Eelgrass shoot metrics from ecological field surveys in six regions along the eastern Pacific coast in June through August of 2019, 2020, and 2021.

Website: https://www.bco-dmo.org/dataset/878857
Data Type: Other Field Results
Version: 1
Version Date: 2022-10-13

Project
» Collaborative Research: The role of a keystone pathogen in the geographic and local-scale ecology of eelgrass decline in the eastern Pacific (Eelgrass disease)

Contributors	Affiliation	Role
Harvell, Drew	Cornell University (Cornell)	Principal Investigator
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Gomes, Carla P.	Cornell University (Cornell)	Co-Principal Investigator
Hawthorne, Timothy	University of Central Florida (UCF)	Co-Principal Investigator
Stachowicz, Jay	University of California-Davis (UC Davis)	Co-Principal Investigator
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Abstract
These data were collected during ecological field surveys of eelgrass (Zostera marina) meadows along the eastern Pacific from southeastern Alaska to southern California. Parameters measured include seagrass morphology, meadow condition (e.g. shoot densities), and incidence and severity of eelgrass wasting disease. Data were collected within the intertidal area of 32 eelgrass meadows distributed in six regions (five-six meadows sampled in the regions of Alaska, British Columbia, Washington, Oregon, California - Bodega Bay, and California - San Diego). Surveys were conducted in between late June and early August in 2019, 2020, and 2021 by teams from six institutions. The influence of disease on seagrass dynamics is not well understood, and these data can further understanding of the environmental drivers of disease by connecting wasting disease with eelgrass condition across a broad geographic gradient.

Table of Contents

- Coverage
- Dataset Description
  - Methods & Sampling
  - Data Processing Description
- Data Files
- Supplemental Files
- Related Publications
- Related Datasets
- Parameters
- Instruments
- Project Information
- Funding

Coverage

Spatial Extent: **N**:55.739078 **E**:-117.10621 **S**:32.62535 **W**:-133.342896
Temporal Extent: 2019-07-02 - 2021-07-28

Methods & Sampling

Field transect surveys

Field surveys of eelgrass meadow sites were conducted at mid-summer low tides at field sites along the west coast of North America in the U.S. and Canada. Samples and data were collected within the intertidal area of 32 eelgrass meadows distributed in six regions (Alaska, British Columbia, Washington, Oregon, California - Bodega Bay, and California -San Diego). Surveys were conducted between late June and early August in 2019, 2020, and 2021 by teams from six institutions.

For each site, three 20 meter transects were laid parallel to the shore at the shoreward (upper edge) of continuous eelgrass, and three lower (intertidal) 20 meter transects were laid at least 4 meters closer to the water. Along each transect, individual eelgrass shoots (blades/leaves) were collected for analysis at 4, 8, 12, 16, and 20 meters). Leaf and shoot samples were transported in individual containers on ice to the laboratory for immediate processing.

Transect locations were recorded using a hand-held GPS (exact model varied between field locations). Salinity was measured at the time of sampling using a refractometer. Temperature loggers (HOBO MX 2201 and UA-001-64, Onset, Bourne, MA) were deployed at each eelgrass meadow site to provide a continuous record of in situ temperature. For HOBO data, see https://www.bco-dmo.org/dataset/877355 and Related Datasets section below.

Laboratory (Morphology and Imaging)

In the lab, eelgrass blades were cleaned and prepared for morphology and imaging to capture disease metrics (see https://www.bco-dmo.org/dataset/879780). Shoot morphology measurements (sheath length, number of leaves, canopy height) were taken by hand in the laboratory. The third-rank leaf from each shoot was analyzed for epiphyte load and grazing scars. Epiphytes were gently scraped from the third-rank leaf onto a pre-weighed foil tin using a flexible plastic ruler. Tins were dried at 60 degrees Celsius until the mass was constant. Epiphyte mass was calculated using the values for the dry weight of the tin with and without the epiphyte sample. The balances used to measure the epiphyte mass had precision of 0.001 grams. Epiphyte load was standardized as the mass of epiphytes per unit of leaf area.

Third-rank leaves were further analyzed for disease metrics through imaging. Cleaned leaves were placed between sheets of acetate and imaged at high resolution (600 dpi) using an Epson Perfection V550 scanner. The high-resolution images were saved in TIFF format and then processed using a program developed by the authors. The Eelgrass Lesion Image Segmentation Application (EeLISA) uses machine learning to identify healthy and diseased eelgrass tissue and outputs the following metrics:

- disease prevalence (presence or absence of disease on a given leaf)
- disease lesion area (absolute size of wasting disease lesions), and
- disease severity (proportion of leaf area damaged by disease).

