Surface water temperature measured at 30-minute sampling intervals from the years 2000 to 2023 at Tatoosh Island, Washington, USA

Website: https://www.bco-dmo.org/dataset/916457
Data Type: Other Field Results
Version: 1
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Project
» Eco-Evolutionary Response to the Scale of Temporal Environmental Fluctuation (Eco Evolutionary Response)

Contributors	Affiliation	Role
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Abstract
This dataset reports observations of surface water temperatures at 30-minute sampling intervals from the year 2000 to the present (2023) from Tatoosh Island, Washington, USA. Data were collected by Tim Wootton and Cathy Pfister, University of Chicago. Observations prior to May 2011 were generated during the growing season (typically late April to early September) using Hydrolab DataSondes, whereas subsequent observations were generated all year using primarily HOBO Pendant temperature/light loggers, supplemented with measurements derived from HOBO conductivity/salinity/temperature logger or Hydrolab DataSondes. These temperatures may be useful for detecting marine heat waves or other temperature anomalies, and for documenting surface temperature dynamics across daily, seasonal, and decadal scales.

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Coverage

Spatial Extent: **Lat**:48.390405 **Lon**:-124.735816667
Temporal Extent: 2000-06-04 - 2023-09-01

Dataset Description

Notes about use of this dataset:
There are no restrictions on access to this dataset. Acknowledgment of the Makah Tribal Council for permission to allow these data to be collected on their lands should be made where possible when the data are an essential part of the publication.

These data series are being actively extended and analyzed by the data provider, and interested investigators may wish to contact the data provider regarding these data, the ecological context under which these data were collected, whether planned use of these data represents redundant efforts, and any details of the data collection process the data provider may have inadvertently neglected to include here. As a rule of thumb for any data made publicly available, including these, investigators intending to use these data for publication

should consider the considerable effort made to gather and organize them, and whether publication would reasonably be possible without including these data. If not, then it may be appropriate to explore involving the author in the publication process.

Methods & Sampling

Data loggers were deployed in a large tide pool (Lat N 48° 23.643', Long W 124° 44.149') approximately 1 meter (m) below its lip, which is located at 0.8 m MLLW. The pool is isolated at tidal levels below this value (ignoring waves) and connected to the eastern Pacific Ocean above this tidal level. Data were generally taken at 30-minute intervals. Before 2011, data were only collected during our summer field season (April-September, depending on year). From 16 May 2011 onward, data were taken nearly continuously, except when the pool was drained to service equipment.

Study location:
Tatoosh Island, Washington, USA. Intertidal/nearshore temperate waters. Depth varies with the tides as the instruments are fixed to the bottom. Data are from an intensively sampled large (>5000 liter) tide pool that is both accessible for servicing during the lowest low tides and allows equipment to be safely installed and remain underwater. The lowest lip of the pool is at 0.8 m MLLW, and equipment is deployed about 1 m below the lip. At tide heights > 0.8 m, the pool is connected to the eastern Pacific Ocean just outside the mouth of the Strait of Juan de Fuca.

Instruments:
Prior to May 2011, data were collected using Hydrolab DataSondes with factory-calibrated settings (OTT-Hydromet, Loveland, Colorado, USA). After this date, the data here were largely taken from 1-2 HOBO Pendant Temperature/Light (UA-002-64) loggers with factory-calibrated settings (Onset Computer, Bourne, Massachusetts, USA). Occasionally, HOBO Pendants were not deployed in this interval, in which case alternative platforms generated the data: Hydrolab DS5x DataSonde (16 May 2011-29 August 2011, 6 April 2012-19 August 2012, 29 May 2014-7 August 2014, 28 April 2021-11 June 2021) or HOBO Conductivity/Salinity data logger (U24-002-C; Onset Computer; 17 August 2012-27 April 2013, 1 September 2016-27 April 2017). All units were attached to the side wall (approximately vertical) of the tide pool using stainless steel hardware and Rawl masonry plugs.

Known Problems or Issues:
There are sampling gaps in fall-winters of 2000-2011 and for several hours during periods when the instrument was being serviced (every 2-4 weeks). There are also occasional small gaps of several hours each when the pool was drained to service or switch out equipment from 2011 onward. Missing temperature values after May 2011 are entered as -100.

