LMG 19-01: 30 Dec. 2019 – 12 February 2019, PAL LTER Cruise 27
Weekly Science Report 4

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 4 overview (Deborah Steinberg, Chief Scientist):

In Week 4 (20-26 Jan.), we sampled the 100, 000, and -100 grid lines, with regular station operations at representative coastal, shelf, and slope stations. This wraps up our regular grid sampling (with the exception of 500.100 -we missed some ops due to weather but will return there as we head back north). Due to extensive ice near the coast and over much of the shelf south of the 000 line, we were not able to get to Charcot Island (on the -100 line, the ice edge extended all the way out to the shelf break!). We completed our third Process Study as well, with sampling and experiments (details in individual reports below) inside the ice, at the ice edge, and outside the ice on the -100 line between -100.100 and -100.120 (**Figs. 1 & 2**). We also conducted paired day vs. night MOCNESS tows at the outer slope -100.160. Finally, we had a long transit north to conduct whale ops along the west coast of Adelaide Island on our way to re-deploy the 300.100 mooring.

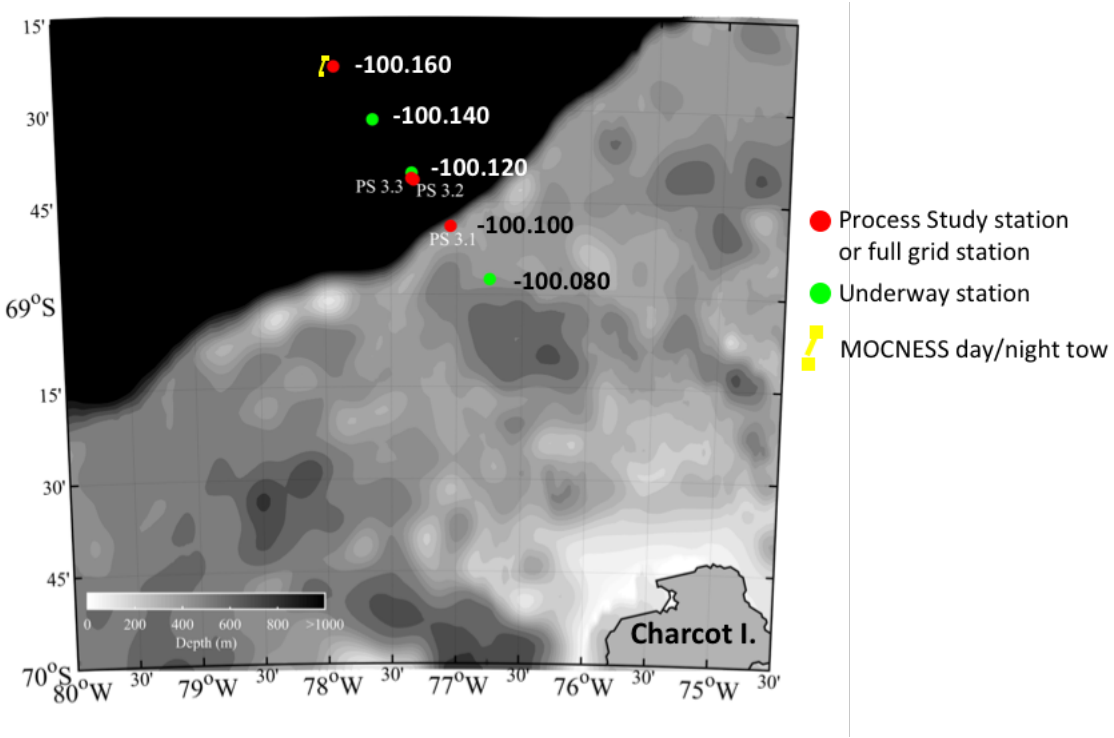

Figure 1. Map of -100 line grid stations sampled or visited, Process Study 3 stations, and MOCNESS tow track across slope station -100.160. PS 3.1 (-100.100) is 'in the ice' (and on the shelf), PS 3.2 (-100.119) is 'out of the ice' (slope), and PS 3.3 (-100.120) is at the 'ice edge' (slope). Note: Our intention was to do the whole study over the shelf, but the ice edge moved offshore during the study due to SE winds, so 2 of the stations are off the shelf. Furthermore, even though PS 3.3 and 3.2 are nearly the same map coordinates, at time of sampling PS 3.2 was 2-3 nm outside the ice edge. Station -100.080 is as far into the ice as we got on this line, as the sea ice became quite thick (we could not take an underway sample there as flow through seawater intake was clogged with ice).