~ For details on the development, testing, and training of EeLISA, see Rappazzo et al. (2021).
~ For methodology details, see Aoki et al. (2022)
~ Additional details for the field surveys are available in the Eelgrass Disease Project Handbook.
~ For 16S rRNA amplicon sequencing of eelgrass associated bacteria, refer to NCBI BioProject PRJNA802566 in the Related Datasets section below.

Data Processing Description

BCO-DMO Processing:
- Imported data from source file "meter_level_shoot_metrics.csv" into the BCO-DMO data system. Data file imported using missing data identifier "NA".
- Converted date to year-month-day format
- Joined this data with the file "eelgrass_study_revised_site_metadata.csv" which had coordinates converted to decimal degrees and consistent LocationNames.
- converted Grazing Scars to have consistent presence/absence instead of mixed (Y/N and numerical)

- Added conventional header with dataset name, PI name, version date.
- Modified parameter (column) names to conform with BCO-DMO naming conventions.

Parameters/Fields for Supplemental Files
(The following parameter descriptions are for the Supplemental File titled "Eelgrass study site metadata". For this dataset's fields, please see the heading "Parameters" below).

- ***SampleCollectionDate***: Date when samples were collected in the field
- ***Region***: Two-letter identifier for the geographic region where the sample was collected (AK=Alaska, BC=British Columbia, WA=Washington, OR=Oregon, BB=Bodega Bay in California, SD=San Diego in California)
- ***SiteCode:*** One-letter identifier for site within a geographic region where the sample was collected (A, B, C, D, E, F)
- ***LocationName***: Full name of each sampling site (eelgrass meadow) where samples were taken
- ***TidalHeight***: Single letter indicating the tidal height at which samples were collected. U = upper tidal height; L = lower tidal height
- ***Transect***: Integer indicating the transect at which samples were collected. Upper transects = 1, 2, 3; Lower transects = 4, 5, 6.
- ***SampleProcessingDate***: Date when samples were processed in the lab
- ***Depth***: Depth relative to MLLW (mean lower low water)
- ***Salinity***: Salinity of surface water at the time of sampling (point measurement made with refractometer or probe)
- ***LocationComments***: Comments describing location including changes between sampling year
- ***TransectBeginDecimalLatitude***: Latitudinal coordinate for the beginning (meter 0) of the transect
- ***TransectBeginDecimalLongitude***: Longitudinal coordinate for the beginning (meter 0) of the transect
- ***TransectEndDecimalLatitude***: Latitudinal coordinate for the end (meter 20) of the transect
- ***TransectEndDecimalLongitude***: Longitudinal coordinate for the end (meter 20) of the transect
- ***Year***: Year in which samples were collected

[table of contents | back to top]

Data Files

File
shoot_metrics.csv (Comma Separated Values (.csv), 399.51 KB) MD5:f1f86cdb31601499e14e0c018cd665e4 Primary data file for dataset ID 878857

[table of contents | back to top]

Supplemental Files

File

Eelgrass study site metadata

filename: eelgrass_study_revised_site_metadata.csv

(Comma Separated Values (.csv), 50.38 KB)
MD5:e17548ddde013aa9a344b97a16e3dfaf

Combined site metadata for eelgrass wasting disease study sites on the western coast of the U.S. and Canada

SampleCollectionDate: Date when samples were collected in the field

Region: Two-letter identifier for the geographic region where the sample was collected (AK=Alaska, BC=British Columbia, WA=Washington, OR=Oregon, BB=Bodega Bay in California, SD=San Diego in California)

SiteCode: One-letter identifier for site within a geographic region where the sample was collected (A, B, C, D, E, F)

LocationName: Full name of each sampling site (eelgrass meadow) where samples were taken

TidalHeight: Single letter indicating the tidal height at which samples were collected. U = upper tidal height; L = lower tidal height

Transect: Integer indicating the transect at which samples were collected. Upper transects = 1, 2, 3; Lower transects = 4, 5, 6.

