Speed and nearest neighbor distances in each trial of Antarctic krill in lab experiments at Palmer Station, Antarctica in November 2022.

Website: https://www.bco-dmo.org/dataset/923530
Data Type: experimental
Version: 1
Version Date: 2024-03-26

Project
» Collaborative Research: Individual Based Approaches to Understanding Krill Distributions and Aggregations (Krill Aggregation)

Contributors	Affiliation	Role
Murphy, David	University of South Florida (USF)	Principal Investigator
Garayev, Kuvvat	University of South Florida (USF)	Student, Contact
Soenen, Karen	Woods Hole Oceanographic Institution (WHOI BCO-DMO)	BCO-DMO Data Manager

Abstract
Laboratory experiments were conducted on schools of Antarctic krill in the novel annular flume at Palmer Station, Antarctica, in November 2022. Using overhead camera along with stereophotogrammetry system the swimming trajectories of krill were recorded while altering flow and light levels in the tank. The purpose of the study is to understand how Antarctic krill schooling structure changes under environmental cues such as flow and light, with the hope that distribution of these important species can be predicted through knowledge of the environment in the wild. Southern Ocean ecologists, biologists, and oceanographers in general could benefit from this work. Kuvvat Garayev and David Murphy from University of South Florida were responsible for the collection and interpretation of data.

Table of Contents

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

Coverage

Location: Palmer Station, Antarctica

Methods & Sampling

We deployed on the *R/V Laurence M. Gould* to Palmer Station, Antarctica in October - December 2022. On the way, we collected krill using an Isaac-Kidd Midwater Trawl net at the following locations: 63°06.5′ S, 61°46.6′ W (on October 5th, 2022) and 64°37.9′ S, 62°14.5′ W (on October 6th, 2022). Krill were kept in two tanks with a continuous seawater supply on the boat until being transferred to holding tanks at the Station. Additional krill were collected from Wilhelmina Bay (64°42.0′ S, 62°16.6′ W) on November 12th by the *R/V Nathaniel B. Palmer*, transported to Palmer Station, and added to the same holding tanks filled with filtered seawater (100 µm).

Data Processing Description

For speed and nearest neighbor distance (NND) calculations, DLTdv8 app in MATLAB was used (Hedrick, T. L. (2008)).

“speed and nnd” is for calculating speed and nearest neighbor distances of krill in the field of view of 3 high-magnification cameras (i.e., cam2, cam5, and cam4). “speed and nnd” contains 4 folders: “trial 4”, “trial 31”, “trial 43”, and “trial 46”.

Each folder contains spreadsheet named 1_data.csv which has several bursts consisting of 3 consecutive frames (rows) separated by NaN rows. Columns, except Column 1 which is NaN, sequentially correspond to X, Y, and Z coordinates of krill in meters. For example, rows 2, 3, and 4 correspond to 3 consecutive time points that make up one burst. Columns 2 to 4 correspond to X, Y, and Z coordinates of one krill, and 5 to 7 correspond to X, Y, and Z coordinates of another krill, etc.

[table of contents | back to top]

Related Publications

Hedrick, T. L. (2008). Software techniques for two- and three-dimensional kinematic measurements of biological and biomimetic systems. Bioinspiration & Biomimetics, 3(3), 034001. https://doi.org/10.1088/1748-3182/3/3/034001
Software

[table of contents | back to top]

Parameters

Parameters for this dataset have not yet been identified

[table of contents | back to top]

Instruments

Dataset-specific Instrument Name	
Generic Instrument Name	Machine Vision Camera System
Dataset-specific Description	Four 4 cameras (5 MP AVT Mako) were time synchronized using StreamPix software and recorded to a system at 20 Hz frame rate (Norpix, Canada). Overhead camera (Camera 1) is equipped with a 8 mm focal length lens (M0824-MPW2, Computar) whereas stereo cameras (Cameras 2-4) are equipped with 25 mm focal length lenses (M3520-MPW2, Computar).
Generic Instrument Description	A machine vision camera captures images or videos of a scene, which are then processed and analyzed using machine vision algorithms.

[table of contents | back to top]

Project Information

Collaborative Research: Individual Based Approaches to Understanding Krill Distributions and Aggregations (Krill Aggregation)

NSF Award Abstract:
Antarctic krill (Euphausia superba) are an ecologically important component of the Southern Ocean's food web, yet little is known about their behavior in response to many features of their aquatic environment. This project will improve understanding of krill swimming and schooling behavior by examining individual responses to light levels, water flow rates, the presence of attractive and repulsive chemical cues. Flow, light and chemical conditions will be controlled and altered in specialized tanks outfitted with high speed digital camera systems so that individual krill responses to these factors can be measured in relevant schooling settings. This analysis will be used to predict preferred environments, define the capacity of krill to detect and move to them (and away from unfavorable ones). Such information will then be used to improve models that estimate the energetic costs of behaviors associated with different types of environments. Linking individual behavior to those of larger krill aggregations will also improve acoustic assessments of krill densities. Understanding the capacity of krill to respond to environmental perturbations will improve our understanding of the ecology of high latitude ecosystems and provide relevant information for the management of krill fisheries. The project will support graduate and undergraduate students and provide training for as post-doctoral associate. Curricular materials and public engagement activities will be based on the project's aims and activities. Project investigators will share model results and predictions of krill movements and school structure with experts interested in krill conservation and management.

The project will use horizontal and vertical laminar flow tunnels to examine krill behavior under naturally relevant conditions. Horizontal (1-10 cm per second) and vertical (1-3 mm per second) flow velocities mimic naturally relevant current patterns, while light levels and spectral quality will be varied from complete darkness to intensities experienced across the depth range inhabited by krill. Attractive phytoplankton odor will be created by dosing the flumes to obtain background chlorophyll a levels approximating average and bloom conditions, while repulsive cues will be generated from penguin guano. Behavior of individual krill in all conditions will be video recorded with cameras visualizing X-Y and Y-Z planes, and 3D movements will be reconstructed by video motion analysis at a 5 Hz sampling rate. The distribution of horizontal and vertical swimming angles and velocities will be used to create an individual based model (IBM) of krill movement in response to each condition, where krill behavior at each model time step is based on random draws from the velocity and angular distributions. Since krill commonly travel in groups, further experiments will examine the behavior of small krill schools in these same conditions to further parameterize variables such as individual spacing. Researchers will examine krill aggregation structure from 3D video records of krill swimming in a specially designed kriesel tank, and compute nearest neighbor distances (NND) and correlations of swimming angles among individuals within the aggregation. Krill movements in the IBM will be constrained to adhere to observed NND and angular correlations. Large scale oceanographic models will be used to define spatial environments in which the modelled krill will be allowed to move using simulated schools of 1000-100,000 krill. Model output will include the school swimming speed, direction and structure (packing density, NND). Researchers will compare available acoustic data sets of krill schools in measured flow and phytoplankton abundance to evaluate the model predictions.

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 Office of Polar Programs (formerly NSF PLR) (NSF OPP)	OPP-1840941

[table of contents | back to top]