Plant biomass and foliar standing crop (FSC) data from macroalgal surveys in Sitka Sound, Alaska kelp beds from 2010 to 2019

Website: https://www.bco-dmo.org/dataset/882019
Data Type: Other Field Results
Version: 1
Version Date: 2022-10-10

Project
» CAREER: Energy fluxes and community stability in a dynamic, high-latitude kelp ecosystem (High latitude kelp dynamics)

Contributors	Affiliation	Role
Kroeker, Kristy J.	University of California-Santa Cruz (UCSC)	Principal Investigator
Bell, Lauren E.	University of California-Santa Cruz (UCSC)	Student, Contact
York, Amber D.	Woods Hole Oceanographic Institution (WHOI BCO-DMO)	BCO-DMO Data Manager

Abstract
Plant biomass and foliar standing crop (FSC) data from macroalgal surveys in Sitka Sound, Alaska kelp beds from 2010 to 2019. These data will be published in Bell, L. E. and Kroeker, K. J. (in review).

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Coverage

Spatial Extent: **N**:57.039 **E**:-135.278 **S**:56.9875 **W**:-135.357
Temporal Extent: 2010-03-09 - 2019-07-22

Methods & Sampling

The following methodology includes a description of how these data were collected as well as how these data were used in the publication Bell and Kroeker (in review).

We conducted monthly surveys of *Macrocystis pyrifera* for folar standing crop (FSC) estimation in Sitka Sound, Alaska from January 2017 - February 2018 at Breast Is. (57.039 N, 135.333 W) and Harris Is. (57.032 N, 135.277 W), and seasonally in July 2018, January 2019, and July 2019 at Breast Is., Harris Is., and Samsing Pinnacle (56.988 N, 135.357 W). We surveyed all unique *M. pyrifera* sporophytes (hereafter, "plants" (Bolton 2016)) within two permanent 30 x 2 m transects at the 5 - 7 m depth (MLLW) contour and counted the total number of fronds extending > 1 m above the holdfast (hereafter, "frond density"). To determine the relationship between frond density and total wet mass (g), we collected and measured *M. pyrifera* plants (excluding their holdfasts) in summer 2017 (*N* = 16) and winter 2018 (*N* = 10) (Kroeker et al. 2020).

In January 2022, we collected *M. pyrifera* stipe and blade tissue collected from the surface canopy, mid canopy, and 1m above the holdfast (*N* = 12 unique plants) to capture within-plant variation in tissue dry mass composition (% wet mass). We used the slopes of the zero-intercept linear regression lines generated from these relationships as conversion factors to calculate wet and dry mass for each surveyed plant from its frond density. Across all *M. pyrifera* tissue samples, wet biomass explained 96% of the variation in dry biomass. Although mean dry mass composition of *M. pyrifera* tissues varied by location along the frond, the range of total variation (8.8-12.6% of wet mass) was small. We chose to use a mean conversion value (10.3% of wet mass) to estimate dry mass for all *M. pyrifera* tissues, as we did not consistently collect the canopy length data necessary to incorporate within-plant variation in dry mass composition. We summed the estimated dry mass of each plant and divided by surveyed area to calculate *M. pyrifera* FSC as dry mass (g · m-2) at each site for each survey.

We performed seasonal surveys of the understory stipitate kelp community, including *Neoagarum fimbriatum* and *Hedophyllum nigripes,* in July 2018 - 20, January 2019 - 2020, and March 2019 at Breast Is., Harris Is., and Samsing Pinnacle. At each site, we counted individuals of these species within two permanent 30 x 2 m transects at the 5 - 7 m depth (MLLW) contour. Starting in March 2019, we also measured a subset of individuals for total blade length and maximum blade width. When we encountered > 10 individuals of either species within a 10 x 1 m swath of a transect, we used the blade morphometrics calculated for the first 10 plants over a subsampled area to estimate total biomass for that species in the rest of that swath. To estimate total dry biomass from blade morphometrics, we collected > 10 individuals of each understory kelp species from each site in August 2018, measured each blade for maximum length and width to estimate surface area (cm-2) and weighed for wet mass (g). We dried collected *N. fimbriatum* and *H. nigripes* individuals at 60 ℃ for at least 24 hrs and reweighed for dry mass (g). For each relationship (blade surface area to wet mass, and blade wet mass to dry mass), we used the slopes of the zero-intercept linear regression lines as conversion factors to calculate a dry mass for each surveyed plant. Blade surface area explained 96% of the variability in thallus wet mass for *N. fimbriatum* and 97% of the variability in thallus wet mass for *H. nigripes* (Table S1; Bell and Kroeker, in review)). Thallus wet mass explained 99% of the variability in dry mass for both *N. fimbriatum* and *H. nigripes.*

