Species percent cover from species resilience and recovery experiments in the rocky intertidal zone of the Oregon Coast from 2011 to 2024

Website: https://www.bco-dmo.org/dataset/990951
Data Type: Other Field Results, experimental
Version: 1
Version Date: 2026-01-30

Project
» LTREB: Testing tipping points in a model rocky intertidal meta-ecosystem – Climate-change, increasing variances, and response mechanisms (LTREB Intertidal Tipping Points)

Contributors	Affiliation	Role
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Abstract
This dataset contains percent cover of species identified from photographs during a species resilience and recovery experiment in the rocky intertidal zone of the Oregon Coast from 2011 to 2024. Experiment/Study abstract: Climate change threatens to destabilize ecological communities, potentially moving them from persistently occupied “basins of attraction” to different states. Increasing variation in key ecological processes can signal impending state shifts in ecosystems. In a rocky intertidal meta-ecosystem consisting of three distinct regions spread across 260 km of the Oregon coast, we show that annually cleared sites are characterized by communities that exhibit signs of increasing destabilization (loss of resilience) over the past decade despite persistent community states. In all cases, recovery rates slowed and became more variable over time. The conditions underlying these shifts appear to be external to the system, with thermal disruptions (e.g., marine heat waves, El Ni~no–Southern Oscillation) and shifts in ocean currents (e.g., upwelling) being the likely proximate drivers. Although this iconic ecosystem has long appeared resistant to stress, the evidence suggests that subtle destabilization has occurred over at least the last decade.

Table of Contents

- Coverage
- Dataset Description
  - Methods & Sampling
  - Data Processing Description
  - BCO-DMO Processing Description
- Related Publications
- Parameters
- Project Information
- Funding

Coverage

Location: Rocky Intertidal along the Oregon Coast. See site information in data.
Spatial Extent: **N**:44.83863831 **E**:-124.05875 **S**:42.717772 **W**:-124.56512
Temporal Extent: 2011-06-02 - 2024-07-23

Methods & Sampling

The purpose of this experiment is to test the recovery rates of rocky intertidal communities to single or repeated disturbance and thereby measure the succession and resilience of the community, respectively. We initiated the experiment series in the low zone in 2011 by haphazardly locating, then permanently marking five pairs of 0.5 x 0.5 m low intertidal plots. In spring/early summer each year from 2011- 2024, we photographed,

then cleared one plot of each pair of all macrobiota, including macrophytes and sessile invertebrates ('removal plots'). Adjacent uncleared reference plots were left intact (controls). We also added succession plots in the early 2020s that were cleared once and allowed to recover (succession plots). Removals were allowed to recover without further intrusion for 12 mo, when they were photographed and recleared for the next year's observations. Plot locations did not change. Mid and high experiments were added in the early 2020s as well to compare how recovery and resilience differed between intertidal zones.

Percent cover of each species was estimated by inspecting photographs. The 0.5 x 0.5 m quadrats were subdivided into 0.1x0.1m subquadrats, each consisting of 4% cover. Abundances of each taxon were estimated by eye for each subquadrat, and totals were obtained by adding across all 25 subquadrats. We grouped species into functional groups for analysis (see Supplemental Files for taxon ids and more category information):

small barnacles = Chthamalus dalli, Balanus glandula
large barnacles = Semibalanus cariosus, Balanus nubilus
gooseneck barnacles = Pollicipes polymerus
mussels = Mytilus californianus, Mytilus trossulus
anemones = Anthopleura xanthogrammica, A. elegantissima
articulated corallines = Corallina vancouveriensis, Bossiella plumosa
red blades = Mazzaella splendens, M. flaccida, M. parksii, Pyropia/Porphyra, Gymnogongrus, Halosaccion,
filamentous reds = Polysiphonia, Microcladia, Endocladia, Odonthalia floccosa,
red turfs= Cryptopleura, Hymenena, Constantinea, Dilsea, Erythrophyllum, Neorhodomela
kelp = Hedophyllum, Alaria, Laminaria, Egregia,
ulvoids = Ulva
worms = serpulids, spirorbids, "worms" at RP form colonies, may be amphipods.
surfgrass = Phyllospadix scouleri, P. torreyi
colonial sessile inverts = Halichondria at YB, hydrozoans (?) at YB 7-14-2022L3S
Notes:
Pisaster in plots counted as bare space
Gymnogongrus counted as red blades
when mid zone PE plots started, placed S plots in winter disturbances, assumed start date was 1/1/2021
went back and separated Chth from Bal gl only in final sample date