SampleProcessingDate: Date when samples were processed in the lab

Depth: Depth relative to MLLW (mean lower low water)

Salinity: Salinity of surface water at the time of sampling (point measurement made with refractometer or probe)

LocationComments: Comments describing location including changes between sampling year

TransectBeginDecimalLatitude: Latitudinal coordinate for the beginning (meter 0) of the transect

TransectBeginDecimalLongitude: Longitudinal coordinate for the beginning (meter 0) of the transect

TransectEndDecimalLatitude: Latitudinal coordinate for the end (meter 20) of the transect

TransectEndDecimalLongitude: Longitudinal coordinate for the end (meter 20) of the transect

Year: Year in which samples were collected

NSF Eelgrass Disease Project 2019 Handbook

filename: eelgrass_disease_project_handbook_v1.2.pdf

(Portable Document Format (.pdf), 1.38 MB)
MD5:f8f77aaf781cc5170a168012c938be31

NSF Eelgrass Disease Project 2019 Handbook v1.2 from MarineGEO

[table of contents | back to top]

Related Publications

Aoki, L. R., Rappazzo, B., Beatty, D. S., Domke, L. K., Eckert, G. L., Eisenlord, M. E., Graham, O. J., Harper, L., Hawthorne, T. L., Hessing-Lewis, M., Hovel, K. A., Monteith, Z. L., Mueller, R. S., Olson, A. M., Prentice, C., Stachowicz, J. J., Tomas, F., Yang, B., Duffy, J. E., … Harvell, C. D. (2022). Disease surveillance by artificial intelligence links eelgrass wasting disease to ocean warming across latitudes. Limnology and Oceanography, 67(7), 1577–1589. Portico. https://doi.org/10.1002/lno.12152
Related Research

Rappazzo, B. H., Eisenlord, M. E., Graham, O. J., Aoki, L. R., Dawkins, P. D., Harvell, D., & Gomes, C. (2021). EeLISA: Combating Global Warming Through the Rapid Analysis of Eelgrass Wasting Disease. Proceedings of the AAAI Conference on Artificial Intelligence, 35(17), 15156-15165. Retrieved from https://ojs.aaai.org/index.php/AAAI/article/view/17779
Methods

[table of contents | back to top]

Related Datasets

IsSupplementedBy

Harvell, D., Gomes, C. P., Hawthorne, T., Stachowicz, J. J., Duffy, J. E., Aoki, L. (2022) **In situ temperature measurements from eelgrass meadow field sites along the west coast of North America recorded from July 2019 to July 2021.** Biological and Chemical Oceanography Data Management Office (BCO-DMO). (Version 1) Version Date 2022-10-14 doi:10.26008/1912/bco-dmo.877355.1 [view at BCO-DMO]
Relationship Description: In situ temperature measurements related to eelgrass disease study

University of California, Davis. 16S rRNA amplicon sequencing of eelgrass associated bacteria. 2022/02. In: BioProject [Internet]. Bethesda, MD: National Library of Medicine (US), National Center for Biotechnology Information; 2011-. Available from: http://www.ncbi.nlm.nih.gov/bioproject/PRJNA802566. NCBI:BioProject: PRJNA802566.

IsRelatedTo

Harvell, D., Gomes, C. P., Hawthorne, T., Stachowicz, J. J., Duffy, J. E., Aoki, L. (2022) **Eelgrass disease metrics from ecological field surveys along the eastern Pacific coast in June through August of 2019, 2020, and 2021.** Biological and Chemical Oceanography Data Management Office (BCO-DMO). (Version 1) Version Date 2022-10-13 doi:10.26008/1912/bco-dmo.879780.1 [view at BCO-DMO]

Harvell, D., Gomes, C. P., Hawthorne, T., Stachowicz, J. J., Duffy, J. E., Aoki, L. (2022) **Eelgrass shoot density measurements taken during ecological field surveys along the eastern Pacific coast in June through August of 2019, 2020, and 2021.** Biological and Chemical Oceanography Data Management Office (BCO-DMO). (Version 1) Version Date 2022-10-13 doi:10.26008/1912/bco-dmo.879764.1 [view at BCO-DMO]

[table of contents | back to top]

Parameters

Parameter	Description	Units
Sample_Date	Date when samples were collected in the field	unitless
Sample_Id	Unique code identifying field samples based on the region, site, transect, tidal height, and sample replicate	unitless
Region	Two-letter identifier for the geographic region where the sample was collected (AK=Alaska, BC=British Columbia, WA=Washington, OR=Oregon, BB=Bodega Bay in California, SD=San Diego in California)	unitless
Site_Code	One-letter identifier for the site within a geographic region where the sample was collected (A, B, C, D, E, F)	unitless
Location	Full name of each sampling site (eelgrass meadow) where samples were taken	unitless
Tidal_Height	Single letter indicating the tidal height at which samples were collected. U = upper tidal height; L = lower tidal height	unitless
Depth	Depth relative to MLLW (mean lower low water)	meters (m)
Salinity	Salinity of surface water at the time of sampling (point measurement made with refractometer or probe)	ppt

