LMG 24-01: PAL LTER Cruise 31
Weekly Science Report 4, 15– 20 January 2024

LTER: Ecological Response and Resilience to "Press-Pulse" Disturbances and a Recent Decadal Reversal in Sea Ice Trends Along the West Antarctic Peninsula

Week 4 overview (Dr. Deborah Steinberg, Chief Scientist):

In Week 4, we finished Process Study 3 at a deep slope water station (200.180) and sampled our furthest south (000 and -100) grid lines. Regular, standard station operations occurred at representative coastal, shelf, and slope stations along the lines, as well as underway sampling between the stations. This wraps up our regular grid sampling! We also made our annual visit to the British Antarctic Survey's Rothera Station on Adelaide Island. We brought three Rothera scientists on board to carry out a cross-calibration of our CTDs and joint water sampling at their historical sampling station in Ryder Bay (2 nm from Rothera), and to exchange samples. We could not go ashore, as in years past, due to the heavy construction underway at their base. We encountered a phytoplankton bloom in Ryder Bay, that turned out to be occurring in a significant portion of Marguerite Bay, which we also sampled (see C-019 report). We recovered the birder team at Avian Island after a successful 6-day field camp to survey the Adélie penguin colony and other seabirds. We ended the week with an attempt to survey the Adélie penguin colony on Charcot Island. This is our furthest south sampling region and was the first time during the cruise we encountered sea ice, which extended about 4 nm out from Charcot I. We could position the ship proximate to the colony site, but the ice was too thick to attempt the small boat operation needed to land our birders on the island, and technical difficulties prevented an attempted drone survey. Thus, we do not know if the colony still exists there, and will need to wait for the next LTER cruise to try again.

Group Reports

C- 021: Physical Oceanography (Dr. Carlos Moffatt, PI; U. Delaware)

Field Team Members: Michael Cappola (lead), Jake Gessay

This week, we turned our attention to CTD data quality analysis, specifically with the SBE43 Dissolved Oxygen Sensors. Throughout the cruise, we have noted a 0.1 ml/l bias between the dual oxygen sensors (**Fig.1**). Earlier in the cruise, we considered swapping one of them out, but since the bias has been consistent and we weren't sure which one to switch, we ultimately decided to leave them in place and use Winkler Titrations (**Fig. 2**) to decide which is the "more" correct sensor. Titrations are still in progress, but initial observations suggest that our secondary SBE43 is more correct. Once all samples have been titrated and quality checked, we will determine if a correction to the SBE43 output is warranted. We are thankful for Shavonna Bent (WHOI) for helping us mix the chemicals required during our port call at Palmer Station. We are also thankful to Leah Chomiak, Riley Palmer, and Marina Ruddick from the University of Miami for training us and providing remote assistance.

On Jan. 16 we transited to Rothera and hosted Alice Clement, Hamish Rodger, and Shea Gilkinson, from the British Antarctic Survey to do an *in situ* comparison-calibration cast for our CTDs. They brought a battery powered SBE19plus CTD fitted with an added dissolved oxygen sensor, fluorometer, transmissometer, and a PAR sensor. We strapped their CTD on to our rosette frame so that the sea water intakes were at the same level (**Fig. 3**), and completed two

casts in Ryder Bay. It was great to work with our British counterparts and we will analyze the data soon.

