LMG 19-01: 30 Dec. 2019 – 12 February 2019, PAL LTER Cruise 27
Weekly Science Report 6

LTER: Land-Shelf-Ocean Connectivity, Ecosystem Resilience and Transformation in a Sea-Ice Influenced Pelagic Ecosystem on the Western Antarctic Peninsula
&
Physiological Ecology of "Herbivorous" Antarctic Copepods
&
Biological and physical drivers of O_2 saturation and net community production variability at the Western Antarctic Peninsula

Week 6 overview (Deborah Steinberg, Chief Scientist):

In Week 6 (3-9 Feb.), we concentrated our final cruise operations in the Palmer Deep region. During Process Study 4, we repeated operations conducted during Process Study 1 in early January. This includes full station operations over the Palmer Deep and a comparison station on the canyon edge, an acoustic transect to map krill, and whale satellite tagging (**Fig. 1**). The end of the week was spent demobilizing at Palmer Station and transferring personnel.

I would like to thank Captain Ernest Stelly and the other ECO officers and crew, and Sean Bercaw and the other ASC staff for an excellent cruise. Their competence and can-do, friendly attitude made my job a pleasure.

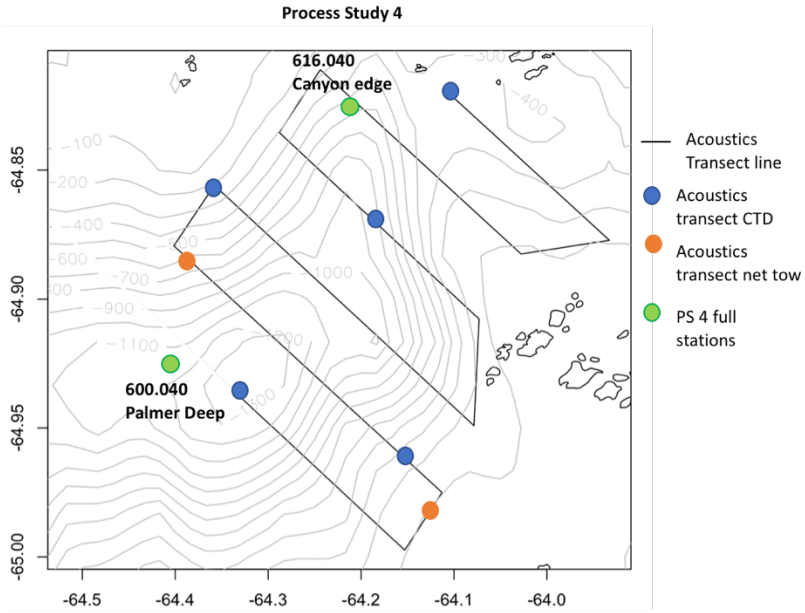

Figure 1. Map of Process Study (PS) 4 acoustic transect and stations.

Individual component reports:

C- 021: Physical Oceanography Component-LTER (Doug Martinson, Lamont Doherty Earth Observatory; PI; Elizabeth Shadwick O-270, Virginia Institute of Marine Science; PI)

Field Team Member: Naomi Manahan

The physical oceanography component primarily focused on wrapping up cruise operations this week, with a full suite of boxes and equipment to send home for refurbishing before they are deployed next season. LMG19-01 brought a successful mooring recovery and deployment, and the data will be a great contribution to the LTER dataset. We look forward to retrieving the deployed sensors on LMG20-01.

C-045: Microbial Biogeochemistry Component-LTER (Hugh Ducklow, Lamont Doherty Earth Observatory; PI)

Field Team Members: Naomi Manahan, Rebecca Trinh, Shawnee Traylor, Johanna Ruff, Srishti Dasarathy

This week we focused on completing our final process study in the Palmer Deep region, as well as packing up the laboratory and preparing our samples for shipment back to the US. LMG19-01 was an extremely successful cruise, with a full suite of measurements and samples that will be contributed to the LTER dataset once they are finished processing. Our port call at Palmer Station was extremely busy, and we'd like to thank all the ECO and ASC staff for their endless assistance throughout this cruise.

