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El Niño and marine heatwaves: Ecological impacts on Oregon rocky intertidal kelp communities at local to regional scales

Ecological Monographs

This document serves as metadata

for the data used in the article.

GENERAL INFORMATION

1. **Title of Dataset:** El Niño and marine heatwaves: Ecological impacts on Oregon rocky intertidal kelp communities at local to regional scales

2. **Author Information:**
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3. **Date of Data Collection:** May – August 2016 to 2018

4. **Geographic Location of Data Collection:** Along 300 km of the Oregon coast. Survey sites were nested within each of three capes or regions (from North to South): Cape Foulweather [Fogarty Creek, Boiler Bay, Depoe Bay], Cape Perpetua [Yachats Beach and Strawberry Hill], and Cape Blanco [Cape Blanco North and Rocky Point]

5. **Funding Sources:** Funding for this study was provided by Incight Scholarship, Gallaudet University Graduate Fellowship, Port Orford Research Development Fund, and Hatfield Marine Science Center's Mamie Markham Research Award to Barbara J. Spiecker, and grants from NSF (OCE1735911, DEB 1050694, DEB 1554702), the David and Lucile Packard Foundation, and the Wayne and Gladys Valley Foundation (Bruce A. Menge).

SHARING/ACCESS INFORMATION:

1. **Licenses/Restrictions Placed on the Data:** Open access

2. **Link to the Publication that Use the Data:** Pending

3. **Recommended Citation for this Dataset:**
   Spiecker, Barbara; Menge, Bruce (2021), El Niño and marine heatwaves: Ecological impacts on Oregon rocky intertidal kelp communities at local to regional scales, Dryad, Dataset, https://doi.org/10.25349/D9360J

DATA & FILE OVERVIEW

1. **File List:**
   a. *Hedophyllum sessile* **percent cover, density, and length**

i.　H. sessile_cover_density_length.csv

b. *Hedophyllum sessile* **growth rate**
　　i.　H. sessile_growth rate.csv

c. *Hedophyllum sessile* **elemental composition (% Carbon, % Nitrogen, C:N)**
　　i.　H. sessile_stable isotope.csv

d. *Egregia menziesii* **percent cover, density, and length**
　　i.　E. menziesii_cover_density_length.csv

e. *Egregia menziesii* **growth rate**
　　i.　E. menziesii_growth rate.csv

f. *Egregia menziesii* **percent rachis breakage**
　　i.　E. menziesii_percent rachis breakage.csv

g. *Postelsia palmaeformis* **percent cover, density, and length**
　　i.　P. palmaeformis_cover_density_length.csv

h. **Environmental data for Oregon shores**
　　i.　Oregon_environmental data.csv

i. **Oregon daily air and water temperature**
　　i.　OR_Daily_AirWaterTemp_1997-2019.csv

j. **Summary of statistical models and their specifications**
　　i.　Summary of statistical models and their specifications.csv

<u>METHODOLOGICAL INFORMATION</u>

1. <u>**Description of Methods Used for Collection/Generation of Data:**</u>
　　a.　Refer to the Spiecker & Menge 2021 article for more details on methods.

File name: H. sessile_cover_density_length.csv

Column Metadata

Year

Month

Date

- Month/day/year

Cape

- Region where the sampling took place
- Cape Foulweather (CF), Cape Perpetua (CP), Cape Blanco (CB)

Site

- Name of the area where the sampling took place
- Fogarty Creek (FC), Boiler Bay (BB), Yachats Beach (YB), Strawberry Hill (SH), Cape Blanco North (CBN), Rocky Point (RP)

Species

- Intertidal kelp species sampled

Transect

- Five permanent (5 x 1 m) plots

Quadrat

- Transects were sampled using 0.5 x 0.5 m^2 quadrats placed contiguously on both sides of a transect line run through the middle of the plot along the 5 m axis

Percent.Cover

- % of target kelp per 0.25 m^2

Density

- # of target kelp individuals per 0.25 m^2

Frond.Length

- Blade centimeters of the longest target kelp individual in each quadrat per 0.25 m^2

File name: H. sessile_growth rate.csv

Column Metadata

Year

Month

Cape

- Region where the sampling took place
- Cape Foulweather (CF), Cape Perpetua (CP), Cape Blanco (CB)

Site

- Name of the area where the sampling took place
- Fogarty Creek (FC), Boiler Bay (BB), Yachats Beach (YB), Strawberry Hill (SH), Cape Blanco North (CBN), Rocky Point (RP)

ID_Number

- Designated ID number for each of the twenty target kelp individuals for tracking purposes.

