Krill swarms detected with active acoustic EK80 onboard small boat surveys in Palmer Deep Canyon, Antarctica during January-March 2020

Website: https://www.bco-dmo.org/dataset/949922
Data Type: Other Field Results
Version: 1
Version Date: 2025-01-30

Project
» Collaborative Research: Physical Mechanisms Driving Food Web Focusing in Antarctic Biological Hotspots (Project SWARM)

Contributors	Affiliation	Role
Bernard, Kim S.	Oregon State University (OSU)	Co-Principal Investigator
Hann, Ashley	Oregon State University (OSU)	Student
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Abstract
These data include identified krill swarms observed by a hull-mounted SIMRAD EK80 single-beam, single frequency (120 kHz) echo sounder (Kongsberg Maritime) hereby referred to as “EK80”. Data were collected in Palmer Deep Canyon, Antarctica during January-March 2020. Small boat surveys were conducted twice weekly over known penguin foraging areas. EK80 data were processed using Echoview software and backscattering zooplankton were identified as krill when within a target strength of -70 dB to -30 dB. The EK80 survey was designed in concert with the ACROBAT, HFR and mooring observations to provide a wholistic view of the food web. Observing the distribution of krill swarms and their correlation with other ecosystem variables is important for understanding how the Palmer Deep ecosystem, and other coastal ecosystems globally, respond to complex coastal ocean currents and ways this system may be resilient to rapid warming. The collection and processing of these data was headed by Ashley Hann and Dr. Kim Bernard.

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Coverage

Location: Palmer Deep Canyon, Antarctic
Spatial Extent: **N**:-64.79720121 **E**:-63.77062609 **S**:-64.9104786 **W**:-64.27354803
Temporal Extent: 2020-01-15 - 2020-03-10

Methods & Sampling

Day trip active acoustic surveys were conducted from Palmer Station Field Season aboard RHIB twice weekly from January-March 2020 using a hull-mounted SIMRAD EK80 single-beam, single frequency (120 kHz) echosounder (Kongsberg Maritime) along transects shown in Figure 1A (Veatch et al 2025).

The echosounder was configured with a 1 s ping rate, 512 µs pulse duration, and 24 µs sampling duration. Calibrations of the echosounder were performed in the vicinity of Palmer Deep Canyon using a tungsten sphere (diameter = 38.1 mm) during February, 2020. Acoustic data were processed in Myriax Echoview software version 11.1 following methods from (Tarling, Klevjer et al. 2009) and (Tarling, Thorpe et al. 2018). Raw data were processed to consider the echosounder calibration and in situ ocean acoustic conditions via incorporation of onboard CTD data, and to remove background noise and other interferences via the Background Noise Removal (De Robertis and Higginbottom 2007) and Impulse Noise Removal (Ryan, Downie et al. 2015) algorithms in Echoview. Krill were then detected using a target strength threshold of -70 dB to -30 dB(Tarling, Klevjer et al. 2009, Tarling, Thorpe et al. 2018) in Echoview following similar parameterization and protocols to (Nardelli, Cimino et al. 2021) and (Reiss, Cossio et al. 2021) (Figure 4, Veatch et al 2025).

Data Processing Description

All acoustically detected krill swarms were manually reviewed before exporting the acoustic data in NASC (Nautical Area Scattering Coefficient) values, a common proxy for organism presence in acoustic measurements. NASC values were calculated per detected swarm and exported along with depth, GPS position (longitude and latitude), swarm height, swarm length, and backscatter (Sv). These methods for acoustic surveys and processing of subsequent acoustic data follow those in (Hann, Bernard et al. 2023).

