LMG 20-01: 30 Dec. 2020 – 05 February 2020 LTER Cruise
Weekly Science Report IV
Palmer Long Term Ecological Research Project: Looking Back in Time Through Ecological Space.
Cruise Overview (O. Schofield, Chief Scientist):

The Gould had an extremely productive week, with impeccable weather until Saturday when a storm blew up and hit the ship with gusts up to 50-knots. The capable crew of Gould navigated us safely through the storm. The week began with the Gould, after deploying the Bird team on Avian Island for their annual census, conducting a series of Process stations on the inshore and offshore stations of the 200-line. We conducted paired day-night MOCNESS tows. Upon completion of the 200-line, the Gould sampled the offshore and mid-shelf historical stations on the 100 and 000 lines. After finishing those lines, the Gould headed back to the Avian Island to recover the birders. At that point, we made the decision to finish the Southern portion of the grid and access the sea ice situation at Charcot Island. The Gould sampled the 100.040 and 000.040 stations and then relocated to sea ice edge offshore Charcot island. We arrived at the Sea ice edge as the storm struck. Despite favorable wind direction, the ice remained ~20 mile barrier to the island, and there was no open water that would allow for launch of a zodiac to permit operations on Charcot; therefore the decision was made to relocate to the north. The plan for the next week is to survey the coastal regions between Avian and Anvers island. The team will begin the whale and penguin censusing efforts at Prospect Point and then Armstrong Reef. The higher trophic sampling will be complemented by CTDs and live net tows. Live net tows will support shipboard experiments on the microbial degradation of krill fecal matter and temperature ranges favorable for juvenile ice fish.

Figure 1. Penguins on ice beside Avian island. (photo credit Amy Chiuchiolo)

C-045: Microbial Biogeochemistry Component (Hugh Ducklow, Lamont Doherty Earth Observatory; PI)
Field Team Members: Rebecca Trinh, Natalia Erazo, Beth Conors, Tom Kelly, Natalie Yingling, Dan Lowenstein

During week 4 we completed the 200 line and dropped off our birder friends on Avian Island. We then transferred 254 oxygen-18 (O-18) samples to our collaborators at the British Antarctic Survey

(BAS) at Rothera Station (Figure 2). The samples will be used to understand the sources of different water masses along the West Antarctic Peninsula (WAP), such as rain, glacial melt, or upwelled deep water, using oxygen isotope fractionation. Figure 2 shows our field team at Rothera Station. In addition to the O-18 collaboration, we work with BAS to co-calibrate our CTD sensors while we are at Rothera so that our oceanographic data along the WAP can be used in conjunction with each other, making the most out of our international collaboration, and giving the most use to our data. We also finished the 000 line, and a good portion of the 100 line before picking up our birder friends from Avian Island.

Figure 2: Our field team at Rothera Station after transferring our O-18 water samples to our BAS collaborators. From left to right: Rebecca Trinh, Dan Lowenstein, Natalie Yingling, Beth Connors, Natalia Erazo, and Tom Kelly.

This week's featured team member is Beth Connors. Beth Connors is a first year PhD student in the Jeff Bowman marine microbial ecology lab at Scripps Institution of Oceanography. She was born in Montclair, NJ and graduated with honors from the University of California, Berkeley with majors in both Marine Science and Integrative Biology. She hopes to study bacterial ecology extensively at Palmer Station and the western Antarctic Peninsula during her PhD and beyond. Beth has been a valuable member of the Ducklow field team, working primarily on the flow cytometer to learn more about bacteria abundance. Additionally, she has been working on a new method to measure bacterial metabolism rates on the flow cytometer without the need for radioactive isotopes.

The use of radioactive isotopes to determine bacterial metabolism is the current gold-standard method in oceanographic research. However, radioisotopes are potentially dangerous and logistically cumbersome to work with on ships, as they require specialized equipment and safety training. In an effort to reduce or eliminate the need for potentially hazardous radioactive isotopes a new method was conducted in side-by-side experiments with the standard radioisotope measurements at the coastal stations on this cruise. This new method, bio-orthogonal non-conical amino acid tagging (BONCAT), replaces the need for radioactive isotope with the modified amino acid L-Azidohomoalanine (AHA). Once bacterial cells are incubated and fixed, a fluorescent tag is bound to the newly incorporated AHA in the cells, and those metabolically active cells can be

counted using traditional flow cytometry methods. Conducting the radioisotope and AHA metabolism experiments in the same *in situ* conditions allows for direct comparison of the two methods. It is an essential preliminary step in reducing the potential hazards of using radioisotopes to determine bacterial metabolism.