We summed plant dry masses and divided by surveyed area to obtain the total dry mass FSC (g · m-2) of each understory species at each site for each survey. In instances where we performed surveys of both stipe counts and blade morphometrics during the same month, we used these calculated season-specific relationships to estimate total dry mass FSC of each species from their stipe densities (stipes · m-2) prior to March 2019. We also used seasonal relationships between stipe counts or blade morphometrics and the season-specific average wet mass of each understory kelp species to estimate the percent composition of understory FSC represented by each species in a survey. Stipe density in January 2020 explained 83% (*N. fimbriatum*) and 97% (*H. nigripes*) of the variability in total dry mass present in the transect, whereas stipe counts in July 2019 and 2020 explained 53% (*N. fimbriatum*) and 98% (*H. nigripes*) of the variability in total thallus dry mass during these periods.

Additional Funding Details:

In addition to primary funding from the NSF award OCE-1752600 additional funding was provided from The David and Lucile Packard Foundation and the North Pacific Research Board’s Graduate Student Research Award (1748-01) to Lauren Bell, PhD University of California Santa Cruz, Award title: "Fish Habitat, Fishes and Invertebrates, Lower Trophic Level Productivity Effect of substrate on herring roe response to global change."

Data Processing Description

BCO-DMO Data Manager Processing Notes:
* File “Sitkakelps_calculated_FSC.csv” imported into the BCO-DMO data system.
* Date format changed to ISO format
* Species list with codes and scientific names extracted from parameter information. Matched to known taxon ids using WoRMS taxa match (2022-09-06). The spelling of "Laminaria setchelii" changed to "Laminaria setchellii" with two Ls after confirming the change with the data submitter. Species list along with identifiers attached as a supplemental data table.
* Latitude and Longitude added to main data table from the provided site list.

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Data Files

File
biomass_and_crop.csv (Comma Separated Values (.csv), 3.06 KB) MD5:27291e54eb3c4bb292cd191cd2e91108 Primary data file for dataset ID 882019

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Supplemental Files

File
Sitka macroalgal survey site list filename: site_list.csv (Comma Separated Values (.csv), 259 bytes) MD5:785b37ebc9f99bea71257234529ad278 Site list for macroalgal surveys conducted in Sitka, Alaska between 2017 to 2020. Parameters (column name, description, units): Site, Site name,unitless Latitude, latitude of site, decimal degrees Longitude,longitude of site, decimal degrees
Sitka macroalgal survey species list filename: species_list.csv (Comma Separated Values (.csv), 490 bytes) MD5:983f490f673acb204083528f4f11e380 Species list for macroalgal surveys conducted in Sitka, Alaska between 2017 to 2020. Parameters (column name, description, units): Sp, species code used in related datasets (e.g. MPYR),unitless ScientificName,The accepted scientific name for the species (as of 2022-09),unitless AphiaID,Taxonomic identifier AphiaID for the species (see World Register of Marine Species),unitless LSID,Life Sciences Identifier (LSID) for the species,unitless

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Related Publications

Bell, L. E., & Kroeker, K. J. (2022). Standing Crop, Turnover, and Production Dynamics of Macrocystis pyrifera and Understory Species Hedophyllum nigripes and Neoagarum fimbriatum in High Latitude Giant Kelp Forests. Journal of Phycology, 58(6), 773–788. Portico. https://doi.org/10.1111/jpy.13291
Results