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Data Files

File
949922_v1_ek80krill.csv(Comma Separated Values (.csv), 659.58 KB) MD5:cd207e24b097bfd1277bbc2cb0b5c6af Primary data file for dataset ID 949922, version 1

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Related Publications

De Robertis, A., & Higginbottom, I. (2007). A post-processing technique to estimate the signal-to-noise ratio and remove echosounder background noise. ICES Journal of Marine Science, 64(6), 1282–1291. doi:10.1093/icesjms/fsm112
Methods

Hann, A. M., Bernard, K. S., Kohut, J., Oliver, M. J., & Statscewich, H. (2023). New insight into Salpa thompsoni distribution via glider-borne acoustics. Frontiers in Marine Science, 9. https://doi.org/10.3389/fmars.2022.857560
Results

Nardelli, S. C., Cimino, M. A., Conroy, J. A., Fraser, W. R., Steinberg, D. K., & Schofield, O. (2021). Krill availability in adjacent Adélie and gentoo penguin foraging regions near Palmer Station, Antarctica. Limnology and Oceanography, 66(6), 2234–2250. Portico. https://doi.org/10.1002/lno.11750
Methods

Reiss, C. S., Cossio, A. M., Walsh, J., Cutter, G. R., & Watters, G. M. (2021). Glider-Based Estimates of Meso-Zooplankton Biomass Density: A Fisheries Case Study on Antarctic Krill (Euphausia superba) Around the Northern Antarctic Peninsula. Frontiers in Marine Science, 8. https://doi.org/10.3389/fmars.2021.604043
Methods

Ryan, T. E., Downie, R. A., Kloser, R. J., & Keith, G. (2015). Reducing bias due to noise and attenuation in open-ocean echo integration data. ICES Journal of Marine Science, 72(8), 2482–2493. doi:10.1093/icesjms/fsv121
Methods

Tarling, G. A., Klevjer, T., Fielding, S., Watkins, J., Atkinson, A., Murphy, E., Korb, R., Whitehouse, M., & Leaper,

R. (2009). Variability and predictability of Antarctic krill swarm structure. Deep Sea Research Part I: Oceanographic Research Papers, 56(11), 1994–2012. https://doi.org/10.1016/j.dsr.2009.07.004
Methods

Tarling, G. A., Thorpe, S. E., Fielding, S., Klevjer, T., Ryabov, A., & Somerfield, P. J. (2018). Varying depth and swarm dimensions of open-ocean Antarctic krill Euphausia superba Dana, 1850 (Euphausiacea) over diel cycles. Journal of Crustacean Biology. https://doi.org/10.1093/jcbiol/ruy040
Methods

Veatch, Jacquelyn, Matthew Oliver, Erick Fredj, Hank Statscewich, Kim Bernard, Ashley M. Hann, Grant Voirol, Heidi Fuchs, William R Fraser, and Josh Kohut. 2024. 'Lagrangian coherent structures influence the spatial structure of marine food webs ', in revision at Communications Earth & Environment
Results

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Related Datasets

IsRelatedTo

Statscewich, H., Veatch, J., Kohut, J., Oliver, M. (2024) **Water temperature, salinity, and optical properties from an Acrobat towed vehicle from bi-weekly grids conducted at Palmer Station, Antarctica in 2020.** Biological and Chemical Oceanography Data Management Office (BCO-DMO). (Version 1) Version Date 2023-12-01 doi:10.26008/1912/bco-dmo.916046.1 [view at BCO-DMO]
Relationship Description: ACROBAT data to provide a wholistic view of the food web.

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Parameters

Parameter	Description	Units
Date_M	Day of observation in YYYMMDD format	unitless
Time_M	Time of observation, fraction of day	unitless
iso8601	Date and time of observation in ISO format: yyyy-MM-dd HH:mm:ss (GMT timezone)	unitless
Lon_M	Longitude	decimal degrees
Lat_M	Latitude	decimal degrees
Depth_mean	Average depth of krill swarm measured from ocean surface	Meters (m)
Sv_mean	Average Backscatter (dB)	dB
NASC	Nautical Acoustic Scattering Coefficient	m^2/nmi^2
Height_mean	Vertical length of swarm	Meters (m)
Thickness_mean	Horizontal across-track length of swarm	Meters (m)
Length	Horizontal along-track length of swarm	Meters (m)
mld	Mixed layer depth as measured by ACROBAT (associated dataset)	Meters (m)
surface	Binary swarm above or below mld	Binary

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Instruments

Dataset-specific Instrument Name	SIMRAD EK80
Generic Instrument Name	Simrad EK80 echo sounder
Dataset-specific Description	Hull-mounted SIMRAD EK80 single-beam, single frequency (120 kHz) echosounder (Kongsberg Maritime)
Generic Instrument Description	A high precision scientific echo sounder, designed to simultaneously operate frequencies ranging from 10 to 500 kHz. EK80 is a modular echo sounder system, and can operate with a combination of split and single beam transducers facilitated by a built-in calibration application. This system was built in succession to the EK60 echo sounder.

