Particle Image Velocimetry videos of flow and spawning over mussel aggregations within a flume at Friday Harbor Labs, Washington during the summer of 2021

Website: https://www.bco-dmo.org/dataset/986706
Data Type: experimental
Version: 1
Version Date: 2025-11-25

Project
» Collaborative Research: Microscale interactions of foundation species with their fluid environment: biological feedbacks alter ecological interactions of mussels (Microscale Mussels)

Contributors	Affiliation	Role
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Abstract
Collected California and Bay mussel particle image velocimetry data within a water flume set to flow conditions between 1 and 4 inches per second. Movies are approximately 20 seconds long. California mussels were imaged on July 2, 2021 and Bay mussels were imaged on June 29, 2021. Due to the warm water the Bay mussels began spawning in the videos.

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Coverage

Location: Flume experiments at Friday Harbor Laboratory, Washington
Temporal Extent: 2021-06-29 - 2021-07-02

Methods & Sampling

Collected 1 California and Bay mussel PIV dataset. Images were collected on a Nikon D7000 DSLR camera. A 325 mW diode-pumped solid-state laser (Laserglow Technologies® Hercules Series) was used for particle image velocimetry measurements. Movies were collected at 30 frames per second.

Individual .tif images are of a 1 cm by 1 cm grid that is used for a scale to size the images from pixel to distance.

One .tif image was collected for the Bay mussel and one .tif image was collected for the California mussel.

The Data File "mussel_PIV_and_spawning.zip" contains the .tif scale images and the following .MOV movies:

Movie bay mussel aggregations (Folder "June29_Bay_spawning/" within zip package)

Took multiple images at zero flow. DSC1043-1050
3 videos with flume flow set to 1 in/sec. DSC1052-1055
3 videos with flume flow set to 2 in/sec. DSC1057-1059
3 videos with flume flow set to 3 in/sec.DSC1060-DSC1063
3 videos with flume flow set to 4 in/sec. DSC1064-DSC1067

Moved to the large flume with the California mussel aggregations (Folder "July2_California_aggregation/" within zip package).
* Each video is about 20 seconds long. PIV imaging

Took multiple images at zero flow. DSC1141-1143
3 videos with flume flow set to 1 in/sec. DSC1144-1146
3 videos with flume flow set to 2 in/sec. DSC1147-1149
3 videos with flume flow set to 3 in/sec. DSC1150-1152
3 videos with flume flow set to 4 in/sec. DSC1153-1155

Organism names (Common Name, Scientific Name, LSID):
California mussel, *Mytilus californianus*, urn:lsid:marinespecies.org:taxname:367837
Bay mussel, *Mytilus trossulus*, urn:lsid:marinespecies.org:taxname:140482

Instrument usage description:
Measurements of flow over the mussels were obtained using a custom-built particle image velocimetry (PIV) experimental setup. A 325 mW diode-pumped solid-state laser (Laserglow Technologies® Hercules Series) was positioned centrally on a platform clamped to the top of the water tunnel test section. The continuous wave laser produced a 532 nm wavelength green light, which was directed vertically downward through a pair of convex lenses to produce a 2-dimensional laser sheet measuring approximately 10 cm by 10 cm. Perpendicular to the laser sheet and level with the coral models, a digital single-lens reflex (DSLR) camera (Nikon Corporation® D7000) with a 24-85mm macro lens was mounted on a tripod.

Data Processing Description

Raw movie files collected on Nikon D7000 camera.

BCO-DMO Processing Description

* Fileset provided to BCO-DMO was packed into zip file mussel_PIV_and_spawning.zip
* File inventory created with metadata for each file including the filename, relative path within the zip package, byte size, md5 checksum, and additional metadata added from provided methods for flow rate, description, collection date, and organism. Table added as supplemental file file_metadata.csv
* SciNames and Life Science Identifiers (LSIDs) added to the metadata for the mussel common names using the World Register of Marine Species (WoRMS) on 2025-11-25.