Figure 2. Crabeater seals at the ice edge near -100.120 during Process Study 3.

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 prepared for the deployment of the mooring at 300.100 during this week by ensuring all sensors were ready to deploy and the mooring line in order. A full suite of temperature, pressure, pH, oxygen, carbon dioxide, and current sensors will be deployed throughout the water column as soon as the weather conditions allow for it. Using a railroad wheel as an anchor, the physical oceanography mooring will sit for one year collecting data at 300.100, with plans to recover the mooring on LMG 20-01.

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 continued to analyze samples along the 100, 000, and -100 line based on the ability of the ship to enter the sea ice. **Fig. 3** shows an example of a CTD cast performed in the ice, with the success of the cast heavily relying on the incredible skill of the ECO crew and ASC support staff.

Figure 3. A CTD deployment within the sea ice on the LTER grid.

Results thus far from real-time analysis of bacterial abundance via flow cytometry and leucine incorporation rates are shown in **Fig. 4**. At grid station 100.100, the highest leucine incorporation rates for the entire cruise were seen, along with some of the highest bacterial abundance measured on LMG19-01. The farthest south grid stations along the -100 line had the lowest leucine incorporation rates and bacterial abundance rates of the cruise.

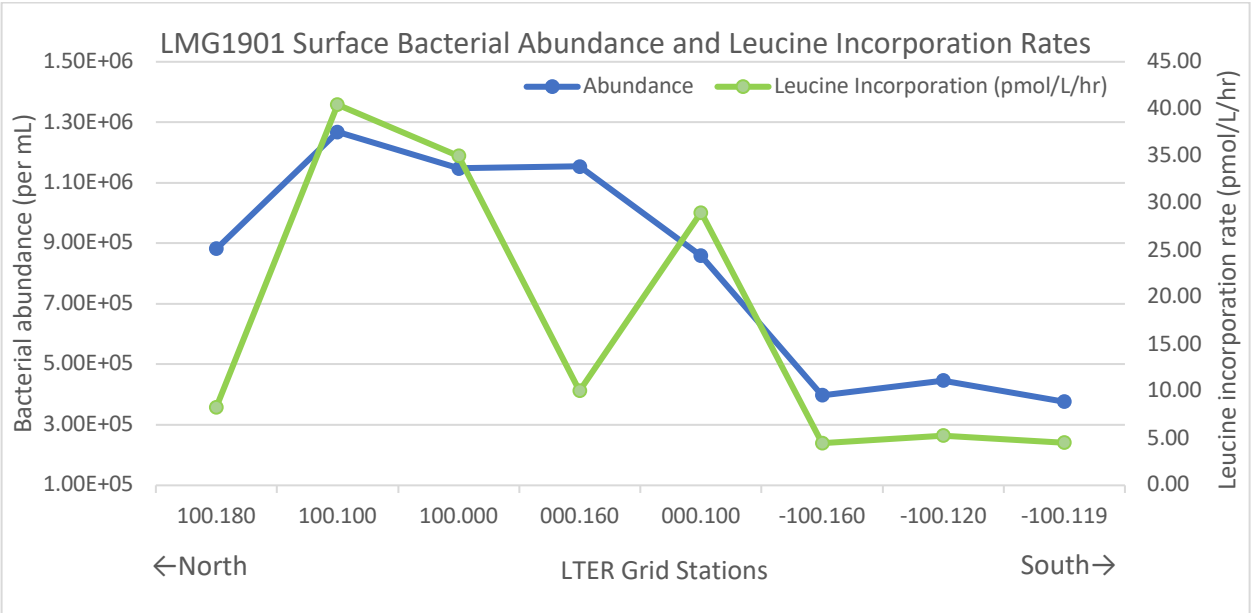

Figure 4. Leucine incorporation rates and bacterial abundances along the three southern-most LTER grid lines along the Western Antarctic Peninsula.

