fully submerged in seawater). Known bad flagged points from these observations were removed from the analysis for all parameters.

Next, data for all parameters was subject to automated tests (Table 1), including 1) a gross range test to check if data for a specific parameter were within reasonable ranges relative to each sensor's output ability and plausible ranges for the parameter in question, 2) a spike test to evaluate if the absolute value of a measurement exceeded a threshold relative to the points around it, and 3) a stuck value test to ensure the logger was recording real fluctuations in its specified measurement. Thresholds per parameter were kept consistent across all ponds. For time points where any individual parameter was flagged by one of these quality control tests, data from that time point were removed from the analysis for all parameters. Automated tests for dissolved oxygen were performed on intermediate data in units of µmol/L rather than the final reported units of µmol/kg.

Parameter	Gross Range Test Limits (lower, upper)	Spike Test Threshold	Stuck Value Threshold
Depth (m)	(0, 2)	0.1	0.01, four subsequent points
Temperature (˚C)	(-2, 40)	1	
DO conc (µmol/L)	(0, 900)	50	
Salinity (psu)	(10, 50)	10	
pH	(6, 9)	0.25	

Table 1. *Thresholds for the initial automated quality control tests for collected data. Data points exceeding these thresholds were flagged and removed prior to subsequent processing.*

Because all four HOBO data loggers measured temperature, each logger's temperature was evaluated independently in the quality control process. The finalized temperature time series presented here represents the median of the four individual sensors' temperature measurements per time point.

Salinity in Practical Salinity Units (PSU) was calculated from conductivity and temperature using the Gibbs Seawater Toolbox (GSW, McDougall and Barker 2011). Onset HOBO Conductivity data loggers are not capable of internal calibration, so data were compared with nearby channel station salinity, water level, and temperature data (Gull Platform, ~1 km away, see Chua et al. OWP related dataset) for salinity calibration and validation. At high tides, when channel and pond water levels were at their highest, temperature data from all five ponds were similar to that in the channel, consistent with the expectation that channel water entered the ponds during high tides. However, the preliminary salinity data from the HOBO loggers in the ponds were offset from the channel salinity data during this period, indicating calibration offsets in the HOBO Conductivity measurements. In order to correct for these calibration offsets, we identified high tide periods when channel water entered the ponds based on water depth and temperature data and determined calibration offsets for the pond salinity measurements by correcting the pond salinity to match that of the channel during these high tide periods. Salinity data reported here for the Ring, Shark, and Long Reach ponds were corrected using this approach. For the final two ponds (White and Drum), the HOBO Conductivity sensors deployed at these sites malfunctioned and did not report any usable data. Salinity data reported for White and Drum ponds are the median calibrated salinity values from the three ponds that did not experience sensor malfunctions.

HOBO DO loggers were calibrated every service trip before deployment using two points: a 100% saturation open air point and a 0% point using sodium sulfite (Na_2SO_3) dissolved in deionized water. HOBO pH loggers were calibrated every service trip before deployment using three-point calibration standards: pH 4.0, pH 7.0, and pH 10.0. Calibration accuracy for both DO and pH was validated based on discrete samples collected at the beginning and end of each deployment (see related dataset). For comparison, pH, DIC, and TA data were converted to hydrogen ion space ([H+]) using the CO2SYSv3 MATLAB package (Lewis & Wallace, 1998; Sharp, 2023; Van Heuven et al., 2011). While discrete sample data was useful for validation of the pH sensors, because of uncertainty in the discrete measurements, no further action was taken in calibration.

Preliminary DO concentration in micromoles per liter provided by the HOBO logger was recalculated using the calibrated salinity (described above), temperature, and depth variables input into the Aanderaa Data Instruments AS (2017) compensation equations. We calculated the density (rho) of the seawater using the calibrated salinity, temperature and depth variables in the GSW to convert the DO time series into micromoles per kilogram. DO percent saturation was calculated by normalizing the recalculated DO concentration to the equilibrium saturation DO concentration ($DO_{sat} = DO_{measured} / DO_{eq\ sat} \times 100$), where DO_{sat} was calculated using the final quality-controlled temperature and salinity (Garcia & Gordon, 1992).