Data Processing Description

NA

BCO-DMO Processing Description

* Sheet 1 "PE_PhotoPlots_Matrix_2024-04-17" of submitted file "BCODMO_PE_PhotoPlots_Matrix_2025-06-23_SAG.xlsx" was imported into the BCO-DMO data system for this dataset. Values "NA" imported as missing data values. Table will appear as Data File: 990951_v1_photoplot-species.csv (along with other download format options).
* Two unnamed columns in the table named "Comment1" and "Comment2"

* Sheet 2 "FunctionalGroups" and Sheet 4 "Notes" of "BCODMO_PE_PhotoPlots_Matrix_2025-06-23_SAG.xlsx" were added directly to the Methods & Sampling metadata section.

* Table within BCODMO_SiteList_STARS_2023-04-11_SAG.xlsx added as supplemental file sitelist_stars.csv

Missing Data Identifiers:
* In the BCO-DMO data system missing data identifiers are displayed according to the format of data you access. For example, in csv files it will be blank (null) values. In Matlab .mat files it will be NaN values. When viewing data online at BCO-DMO, the missing value will be shown as blank (null) values.

* Column names adjusted to conform to BCO-DMO naming conventions designed to support broad re-use by a variety of research tools and scripting languages. [Only numbers, letters, and underscores. Can not start with a number]

* Date converted to ISO 8601 format

* Table of functional group name, column in dataset, and the SciNames included in the group were added as a supplemental file (functional_group_scinames_and_ids.csv) by parsing information provided Sheet 2 "FunctionalGroups" and Sheet 4 "Notes" of "BCODMO_PE_PhotoPlots_Matrix_2025-06-23_SAG.xlsx."
Taxon ids AphiaID and LSID were added from the World Register of Marine Species (lookup was on 2026-01-26).

Notes on SciNames and matching:

Alaria is an accepted taxon for two separate organisms. The usage in this dataset was matched to Alaria Greville, 1830 (urn:lsid:marinespecies.org:taxname:144194) that is a kelp not the Alaria that is a worm "Alaria esculenta (Linnaeus) Greville, 1830" urn:lsid:marinespecies.org:taxname:145716 (since this is in the kelp category).

Typos in scinames corrected (from->to):
Balanus nubilis
Balanus nubilus (urn:lsid:marinespecies.org:taxname:594745)

Corallina vancourveriensis
Corallina vancouveriensis (urn:lsid:marinespecies.org:taxname:494902)

[table of contents | back to top]

Related Publications

Menge, B. A., Gravem, S. A., Johnson, A., Robinson, J. W., & Poirson, B. N. (2022). Increasing instability of a rocky intertidal meta-ecosystem. Proceedings of the National Academy of Sciences, 119(3). https://doi.org/10.1073/pnas.2114257119
Results

[table of contents | back to top]

Parameters

Parameter	Description	Units
PhotoID	Identifier for each photo showing SiteCode, Zone, Replicate, Treatment, and PhotoDate. E.g. BB_L_1_R_2011-06-02	unitless
PlotID	Identifier for each photo showing SiteCode, Zone, Replicate, Treatment. E.g. BB_L_1_R	unitless
Project	PE for PreEmption Project	unitless
State	State experiment performed. All Oregon	unitless
Region	Region experiment performed. All Oregon	unitless
Cape	Cape experiment performed (Foulweather, Perpetua, Blanco)	unitless
SiteCode_STARS	Abbreviated Site Code	unitless

Site	Site Name	unitless
Latitude	Latitude of Site	decimal degrees
Longitude	Longitude of Site	decimal degrees
Zone	Zone of Plot (High, Medium, Low)	unitless
Rep	Replicate. Each replicate has one of each treatment and is clustered in space (1 to 5).	unitless
Treat	Detailed treatment of the plot (C = Control, never cleared; S = Sucession, cleared one time; R = Removal, plot cleared annually)	unitless
RepTreat	Combined Rep and Treat. E.g. 1_S or 3_C	unitless
PhotoDate	Date photo taken	unitless
Year	Year photo taken	unitless
Month	Month photo taken	unitless
Day	Day photo taken	unitless
Survey	Identifier for each survey showing SiteCode, Project, Date E.g. BB_PreEmption_2011-06-02	unitless
YearRemovalStart	Year clearance started. Usually clearances are in spring and plots are monitored until the following spring	unitless
YearRemovalEnd	Year clearance ended. Usually clearances are in spring and plots are monitored until the following spring	unitless
YearNumber	Sequetion year of project. Year 1 is 2011	unitless
YearRange	Years spanned from spring to spring	unitless
RemovalDate	Date clearance started. Usually clearances are in spring and plots are monitored until the following spring	unitless