B-461: Biological and physical drivers of O_2 saturation and net community production variability at the Western Antarctic Peninsula (Nicolas Cassar, Duke U., PI)

Field Team Member: Alexandria (Alex) Niebergall

Overall, this cruise was very successful in terms of data and sample collection. The Equilibrator Inlet Mass Spectromer (EIMS) ran very smoothly for the entire cruise. These data will be very valuable for calculating net community production from surface O_2/Ar measurements across the entire cruise track. The majority of my discrete sampling was completed during the grid. In total I took 156 samples for 16S/18S amplicon sequencing from both CTDs and the ship's underway system. These samples will be used to examine the microbial community composition across the grid. I also took 288 discrete samples for dissolved N_2O analysis from various depths at every grid station with a CTD. These samples were collected between 5m and 500m in depth, following methods outlined in Izett et al. (2018) and will be used to examine the effects of vertical mixing on surface O_2/Ar measurements, as initially proposed in Cassar et al. (2014). As this method has not been extensively tested in the field, these samples will be very valuable in assessing and troubleshooting this method for future cruises. All together, the data collected on this cruise will allow us to examine the relationship between microbial community composition and net community production, both for this cruise independently, and as a longer time series to assess how these relationships are changing over time in the Western Antarctic Peninsula.

Izett, R.W., Manning, C.C., Hamme, R.C., & Tortell, P.D. (2018). Refined estimates of net community production in the Subarctic Northeast Pacific derived from ΔO_2/Ar measurements with N_2O-based corrections for vertical mixing. *Global Biogeochemical Cycles, 32,* 326-350. https://doi.org/10.1002/2017B00572

Cassar, N., Nevison, C.D., & Manizza, M. (2014). Correcting oceanic O_2/Ar-net community production estimates for vertical mixing using N_2O observations. *Geophysical Research Letters, 41,* 8961-8970. https://doi.org/10.1002/2014GL062040.

Figure 2. Alexandria (Alex) Niebergall, field team member for Cassar project.

C-019: Phytoplankton Component-LTER (Oscar Schofield, Rutgers, P.I.)

Field Team Members: Nicole Waite (lead), Emily Slesinger, Samantha Schofield, Hailey Conrad, Kim Thamatrakoln

This week we conducted our final two CTD and AC-9 deployments back in the Palmer Canyon for Process Study 4, repeating the Palmer Deep and Canyon Edge stations from Process Study 1 at the start of the cruise. We observed a phytoplankton bloom, with higher fluorescence and higher primary production than at the start of the cruise (**Fig. 3**).