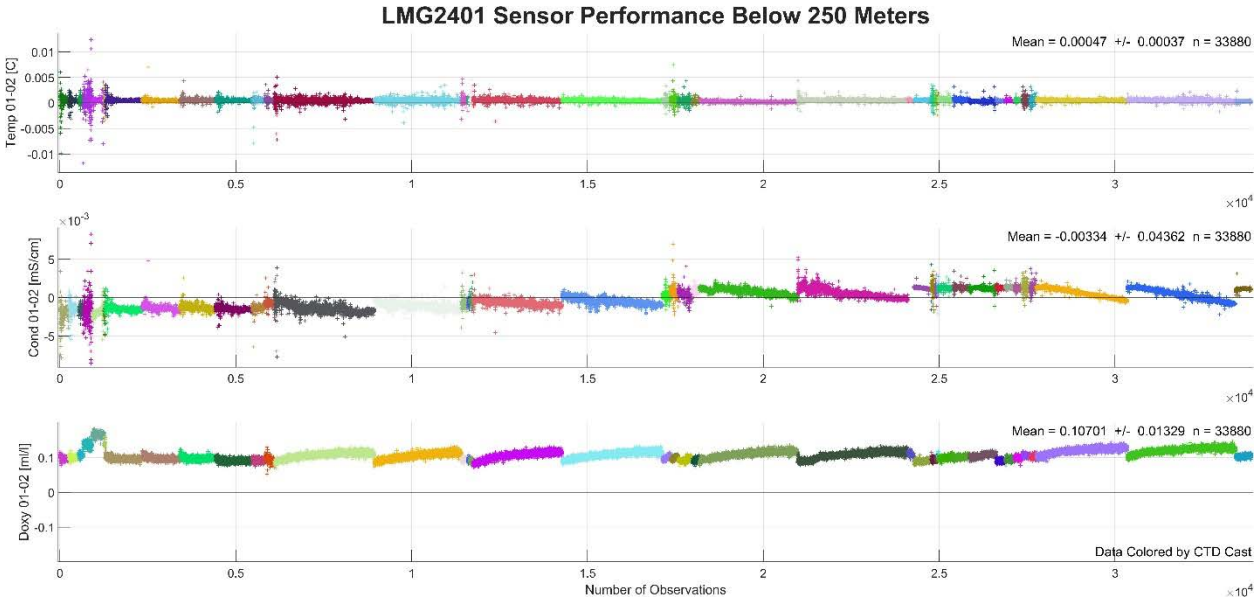

Figure 1. Plots of primary sensor minus the secondary sensor to show bias. Temperature and conductivity sensors (upper two panels) are performing well (centered on 0 ml/l), but notice in the lower panel that dissolved oxygen is centered on 0.1 ml/l instead of 0 ml/l.

Figure 2. Auto titrator setup up in a fume hood.

Figure 3. SBE19plus from the British Antarctic Survey that attached to our rosette next to our SBE9plus.

C-045: Biogeochemistry (Dr. Ben Van Mooy, PI; Woods Hole Oceanographic Institution)

Field Team Members: Zephyr Girard (lead), Hannah Goldberg, Dr. Laura Mota, Rachel Davitt

This week the biogeochemistry group finished up our grid sampling for POC, lipids, carbohydrates, flow cytometry, nutrients, alkalinity, and oxygen isotopes. We added additional sampling in the high fluorescence area near Rothera station (>60 mg/L chlorophyll a) (**Fig. 4**) as

well as in the larger bloom area (identified using satellite imagery) in Marguerite Bay at Station 200.-040.

We also recovered our final particle interceptor trap (PIT) from the 200.180 station. This was our only deep offshore/slope station, and our filters looked like those from prior deployments but with slightly less material (**Fig. 5**). They contained krill fecal pellets and diatom chains just like the coastal sediment trap deployment on the 200 line.

With the assistance of the zooplankton group, we also picked individual krill fecal pellets from zooplankton caught in the bloom area/ Marguerite Bay which will be analyzed using our lab's single particle lipidomics workflow. These lipidomes will then be compared to those of the fecal pellets collected from zooplankton elsewhere in the grid to see how different food availability impacts the lipids krill produce.

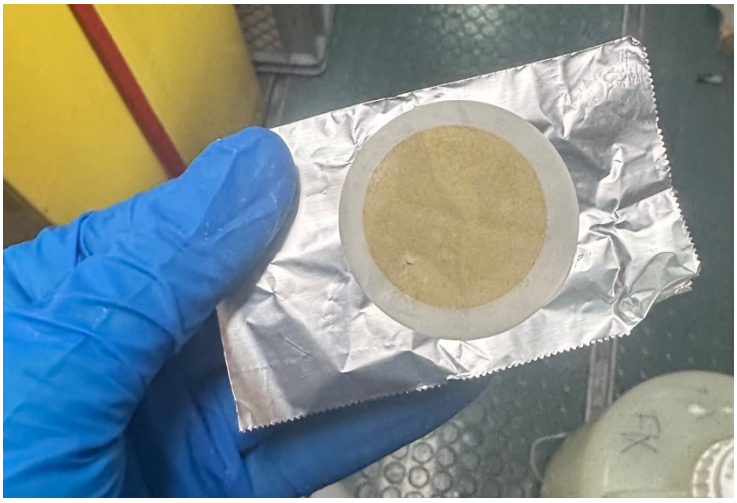

Figure 4. Filter showing high Chl a / organic particles from 15m deep at the CTD station in Ryder Bay near Rothera Station. Only 0.5 L of seawater was filtered.