DaysElapsed	Days since clearance started for the site (even if plot wasn't cleared).	days
Method	All data types are % cover	unitless
Bare_space	% cover of this species category	percent (%)
Mussels	% cover of this species category	percent (%)
Semibalanus	% cover of this species category	percent (%)
Balanus_glandula	% cover of this species category	percent (%)
Chthamalus	% cover of this species category	percent (%)
Gooseneck_barnacles	% cover of this species category	percent (%)
Anemones	% cover of this species category	percent (%)
Worms	% cover of this species category	percent (%)
Colonial_sessile_inverts	% cover of this species category	percent (%)
Coralline_crusts	% cover of this species category	percent (%)
Algal_crusts	% cover of this species category	percent (%)
Articulated_corallines	% cover of this species category	percent (%)
Red_blades	% cover of this species category	percent (%)
Red_filamentous	% cover of this species category	percent (%)
Red_turfs	% cover of this species category	percent (%)
Fucoids	% cover of this species category	percent (%)
Kelp	% cover of this species category	percent (%)

Surfgrass	% cover of this species category	percent (%)
Ulva	% cover of this species category	percent (%)
Other_green_algae	% cover of this species category	percent (%)
Diatoms	% cover of this species category	percent (%)
Total_cover	Summed % cover for plot. Usually equals 100 unless part of plot was not analyzed (glare, shadow, etc.)	percent (%)
Comment1	Comment 1	unitless
Comment2	Comment 2	unitless

[table of contents | back to top]

Project Information

LTREB: Testing tipping points in a model rocky intertidal meta-ecosystem – Climate-change, increasing variances, and response mechanisms (LTREB Intertidal Tipping Points)

Coverage: West coast of North America

NSF abstract:

In recent decades, ocean ecosystems, long thought to be immune to change, have undergone disruptions to their structure, diversity, and geographic range, yet the actual underlying reasons for such changes in oceanic biota are often unclear. Coastal intertidal zones (i.e., the shore between high and low tides) have long served as important ecological model systems because of advantages in accessibility and ease of observation, occupancy by easily studied and manipulated organisms of relatively short lifespans, and exposure to often severe environmental conditions. This research will address the stability of a well-known rocky shore system along the Oregon and California coasts. Prior long-term research indicates that, although casual observation suggests these systems are stable, in fact, they may be on the cusp of shifting into another state, losing iconic organisms like mussels and sea stars, and becoming dominated by seaweeds. These changes might be comparable to losing trees and large predators from terrestrial systems. This study would result in the training of undergraduates and graduate students, including individuals from under-represented groups. Additionally, this study would include outreach to the general public.

The researchers will focus particularly on impacts of increasing and more variable warming on community recovery. For example, climate oscillations (e.g., El Niño), coastal upwelling, and particularly temperature have all changed in recent decades in ways leading to increased stress on intertidal biota. In apparent response, coastal ecosystems evidently have become less productive, organismal performance (growth, reproduction) has declined, and key dynamical processes (species interactions) have weakened. The new research will pursue these strong hints of an impending “tipping point” by (1) continuing the projects that led to the insights of increasing instability, (2) adding new projects that will pinpoint ecological changes, and (3) expanding the region of work to include locations in California. Research will assess whether or not sea stars recover from wasting disease, experimentally test if species interactions are indeed weakening, quantify the annual inputs of new prey and changes in abundance, diversity, stability, and resilience of intertidal communities, and document changes in the physical environment. Using field observations and experiments, the research will provide insight into impacts of environmental change, particularly warming, on the future of coastal ecosystems, and

more generally, into possible future states of Earth’s ecosystems. Using these data, we will test the hypothesis that direct and indirect effects of climate change are driving, or may drive these systems into new, alternative states.

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.

[table of contents | back to top]

Funding

Funding Source	Award
NSF Division of Environmental Biology (NSF DEB)	DEB-2050017

[table of contents | back to top]