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

The Equilibrator Inlet Mass Spectrometer (EIMS) has run continuously for the entire week. We will use these measurements to calculate Net Community Production along the cruise track. I took duplicate 4L water samples, filtered through 0.2um Sterivex filters at grid stations and underway stations on the 100, 000, and -100 lines. These will be used for 16S/18S amplicon sequencing at Duke to examine the microbial community composition. I also took some opportunistic samples for 16S/18S amplicon sequencing along the ice edge. I took duplicate 60ml water samples from 7 depths at each grid station on the 100, 000, and -100 lines for N_2O analysis. These samples will be used to estimate the effects of upwelling on the EIMS measurements.

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 finished sampling the LTER grid, completing stations on the 100, 0, and -100 line. We also completed Process Study 3 on the -100 grid line, comparing “in ice”, “out of ice”, and “ice edge” water and phytoplankton communities in the far south region of the WAP. We conducted 9 CTD casts and water collection along with associated AC-9 casts for optical properties for each CTD (**Fig. 5**). Incubation experiments have continued as well, with a final incubation set started using ice algae.

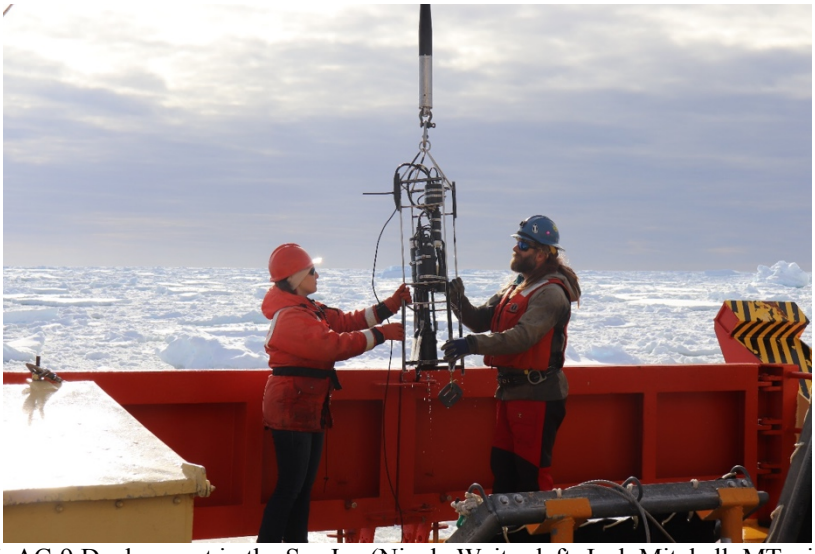

Figure 5. AC-9 Deployment in the Sea Ice (Nicole Waite -left, Josh Mitchell, MT -right)

Primary Production experiments, using radio-labeled C-14 Sodium Bicarbonate, have been ongoing throughout the cruise – and with the completion of the grid, we are able to compare production rates spatially along the grid. Overall, production rates have been low this year compared to last year. However, measurements do show a trend of increasing primary production from north to south along the WAP (**Fig. 6**).

