Weekly surface water quality measurements in Narragansett Bay from 1959-2019

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Project
» Narragansett Bay Long-Term Plankton Time Series (NBPTS)

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Abstract
The Narragansett Bay Long-Term Plankton Time Series is one of the world's longest-running plankton surveys. Beginning in 1959, weekly samples have been collected to assess phytoplankton biomass with chlorophyll a and to characterize the chemical and physical parameters of Narragansett Bay (i.e., water temperature, salinity, chlorophyll a, silicate, phosphate, ammonium, nitrate/nitrite, water clarity, and light). Samples are collected once per week - regardless of tidal stage - for temperature, salinity, turbidity, chlorophyll a, and nutrients. This dataset provides weekly discrete surface concentrations for all parameters from 1959-2019 with support from the University of Rhode Island by the U.S. Department of Fish and Wildlife.

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Coverage

Spatial Extent: **Lat**:41.56861 **Lon**:-71.39194
Temporal Extent: 1959 - 2019

Acquisition Description

Methodology:
Surface water temperature, salinity, chlorophyll a (chl a), silicate (SiO4), phosphate (PO4), ammonium (NH4), nitrate/nitrite (NO3/2), water clarity (Secchi depth) and light (irradiance) were collected weekly at the NBPTS location from 1959-2019.

The detailed methodology will be included in an upcoming manuscript: Thibodeau, P.S., Puggioni, G., Strock, J., Borkman, D., and Rynearson T.A., Using one of the world’s longest plankton time series to identify long-term changes in phytoplankton biomass and phenology. In prep, Target journal: Global Change Biology.

Sampling and analytical procedures:
Weekly surface water temperature and salinity were determined using a bucket sample. Total surface chl a was determined weekly at the NBPTS location from May 1968 to 2019, by filtering whole seawater over 25 mm diameter GF/F filters and measured fluorometrically using three protocols, either following Yentsch and Menzel (1963) as outlined in Li and Smayda (1998) after frozen storage at -20°C (1959-1997), or following Strickland and Parsons (1972) after frozen storage at -20°C (1997-2007), or following Graff & Rynearson (2011) with no filter storage (2008-2019). We expanded an existing, corrected chl a data set (1999-2007) (Graff & Rynearson 2011) by applying the same correction factor to historical chl a measurements (1968-1997) to account for pigment loss on frozen filters.

From 1959 to 2003, water samples for nutrients were collected with a plastic bucket and stored in 20 L polyethylene carboys until returned to the laboratory for analysis (within 90 minutes) (Furnas 1983) and then filtered through pre-rinsed GFC glass fiber filters (Furnas et al. 1976). Between 1969 and 1997, PO4, SiO4, and NO3 were determined via either manual colorimetric methods (Strickland & Parsons 1972) or automated colorimetric methods using a Technicon autoanalyzer following the methodologies of (Furnas et al. 1976; Furnas 1983) and references therein (Armstrong 1951; Grasshoff 1966; Wood et al. 1967). NH4 concentrations were determined via the Witting-Buch method (Barnes 1959) from 1972 to 1980.

Post 1980, NH4 measurements were made via automated colorimetric methods using an autoanalyzer following the methodologies of Furnas et al. (1976), Furnas (1983), and (Solórzano 1969). Since only surface NO3 data were available before 1994, and only surface NO3/2 data were available in 1995 & 1996, a correction factor of 1.04 was determined through regression analysis by comparing observed NO3/2 measurements from 2003 to 2019 with NO3 concentrations measured during the same period. Methods of analysis of PO4, SiO4, and NO3 from 1959 to 1963 were not described in the historic archives but were likely similar to methods used from 1969 to 1997 (colorimetric). From 2003 to 2019, surface nutrient samples for PO4, SiO4, NH4, and NO3/2 were collected weekly at NBPTS and kept on ice and filtered within one to three hours of collection.