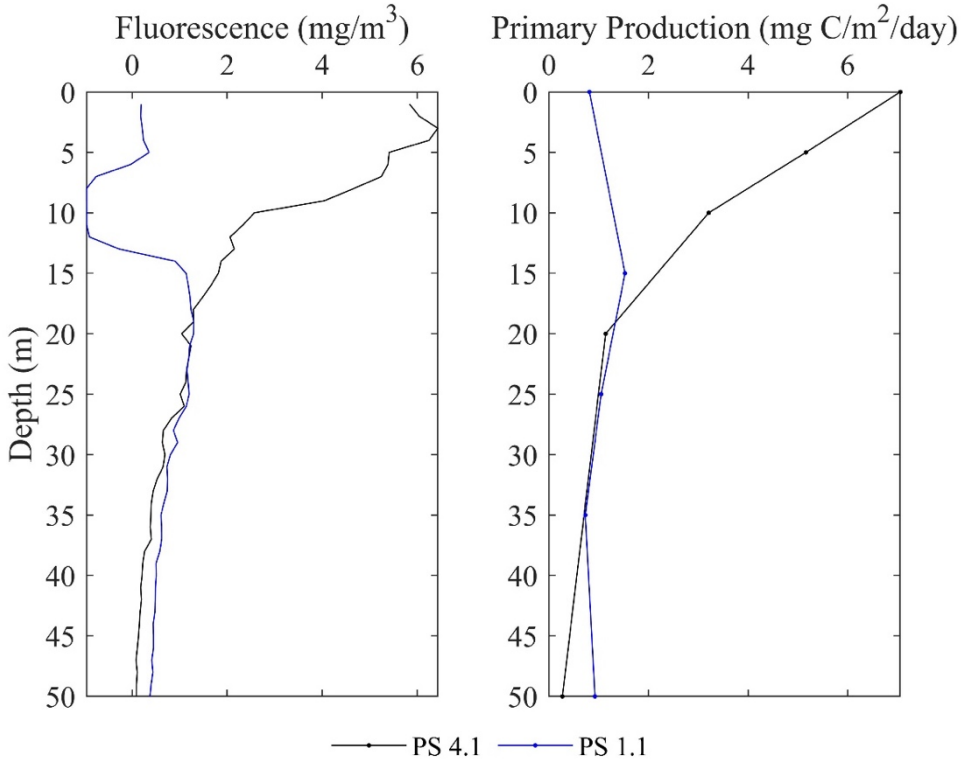

Figure 3. Fluorescence (left) and Primary Production (right) at Palmer Deep, station 600.040, at the end of the cruise in February during Process Study 4 (black) compared to that in early January during Process Study 1 (blue).

We had a productive port call at Palmer Station, transferring cargo back and forth, cleaning equipment and incubators, and packing up all of our supplies and instruments to head north. With all of our work completed, we also had some time to get one final time to experience Antarctica for the year – with a hike up the glacier at Palmer Station (**Fig. 4**). We also said goodbye to Hailey as we started our journey home, who moved onto Palmer Station and will remain as part of our field team at Palmer until April. It's been a productive cruise and we are looking forward to getting home, analyzing all of our samples and data, and can't wait to be back again next year!

Figure 4. Hailey and Emily hiking the glacier at Palmer Station.

C-020: Zooplankton Component-LTER (Debbie Steinberg, VIMS; PI)

Field Team Members: Deborah Steinberg, Joe Cope, Patricia Thibodeau, Joshua Sacks, and Samuel Malmquist

Our final operations in Palmer Deep went smoothly, and we now have a nice comparison data set with the beginning of the cruise, and with the acoustic data sets from Palmer Station this season. During the acoustic transect we saw krill schools were mostly located on the canyon edges where they were located deeper (~ 75-120m) than in the middle of the canyon where the schools were shallow (upper 50m). There was a lot of whale feeding activity in the region, and examining the overlap of the whale (and penguin) tracks with our prey mapping will be very instructive for examining predator competition interactions. At PS 4.1 (600.040) we also completed our last fecal pellet production experiment with *E. superba*. All the zooplankton team members got a chance to catch up at Palmer station at the end of the cruise (**Fig. 5**). The end of cruise tally: 120 zooplankton tows (8 of them MOCNESS tows), 2 acoustic transects, 11 fecal pellet production experiments, 5 pteropod metabolism experiments, and numerous gut fluorescence and other samples for analysis. We found the fewest salps (i.e., almost none) this season compared to all our cruises over the past 11 years; given that this was a higher than normal sea ice year, high krill abundance and low salps fits with our predictions.

Figure 5. Zooplankton Team members on LMG 19-01 and at Palmer Station (PS). From left to right: Ann Tarrant (B-258), Leigh West (PS), Jack Conroy (PS), Joe Cope, Joshua Sacks, Patricia Thibodeau, Deborah Steinberg, and Samuel Malmquist.