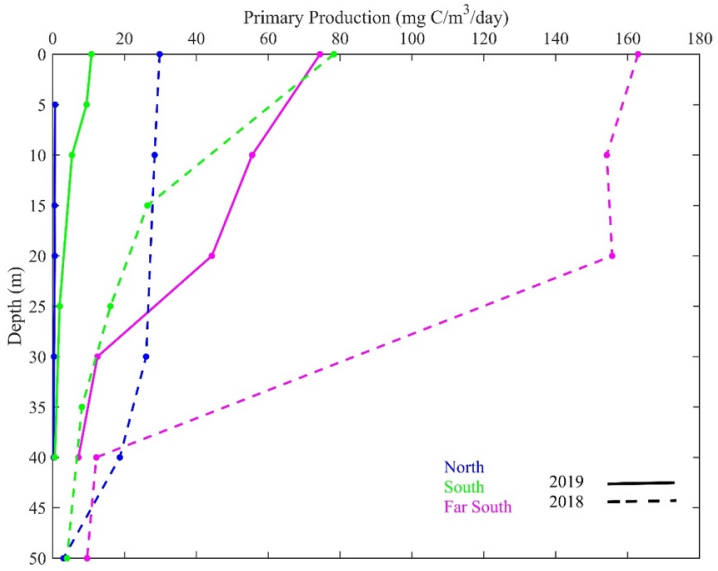

Figure 6. Primary Production rates in the North (blue), South (green), and Far South (pink) of the WAP this year (2019, solid line) compared to last year (2018, dashed line).

Additionally, in Process Study 3, we were able to compare primary production rates of phytoplankton in the sea ice (PS 3.1), out of the sea ice (PS 3.2), and along the sea ice edge (PS 3.3). Primary production rates were low (less than 5 mg C/m^3/day) for all stations in Process Study 3, however, there was higher production at the "in-ice" station compared to the "out-of-ice" and "ice-edge" stations (**Fig. 7**).

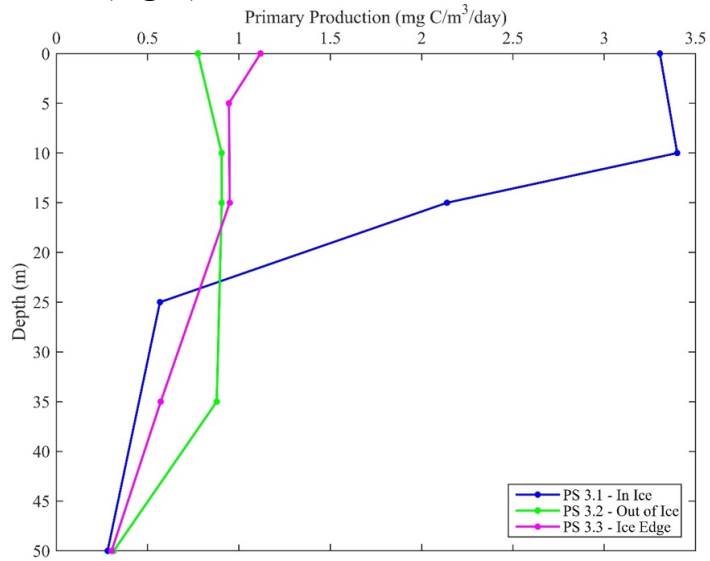

Figure 7. Primary Production rates from Process Study 3 – "in-ice" station in blue, "out-of-ice" station in green, and "ice-edge" station in pink.

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

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

We concentrated our operations along the far south grid lines, and at the 3-day process study situated at the ice edge on the -100 grid line. In addition to our regular grid station operations, we conducted day and night sampling of zooplankton distribution at discrete depth intervals using the MOCNESS (Multiple Opening-Closing Net Environmental Sensing System) to investigate depth distribution and diel vertical migration of zooplankton at the slope process study station (-100.160).

Figure 8. Antarctic krill (*Euphausia superba*). Note their very green guts- from feeding on phytoplankton. Photo by P. Thibodeau

We also conducted additional experiments this week measuring pteropod (*Limacina helicina*) metabolism and *Euphausia superba* (**Fig. 8**) fecal pellet production (**Fig. 9**). During Process Study 3 we compared zooplankton community structure, *E. superba* gut fluorescence (as a feeding proxy), and *E. superba* fecal pellet production between 'in ice', 'ice edge', and 'outside ice' stations. There was an obvious difference between the ice edge and outside ice stations in the amount of fecal material produced, with higher fecal pellet production at the ice edge (**Fig. 9**). This is likely due to higher production or different phytoplankton community structure at the ice edge (which we will examine with the phytoplankton team), or possibly feeding on algae released from ice floes.