Data Processing Description

Where two HOBO Tidbit loggers were installed at the same time, the data are the average of the two readings.

BCO-DMO Processing Description

- Imported original file "Tatoosh Water Temp Cumulative BCO-DMO.csv" into the BCO-DMO system.
- Converted the date-time (local) field to ISO 8601 format.
- Added a date-time field in UTC in ISO 8601 format.
- Added columns for latitude and longitude and populated with the values provided in the metadata (all data taken from the same location).
- Renamed the "Average Temp, °C" column to comply with BCO-DMO naming conventions.
- Saved the final file as "916457_v1_tatoosh_island_surface_water_temp.csv".

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Parameters

Parameter	Description	Units
ISO_DateTime_Local	Date/time of sample (Pacific Daylight Time, GMT-7:00) in ISO 8601 format	unitless
ISO_DateTime_UTC	Date/time of sample (UTC) in ISO 8601 format	unitless
Average_Temp_C	Measured water temperature (degrees C). Missing temperature values are recorded as -100.	degrees Celsius
Latitude	Latitude of sampling location (Tatoosh Island, Washington, USA)	decimal degrees
Longitude	Longitude of sampling location (Tatoosh Island, Washington, USA)	decimal degrees

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Instruments

Dataset-specific Instrument Name	HOBO Conductivity/Salinity data logger (U24-002-C)
Generic Instrument Name	Data Logger
Dataset-specific Description	Occasionally, HOBO Pendants were not deployed in this interval, in which case alternative platforms generated the data (Hydrolab DS5x DataSonde or HOBO Conductivity/Salinity data logger (U24-002-C)).
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.

Dataset-specific Instrument Name	Hydrolab DataSondes
Generic Instrument Name	HydroLab DataSonde
Dataset-specific Description	Prior to May 2011, data were collected using Hydrolab DataSondes with factory-calibrated settings (OTT-Hydromet, Loveland, Colorado, USA).
Generic Instrument Description	Hydrolab DataSonde Multiparameter Probes have sensors for temperature, conductivity, salinity, specific conductance, TDS, pH, ORP, dissolved oxygen, turbidity, chlorophyll a, blue-green algae, Rhodamine WT, ammonium, nitrate, chloride, ambient light (PAR), and total dissolved gas.

Dataset-specific Instrument Name	Hydrolab DS5x DataSonde
Generic Instrument Name	Hydrolab Series 5 probes
Dataset-specific Description	Occasionally, HOBO Pendants were not deployed in this interval, in which case alternative platforms generated the data (Hydrolab DS5x DataSonde or HOBO Conductivity/Salinity data logger (U24-002-C)).
Generic Instrument Description	Multi-parameter probes that can measure from 12 (MS5) to 16 (DS5 and DS5X) parameters simultaneously. Measurements include temperature, depth, conductivity, salinity, specific conductance, TDS, pH, ORP, dissolved oxygen, turbidity, chlorophyll a, blue-green algae, Rhodamine WT, ammonium, nitrate, chloride, PAR and total dissolved gases. These probes can be deployed at depths up to 200 m and can be used in continuous monitoring programs.

Dataset-specific Instrument Name	HOBO Pendant Temperature/Light (UA-002-64) loggers
Generic Instrument Name	Onset HOBO Pendant Temperature/Light Data Logger
Dataset-specific Description	After May 2011, data were largely taken from HOBO Pendant Temperature/Light (UA-002-64) loggers with factory-calibrated settings (Onset Computer, Bourne, Massachusetts, USA).
Generic Instrument Description	The Onset HOBO (model numbers UA-002-64 or UA-001-64) is an in-situ instrument for wet or underwater applications. It supports light intensity, soil temperature, temperature, and water temperature. A two-channel logger with 10-bit resolution can record up to approximately 28,000 combined temperature and light measurements with 64K bytes memory. It has a polypropylene housing case. Uses an optical USB to transmit data. A solar radiation shield is used for measurement in sunlight. Temperature measurement range: -20 deg C to 70 deg C (temperature). Light measurement range: 0 to 320,000 lux. Temperature accuracy: +/- 0.53 deg C from 0 deg C to 50 deg C. Light accuracy: Designed for measurement of relative light levels. Water depth rating: 30 m.