Samples were run following Grasshoff (1976) for all nutrients as well as and EPA Method 353.4 for NO3/2, EPA Method 365.3 for NH4, EPA Method 365.5 and Murphy and Riley (1962) for PO4, and Parsons et al. (1984) for SiO4. Light, measured as irradiance (W m-2), was collected weekly at NBPTS from 1959 to 1996. Photosynthetically active radiation (PAR) data were obtained from the National Estuarine Research Reserve, Narragansett Bay station (41° 38.22’ N, 71° 20.34’ W) (http://cdmo.baruch.sc.edu/) to provide light data from 2003 through 2019. A conversion factor (2.1) was used to convert irradiance (W m-2) data from 1959 to 1996 into comparable data in the form of µmol m-2 s-1 (Sager & McFarlane 1997). Secchi depth (i.e., water clarity) was measured weekly at NBPTS from 1972 to 1996 and then again from Dec. 2003 through 2019.

No data were collected for the following parameters during the following years:
- Temperature: 1997-1999; 2012
- Salinity: 1964-1970; 1997-1999; 2012
- Secchi Depth: Collection did not begin until 1972, 1997-2003; 2012
- Light: 1997-2003
- Phosphate: 1964-1970; Biweekly or no sampling 1988; Biweekly sampling only 1990-1993; 1997-2003
- Ammonium: Collection did not begin until 1972; Biweekly or no sampling 1988; Biweekly sampling only 1990-1993; 1997-2003
- Nitrate/nitrite: 1963-1970; Biweekly or no sampling 1988; Biweekly sampling only 1990-1993; 1997-2003
- Silicate: 1964-1970; Biweekly or no sampling 1988; Biweekly sampling only 1990-1993; 1997-2003; 2010-2013
- Chlorophyll: Collection did not begin until 1968; 1970-1971; Biweekly sampling only 1990-1994; 1995-1999; 2012

Processing Description

Data Processing:
Data processed via Excel Version 2202 and R Version 4.1.2.

BCO-DMO Processing:
- renamed fields to comply with BCO-DMO naming conventions;
- replaced "NA" with "nd" (no data);
- rounded all numeric fields to the 100th decimal position (0.00).

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Related Publications

Furnas, M. J., Hitchcock, G. L., & Smayda, T. J. (1976). NUTRIENT-PHYTOPLANKTON RELATIONSHIPS IN NARRAGANSETT BAY DURING THE 1974 SUMMER BLOOM. Estuarine Processes, 118–133. https://doi.org/10.1016/b978-0-12-751801-5.50018-6
Methods

Furnas, M.J., (1983). Community structure, biomass and productivity of size-fractionated summer phytoplankton populations in lower Narragansett Bay, Rhode Island. Journal of Plankton Research, 5(5), 637–655. https://doi.org/10.1093/plankt/5.5.637
Methods

Graff, J. R., & Rynearson, T. A. (2011). Extraction method influences the recovery of phytoplankton pigments from natural assemblages. Limnology and Oceanography: Methods, 9(4), 129–139. doi:10.4319/lom.2011.9.129
Methods

Strickland, J. D. H. and Parsons, T. R. (1972). A Practical Hand Book of Seawater Analysis. Fisheries Research Board of Canada Bulletin 157, 2nd Edition, 310 p.
Methods

Thibodeau, P.S., Puggioni, G., Strock, J., Borkman, D., and Rynearson T.A.. Long-term declines in chlorophyll a and shifts in phenology revealed by a 60-year estuarine plankton time series. In prep, Target journal: Global Change Biology.
Results

Yentsch, C. S., & Menzel, D. W. (1963). A method for the determination of phytoplankton chlorophyll and phaeophytin by fluorescence. Deep Sea Research and Oceanographic Abstracts, 10(3), 221–231. doi:10.1016/0011-7471(63)90358-9
Methods

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Parameters

Parameter	Description	Units
year	4-digit year sample measurement was collected	unitless
week	week sample measurement was collected	weeks
light	irradiance	Watts per meter squared (W m-2)
PO4	phosphate (PO4)	micromolar (µM)
NH4	ammonium (NH4)	micromolar (µM)
NO3_2	nitrate/nitrite (NO3/2)	micromolar (µM)
SiO4	silicate (SiO4)	micromolar (µM)
Precip	Precipitation	inches (in)
Secchi_depth	Secchi depth	meters (m)
Salinity	salinity	unitless
Temperature_SURF	water temperature	degrees Celsius (°C)
ChlA	chlorophyll a	milligrams chlorophyll per meter cubed (mg chl m-3)