Growth_Rate

- Blade centimeters per day
- Monthly growth rate was quantified by punching a hole in the longest vegetative blade of each individual 5 cm above the meristematic region. Growth was measured as the distance between the base of the blade and the hole which moves away from the holdfast as the blade grows.

File name: H. sessile_stable isotope.csv

Year

Cape

- Region where the sampling took place
- Cape Foulweather (CF), Cape Perpetua (CP), Cape Blanco (CB)

Site

- Name of the area where the sampling took place
- Fogarty Creek (FC), Boiler Bay (BB), Yachats Beach (YB), Strawberry Hill (SH), Cape Blanco North (CBN), Rocky Point (RP)

Replicate

- One-inch square sections of three separate individuals (replicates)

C

- Percent carbon in the sample

N

- Percent nitrogen in the sample

C_N

- The ratio of percent carbon and percent nitrogen

File name: E. menziesii_cover_density_length.csv

Column Metadata

Year

Month

Date

- Month/day/year

Cape

- Region where the sampling took place
- Cape Foulweather (CF), Cape Perpetua (CP), Cape Blanco (CB)

Site

- Name of the area where the sampling took place
- Fogarty Creek (FC), Boiler Bay (BB), Yachats Beach (YB), Strawberry Hill (SH), Cape Blanco North (CBN), Rocky Point (RP)

Species

- Intertidal kelp species sampled

Transect

- Five permanent (5 x 1 m) plots

Quadrat

- Transects were sampled using 0.5 x 0.5 m^2 quadrats placed contiguously on both sides of a transect line run through the middle of the plot along the 5 m axis

Percent.Cover

- % of target kelp per 0.25 m^2

Density

- # of target kelp individuals per 0.25 m^2

Frond.Length

- Rachis centimeters of the longest target kelp individual in each quadrat per 0.25 m^2

File name: E. menziesii_growth rate.csv

Column Metadata

Year

Month

Cape

- Region where the sampling took place
- Cape Foulweather (CF), Cape Perpetua (CP), Cape Blanco (CB)

Site

- Name of the area where the sampling took place
- Fogarty Creek (FC), Boiler Bay (BB), Yachats Beach (YB), Strawberry Hill (SH), Cape Blanco North (CBN), Rocky Point (RP)

ID_Number

- Designated ID number for each of the twenty target kelp individuals for tracking purposes.

Growth_Rate

- Rachis centimeters per day
- Monthly growth rate was quantified by punching a hole in the longest vegetative blade of each individual 5 cm below the intercalary meristematic region. Growth was measured as the distance between the meristematic region and the previous hole.

File name: E. menziesii_percent rachis breakage.csv

Column Metadata

Year

Month

Cape

- Region where the sampling took place
- Cape Foulweather (CF), Cape Perpetua (CP), Cape Blanco (CB)

Site

- Name of the area where the sampling took place
- Fogarty Creek (FC), Boiler Bay (BB), Yachats Beach (YB), Strawberry Hill (SH), Cape Blanco North (CBN), Rocky Point (RP)

Breakage

- Total individuals with broken rachis
- Individuals lacking a rachis beyond the site of the hole punch (for the growth measurement) was recorded as "broken"

Total_Measured

- Total number of individuals measured

Percent_Breakage

- Percent rachis breakage was calculated by dividing the number of "broken" individuals (Breakage) by the total number of the tagged individuals (Total_Measured).

File name: P. palmaeformis_cover_density_length.csv

Column Metadata

Year

Month

Date

- Month/day/year

Cape

- Region where the sampling took place
- Cape Foulweather (CF), Cape Perpetua (CP), Cape Blanco (CB)

Site

- Name of the area where the sampling took place
- Fogarty Creek (FC), Depoe Bay (DB), Yachats Beach (YB), Cape Blanco North (CBN)

Species

- Intertidal kelp species sampled

Transect

- Five permanent (5 x 1 m) plots

Quadrat

- Transects were sampled using 0.5 x 0.5 m^2 quadrats placed contiguously on both sides of a transect line run through the middle of the plot along the 5 m axis

Percent.Cover

- % of target kelp per 0.25 m^2

Density

- # of target kelp individuals per 0.25 m^2

Frond.Length

- Frond centimeters of the longest target kelp individual in each quadrat per 0.25 m^2

Stipe.Length

- Stipe centimeters of the longest target kelp individual in each quadrat per 0.25 m^2

File name: Oregon_environmental data.csv

Column Metadata

Plot

- Denoted by year_month_site_transect_quadrat
- Site abbreviations: Fogarty Creek (FC), Boiler Bay (BB), Yachats Beach (YB), Strawberry Hill (SH), Cape Blanco North (CBN), Rocky Point (RP)

Chla

- Chlorophyll-a (µg/L**)**
- Monthly Chl-a was extracted from bottle samples taken from the surf zone at every site.