B-258: Physiological ecology of 'herbivorous' Antarctic copepods (Ann Tarrant, Woods Hole Oceanographic Institution; PI and field team member)

This week, copepods were sampled from the 600.040 station. Copepods were relatively sparse, so we conducted multiple 2-m net tows. Individual copepods were preserved for RNA analysis: 14 *Calanoides acutus,* 4 *Calanus propinquus,* 4 *Rhincalanus gigas,* and 1 *Paraeuchaeta antarctica.* Copepods were individually photographed. These samples will enable comparisons

with copepods sampled from the same site in early January. I have worked on curating the sample database and proceeded with morphometric analyses (prosome length, body volume, oil sac volume). Samples, equipment and supplies have been packed and prepared for shipment.

C-013: Seabird Component-LTER (William Fraser, PI)

Field Team Members: Megan Roberts and Anne Schaefer

This week was used to conduct bridge-based surveys during the final Process Study and along the entirety of the acoustic transect grid in the Palmer/Palmer deep region. The birders also deployed to the Joubin Islands to look for 6 IGU satellite tags that were deployed on penguins on Island 8 by the Palmer Station bird team. Our team successfully retrieved 3 of the tags. During this week, we also extracted otoliths from blue-eyed shag bolus samples collected from Avian Island (**Fig. 6**), and then packed up our laboratory equipment and organized field gear and samples for offload at Palmer Station.

The birder team (**Fig. 7**) would like to sincerely thank Captain Ernest Stelly and all the mates for their hard work and for keeping us all safe during the LTER cruise. We are also grateful to the ASC team, especially the MTs, Josh and Holly, and the ETs, Gabby and Adina, for their help in scouting routes and landing sites and for getting us safely to and from the ship to our research sites. We would also like to thank our MLT, Diane, for all of her assistance out in the field and in the lab. Finally, a big thank you to Sean Bercaw and Debbie Steinberg for their support and for making this such a successful research cruise.

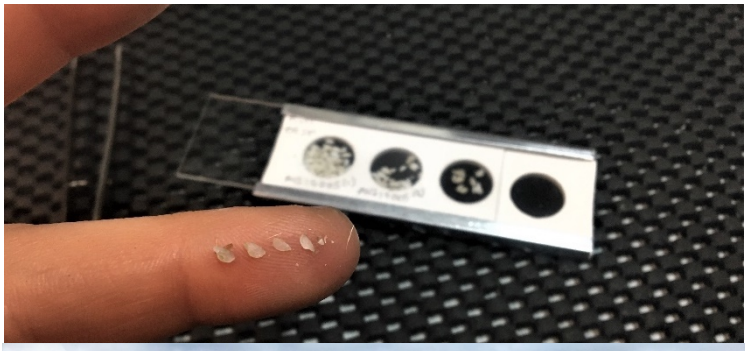

Figure 6. Otoliths extracted from blue-eyed shag bolus samples collected on Avian Island.

Fig. 7. C-013 field team: From L-R: Darren Roberts (Palmer Station team, PS), Bill Fraser (PS), Megan Cimino (PS), Anne Schaefer, Megan Roberts, Alex Dutcher (PS).

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C-024: Cetacean Biology & Ecology-LTER (Ari Friedlaender, University of California, Santa Cruz, PI).

Field Team Members: Michelle Modest, Ross Nichols

Over the last week, the whale team commenced tagging operations in the Palmer Deep area. Sightings and biopsy operations (**Table 1**) have shifted to prioritize and support the tagging effort. Inclement weather proved a challenge for us to find taggable conditions, but with the help of crew aboard the LMG and whale scouting operations from Palmer Station, we were able to find two windows to perform tag deployments. 4 suction cup tags were deployed on adult humpback whales. 2 tags (Tags 22 and 23) were deployed on 2/3/2019, and another 2 (Tags 27 and 40) on 2/5/2019.