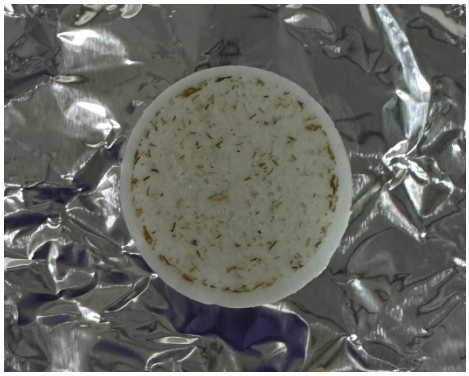

Figure 5. Sediment trap material from a slope (200.180) grid station, mostly comprised of krill fecal pellets, and also diatoms.

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

Field Team Members: Heather Forrer (lead), Jake Gessay, Mya Sharpe, Dr. Ahmed El-habashi

This week the C-019 group wrapped up Process Study 3 at slope station 200.180, involving multiple CTD and optics casts, a 24-hour diel incubation, and micro-plastics sampling. These were in addition to the core measurements of chlorophyll-a, HPLC, discrete IFCB samples, photosynthetic quantum yields, and light absorption spectra of particulate phytoplankton pigments. Process Study 3 was shortly followed by a visit from Rothera research technicians for a CTD calibration cast at station 'CTD 3' in Ryder Bay on Jan. 16. This provided a fortuitous opportunity for near-shore sampling in a very productive area where CTD florescence was very high, at >60 mg/m^3 at the chlorophyll maximum (**Fig. 6**, **Fig. 7a**). We sampled for chlorophyll-a, HPLC and discrete IFCB samples within the upper 100 m aiming to characterize the phytoplankton community in this very productive area. This CTD calibration cast was then followed by

subsequent stations at the 'Fish Hot Spot' (**Fig. 2b**) and 'Bloom site' (location provided by Jessie Turner (University of Connecticut) at 200.-040 for an exploratory CTD grid station (**Fig. 2c**) where a full suite of samples were collected. Notably, while still remaining high, the water column florescence decreased and deepened in the water column where the satellite imagery indicated the main bloom was (**Fig. 6**), with a chlorophyll maximum of ~12 mg/m^3 observed at this 'Bloom site' at ~30 m, as well as a deep chlorophyll maximum of ~5 mg/m^3 was observed at 95 m (**Fig. 7c**). Microscope analysis indicated that the bloom was mostly comprised of large diatoms, including *Corethrons* and *Thalassiosira* spp. (**Fig. 8**). In addition to these highly productive inshore stations, we completed sampling along the 200, 000 and -100 lines.

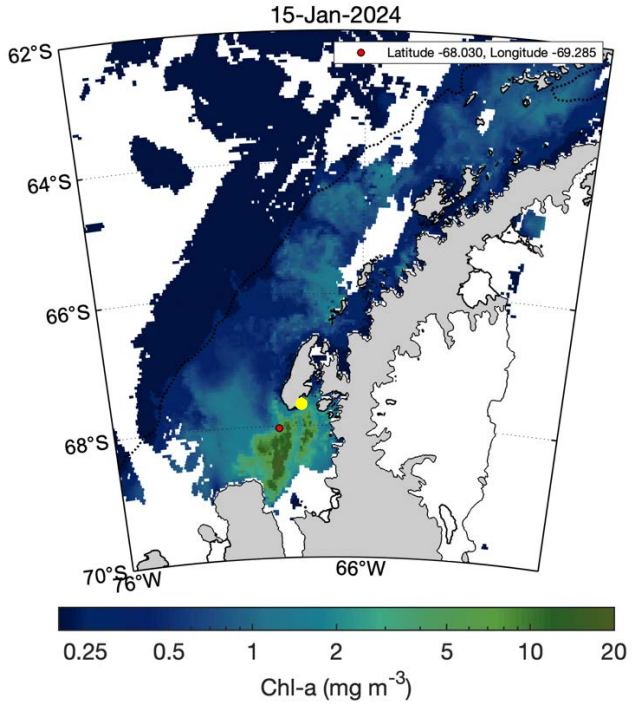

Figure 6. Satellite derived chlorophyll-a showing the large diatom bloom in Marguerite Bay. The yellow dot is Rothera Station in Ryder Bay, just 20 km south of that is 'Fish hot spot'; red dot is the location of the 'Bloom site', LTER grid station 200.-040.