Transect	Integer indicating the transect at which samples were collected. Upper transects = 1, 2, 3; Lower transects = 4, 5, 6.	unitless
Meter	Exact meter along the transect where an individual sample was collected (m4, m8, m12, m16, m20)	unitless
Blade	Integer indicating the replicate number for the disease and epiphyte blades collected along each transect. Values are 1-25	unitless
Longest_Blade_Length	Length of the longest blade in a shoot measured by hand in the lab	millimeters (mm)
Longest_Blade_Width	Width of the longest blade in a shoot measured by hand in the lab	millimeters (mm)
Sheath_Length	Length of the sheath, measured by hand in the lab	millimeters (mm)
Scanned_Blade_Length	length of individual blades, from the top of the sheath to the tip, measured by hand in the lab; scanned blades are 3rd rank at all sites expect 2nd rank at OR	millimeters (mm)
Scanned_Blade_Width	Width of individual blade measured by hand in the lab; scanned blades are 3rd rank at all sites except 2nd rank at OR	millimeters (mm)
Prevalence_Hand	Presence or absence of disease based on a rapid manual assessment during processing; this value is NOT used for further analysis but is a quick confirmation that disease absence was verified for any totally healthy shoots that were not scanned during processingFactor indicating the presence or absence of wasting disease on a blade based on a rapid manual assessment during processing. Values are 0 = healthy or disease is absent; 1 = disease is present. (This value is NOT used for further analysis but is a quick confirmation that disease absence was verified for any totally healthy shoots that were not scanned during processing)	unitless
Grazing_Scars	Integer indicating the presence or absence of grazing scars on the third rank blade. 0= no grazing scar; 1= grazing scars are present	unitless
Broken_Tip	Code indicating presence of a broken leaf tip on an individual blade, Y = yes, tip is broken, N = no, tip is intact	unitless
Epiphyte_Dry_Mass	Dry mass of epiphytes scraped from the scanned blade	grams (g)

Blade_Area_Hand	Blade area of scanned blade calculated from measurements of length and width made by hand in the lab	centimeters squared (cm2)
Number_Leaves	Count of leaves on the shoot (not collected in 2019)	unitless
TransectBeginDecimalLatitude	Latitudinal coordinate for the beginning (meter 0) of the transect	decimal degrees
TransectBeginDecimalLongitude	Longitudinal coordinate for the beginning (meter 0) of the transect	decimal degrees
TransectEndDecimalLatitude	Latitudinal coordinate for the end (meter 20) of the transect	decimal degrees
TransectEndDecimalLongitude	Longitudinal coordinate for the end (meter 20) of the transect	decimal degrees
Notes	Comments from field and lab	unitless

[table of contents | back to top]

Instruments

Dataset-specific Instrument Name	hand-held GPS
Generic Instrument Name	Global Positioning System Receiver
Dataset-specific Description	Transect locations were recorded using a hand-held GPS (exact model varied between field locations).
Generic Instrument Description	The Global Positioning System (GPS) is a U.S. space-based radionavigation system that provides reliable positioning, navigation, and timing services to civilian users on a continuous worldwide basis. The U.S. Air Force develops, maintains, and operates the space and control segments of the NAVSTAR GPS transmitter system. Ships use a variety of receivers (e.g. Trimble and Ashtech) to interpret the GPS signal and determine accurate latitude and longitude.

Dataset-specific Instrument Name	Epson Perfection V550 scanner
Generic Instrument Name	Image scanner
Dataset-specific Description	Cleaned eelgrass blades were imaged at high resolution (600 dpi) using an Epson Perfection V550 scanner.
Generic Instrument Description	An electronic device that generates a digital representation of an image for data input to a computer. OR a receiver designed to search for a signal within a specified frequency range. [Definition Source: NCI]

Dataset-specific Instrument Name	HOBO MX2201 temperature logger
Generic Instrument Name	Onset HOBO Pendant MX2201 temperature logger
Generic Instrument Description	The Onset HOBO MX2201 is an in-situ instrument for wet or underwater applications. It supports soil temperature, temperature, and water temperature. A one-channel logger that records up to approximately 96,000 measurements or internal logger events with 8K bytes memory. It has a polypropylene housing case. Uses Bluetooth to transmit data. Can be used with a solar radiation shield. Measurement range: -20 deg C to 70 deg C. Accuracy: +/- 0.50 deg C from 0 deg C to 50 deg C. Water depth rating: 30.5 m

Dataset-specific Instrument Name	HOBO UA-001-064 temperature logger
Generic Instrument Name	Onset HOBO Pendant Temperature/Light Data Logger
Generic Instrument Description	The Onset HOBO (model numbers UA-002-64 or UA-001-64) is an in-situ instrument for wet or underwater applications. It supports light intensity, soil temperature, temperature, and water temperature. A two-channel logger with 10-bit resolution can record up to approximately 28,000 combined temperature and light measurements with 64K bytes memory. It has a polypropylene housing case. Uses an optical USB to transmit data. A solar radiation shield is used for measurement in sunlight. Temperature measurement range: -20 deg C to 70 deg C (temperature). Light measurement range: 0 to 320,000 lux. Temperature accuracy: +/- 0.53 deg C from 0 deg C to 50 deg C. Light accuracy: Designed for measurement of relative light levels. Water depth rating: 30 m.

