Percent cover and density measurements of sessile and mobile intertidal species from an Annual Colonization Experiment (ACE) in the rocky intertidal zone, Oregon Coast from 2011 to 2023

Website: https://www.bco-dmo.org/dataset/990939
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
Menge, Bruce A.	Oregon State University (OSU)	Principal Investigator
Gravem, Sarah	Oregon State University (OSU)	Co-Principal Investigator
York, Amber D.	Woods Hole Oceanographic Institution (WHOI BCO-DMO)	BCO-DMO Data Manager

Abstract
This dataset contains percent cover and density measurements of species identified from photographs during the experiment described below. Experiment/Study abstract: We tested the effects of predation, competition and facilitation on the annual colonization of rocky intertidal invertebrates from 2011-2023 at 6 sites along the Oregon coast. Mid zone factorial experiments testing the interactive effects of predation (primarily by whelks), competition, and facilitation on colonizers of annually cleared plots in the mid zone at core sites (ACE = Annual Colonization Experiment). The long-term goal was to determine if whelk-prey interactions varied with environmental change. Effects (interaction strengths) of each interaction were determined at the end of each experiment (fall of each year) by calculating the difference between cage controls and predator exclusion cages (predation effect, presumably by whelks in this mid-intertidal zone), exclusion cages with mussels removed after settlement (competition effect, primarily of mussels on barnacles), and exclusion cages with barnacles removed (facilitation effect of barnacles on mussels). ACE is now in its 14th year, and results through 2023 show that strengths of each of these interaction types have varied in space and time. The relative importance of interactions on prey abundance varied among types; facilitation by barnacles on mussels was the strongest effect, followed by predation effect of whelks on sessile invertebrates, with weak effects of competition between sessile invertebrates. Barnacle and mussel colonization rate is quantified using replicated marked plots that are cleared each spring prior to initiation of heavy settlement and then photographed in fall (October-December) after abatement of settlement and growth.

Table of Contents

Coverage

Location: Rocky Intertidal along the Oregon Coast. See accompanying site information in data
Spatial Extent: **N**:44.83863831 **E**:-124.05875 **S**:42.717772 **W**:-124.56512
Temporal Extent: 2011-06-01 - 2023-11-29

Dataset Description

ACE = Annual Colonization Experiment

Methods & Sampling

Species interaction experiments called ACE, Annual Colonization Experiment includes six treatments to test the main and interactive effects of predation, competition and disturbance on annual colonization of rocky substrates in the mid-zone of the rocky intertidal along the Oregon Coast (see site list attached). The experiment began in 2011 and is repeated annually. All plots are 15 x 15cm and fixed, and the experiment is repeated in the same location each year. Each spring (usually April or May), all plots are cleared of all biomass using scrapers and oven cleaner to reset the community. The exception is the control plots (CO) which were started in 2021 and are nearby plots that have never been intentionally disturbed. There are 6 treatments that include 1) undisturbed controls of the climax community which is typically mussel-dominated, 2) marked plots that are cleared annually to capture annual prey colonization and serve as controls for the interaction experiments, 3) 2) partial cages that serve as cage controls for the interaction experiments 3) predator exclusion cages where an open-topped metal cage is placed around the plot to deter entry by predatory whelks and sea stars and where mussel and barnacle colonization occurs undeterred (to test predation), 4) predator exclusion + barnacle removal cages in which predator are excluded plus barnacle settlers removed (to test facilitation by barnacles of mussels), and 5) predator exclusion + mussel removal cages in which predator are excluded plus mussel settlers removed (to test competition effects of mussels on barnacles). All plots are photographed approximately monthly, and treatments are maintained by removing predators that in the cages and by clearing the relevant competitors (mussels or barnacles). Photos are analyzed by overlaying a 5 x5 grid onto the photo in Image J (so that each square is 4% cover) and estimating the % cover of each major space holder to the nearest 1%. Space holders include: free space, algal crusts, acorn barnacles, gooseneck barnacles, mussels, articulated coralline algae, foliose algae and other sessile invertebrates. We also count the number of sea stars, whelks, and other herbivores. Each spring, all plots are cleared and biomass collected (except controls). Biomass of functional groups is measured as wet and dry mass of mussels, barnacles, gooseneck barnacles, mobile predators, herbivores, and other.

BCO-DMO Processing Description

* Table within sheet 1 of the submitted file "BCODMOSubmission_ACEMasterWide_ByFunc_2025-07-16.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: 990939_v1_ace-experiment.csv (along with other download format options).

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.

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

[table of contents | back to top]

Parameters

Parameter	Description	Units
PhotoID	Identifier for each photo showing SiteCode, StartYear, Replicate, Treatment, and PhotoDate. E.g. CB_2011_5_MP_2012-04-10.	unitless
PlotID	Identifier for each plot showing SiteCode, Replicate, Treatment. E.g. CB_5_MP.	unitless
SurveyID	Identifier for each survey showing SiteCode, Project, Date E.g. CB_ACE_2012-04-10.	unitless

ProjectCode	ACE for Annual Colonization Experiment.	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
Treat	Detailed cage treatment of the plot. [CO = Control, never cleared; MP = Marked Plot Control, plot cleared annually; FC = Partial Fence Control, plot cleared annually; CG = Predator exclusion cage, plot cleared annually; CG-C = Predator exclusion cage, barnacles removed ~monthly, plot cleared annually; CG-M = Predator exclusion cage, mussels removed ~monthly, plot cleared annually]	unitless
PredTreat	Predator treatment of the plot. Cages exclude predators, primarily whelks in this zone . [Predators present, Predators absent]	unitless
CompTreat	Competitor treatment of the plot. Competitors removed ~monthly. [No competitors, removed, Mussels removed, Barnacles removed]	unitless
CageTreat	Simple Cage Treatment of the plot. [Cage absent, Cage present]	unitless
ClearTreat	Annual clearing treatment of the plot. [Cleared, Not cleared]	unitless
StartYear	Year clearance started. Usually clearances are in spring and plots are monitored until the following spring.	unitless
StartDate	Date clearance started. Usually clearances are in spring and plots are monitored until the following spring.	unitless
DaysSinceClear	Days since clearance started for the site (even if plot wasn't cleared).	unitless
Season	Season photo taken.	unitless

Date	Date photo taken.	unitless
Year	Year photo taken.	unitless
Month	Month photo taken.	unitless
Day	Day photo taken.	unitless
Rep	Replicate. Each replicate has one of each treatment and is clustered in space. [1 to 5]	unitless
Tot_Free	Total % cover free space.	percent
Tot_Crust	Total % cover algal crusts.	percent
Tot_AcornBarns	Total % cover acorn barnacles.	percent
Tot_GooseBarns	Total % cover gooseneck barnacles.	percent
Tot_Muss	Total % cover mussels.	percent
Tot_OthSessInv	Total % cover other sessile invertebrates.	percent
Tot_ArtCoral	Total % cover articulated coralline algae.	percent
Tot_Foliose	Total % cover foliose algae.	percent
Tot_Stars	Total number of sea stars.	count
Tot_Whelks	Total number of whelks.	count
Tot_Herb	Total number of herbivores - snails and chitons.	count
Tot_OthMobInv	Total number of other mobile invertebrates.	count

[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]