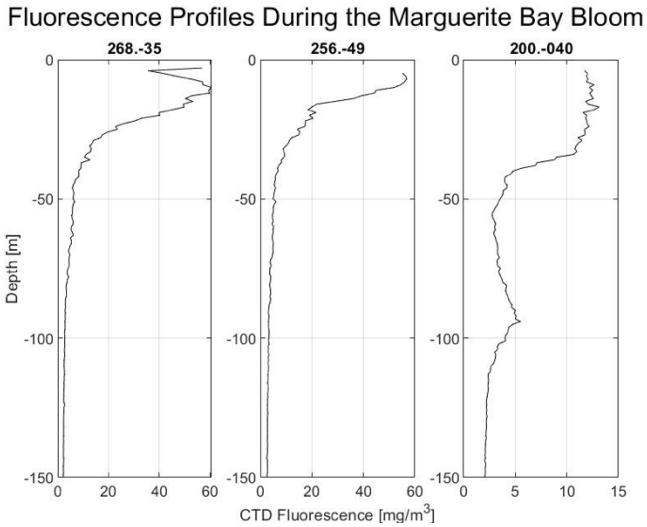

Figure 7. Florescence profile of a) Rothera 'CTD 3' station in Ryder Bay, 2 nm from Rothera Station b) 'Fish Hot Spot' and c) 'Bloom site' 200.-040. Distinctive chlorophyll maxima of ~60 mg/m^3 observed at Rothera 'CTD 3' and 'Fish Hot Spot', while an additional deep chlorophyll maxima was observed at the 'Bloom site' at LTER grid station 200.-040.

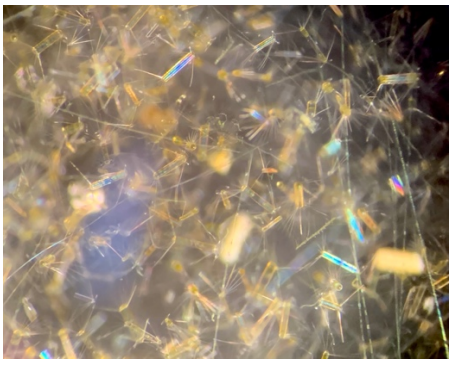

Fig. 8. Microscope image of large diatoms from bloom sampled in Ryther Bay. The same species were found in other bloom sites in Marguerite Bay. Photo by Hannah Gossner.

With regards to the HyperSAS, the sea state continued to be excellent for continuous operation. The HyperSAS collected spectra from the 200, 000, and -100 lines, as well as the transit to Rothera and Charcot I (**Fig. 9, 10**). During the CTD casts in Ryder Bay near Rothera, we noticed that the fluorescence was extremely high (>60 mg/m^3) and the water was visibly green. The bloom appeared to be much stronger near the coast by Rothera, but the core of the bloom at 200.-040 was still very productive. The HyperSAS collected over 40 hours of continuous spectra in the bloom and the lighting conditions were excellent; clear skies and calm seas.

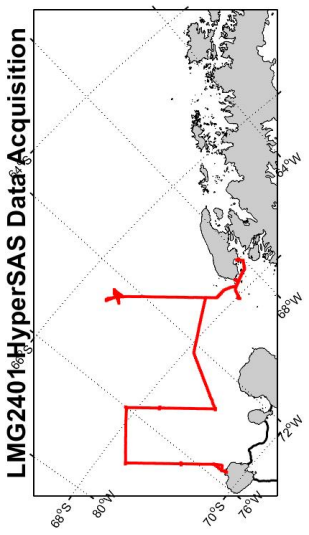

Figure 9. Region of HyperSAS data acquisition for week 4.