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Parameters

Parameters for this dataset have not yet been identified

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Instruments

Dataset-specific Instrument Name	Nikon D7000 camera
Generic Instrument Name	Camera
Dataset-specific Description	Raw movie files collected on Nikon D7000 camera
Generic Instrument Description	All types of photographic equipment including stills, video, film and digital systems.

Dataset-specific Instrument Name	Laserglow Technologies® Hercules Series
Generic Instrument Name	Particle Image Velocimetry (PIV) system
Dataset-specific Description	Diode-pumped solid-state laser (Laserglow Technologies® Hercules Series) was used for particle image velocimetry measurements
Generic Instrument Description	Measures 2D velocity flow fields, usually by scanning particles with a laser beam and capturing images of the illuminated particles.

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Project Information

Collaborative Research: Microscale interactions of foundation species with their fluid environment: biological feedbacks alter ecological interactions of mussels (Microscale Mussels)

Coverage: University of Washington Friday Harbor Laboratories

NSF Award Abstract:
The project investigates how the metabolic activity of dense aggregations of marine organisms alter the water chemistry of their interstitial spaces, and how these microscale alterations feedback to affect the organisms' interactions in coastal ecosystems. The research team focuses on bivalve mussels, foundation species that form dense 'beds' typically known for facilitating other species by ameliorating harsh flow conditions. This ability can become a liability, however, if flow is not sufficient to flush the interstitial spaces and steep, metabolically-driven concentration gradients develop. The research evaluates whether corrosive chemical microclimates (such as low oxygen or low pH) are most extreme in low flow, high temperature conditions, especially for dense aggregations of mussels with large biomass and/or high respiration rates, and if they negatively impact mussel beds and the diverse biological communities they support. The research addresses a global societal concern, the impact of anthropogenic climate change on coastal marine ecosystems, and has potential applications to aquaculture and biofouling industries by informing adaptation strategies to "future-proof" mussel farms in the face of climate change and improved antifouling practices for ships, moorings, and industrial cooling systems. The project forges new collaborations with investigators from three campuses and integrates research and education through interdisciplinary training of a diverse group of graduate, undergraduate and high school students. STEM education and environmental stewardship is promoted by the development of a K-12 level science curriculum module and a hand's-on public exhibit of bivalve biology at a local shellfish farm. Research findings are disseminated in a variety of forums, including peer-reviewed scientific publications and research presentations at regional, national and international meetings.

The research team develops a framework that links environmental conditions measured at a coarse scale (100m-100km; e.g., most environmental observatories) and ecological processes at the organismal scale (1 cm – 10 m). Specifically, the project investigates how aggregations of foundation species impact flow through interstitial spaces, and how this ultimately impacts water chemistry immediately adjacent to the organisms. The research focuses on mytilid mussels, with the expectation that the aggregation alters the flow and chemical transport in two ways, one by creating a physical resistance, which reduces the exchange, and the other by enhancing the exchange due to their incurrent/excurrent pumping. These metabolically-driven feedbacks are expected to be strongest in densely packed, high biomass aggregations and under certain ambient environmental conditions, namely low flow and elevated temperature, and can lead to a range of negative ecological impacts that could not be predicted directly from coarse scale measures of ambient seawater chemistry or temperature. The team develops computational fluid dynamic (CFD) models to predict interstitial

flows and concentration gradients of dissolved oxygen and pH within mussel beds. The CFD model incorporates mussel behavior and physiological activity (filtration, gaping, respiration) based on published values as well as new empirical work. Model predictions are compared to flow and concentration gradients measured in mussel aggregations in the laboratory and field. Finally, the team conducts several short-term experiments to quantify some of the potential negative ecological impacts of corrosive interstitial water chemistry on mussel aggregations, such as reduced growth, increased dislodgement, increased predation risk, and reduced biodiversity. Because the model is based on fluid dynamic principles and functional traits, the framework is readily adaptable to other species that form dense assemblages, thereby providing a useful tool for predicting the ability of foundation species to persist and provide desirable ecosystem services under current and future multidimensional climate scenarios.

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-2050345

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