BCO-DMO Processing Description

- Imported "Drum_finaldataset.xlsx", "LongReach_finaldataset.xlsx", "RingEast_finaldataset.xlsx", "Shark_finaldataset.xlsx", "White_finaldataset.xlsx" into the BCO-DMO system
- Concatenated all files
- Converted date time to ISO 8601 format
- Used the files names to create a "site" parameter with the study sites listed
- Rounded values as requested by submitter -- Depth: 4 decimal places, Salinity: 3 decimal places, DOconc: 4 decimal places, DOsat: 4 decimal places, and pH: 4 decimal places
- Exported file as "988873_v1_salt_pond_monitoring.csv"

Problem Description

Data points that were missing or flagged in the quality control tests were removed in the reported datasets. Conductivity sensor malfunctions found after monitoring in White and Drum Ponds resulted in no usable conductivity measurements from those ponds. Instead, the reported salinity values are the median values per timestamp from the three other ponds (see Data Processing section).

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Related Publications

Aanderaa Data Instruments AS. (2017, June). TD 269 OPERATING MANUAL: OXYGEN OPTODE 4330, 4835, 4831. https://www.aanderaa.com/media/pdfs/oxygen-optode-4330-4835-and-4831.pdf
Methods

Garcia, H. E., & Gordon, L. I. (1992). Oxygen solubility in seawater: Better fitting equations. Limnology and Oceanography, 37(6), 1307–1312. doi:10.4319/lo.1992.37.6.1307
General

Integrated Ocean Observing System (U.S.). (2018). Manual for real-time quality control of dissolved oxygen observations : a guide to quality control and quality assurance for dissolved oxygen observations in coastal oceans. *NOS (National Ocean Service)*. https://doi.org/10.25923/Q0M1-D488
Methods

Lewis, E., Wallace, D., & Allison, L. J. (1998). Program developed for CO2 system calculations (No. ORNL/CDIAC-105). Brookhaven National Lab., Dept. of Applied Science, Upton, NY (United States); Oak Ridge National Lab., Carbon Dioxide Information Analysis Center, TN (United States). doi: 10.2172/639712
Methods

Palevsky, H. I., Clayton, S., Benway, H., Maheigan, M., Atamanchuk, D., Battisti, R., Batryn, J., Bourbonnais, A., Briggs, E. M., Carvalho, F., Chase, A. P., Eveleth, R., Fatland, R., Fogaren, K. E., Fram, J. P., Hartman, S. E., Le Bras, I., Manning, C. C. M., Needoba, J. A., … Yoder, M. (2024). A model for community-driven development of best practices: the Ocean Observatories Initiative Biogeochemical Sensor Data Best Practices and User Guide. Frontiers in Marine Science, 11. https://doi.org/10.3389/fmars.2024.1358591
Methods

Sharp, J. D., Pierrot, D., Humphreys, M. P., Epitalon, J.-M., Orr, J. C., Lewis, E. R., & Wallace, D. W. R. (2023). *CO2SYSv3 for MATLAB* (Version v3.2.1) [Computer software]. Zenodo. https://doi.org/10.5281/ZENODO.7552554
Software

Supino, J., Fogaren, K.E., Chua, E.J., and Palevsky, H.I. (2025). Tidal salt pond net ecosystem metabolism over a full annual cycle from high resolution continuous measurements in an anthropogenically impacted salt marsh. Manuscript in preparation.
Results