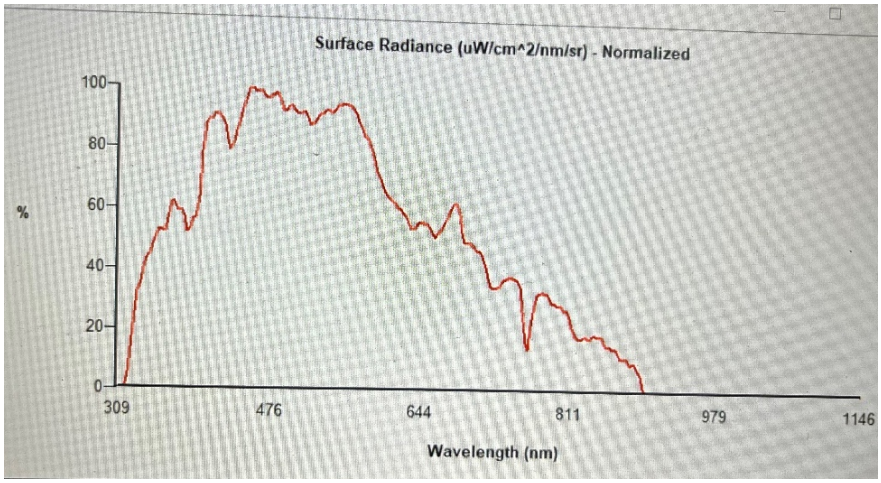

Figure 10. A screenshot of HyperSAS Surface Radiance. Note the increased energy in the green to red wavelengths, as well as the red peak near ~660 nm, which is likely fluorescing phytoplankton. Data are preliminary.

For optics, Particle size-distribution (PSD), also called volume distribution of the water column, were obtained at each station using the laser diffraction technique. **Fig. 11a** shows the PSD at one of our far south, slope stations, indicating that just below surface water is dominated by the 0.5 µm particles, likely smaller size than we would predict compared to coastal stations. A profile of these 0.5 µm particles down to 60 m shows the concentration of these small particles greatly decreases in deeper waters (**Fig. 11b**).

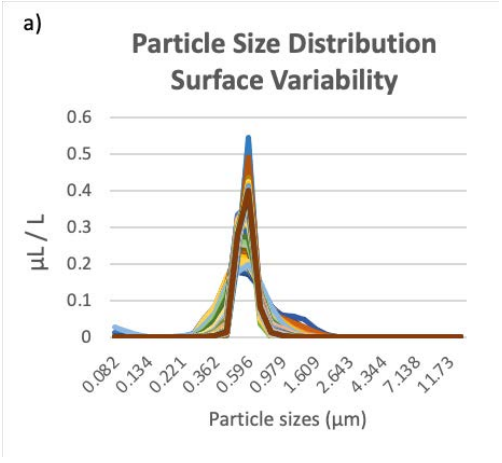

Figure 11. Particle size distribution (PSD) at outer slope station -100.160. a) PSD in surface waters, each color is progressing through time (I minute intervals, during cast b) Depth profile of 0.5 µm particles

C-020: Zooplankton (Dr. Deborah Steinberg, PI; Virginia Institute of Marine Science)

Field Team Members: Deborah Steinberg (lead), Joe Cope, Meredith Nolan, Hannah Gossner, and Connor Shea

In this third week, we completed sampling the 000 and -100 grid lines. In this far south region of the LTER grid, juvenile Antarctic krill *Euphausia superba* are still dominating the catch, as they were to the north. In some of the coastal stations we also found high abundance of larvae of the Antarctic silverfish *Pleurogramma antarctica*, and at one station many juveniles of this species (**Fig. 12**). A station ~20 km south of Rothera in Marguerite Bay where we encountered a phytoplankton bloom (the 'Fish hot spot' mentioned above; not a regular LTER grid station), has been a larval fish 'hot spot' over several years, and this year again contained many Antarctic silverfish larvae. The crystal krill *Euphausia crystallorophias* became more abundant at these far south stations, especially along the coast. Large copepods such as *Rhincalanus gigas* and the carnivorous *Paraeuchaeta antarctica* were also conspicuous in these far south stations (**Fig. 13**).

Day and night sampling of zooplankton distribution at discrete depth intervals using the MOCNESS to investigate depth distribution and diel vertical migration (DVM) of zooplankton at the offshore slope process study station (200.180) indicated salps were undergoing DVM, migrating from 300-400m during the day into the surface 0-50m at night.

We continued to do live incubations of abundant zooplankton species to collect fecal pellets for various biogeochemical analyses and to use to help identify sinking particles in the sediment traps, which have been almost exclusively krill fecal pellets (**Fig. 14**).

Figure 12. Juvenile Antarctic silverfish *Pleurogramma antarctica* from a far south coastal station (LTER grid station 000.000). For scale, the petri dish is 10 cm in diameter. Photo by Debbie Steinberg.

Figure 13. The carnivorous copepod *Paraeuchaeta antarctica.* Note large, red feeding apendages used for 'stabbing' prey. Photo by Hannah Gossner.