Tag Deployments (**Fig. 8**)

2/3/2019 – We began tagging operations on Feb. 3 and were greeted by heavy fog while searching for foraging humpback whales. While transiting to the canyon edge of Palmer Deep, we encountered a group of three humpback adults that appeared to be resting (slow movement of the whale while at the surface, and longer surface intervals to breathe). This behavior was advantageous for tagging, as the whale's behavioral response to a small craft is abated. Our team, with the assistance of MT Holly Martin, managed to tag 2 of the humpback whales in the group, along with a biopsy sample on each individual.

Tag 23 released from the humpback first after 9 hours. Using satellite location updates transmitted from the tag, the LMG managed to approach within a quarter mile of the tag's location. A zodiac was then deployed to use a VHF antenna to track the VHF transponder equipped to the tag. After an arduous search, the tag was found surrounded by a flock of seabirds and successfully recovered.

Tag 22 released from the whale after 30 hours, and was recovered using the RHIB vessels deployed from Palmer station. The Palmer station whale team, Greg Larson and Logan Pallin, along with a Palmer Marine Technician, successfully collected the tag.

2/5/2019 – After being weathered out on most of Feb. 4, we began tagging operations around the Palmer Station area. We found multiple groups of foraging whales in Wiley Bay, NW of Palmer Station. We deployed 2 additional suction cup tags on two separate humpback adults engaged in bubble net feeding.

Tag 27 released from the whale after 24 hours on the whale while foraging (**Fig. 9, 10**). The tag was recovered on the Feb. 7 from a RHIB deployed from Palmer Station.

Tag 40 released from the whale after 36 hr., and was recovered in the same evolution as tag 27.

Our cumulative tag on time for this week's deployments was nearly 100 hours of time recorded. These data include time, depth, acceleration, tilt, and direction of the whale while engaged in almost constant foraging bouts in the Palmer Deep area. Biopsies and photo ID's were taken of these animals, allowing for genetic identification, sex, pregnancy status, and hormone analysis to complement the foraging strategies.

Table 1. The Total statistics of our sightings from the LMG 1901 from 12.28.2018 – 2.10.2019.

	Total Whales Sighted	Total Calves	Total Adults
Humpback	298	6	292

Minke	4	0	4
Orca	10	0	10
Fin Whale	6	0	6
Unknown	41	0	41
Totals	**360**	**6**	**354**