Van Heuven, S., Pierrot, D., Rae, J. W. B., Lewis, E., & Wallace, D. W. R. (2011). MATLAB Program Developed for CO2 System Calculations. ORNL/CDIAC-105b. Carbon Dioxide Information Analysis Center (CDIAC). https://doi.org/10.3334/CDIAC/OTG.CO2SYS_MATLAB_V1.1
https://doi.org/10.3334/CDIAC/otg.CO2SYS_MATLAB_v1.1
Software

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Related Datasets

IsRelatedTo

Supino, J., Fogaren, K. E., Chua, E. J., Palevsky, H. I. (2025) **Discrete sample measurements of dissolved oxygen, dissolved inorganic carbon, and total alkalinity from the Seven Mile Island Innovation Laboratory (SMIIL) from Aug 2022 to Jun 2024.** Biological and Chemical Oceanography Data Management Office (BCO-DMO). (Version 1) Version Date 2025-08-18 doi:10.26008/1912/bco-dmo.971872.1 [view at BCO-DMO]
Relationship Description: Dissolved oxygen and carbonate chemistry discrete samples were collected for sensor validation at the beginning and end of each deployment of continuous sensing instrumentation.

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Parameters

Parameter	Description	Units
datetime_utc	Sampling date and time in UTC	unitless
site	Site of sampling (Drum, Long Reach, Ring East, Shark, or White)	unitless
lat	Sampling location latitude, North is positive	decimal degrees
lon	Sampling location longitude, West is negative	decimal degrees
depth	Sampling depth	meters
salinity	Salinity in Practical Salinity Units (PSU)	Practical Salinity Units (PSU)
temperature	Temperature	degrees Celsius
DOconc	Dissolved oxygen concentration	µmol/kg
O2sol	Equilibrium dissolved oxygen concentration, as calculated using the final quality-controlled temperature and salinity (Garcia & Gordon, 1992)	µmol/kg
DOsat	Dissolved oxygen percent saturation, calculated from the cleaned DO concentration, salinity, and temperature data	percent
pH	pH (total scale)	unitless

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Instruments

Dataset-specific Instrument Name	Onset HOBO pH and Temperature Data Logger (MX2501)
Generic Instrument Name	Onset HOBO pH and Temperature data logger MX2501
Dataset-specific Description	HOBO pH and Temperature Data Loggers measured the pH in the pond seawater.
Generic Instrument Description	The HOBO MX2501 pH and Temperature Data Logger is designed for long-term monitoring of pH in estuaries, lakes, streams, rivers, and oceans. Leveraging Bluetooth Low Energy® (BLE) technology, the MX2501 pH Logger communicates wirelessly with the free HOBOconnect app and your mobile device or Windows computer, making logger setup, calibration, and data offload quick and easy. A guided pH calibration process on the HOBOconnect app makes an otherwise complicated process easier to follow. This affordable and compact logger dramatically cuts the time and effort needed to collect field data, while also offering higher resolution data. (NOTE: pH electrodes should always be stored in storage solution when not deployed).

Dataset-specific Instrument Name	Onset HOBO Salt Water Conductivity/Salinity Data Logger (U24-002-C)
Generic Instrument Name	Onset HOBO Saltwater Conductivity/Salinity data logger U24-002-C
Dataset-specific Description	HOBO Salt Water Conductivity/Salinity Data Loggers measured the electrical conductivity of the seawater in the pond.
Generic Instrument Description	HOBO Salt Water Conductivity/Salinity Data Logger is a cost-effective data logger for measuring cost-effective data logger for measuring salinity, conductivity, and temperature in saltwater environments with relatively small changes in salinity (±5,000 µS/cm) such as saltwater bays, or to detect salinity events such as upwelling, rainstorm, and discharge events.

