Pisaster Counts and Sea Star Wasting Disease Incidence on Tatoosh Island, Makah Reservation, Washington 2014-2025

Website: https://www.bco-dmo.org/dataset/1003083
Data Type: Other Field Results
Version: 1
Version Date: 2026-07-28

Project
» Eco-Evolutionary Response to the Scale of Temporal Environmental Fluctuation (Eco Evolutionary Response)
» LTREB: Ecological Dynamics in an Experimentally-Tractable Natural Ecosystems (LTREB Ecological Dynamics)

Program
» Long Term Research in Environmental Biology (LTREB)

Contributors	Affiliation	Role
Wootton, Timothy	University of Chicago	Principal Investigator
Rauch, Shannon	Woods Hole Oceanographic Institution (WHOI BCO-DMO)	BCO-DMO Data Manager

Abstract
To better understand the impacts of disease on an important predator and its associate community, standardized count data were initiated by J. Timothy Wootton on Tatoosh Island, Makah Reservation, Washington, USA in 2014 as the sea star wasting disease epidemic of 2013-2014 was progressing on the northeastern Pacific Ocean. At the time of study, signs of disease were absent from Tatoosh Island. Six sites with relatively large, uniform benches on shores with high wave exposure were selected for study areas. Surveys were carried out in the intertidal zone in late spring and summer during periods with strong spring tides to maximize population counts. The area of lower intertidal bench at each sampling site was estimated by tape measure as length x width (meters) of the lower intertidal (below lower limit of the mussel bed in 2014) assuming a rectangular area. Counts were made by the investigator by systematically walking along each site and counting each individual of Pisaster ochraceus encountered, noting whether it had signs of disease (lesions/ruptured body parts, missing arms, thin profile with crossed arms), and whether it was larger than 10 centimeters in diameter. Data characterize the decadal population dynamics and disease dynamics of a keystone sea star predator.

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Coverage

Spatial Extent: **N**:48.3919 **E**:-124.7326 **S**:48.3899 **W**:-124.7411
Temporal Extent: 2014-05-30 - 2025-07-25

Methods & Sampling

Standardized count data were initiated by J. Timothy Wootton on Tatoosh Island, Makah Reservation,

Washington, USA in 2014 as the sea star wasting disease epidemic of 2013-2014 was progressing on the northeastern Pacific Ocean. At the time of study, signs of disease were absent from Tatoosh Island. Six sites scattered around the periphery of the island (Glacier, Glacier Control, West Island Wall, East Strawberry, Simon's Landing, Toad Point) with relatively large, uniform benches on shores with high wave exposure were selected for study areas. Surveys were carried out in the intertidal zone in late spring and summer during periods with strong spring tides to maximize population counts. The area of lower intertidal bench at each sampling site was estimated by tape measure as length x width (meters) of the lower intertidal (below lower limit of the mussel bed in 2014) assuming a rectangular area. Counts were made by the investigator by systematically walking along each site and counting each individual of *Pisaster ochraceus* (urn:lsid:marinespecies.org:taxname:240755) encountered, noting whether it had signs of disease (lesions/ruptured body parts, missing arms, thin profile with crossed arms), and whether it was larger than 10 centimeters in diameter. Counts at one site (West Island Wall) were made from across a large surge channel using binoculars when necessary to inspect the condition of individual sea stars.

Data Processing Description

Raw data are reported here.

BCO-DMO Processing Description

- Imported original file "Pisaster Counts Tatoosh BCODMO.csv" into table "pisaster_counts_tatoosh" into the BCO-DMO system.
- Treated "-9999" as a missing value. Note that missing values are empty/blank in the final CSV file.
- Renamed columns to comply with BCO-DMO naming conventions.
- Saved the final file as "1003083_v1_pisaster_counts_tatoosh.csv".

Problem Description

Sampling on some dates at some sites is missing because of time constraints and ocean conditions. These were indicated in the original file with -9999. Missing data are empty/blank in the final CSV file published through BCO-DMO.

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Related Publications

Wootton, J. T., Miranda, K., Henry, A. K., Pfister, C. A. In Review. Field experiments predict ecological response to a large-scale epidemic of an anti-keystone pathogen. Proceedings of the National Academy of Sciences, USA.
Results

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Parameters

Parameter	Description	Units
Date	Date of observation	unitless
Site	Informal name of sampling site on Tatoosh Island	unitless
BenchArea	Approximate area of sampling site	square meters
PisasterCount	Total number of individual Pisaster counted at each site	number of individuals
SmallCount	Number of observed individual Pisaster that were less than10 centimeters in diameter	number of individuals
DiseaseSigns	Number of individuals exhibiting signs of sea star wasting disease	number of individuals
Lesions	Number of individuals exhibiting lesions or burst body parts	number of individuals
MissingArms	Number of individuals with fewer than 5 healthy, fully grown arms	number of individuals
Latitude	General latitude of sampling site	decimal degrees N
Longitude	General longitude of sampling site	decimal degrees W (as negative number)

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Instruments

Dataset-specific Instrument Name	Swarovski WB-SLC 8x30 binoculars
Generic Instrument Name	Binoculars Handheld
Dataset-specific Description	Used during human observation.
Generic Instrument Description	Handheld binoculars, generally used for bird or mammal observations.