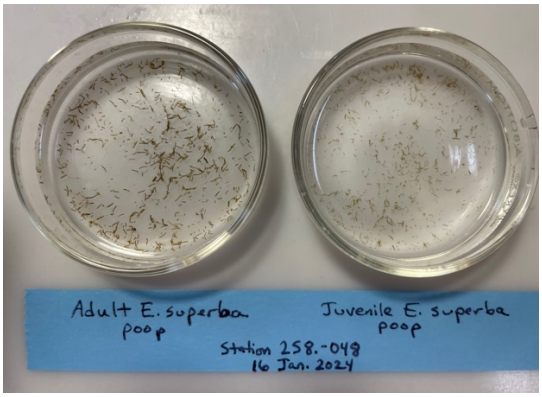

Figure 14. Fecal pellets of adult and juvenile krill *E. superba* collected in live animal experiments. Photo by Debbie Steinberg.

C-013: Seabird Component-LTER (Megan Cimino, PI; UC Santa Cruz and NOAA)

Field Team Members: Allie Northey (lead), Helena Dodge

This past week, with the help of ASC staff and grantees, we established our annual field camp at Avian Island (Jan. 11-17) (**Figs. 15, 16**). The weather was beautiful, with sunshine and blue skies for the majority of our stay (**Fig. 15-18**). We were able to complete all science goals. Our work at Avian is focused primarily on the breeding success and foraging ecology of Adélie penguins, however we were able to use the limited access to the area to collect samples, and census multiple species for localized population dynamics as well as collect data on foraging. The same data is collected at Palmer and makes for a useful comparison of bird nesting and foraging at two sites along the peninsula with different sea ice characteristics.

Figure 15. Adélie Penguin colonies on Avian Island. Photo Allie Northey.

Figure 16. Field camp set up on Avian Island. Photo by Allie Northey.

While on Avian, we conducted breeding colony censuses of Adélie Penguins. In order to better understand foraging, we approach the problem from multiple angles. Diet samples from 32 adult Adélie penguins were collected and three GPS tags were deployed on three different adults to track discreet foraging runs. These data provide insight into foraging at Avian compared to the Palmer area over a short time scale. For long-term analysis of fish consumption, we collect excrement material from 'sediment traps' (penguin poop collectors) to extract fish otoliths that have accumulated over the course of the year, and are eventually used to identify fish to species level.

When Skuas feed on Adélie Penguin chicks, they often leave the feet and skeleton intact. These chick feet were collected for stable isotope analysis. This is used as means of analyzing diets that covers a longer time span than the diets we collect while on island. Furthermore, we collected eggshell pieces from Adélie Penguins for mercury analyses.

Fig. 17. Avian Island evening. Photo by Allie Northey.

Full island surveys of nesting Southern Giant Petrels and Blue Eyed Shags were completed. Additionally, this year, we GPS mapped all Southern Giant Petrel nests on the island which was a huge effort and very successful! South Polar Skua fecal samples were collected and will be analyzed for fish otoliths to better understand Skua foraging. We collected boli from Blue Eyed Shags, primarily piscavores, to better understand what fish species are found in the area, as well as to detect long term changes in Blue Eyed Shag diets. A marine mammal census was also conducted. The majority of marine mammals on Avian are Southern elephant seals. We sincerely thank the ASC staff, science grantees, and the entire *L.M. Gould* team who helped with camp set up and deployment at Avian Island.

Fig. 18. Avian Island field team, Helena Dodge and Allie Northey.

C-024: Cetacean Biology & Ecology (Ari Friedlaender, PI; UC Santa Cruz)

Field Team Members: Ross Nichols (lead), Dr. Jennifer Allen

This week, the whale team assisted the birder team in an attempt to survey Charcot Island, however, technical issues related to the UAS prevented a launch. These UAS system issues were later resolved prior to our normal whale operations. During this week, the whaler team collected 7 biopsy samples from adult humpback whales. These 7 animals were a part of three groups, of which, we performed a UAS flight over each group, gathering paired photogrammetry

measurements over each animal we biopsied. Two of the groups were performing Bubble Net Feeding shown below (**Fig. 19)**. Additionally, we collected Fluke and dorsal photos of each whale, which we will be able to use for individual matching.

Figure 19. Two adult Humpback whales performing a Bubble Net, feeding on shallow krill. Photo collected under NMFS Permit No. 23095.