Dataset-specific Instrument Name	Onset HOBO Water Level Data Logger (U20-L-01)
Generic Instrument Name	Onset HOBO U20L water level logger series
Dataset-specific Description	HOBO Water Level Data Loggers measure pressure. Water level (depth) was calculated by comparing the sensor pressure to an additional pressure sensor not submerged in water.
Generic Instrument Description	The HOBO U20L is designed for monitoring changing water levels in a variety of applications including tidal areas, streams, lakes, wetlands, and groundwater. It outputs pressure, water level, and temperature data. The instrument can record samples, sensor measurements at each logging interval, and events data, occurrences such as a bad battery or host connected. The samples are recorded as absolute pressure values, which are later converted to water level readings using software. Absolute pressure is atmospheric pressure plus water head. The deployment of an additional HOBO U20L at the surface can be used to compensate for barometric pressure changes. Each instrument is individually calibrated. They require a coupler and optic base station or HOBO waterproof shuttle to connect to a computer. The instrument is operated with a 3.6 V lithium battery. This series contains 3 models, U20L-01, U20L-02, and U20L-04, with different operation ranges, calibrated ranges, and burst pressures. The pressure sensor is temperature compensated between 0 and 40 degrees Celsius (C), and calibrated between 69 and a maximum of 400 kPa (depending on the model). Its accuracy is within 0.3 % of the full scale for absolute pressure, and 0.1 % FS for water level readings. The temperature sensor operates between -20 and 50 degrees C, with an accuracy of 0.44 deg C, and a resolution of 0.1 deg C. The drift is 0.1 deg C per year.

Dataset-specific Instrument Name	Onset HOBO Dissolved Oxygen Data Logger (U26-001)
Generic Instrument Name	Onset HOBO U26-001 Dissolved Oxygen Data Logger
Dataset-specific Description	HOBO Dissolved Oxygen Data Loggers measured the concentration of oxygen in the pond seawater.
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.

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Project Information

Sediment transport and water quality in watersheds and coastlines of the United States (SMIIL Water Quality)

Coverage: Coastal New Jersey (Seven Mile Island Innovation Lab)

Salt marshes are highly productive, dynamic coastal environments that experience large fluctuations in biogeochemical parameters such as dissolved oxygen and pH in response to both natural forcings and anthropogenic impacts. At present, we have a limited understanding of the magnitude of biogeochemical variability in coastal habitats, hindering our ability to predict how they will respond in the future to episodic events and long-term change. This incomplete picture owes to a lack of sustained water quality measurements in coastal and estuarine systems worldwide.

This project investigates biogeochemical cycling in the Seven Mile Island Innovation Laboratory (SMIIL), a network of tidal marshes and channels in coastal New Jersey that is a site of historic and contemporary dredging and a testbed for marsh restoration techniques such as beneficial use of dredged sediment. It leverages multiple data sets of continuous, high-frequency (10-minute) measurements of physical and biogeochemical parameters, including water depth, temperature, salinity, dissolved oxygen, pH, chlorophyll a, and turbidity, as well as precipitation, wind speed, wind direction, temperature, relative humidity, and atmospheric pressure data. Two long-term biogeochemical sensor data sets, comprising a three-year time series at three sites in the main marsh channel (from June 2021–June 2024) and 1-2 year time series at six distinct salt ponds (August 2022–June 2024), were collected. Additionally, short-term (~months long) dredging and sediment placement monitoring data were collected at five different locations in 2022 and 2023. Data collection was designed to capture a variety of natural (diel, tidal, seasonal, storm-related) and human-created (sediment dredging and placement) conditions. Factory-calibrated biogeochemical sensors were field calibrated and maintained every 4 to 12 weeks. Discrete samples for dissolved oxygen, total alkalinity, and dissolved inorganic carbon were collected at the start and end of each sensor deployment for additional sensor calibration and validation. Altogether, our high-quality, multiyear dataset provides critical insights into the inherent variability of biogeochemical conditions in temperate salt marshes on diel and seasonal timescales, as well as how they may respond to transient events (e.g., storms, dredging activities) and over the longer term.

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Funding

Funding Source	Award
U.S. Army Engineer Research and Development Center (ERDC)	W912HZ2020061–RA3

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