Preliminary data show the variability in both bacterial abundance and bacterial production using the radioisotope method between sampling stations (Figure 3), as well as the variance between bacterial abundance and bacterial production at a given station. Interestingly, it appears that areas of highest bacterial production do not coincide with areas of highest bacterial abundance in the water column, with higher production rates tending to occur shallower in the water column than where we see maximum bacterial cell abundance. It will be interesting to see if the BONCAT bacterial production method yields similar results to the radioisotope method. In addition to bacterial production and bacterial abundance, bacterial DNA samples were taken at each depth at each station to better under which bacteria are responsible for higher production rates and organic matter remineralization.

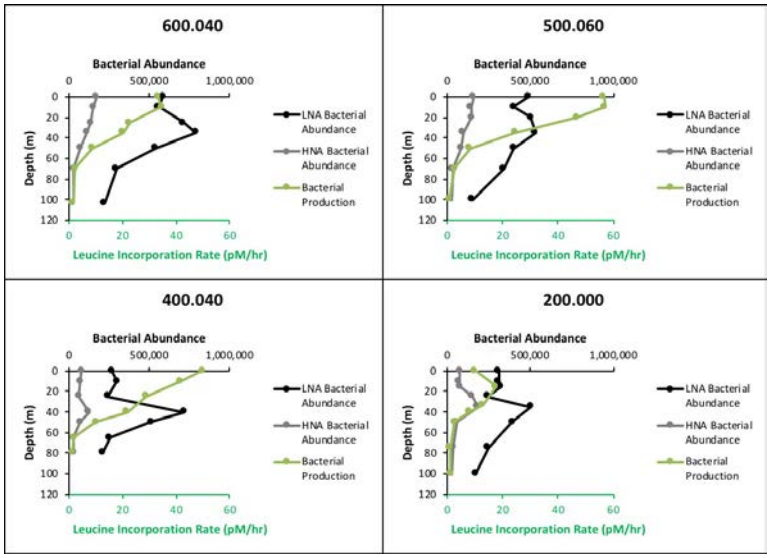

Figure 3: Bacterial abundance of low nucleic acid (LNA) (black) and high nucleic acid (HNA) bacteria (grey) using flow cytometry and bacterial production rate (green) using radioisotope at each coastal station within the top 100 meters of the water column.

C-019: Phytoplankton Component (Oscar Schofield, Rutgers University; PI)
Field Team Members: Oscar Schofield, Steve Ackelson, Quintin DiouCass, Jacqueline Veatech, Laura Wiltsee, Gabrielle Rosenthal

The LTER continued its bio-optical profiling combined with traditional LTER phytoplankton measurements that include High Performance Chromatography, Chlorophyll a, 14C uptake (Figure 5), eDNA measurements, and FIRE. The flow cytobot, provided measurements of the particle number, size distribution and high resolution images of the individual plankton, while the Fluorescence Induction Relaxation Emission (FIRE) provided photosynthetic quantum yield measurements. The two instruments collected continuous underway measurements of surface waters and discrete measurements as a function of depth at the full stations across the grid.

Data from the Week 4 grid efforts, showed 14C uptake rates, not surprisingly, decreased as the ship transected offshore with productivity vertical distributions showing peak and rather uniform productivities in the upper mixed layer. Additionally, there significantly higher phytoplankton 14C uptake rates in the Southern stations of the sampling grid. Overall productivity rates are mid-level compared to the long term LTER 14C-database.

The optical profiler has been deployed at all stations to date with the exception of Station 100.040, where sea state and wind conditions prohibited deployment. At each station, profiles of the following water parameters were measured from near surface to the maximum length of the power/communications cable; water temperature (t °C), salinity (s psu), backscatter (b_b m^{-1}), absorption (a, m^{-1}), attenuation (c, m^{-1}), and particle size distribution (PSD). Examples of data are shown (Fig 4) comparing conditions at the nearshore (040) and offshore (200) stations along the 100 sampling line. The near-surface waters were cooler and less saline compared with the offshore waters and the surface mixed layer was shallower at the inshore station. Both stations exhibited a surface mixed layer and pronounced pycnocline; 12 m depth at the inshore station and 28 m depth at the offshore station. Near-surface particle characteristics, measured with a Sequoia Scientific Inc. LISST-100x instrument, were quite dissimilar at the two stations. Relatively high concentrations of smaller particles dominated the surface waters at the inshore station and these particles appear to have been confined to the surface mixed layer. Offshore, larger and less numerous particles characterize the near-surface water. However, at depth (depth >30 m), the two stations were similar, indicating larger, less numerous particles. Thus, particle abundance along the survey line appears decrease and particle size to increase with distance offshore and depth.