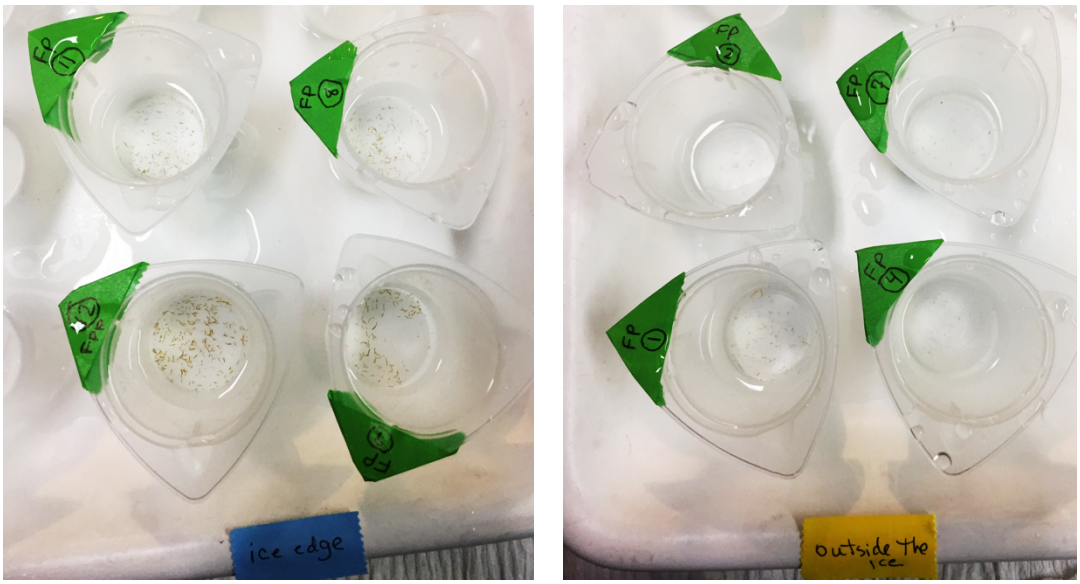

Figure 9. Antarctic krill (*Euphausia superba*) fecal pellet production experiment from Process Study 3- ice edge vs. outside the ice in open water. Each cup holds krill fecal pellets produced from one krill collected and incubated in seawater from each site for 6 hr. A noticeably higher amount of fecal matter was produced by krill from the ice edge (left) vs. outside the ice in open water (right).

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

This week, live copepods were sampled from four stations in the far south (100.180, 000.100, -100.100 and -100.160). *Calanus propinquus* were relatively abundant in some of these stations compared with stations farther north. Individual copepods were preserved in RNA later (39 *C. acutus,* 38 *C. propinquus*, and 9 *R. gigas*), and pooled samples were frozen for enzymatic or lipid analysis (11 pools of *C. acutus,* and 15 of *C. propinquus*). These animals were individually photographed for morphometric analysis. Sampling was completed of the *C. acutus* feeding experiment that was started in week 2 (~240 animals). With the increased abundance of *C. propinquus*, a new feeding experiment was started (~92 animals) that will be sampled next week.

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

Field Team Members: Megan Roberts and Anne Schaefer

This week we processed samples collected on Avian Island and conducted bridge-based sea bird and mammal surveys along the grid. This consisted of processing 26 diet samples, preparing Adélie penguin toe nails for stable isotope analysis, entering data, and conducting stationary and transect surveys along the 100, 000, and -100 lines.

Diet samples this year were noticeably different from last year in terms of relative abundance of fish and krill (**Fig. 10**). *Euphausia superba* was the dominate krill species within diets again this year and was found in every sample. Fish was much less prominent than in previous years, and in most cases no evidence of fish was observed in this year's samples. We also found evidence of *Euphausia crystallorophias* and a couple species of amphipods in several of the diets.