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Project Information

Collaborative Research: Physical Mechanisms Driving Food Web Focusing in Antarctic Biological Hotspots (Project SWARM)

Coverage: West Antarctic Peninsula

NSF Award Abstract:
Undersea canyons play disproportionately important roles as oceanic biological hotspots and are critical for our understanding of many coastal ecosystems. Canyon-associated biological hotspots have persisted for thousands of years Along the Western Antarctic Peninsula, despite significant climate variability. Observations of currents over Palmer Deep canyon, a representative hotspot along the Western Antarctic Peninsula, indicate that surface phytoplankton blooms enter and exit the local hotspot on scales of ~1-2 days. This time of residence is in conflict with the prevailing idea that canyon associated hotspots are primarily maintained by phytoplankton that are locally grown in association with these features by the upwelling of deep waters rich with nutrients that fuel the phytoplankton growth. Instead, the implication is that horizontal ocean circulation is likely more important to maintaining these biological hotspots than local upwelling through its physical concentrating effects. This project seeks to better resolve the factors that create and maintain focused areas of biological activity at canyons along the Western Antarctic Peninsula and create local foraging areas for marine mammals and birds. The project focus is in the analysis of the ocean transport and concentration mechanisms that sustain these biological hotspots, connecting oceanography to phytoplankton and krill, up through the food web to one of the resident predators, penguins. In addition, the research will engage with teachers from school districts serving underrepresented and underserved students by integrating the instructors and their students completely with the science team. Students will conduct their own research with the same data over the same time as researchers on the project. Revealing the fundamental mechanisms that sustain these known hotspots will significantly advance our understanding of the observed connection between submarine canyons and persistent penguin population hotspots over ecological time, and provide a new model for how Antarctic hotspots function.

To understand the physical mechanisms that support persistent hotspots along the Western Antarctic Peninsula (WAP), this project will integrate a modeling and field program that will target the processes responsible for transporting and concentrating phytoplankton and krill biomass to known penguin foraging locations. Within the Palmer Deep canyon, a representative hotspot, the team will deploy a High Frequency Radar (HFR) coastal surface current mapping network, uniquely equipped to identify the eddies and frontal regions that concentrate phytoplankton and krill. The field program, centered on surface features identified by the HFR, will include (i) a coordinated fleet of gliders to survey hydrography, chlorophyll fluorescence, optical backscatter, and active acoustics at the scale of the targeted convergent features; (ii) precise penguin tracking with GPS-linked satellite telemetry and time-depth recorders (TDRs); (iii) and weekly small boat surveys that adaptively target and track convergent features to measure phytoplankton, krill, and hydrography. A high resolution physical model will generalize our field measurements to other known hotspots along the WAP through simulation and determine which physical mechanisms lead to the maintenance of these hotspots. The project will also engage educators, students, and members of the general public in Antarctic research and data analysis with an education program that will advance teaching and learning as well as broadening participation of under-represented groups. This engagement includes professional development workshops, live connections to the public and classrooms, student research symposia, and program evaluation. Together the integrated research and engagement will advance our understanding of the role regional transport pathways and local depth dependent concentrating physical mechanisms play in sustaining these biological hotspots.

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 Office of Polar Programs (formerly NSF PLR) (NSF OPP)	OPP-1745009
NSF Office of Polar Programs (formerly NSF PLR) (NSF OPP)	OPP-1744884
NSF Office of Polar Programs (formerly NSF PLR) (NSF OPP)	OPP-1745011
NSF Office of Polar Programs (formerly NSF PLR) (NSF OPP)	OPP-1745018
NSF Office of Polar Programs (formerly NSF PLR) (NSF OPP)	OPP-1745023
NSF Office of Polar Programs (formerly NSF PLR) (NSF OPP)	OPP-1745081

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