Dataset-specific Instrument Name	hand-counter
Generic Instrument Name	Hand-held counter device
Dataset-specific Description	A hand-counter was used during human observations.
Generic Instrument Description	A hand-counter or tally counter is a device used to keep track of a numerical count.

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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.

LTREB: Ecological Dynamics in an Experimentally-Tractable Natural Ecosystems (LTREB Ecological Dynamics)

Coverage: Tatoosh Island, Washington, United States of America

NSF Award Abstract for DEB-0919420:

This award is funded under the American Recovery and Reinvestment Act of 2009 (Public Law 111-5).

A core challenge for ecologists is to develop frameworks to predict how complex natural communities and ecosystems will respond to environmental impacts such as species extinction and global change. Because ecological interactions are comprised of complex networks, meeting this challenge requires an integration of mathematical frameworks with empirical data. In this project, the investigator will extend several long-term multi-species data sets for marine rocky intertidal organisms and environmental conditions, and use these data to estimate species interaction strengths in dynamic, multi-species models. These results will then be used to test for general patterns of interaction strength and to generate predictions for different potential environmental impacts. Long-term species manipulation experiments in this intertidal habitat will be used to validate predictions generated by multi-species models.

Results of this study will significantly enhance the ability to address an urgent societal need - the prediction of natural ecosystem responses to global change, including climate change. In the process, the study will increase collaboration and data sharing among university researchers and governmental management agencies (Tribal and NOAA National Marine Sanctuary staff), provide advanced training for Ph. D. students, and facilitate research experience for undergraduate in ecological science. Data associated with the project will be publicly available through the University of Chicago, the Knowledge Network for Biocomplexity, and through the Ecological Society of America's Ecological Archives.

NSF Award Abstract for Continuing Award DEB-1556874:

A central goal for ecology is to document if and how the environment is changing, to determine the causes of these changes, and to predict what the consequences of these changes will be to ecological systems. This is a challenge because of the complex network of connections among the living organisms and the non-living parts of ecosystems. Mathematical models are essential tools to keep track of these ecological interactions and to predict how they will respond to environmental changes. However, models need to be linked to data from nature. Two major challenges in developing predictive models of environmental change are 1) collecting sufficient data on how interactions among a complete set of species and environmental factors change over time, and (2) rigorously testing model predictions with experiments. This study will combine a quarter-century long series of data on 100+ species and relevant environmental variables in the rocky shoreline of Tatoosh Island in Washington state, with a long-term field experiment that mimics the extinction of a key species, the California mussel. The long term data will be applied to several different modeling approaches and predictions from these models will subsequently be tested with the long-term field experiment. The research will identify the most promising modeling approaches for making ecological prediction, and make them available to ecosystem managers and policy makers interested in the consequences of environmental impacts such as species extinction and global change. The comprehensive data series also will be made available to other scientists to be used as a platform for additional studies. This project will also engage undergraduate students in field research, data management, mathematical modeling, and in communicating with the public, managers, and policy makers. Furthermore, because the challenge of understanding networks of species interactions is shared with other scientific disciplines that deal with complex networks, project results will be of general value in other disciplines.

The researcher will conduct annual surveys of replicated permanent plots for plants and animals on the shoreline in two ways: 1) by documenting the species identities under 2,600 fixed points over a 5-year period and generating annual transition probabilities among species, and 2) by generating abundance estimates in permanent 60 x 60 cm census plots. Fifteen experimental plots will be maintained by selectively removing individuals of Mytilus californianus when they appear, leaving all other species undisturbed. Environmental data will be collected every 30 minutes using a submersible data logger and a land-based weather station. Water chemistry, including critical nutrients, will be monitored. These data will be analyzed in several ways, including 1) parameterizing transition-based models (Markov chain models, spatially-explicit cellular automata) with environmental dependencies, 2) parameterizing multi-species population dynamic models from plot counts, 3) applying multi-spatial cross-convergent mapping and testing whether it accurately detects key species known to have strong causal effects from independent experiments, 4) applying neural network models and testing their predictions about the consequences of species extinction, and 5) testing whether there is a relationship between the variability of a species' abundance through time and its importance to the ecosystem as assessed by independent experiments. The community modeling projects enabled by the rich long term data sets have a strong potential to advance our understanding of mechanisms underlying community dynamics and their response to environmental change.

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Program Information

Long Term Research in Environmental Biology (LTREB)

Website: https://www.nsf.gov/funding/opportunities/ltreb-long-term-research-environmental-biology

Long Term Research in Environmental Biology (LTREB)

Supports research for a period of 10 years or longer to generate an extended time series of data with a focus on evolutionary biology, ecology and ecosystem science.

Synopsis
The Long Term Research in Environmental Biology (LTREB) Program supports the generation of extended time series of data to address important questions in evolutionary biology, ecology, and ecosystem science. Research areas include, but are not limited to, the effects of natural selection or other evolutionary processes on populations, communities, or ecosystems; the effects of interspecific interactions that vary over time and space; population or community dynamics for organisms that have extended life spans and long turnover times; feedbacks between ecological and evolutionary processes; pools of materials such as nutrients in soils that turn over at intermediate to longer time scales; and external forcing functions such as climatic cycles that operate over long return intervals.

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Funding

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

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