Biopsies	Total Samples
Humpback	45
Minke	0

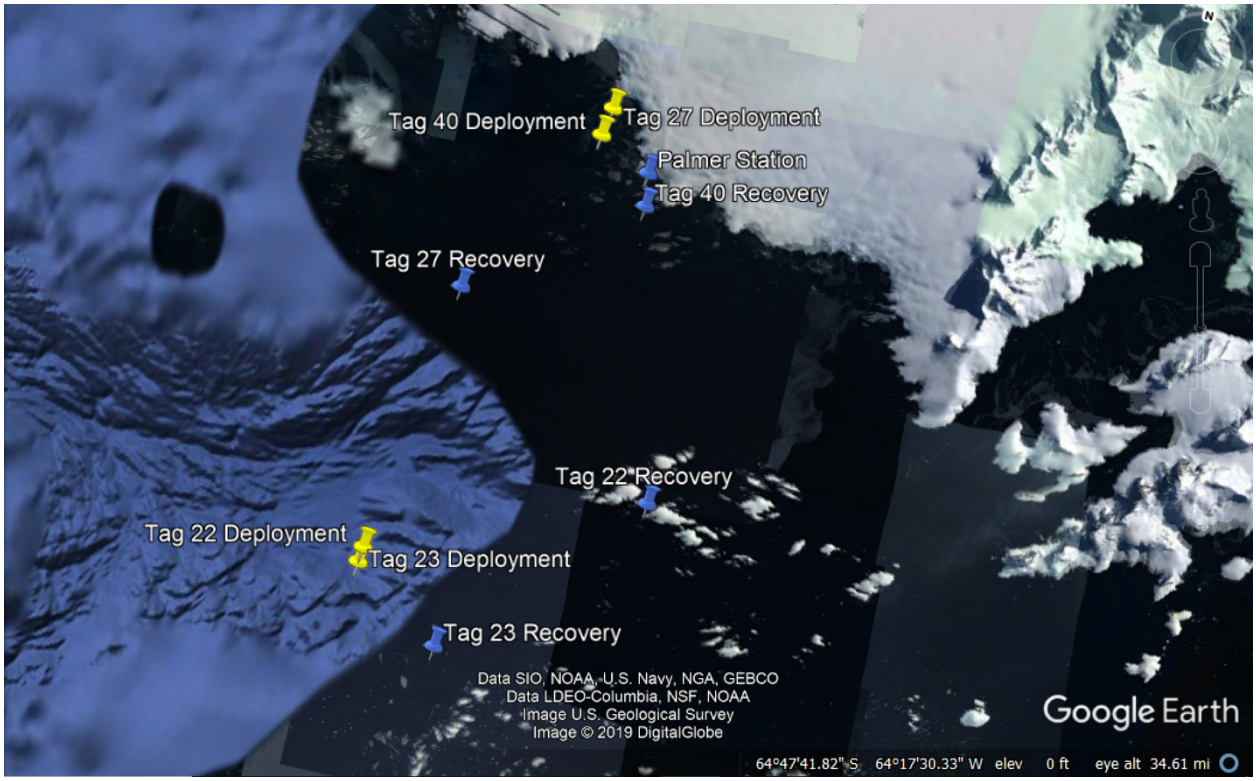

Figure 8. Map of tag deployments and recoveries over the last week.

Figure 9. Tag 27 on the back of a humpback whale. The tag is positioned as close to the head as possible to capture local accelerations and movements of the head while foraging.

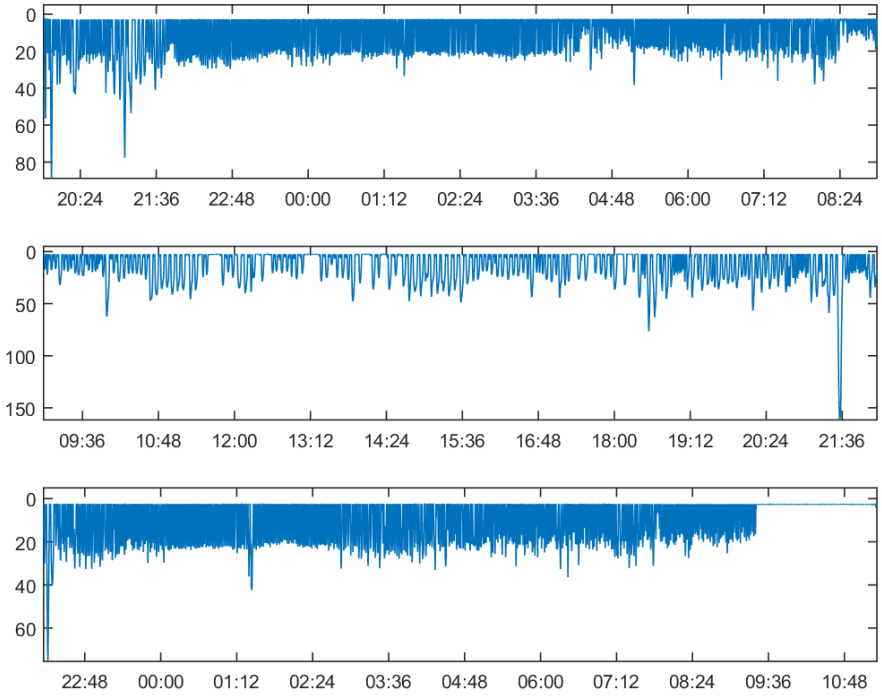

Figure 10. Dive profile collected from Tag 27, attached to a humpback whale for 24 hours.