Bolton, J. J. (2016). What is aquatic botany?— And why algae are plants: The importance of non-taxonomic terms for groups of organisms. Aquatic Botany, 132, 1–4. https://doi.org/10.1016/j.aquabot.2016.02.006
Methods

Kroeker, K. J., Powell, C., & Donham, E. M. (2020). Windows of vulnerability: Seasonal mismatches in exposure and resource identity determine ocean acidification’s effect on a primary consumer at high latitude. Global Change Biology, 27(5), 1042–1051. doi:10.1111/gcb.15449
Methods

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Parameters

Parameter	Description	Units
Site	Name of rocky reef location in Sitka Sound where survey occurred. See methods for lat/long	unitless
Latitude	Site latitude	decimal degrees
Longitude	Site longitude	decimal degrees
Sp	Species of macroalga surveyed (MPYR = Macrocystis pyrifera, NFIM = Neoagarum fimbriatum, HNIG = Hedophyllum nigripes)	unitless
survey_date	Date of survey. Format is MM/DD/YY	unitless
FSC_dry	Foliar standing crop in units of dry mass per square meter. Detection limit: 0.0001g	grams per square meter (g/m2)
SE_FSC_dry	Standard error in estimate of foliar standing crop in units of dry mass. Error calculated from replicate transects. Detection limit: 0.0001g	grams per square meter (g/m2)

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Project Information

CAREER: Energy fluxes and community stability in a dynamic, high-latitude kelp ecosystem (High latitude kelp dynamics)

Coverage: SE Alaskan coastal waters

NSF Award Abstract:
High latitude kelp forests support a wealth of ecologically and economically important species, buffer coastlines from high-energy storms, and play a critical role in the marine carbon cycle by sequestering and storing large amounts of carbon. Understanding how energy fluxes and consumer-resource interactions vary in these kelp communities is critical for defining robust management strategies that help maintain these valuable ecosystem services. In this integrated research and education program, the project team will investigate how consumer populations respond to variability in temperature, carbonate chemistry and resource quality to influence the food webs and ecosystem stability of kelp forests. A comprehensive suite of studies conducted at the northern range limit for giant kelp (Macrocystis pyrifera) in SE Alaska will examine how kelp communities respond to variable environmental conditions arising from seasonal variability and changing ocean temperature and acidification conditions. As part of this project, undergraduate and high school students will receive comprehensive training through (1) an immersive field-based class in Sitka Sound, Alaska, (2) intensive, mentored research internships, and (3) experiential training in science communication and public outreach that will include a variety of opportunities to disseminate research findings through podcasts, public lectures and radio broadcasts.

Consumer-resource interactions structure food webs and govern ecosystem stability, yet our understanding of how these important interactions may change under future climatic conditions is hampered by the complexity of direct and indirect effects of multiple stressors within and between trophic levels. For example, environmentally mediated changes in nutritional quality and chemical deterrence of primary producers have the potential to alter herbivory rates and energy fluxes between primary producers and consumers, with implications for ecosystem stability. Moreover, the effects of global change on primary producers are likely to depend on other limiting resources, such as light and nutrients, which vary seasonally in dynamic, temperate and high latitude ecosystems. In marine ecosystems at high latitude, climate models predict that ocean acidification will be most pronounced during the winter months, when primary production is limited by light. This project is built around the hypothesis that there could be a mismatch in the energetic demands of primary consumers caused by warming and ocean acidification and resource availability and quality during winter months, with cascading effects on trophic structure and ecosystem stability in the future. Through complementary lab and field experiments, the project team will determine 1) how temperature and carbonate chemistry combine to affect primary consumer bioenergetics across a diversity of species and 2) the indirect effects of ocean acidification and warming on primary consumers via environmentally mediated changes in the availability, nutritional quality and palatability of primary producers across seasons. Using the data from the laboratory and field experiments, the project team will 3) construct a model of the emergent effects of warming and ocean acidification on trophic structure and ecosystem stability in seasonally dynamic, high latitude environments.

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-1752600

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