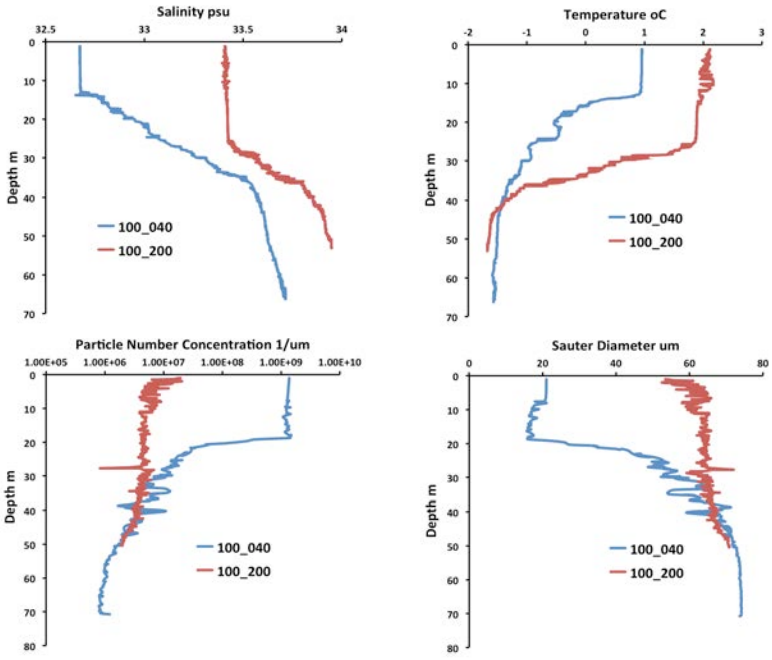

Figure 4. Example data along the 100 LTER survey linen collected with the NRL IOP profiling system.

C-020. Zooplankton Component (Debbie Steinberg, VIMS; PI)
Field Team: Joe Cope, Kharis Schrage, Andrew Corso, Kristen Sharpe, and Courtney Lorey.

During the fourth week, we deployed our 1- and 2-m nets along the 200, 100, and 000 grid lines. Salps have continued to be nearly absent, while the krill *Thysanoessa* and copepods have been numerically dominant. The Antarctic krill, *Euphausia superba*, and the ice krill, *E.*

crystallorophias, have been common. A day/night pair of MOCNESS tows were taken at a coastal station, 200.000 and at a slope station, 200.200. The offshore station is interesting because we fish down to 1000m and always collect unique animals (Figure 5). We continued to collect animals for gut fluorescence and future physiological studies. Figure 6 shows the deployment of the MOCNESS system.

Figure 6. Deploying the MOCNESS system from the back deck of the Gould during week 4.

The nets that are trawled during the cruise are primarily designed to sample zooplankton. However, a variety of larval fishes are incidentally captured in the nets. During LMG 20-01, we have collected 15+ species from eight different families, Nototheniidae, Artedidraconidae, Harpagiferidae, Channichthyidae, Bathydraconidae, Myctophidae, Paralepididae, and Bathylagidae. The annual collection of larval fishes from PAL LTER has created the longest continuously running time-series of Antarctic ichthyofauna internationally. Andrew, a PhD candidate in Debbie's lab, is using the larval fish collection to address several research areas, including long-term dynamics, predator-prey interactions, thermal tolerances, and the potential for

Figure 5. Some deep-sea animals caught by the MOCNESS, an amphipod Cyphocaris and a stomiiform fish. (Photo credits Andrew Corso)

bycatch of larvae in the krill fishery.

During this cruise, Andrew is finding the critical thermal maximum (CT_{Max}) for two closely related families - Channichthyidae and Artedidraconidae. Established in the 1970s, CT_{Max} is calculated by immediately placing fishes in a tank and heating the water at a rate of 0.3°C/minute. The temperature at which a fish loses swimming activity is recorded as its CT_{Max}. Although the test is simplistic, it is commonly used to estimate the thermal tolerance of fishes. This information is valuable for predicting which taxa will be most susceptible to global warming. Future research can also be prioritized based on the results of CT_{Max} determination. Several studies have found the

CT_{Max} for adult Antarctic fishes, but there is no existing information on the thermal tolerance of any larval channichthyid (Figure 7) or artedidraconid.

Figure 7. Above is an underwater photograph of the larval channichthyid Pagetopsis macropterus. These larvae hatch during winter (~ May) so they can reach a relatively large size (~ 45 mm) by summer. They are ferocious predators (Figure 8) and consume many other species of larval fishes that hatch during December – February.