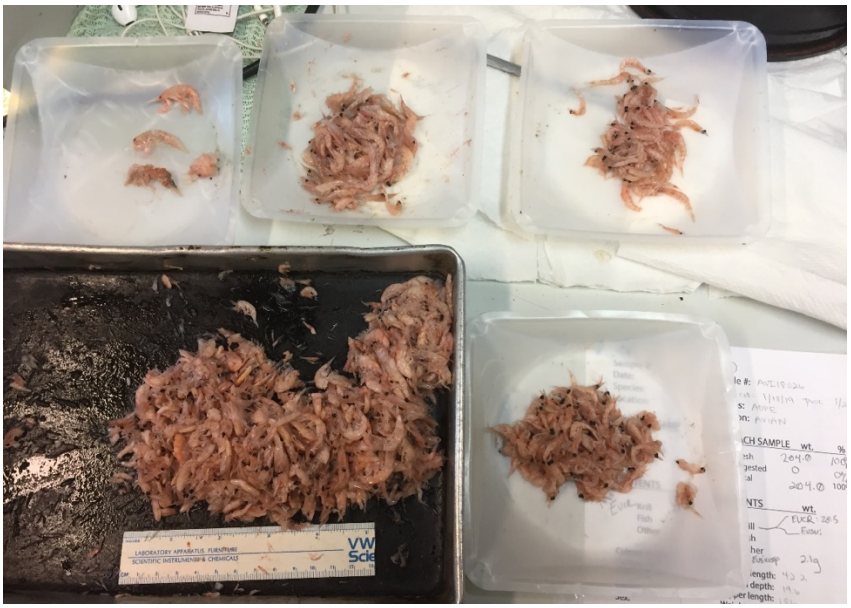

Figure 10. *Euphausia superba*, *Euphausia crystallorophias*, and amphipods found in one diet sample.

During grid line surveys, we spotted several species of birds, including: Southern Fulmars, Southern Giant Petrels, Antarctic Petrels, and Snow Petrels (**Fig.11**). Our highest density bird groups consisted of Southern Fulmars and Snow Petrels. Additionally, off survey, while in ice, we spotted one juvenile Emperor Penguin, and had a very rare sighting of a Ross Seal (**Fig.11**). We also encountered numerous Crabeater Seals and a few Weddell and Leopard Seals while in the ice.

Figure 11. Antarctic Petrel near -100 line (left) and Ross Seal (right; photo by A. Schaefer).

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

Field Team Members: Michelle Modest, Ross Nichols

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Sightings Operations

Normal whale operations continued this week. Humpbacks were the sole species observed this week and continue to show significantly low numbers compared to our observations further north (**Tables 1, 2**). Whales observed this week were seen foraging at the surface using surface lunge feeding, bubble net feeding, and transiting. Photo ID was taken on all animals that were present during zodiac deployments and include a dorsal fin photo and matching fluke photo for later identification. We have also taken photos of surface lunge feeding behavior of humpbacks foraging in pairs. The humpbacks will make coordinated lunges on surface prey patches that have an incredible level of synchrony. See **Fig. X** for a lunge feeding photo sequence.

Biopsy operations

This week our team collected 5 biopsies on humpback whales. All 5 of these whales showed lunge feeding behavior and shallow prey foraging. The samples acquired of these lower latitude whales is vital to our effort. Humpback subpopulations coexist in the austral summers along the Western Antarctic Peninsula, comparing the genetic information acquired through biopsies will show their demography and distribution of these subpopulations as the season continues.

Table 1. Weekly statistics of our sightings from LMG 1901 from 1.21.2019 – 1.27.2019.

	Weekly Whales Sighted	Total Calves	Total Adults
Humpback	8	0	8
Minke	0	0	0
Orca	0	0	4
Fin Whale	0	0	0
Unknown	0	0	0
Totals	**8**	**0**	**8**

Biopsies	Total Samples
Humpback	5
Minke	0

Table 2. Cumulative statistics of our sightings from LMG 1901 from 12.28.2018 – 1.27.2019.

	Total Whales Sighted	Total Calves	Total Adults
Humpback	252	4	252
Minke	4	0	4
Orca	10	0	10
Fin Whale	6	0	6
Unknown	41	0	41
Totals	**318**	**4**	**314**

Biopsies	Total Samples
Humpback	18
Minke	0

Figure 3. Two adult humpback whales perform a synchronous lunge feed at the surface (sequence is clockwise from top left). The whales open their mouths upon reaching the surface on their right sides, engulfing a shallow prey patch. In this photo series, you can see that both whales are rolled onto their right side. The right side of each whale is the upper left jaw, and the left side of each whale shows their expanded throat pleats.