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Instruments

Dataset-specific Instrument Name	Lachat Quick Chem 8000 Flow Injection Analyzer
Generic Instrument Name	Flow Injection Analyzer
Dataset-specific Description	From 2003 to 2019, surface nutrient samples for PO4, SiO4, NH4, and NO3/2 were filtered with acid washed 60 ml syringes and filtering tips (Millipore) using 0.45 mm cellulose filtering membranes (Millipore). Samples were run on a Lachat Quick Chem 8000 Flow Injection Analyzer.
Generic Instrument Description	An instrument that performs flow injection analysis. Flow injection analysis (FIA) is an approach to chemical analysis that is accomplished by injecting a plug of sample into a flowing carrier stream. FIA is an automated method in which a sample is injected into a continuous flow of a carrier solution that mixes with other continuously flowing solutions before reaching a detector. Precision is dramatically increased when FIA is used instead of manual injections and as a result very specific FIA systems have been developed for a wide array of analytical techniques.

Dataset-specific Instrument Name	Calibrated refractometer (American Optical)
Generic Instrument Name	Refractometer
Dataset-specific Description	Surface water salinity was determined using a calibrated refractometer (American Optical) from 1959 to 2008.
Generic Instrument Description	A refractometer is a laboratory or field device for the measurement of an index of refraction (refractometry). The index of refraction is calculated from Snell's law and can be calculated from the composition of the material using the Gladstone-Dale relation. In optics the refractive index (or index of refraction) n of a substance (optical medium) is a dimensionless number that describes how light, or any other radiation, propagates through that medium.

Dataset-specific Instrument Name	Technicon Autoanalyzer
Generic Instrument Name	Technicon AutoAnalyzerII
Dataset-specific Description	Between 1969 and 1997, PO4, SiO4, and NO3 were determined via either manual colorimetric methods or automated colorimetric methods using a Technicon autoanalyzer. NH4 measurements were also made via automated colorimetric methods using an autoanalyzer.
Generic Instrument Description	A rapid flow analyzer that may be used to measure nutrient concentrations in seawater. It is a continuous segmented flow instrument consisting of a sampler, peristaltic pump, analytical cartridge, heating bath, and colorimeter. See more information about this instrument from the manufacturer.

Dataset-specific Instrument Name	Calibrated thermometer (Fischer Scientific)
Generic Instrument Name	Thermometer
Dataset-specific Description	Surface water temperature was determined using a bucket sample calibrated thermometer (Fischer Scientific) from 1959 to 2008.

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Project Information

Narragansett Bay Long-Term Plankton Time Series (NBPTS)

Website: https://web.uri.edu/gso/research/plankton/

The Narragansett Bay Long-Term Plankton Time Series is one of the world's longest-running plankton surveys. Beginning in 1957, weekly samples have been collected to assess the phytoplankton community and characterize the physical parameters of Narragansett Bay.

Samples are collected once per week -regardless of tidal stage- for temperature, salinity, turbidity, size-fractionated chlorophyll a and nutrients. Microplankton community composition (size range >10µm, both species identification and abundance) is determined using a light microscope to quantify live samples. The species list for the >10µm size fraction includes 246 different species or species complexes of protists. Samples are also collected for the determination of copepod and ctenophore concentrations.

Funding for the time series has come from the University of Rhode Island since 1999. Ship time is frequently provided by the U.S. Department of Fish and Wildlife.

This Time Series is related to the following projects at BCO-DMO:

- Connecting local, regional and global scales of gene flow in planktonic marine diatoms (https://www.bco-dmo.org/project/511708)
- Dimensions: Collaborative Research: Genetic, functional and phylogenetic diversity determines marine phytoplankton community responses to changing temperature and nutrients (https://www.bco-dmo.org/project/712787)
- LTER: Linking Pelagic Community Structure with Ecosystem Dynamics and Production Regimes on the Changing Northeast US Shelf (https://www.bco-dmo.org/project/747769)
- Quantifying Temperature Dependence In Growth & Grazing Rates of Planktonic Herbivores (https://www.bco-dmo.org/project/739232)
- RII Track-1: Rhode Island Consortium for Coastal Ecology Assessment, Innovation, and Modeling (https://www.bco-dmo.org/project/836631)

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Funding

Funding Source	Award
NSF Division of Ocean Sciences (NSF OCE)	OCE-1638834
NSF Division of Ocean Sciences (NSF OCE)	OCE-1655686
NSF Office of Integrative Activities (NSF OIA)	OIA-1655221

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