Channichthyids, or the white-blooded icefishes, are the only known vertebrate that lacks the expression of hemoglobin, a protein normally found in red blood cells that is responsible for transporting oxygen. They cope with this loss by directly diffusing oxygen across their thin skin into an enlarged circulatory system that can transport larger volumes of blood and oxygen. With these adaptations, their oxygen carrying capacity is still less than 10% of the red-blooded Antarctic fishes. Due to their limited oxygen carrying capacity, channichthyids are stenothermal and are predicted to be the most sensitive Antarctic fish to climate change. Larval fishes often do not possess fully developed ventilation and circulator systems. If these systems are further

Figure 8. A ferocious predator, a krill seeing this is having a bad day!

underdeveloped in larval channichthyids, they should have a lower thermal tolerance than red-blooded artedidraconids. The four larval channichthyids that have been tested have a significantly lower average CT_{Max} (11.2 $\pm$ 0.56°C) than the four larval artedidraconids tested (17.2 $\pm$ 0.39°C).

C-013. Penguin and Seabird Component (William Fraser, Polar Ocean Research; PI)
Field Team: Anne Schaefer and Leigh West

During the third week of the LTER, the birders established a field camp at Avian Island. With the help of ASC staff, we deployed to Avian Island the morning of January 17 and were picked up during the afternoon of January 23. Our work at Avian was focused primarily on the breeding success and foraging ecology of Adélie penguins (Figure 9), however we also conducted surveys of multiple other species to understand localized population dynamics and we collected samples for data on foraging. The same data is collected in the Palmer area and provides a useful comparison of bird nesting and foraging dynamics at two sites with different sea ice characteristics along the WAP.

Figure 9. Adélie penguins on Avian Island, January 2020. Photo credit Anne Schaefer.

While on Avian, we conducted breeding colony censuses of Adélie penguins and weighed and measured créched chicks. We took a multi-prong approach to understand Adélie foraging ecology on the island. We collected diet samples from 28 adult penguins returning to the island to feed their chicks. We also deployed 2 GPS tags on nesting adult Adélies to record the locations of

discreet foraging runs. These data provide interesting insights into foraging at Avian compared to the Palmer area over a short time scale. For a longer time-scale understanding of fish consumption, we collected excrement material from sediment traps from which we will extract fish otoliths that have accumulated over the course of the year. These fish otoliths will be used to identify fish species consumed. Skuas often depredate penguin chicks and leave the feet and skeleton intact; so we collected chick feet for stable isotope analysis, which will provide insight into chick diets for the entire period of toe-nail growth. We also deployed 19 geolocating depth recorders, which will provide insight into Adélie movement and foraging ecology until next year when the tags are retrieved.

We completed full island surveys of nesting southern giant petrels and blue-eyed shags (Figure 10). South polar skua fecal samples were collected and will be processed for fish otoliths to better understand skua foraging. We collected boli from blue-eyed shags, which are primarily piscivorous, to better understand which fish species are available in the general area, as well as to detect long term changes in blue-eyed shag diets. We also conducted a marine mammal census (Figure 10). The vast majority of marine mammals observed were southern elephant seals, but we also observed Weddell seals, fur seals, crabeater seals, and humpback whales.

Figure 10. Left: A Weddell seal snoozes on the beach near southern giant elephant seals. Right: Blue-eyed shags. Photo credits Anne Schaefer

We are sincerely grateful for the assistance of the ASC staff who helped with camp set up and take down at Avian. We would also like to thank Sean Bercaw and Oscar Schofield for their support and help achieving our main goal of establishing the camp at Avian Island.

C-024. Whale Component (Ari Friedlaender, UC Santa Cruz; PI)
Field Team: Ross Nichols, Amanda Lohmann

The Friedlaender lab consists of Amanda Lohman and Ross Nichols aboard the LMG 20-01. Over the course of 20-01, the Friedlaender group has collected a variety of cetacean data to better understand their presence and behavior along the LTER grid. Sightings information of all cetacean groups has been collected along the grid with **157** humpback whales, **6** minke whales and **4** orcas being sighted so far. Photo identification photos have been taken of **62** humpback whales thus far aboard the cruise by capturing photos of distinctive scars, coloration, dorsal fins and flukes of individuals (Figure 11). We have collected **36** humpback whale biopsies, **12** of which will be used to determine the presence or absence of persistent organic pollutants contained within the blubber. All biopsy samples will be analyzed for demographic, genetic and hormonal information of each individual. In comparison to 19-01, whales have been sighted in greater numbers at lower latitudes than previous years.

Figure 11. Whalers collecting pictures of whale distinctive markings to identify individuals along the WAP.