Pre-experiment Urchin Barren Characterization

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

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Abstract
Before experimental manipulation with caged Pycnopodia helianthoides presence, we characterized ambient density, gonad index, and size distributions of urchin communities (Strongylocentrotus droebachiensis and Mesocentrotus franciscanus) in three replicate urchin barrens in Sitka Sound, AK (57°2'1"N 135°15'51"W) from February 11-20, 2023. Via SCUBA we conducted swath surveys where grazers were identified, counted, measured (test diameter), and randomly collected for gonad dissections. These surveys serve as a baseline to describe these sites as true barrens and to compare experimental results to.

Table of Contents

Coverage

Location: Sitka Sound, Alaska, USA (57.033762 N, 135.264282 W) depth 6-9m
Spatial Extent: **N**:57.036 **E**:-135.255 **S**:57.033 **W**:-135.28
Temporal Extent: 2023-02-11 - 2023-02-20

Methods & Sampling

Surveys

Three urchin barren sites, Ellsworth Cut (57.036, -135.280), Harris Island (57.033, -135.277), and Whale Park (57.033, -135.255), were identified as potential sites for Pycnopodia experiments because they all had transitioned in the last several years from kelp-dominated habitats to barren. Sites were qualitatively similar in rugosity (low rugosity), substrate (bedrock, with some boulder and cobbles), and depth (6-9m). In order to better characterize the shifting state of these subtidal environments before experimental manipulation, we

surveyed the density and size structure of dominant grazers (H. kamtschatkana, M. franciscanus and S. droebachiensis) at each site using a swath approach on SCUBA (2 x 30m at Ellsworth Cut and Harris Island, and 2 x 15m at Whale Point). Urchin test diameters and longest abalone shell lengths were measured with calipers.

Gonad Indices

We also compared the gonad indices of randomly collected red sea urchins (M. franciscanus) at our three sites to an intact kelp forest reference site (Magic Island; 57.098, -135.401) about ~12 km away from the nearest experimental site. We measured the gonad index of M. franciscanus individuals from each site (N = 9-11) as: [wet mass of gonadal tissue/ total mass of the organism]*100.

Analysis

Mean and standard deviation of density and size were calculated for each species at all three barren sites with each 10m2 block of the swath surveys acting as a replicate. H. kamtchatkana was dropped from analysis for low replication. Two sample independent t-tests were used to compare means and variances between urchin species groups for density and size across sites. Gonad index was calculated and averaged for each barren site and the singular kelp forest site. T-tests were similarly used to compare average gonad content in barren sites versus the kelp forest site.

BCO-DMO Processing Description

- Added a column "ISO_Datetime" from the separate date and time columns (the original columns have been retained within the data file)

[table of contents | back to top]

Parameters

Parameter	Description	Units
Lat	Latitude	decimal degrees
Long	Longitude	decimal degrees
Site	Urchin barren site name.	unitless
ISO_DateTime	Date time in UTC.	unitless
Date	YYYY-MM-DD, AKST (Alaska Standard Time), UTC-9.	unitless
Time	HH:MM, AKST (Alaska Standard Time), UTC-9.	unitless
Diver	Diver identity.	unitless
Meter_marks	5mx2m block along 30m long transect that diver sampled.	unitless
Species	Grazer species (HALIKAM=Haliotis kamtschatkana, STRODRO= Strongylocentrotus droebachiensis, STROFRAN=Mesocentrotus franciscanus).	unitless
Scientific_Name	Scientific name of represented species in this data file.	unitless
Count	Count of corresponding species in that block of swath.	individual
Area_m2	Area sample for respective count and size data, if <10 diver subsampled due to high urchin density.	meters squared (m2)
Density_m2	Count of grazer species divided by sampled area.	meters squared (m-2)
notes	Field notes.	unitless

[table of contents | back to top]

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.

[table of contents | back to top]

Funding

Funding Source	Award
NSF Division of Ocean Sciences (NSF OCE)	OCE-1752600

[table of contents | back to top]