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Project Information

Eco-Evolutionary Response to the Scale of Temporal Environmental Fluctuation (Eco Evolutionary Response)

Coverage: Salish Sea, Washington, USA

NSF Award Abstract:
Cyclical variations in environmental conditions, like tides or seasons, comprise a common theme in nature. Living organisms must cope with repetitive arrivals of unfavorable conditions for survival. Therefore species around the world are under evolutionary pressure to schedule their "life cycles" or "life histories" to fit the environmental cycle regimes within which they reside. Recent climate change has shifted historical cyclical patterns in many ecosystems, such as season length, resulting in mismatches between life histories and the ideal environmental conditions of plants and animals, to the detriment of population persistence and ecological stability. Adaptive evolution offers a mechanism that may buffer these mismatches. Accumulating evidence of shifts in life history schedules from around the world shows us that much remains to be done to understand how life histories are "fit" to environmental cycles, and to changes in cycles, despite their everyday familiarity. Testing theoretical ideas with data and experiments is essential. Marine coastal habitats are subject to

conspicuous cycles occurring at multiple time scales, such as diel, tidal, lunar, seasonal, and multi-annual fluctuations. Populations of the intertidal crustacean Tigriopus californicus occupy rocky shore across the entire eastern Pacific coastline in upper tidepools that are periodically wave-swept at high tide at varying intervals. This project develops mathematical models to uncover fundamental rules of life history variation and adaptation in regularly varying environments, and tests hypotheses across Tigriopus californicus populations experiencing varying tidal disturbances using efficient and highly replicated field collections and manipulative experiments in the lab. Beyond producing broadly applicable theory and abundant open-access data, the investigators engage with local Makah Tribe students near field sites for sampling and natural history studies to enhance STEM education in an underserved rural community. Furthermore, the project expands the nation's scientific capacity by training undergraduate and graduate students in experimental design, theoretical modelling in population ecology and life history evolution, and data analysis.

How natural populations persist in variable environments has been a long-standing question in ecology and evolution. In particular, cyclical variability is common in nature, and many species show predictable life history strategies that follow cycles in nature (e.g. phenology). However, a general conceptual framework is lacking for how adaptation to cycles occurs and how the scaling of life histories to fluctuations buffers changes in the environment. Marine environments fluctuate predictably across a range of temporal scales, such as tidal and seasonal, and provide unique opportunities to study population persistence and evolution in cyclical environments. A general mathematical framework is developed that explores life history optimization in the context of cyclically varying environments. The marine intertidal copepod Tigriopus californcus is ideal for testing model predictions and motivating extensions. Many isolated populations can be sampled entirely in the field, and the short timescale of tide cycles, short generation times, and ease of frequent sampling will provide a dense dataset of eco-evolutionary patterns in response to natural disturbance regimes. Pilot studies have established experimental populations in the laboratory, and have proven that Tigriopus californcus is amenable to careful manipulations of simulated disturbance frequency (both cyclical and stochastic) that seamlessly translate to the model framework. The combination of modelling, field parameterization, and experimental investigation of life histories in cyclical and stochastic environments is a novel and holistic approach to the question of life history diversity within an environment. Finally, a general understanding of evolutionary mechanisms in cyclical environments can improve predictions of the fate of populations when natural cycles are perturbed, which is expected across many ecosystems due to climate change.

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.

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Funding

Funding Source	Award
NSF Division of Ocean Sciences (NSF OCE)	OCE-0928232
NSF Division of Ocean Sciences (NSF OCE)	OCE-1851489
NSF Division of Ocean Sciences (NSF OCE)	OCE-0117801
NSF Division of Ocean Sciences (NSF OCE)	OCE-0452687
NSF Division of Environmental Biology (NSF DEB)	DEB-0919420
NSF Division of Environmental Biology (NSF DEB)	DEB-1556874

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