Dataset-specific Instrument Name	refractometer (?? need info on make/model from PIs)
Generic Instrument Name	Refractometer
Dataset-specific Description	Salinity was measured at the time of sampling using a refractometer.
Generic Instrument Description	A refractometer is a laboratory or field device for the measurement of an index of refraction (refractometry). The index of refraction is calculated from Snell's law and can be calculated from the composition of the material using the Gladstone-Dale relation. In optics the refractive index (or index of refraction) n of a substance (optical medium) is a dimensionless number that describes how light, or any other radiation, propagates through that medium.

Dataset-specific Instrument Name	Balance
Generic Instrument Name	scale or balance
Dataset-specific Description	Balances used to measure epiphyte mass had precision of 0.001 g
Generic Instrument Description	Devices that determine the mass or weight of a sample.

[table of contents | back to top]

Project Information

Collaborative Research: The role of a keystone pathogen in the geographic and local-scale ecology of eelgrass decline in the eastern Pacific (Eelgrass disease)

Coverage: West coast of North America, from San Diego to Alaska

This project is part of the Marine Global Earth Observatory (MarineGEO), directed by the Smithsonian's Tennenbaum Marine Observatories Network (TMON); a global network of partners focused on understanding how coastal marine ecosystems work—and how to keep them working https://marinegeo.si.edu/

NSF Abstract:

Pathogens may be unrecognized key species in many ecosystems, causing massive impacts on other species and habitats despite the microscopic size of disease-causing organisms. Yet the triggers to disease epidemics likely involve complex interactions among changing environmental conditions and associated biological communities. In the ocean, understanding disease outbreaks has been hindered by inadequate knowledge of how these various influences interact to determine susceptibility and resilience to disease. This project integrates research in community and disease ecology with microbial genomics, geospatial analysis, and state-of-the-art computational approaches toward an unprecedented understanding of the causes and consequences of wasting disease in eelgrass, an important vegetation type supporting coastal and estuarine ecosystems throughout the northern hemisphere. The research advances frontiers in understanding the growing but poorly appreciated threat of marine diseases, how disease ecology interacts with environmental change, and its consequences for the extensive ecosystems and coastal communities that depend on eelgrass, across 23 degrees of latitude along the Pacific coast of North America. The research will inform better management of threatened seagrass ecosystems, which provide important services including fisheries habitat, erosion control, carbon storage, and capture of nutrient runoff. The research will foster integrative approaches in the next generation, including high school students, undergraduates, graduate students, and postdocs working on the project, and each investigator's institution will work to recruit participants from under-represented groups. Best practices developed under this award, including the Eelisa disease app and drone mapping, will be disseminated for broader surveillance of seagrass disease and coastal habitat quality by both professional and citizen scientists in coordination with the Global Ocean Observing System's (GOOS) develpoment of seagrass extent as an Essential Ocean Variable.

The triggers to marine disease epidemics are likely complex, and progress in understanding them has been hindered by a poor understanding of the multifaceted ecological context of the host-disease interaction. This project's overarching goal is to disentangle the web of direct and indirect interactions by which changing climate mediates prevalence of eelgrass wasting disease, and its consequences for threatened but important eelgrass ecosystems. The centerpiece is a comparative, cross-scale survey of eelgrass community composition, microbiome, and disease prevalence along thermal gradients of latitude and exposure to the ocean, providing the first coast-wide picture of disease dynamics in response to environmental change. In situ sampling will be linked to dynamics of eelgrass at landscape scales using unmanned aerial systems (drones) to quantify high-resolution changes in eelgrass extent and habitat quality. Experiments will test how the diverse biological community mediates impacts of the pathogen on eelgrass ecosystems.

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-1829890
NSF Division of Ocean Sciences (NSF OCE)	OCE-1829922
NSF Division of Ocean Sciences (NSF OCE)	OCE-1829921
NSF Division of Ocean Sciences (NSF OCE)	OCE-1829992

[table of contents | back to top]