DIN

- Dissolved Inorganic Nitrogen (µM)
- Monthly DIN was extracted from bottle samples taken from the surf zone at every site.

SST

- Sea surface temperature (°C)
- Daily SST was measured at every site using HOBO TIDBIT and/or Pendant temperature loggers held to the rock with small stainless-steel cages. The loggers sampled at 5-min intervals in the low intertidal at all sites. A detiding program was used to separate air from water temperatures.

SAT

- Surface air temperature (°C)
- Daily SST was measured at every site using HOBO TIDBIT and/or Pendant temperature loggers held to the rock with small stainless-steel cages. The loggers sampled at 5-min intervals in the low intertidal at all sites. A detiding program was used to separate air from water temperatures.

MEI

- Multivariate El Niño Index (sea surface temperature (°C) anomalies)
- MEI v2 data were obtained from NOAA's Physical Sciences Laboratory (https://psl.noaa.gov/enso/mei/)

NPGO

- North Pacific Gyre Oscillation (sea surface height (centimeters) anomalies)
- NPGO data were obtained from Georgia Institute of Technology; http://www.o3d.org/npgo/)

BEUTI

- Biologically Effective Upwelling Transport Index (mmol m^{-1} s^{-1})
- BEUTI data were measured offshore between 31°N and 47°N latitudes at 1° resolution (https://oceanview.pfeg.noaa.gov/products/upwelling/intro)

SWHT

- Significant Wave Height (feet)
- Monthly SWHT was measured by NOAA buoys 20 nautical miles west of the Oregon coast at 42°N (Station 46015) and 45°N (Station 46050) latitudes (https://www.ndbc.noaa.gov/)

File name: OR_Daily_AirWaterTemp_1997-2019.csv

Column Metadata

Air/water

- Denotation whether the temperature was measured in air or water

Cape

- Region where the sampling took place
- Cape Foulweather (CF), Cape Perpetua (CP), Cape Blanco (CB)

Site

- Name of the area where the sampling took place
- Fogarty Creek (FC), Boiler Bay (BB), Yachats Beach (YB), Strawberry Hill (SH), Cape Blanco North (CBN), Rocky Point (RP)

Date

- Month/day/year

Day

Month

Year

Mean

- Average temperature (°C)

Stddev

- Standard deviation of temperature

File name: Summary of statistical models and their specifications.csv

Column Metadata

Rationale

- Reason for the statistical analysis

Response Variable and Transformation

- List response variable(s) used in the analysis and any transformation applied

Model Type

- Hierarchical Linear Mixed Model (HLMM) was used to account for fixed and random effects. Hierarchical Generalized Linear Mixed Model (HGLMM) was used to account for the fixed and random effects, and to specify a non-Gaussian distribution. Correlation coefficients were used to measure the strength and direction of the relationship between kelp performance metrics and environmental variables. Asterisks represent residuals of the response variable after controlling for the "Year" factor.

Model Estimation, Distribution, and Correction

- Restricted Maximum Likelihood (REML), Residual Subject-specific Pseudo-Likelihood (RSPL), and Kenward-Roger approximation (KR) were used to minimize small sample size bias and prevent inflation of Type-I error rates.

Fixed Effects

- Fixed effects used for the analysis
- Month(Year) = Month nested in Year
- Year*Cape = Year x Cape interaction

Random Effects

- The nesting structures of random effects were arranged from the lowest level to the highest level. (1) SPACE: "Quadrats" → "Transects" → "Site" → "Cape". Elemental composition has a different nesting structure and it consists of "Replicate" → "Site" → "Cape"; (2) TIME: "Month" → "Year".

Multiple Pairwise Comparison Method

- Least Square Means method (LSM) was used to adjust for means of other factors in the model.

Back-Transformation

- Transformed data were back-transformed to acquire interpretable least square means and standard error. The delta method was used for the back transformation of standard error.

Software and code

- List of software and code used for the analysis