Cruise Report

Eco-FOCI Spring Moorings

Cruise DY21-03

NOAAs Oscar Dyson

May 01 – May 20, 2021

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**Cruise Objectives:**

The primary objective of cruise DY21-03 was the recovery of the moorings at M2 and M4 followed by the deployment of surface moorings at M2 and subsurface moorings at M4.   CTD stations were to be conducted on the 70m isobath and at the boxes around each station at M2, M4, and M5. In addition to CTD measurements, bongos were to be taken at every other station along the 70m isobath and at the box stations around M2, M4, and M5. CalVET samples were to be taken at the center of each mooring box location to assess the small zooplankton population. Rapid Zooplankton Assessments were to be conducted at every other bongo station to generate data for early ecosystem assessment. The end point of the 70m isobath line was the ice edge which was projected to be near the NW corner of St Mathew Island.  CTD/Bongos were also to be occupied around the Unimak box in Unimak Pass.  A final mooring was to be deployed at mooring site UPP along with several MML mooring turnarounds and recoveries.  PUFF moorings were to be deployed at various sites in the Bering Sea.

Equipment tests were scheduled to be conducted with the CPICS plankton imaging camera and the Rinko oxygen sensor which was doing comparisons of different oxygen sensors during most CTD casts. Special sample requests were made to collect zooplankton for lipid analysis (Suryan, Auke Bay Laboratory, AFSC), Harmful Algal Bloom research (Lefevbre, NWFSC), and for crab larvae (Fedewa, AFSC).

**Operations:**

The operations consisted of 5 main categories, moorings, ctd’s, bongo/CalVET tows, bird and marine mammal observations.

**1) Moorings**: Geoff Lebon, Matias Gradilla, Jessica Crance, Dave Kimmel.

Mooring operations for DY21-03 consisted of 9 moorings recovered and 9 moorings deployed. These included 2 ADCP (Acoustic Doppler Current Profiler) moorings turned around and 1 other deployed, 3 passive acoustic moorings turned around and 2 recovered, 1 physical oceanographic mooring deployed, 9 popup moorings deployed, and 2 surface moorings deployed. All mooring operations were performed without incident or damage to any instrumentation. One ADCP mooring had to be recovered by attempted dragging as the release failed to operate properly. Upon being hit by the drag wire the mooring released. A complete list of all instruments attached to each mooring is listed in the tables below.

**Moorings recovered**, ADCP = Acoustic Doppler Current Profiler; Eco=flourescence; SeaCat=conductivity, temperature, depth; MicroCat=conductivity, temperature, depth; Optode=oxygen sensor; SBE Temp=temperature sensor; AURAL=passive acoustics.

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Mooring | ADCP | Current Meter | Eco | MTR | Micro Cat | SBE16 | Optode | SBE Temp | Aural | Seafet | pCO2 |
| 19BSP-2B | 1 |  |  |  |  |  |  |  | 1 |  |  |
| 19BS-2C |  | 1 | 3 |  | 3 | 1 | 1 | 7 |  | 1 | 1 |
| 20BSP-4A | 1 |  |  |  |  |  |  |  | 1 |  |  |
| AL20\_AU\_UN01b |  |  |  |  |  |  |  |  | 1 |  |  |
| AL20\_AU\_PM02b |  |  |  |  |  |  |  |  | 1 |  |  |
| AL19\_AU\_BS3 |  |  |  |  |  |  |  |  | 1 |  |  |
| AL19\_AU\_UM01 |  |  |  |  |  |  |  |  | 1 |  |  |
| AL19\_AU\_BS10 |  |  |  |  |  |  |  |  | 1 |  |  |

**Moorings deployed**, ADCP = Acoustic Doppler Current Profiler; Eco=flourescence; SeaCat=conductivity, temperature, depth; MicroCat=conductivity, temperature, depth; Optode=oxygen sensor, SBE Temp=temperature sensor; TDGP=Gas Tension, AURAL=passive acoustics.

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Mooring | ADCP | Current Meter | Eco | MTR | Micro Cat | SBE16 | Oxygen | SBE Temp | Aural | TDGP | pCO2 |
| 21UPP-1A | 1 |  |  |  | 1 |  |  |  |  |  |  |
| 21BSP-2A | 1 |  |  |  |  | 1 | 1 |  | 1 |  |  |
| 21BSPR-2A |  | 1 | 1 |  | 1 | 1 | 3 |  |  |  |  |
| 21BSM-2A |  |  | 5 | 4 | 3 | 3 | 2 | 9 |  | 1 | 1 |
| 21BS-4A |  |  | 2 | 8 | 3 |  |  | 6 |  |  |  |
| 21BSP-4A | 1 |  |  |  |  |  |  |  | 1 |  |  |
| AL21\_AU\_UN01a |  |  |  |  |  |  |  |  | 1 |  |  |
| AL21\_AU\_UM01 |  |  |  |  |  |  |  |  | 1 |  |  |
| AL21\_AU\_BS10 |  |  |  |  |  |  |  |  | 1 |  |  |

**2) CTD’s:** Shaun Bell, Natalie Monacci, Matias Gradilla, Jessica Crance, and Geoff Lebon.

The CTD objective for the cruise was to perform CTDs along the 72m isobath from the M2 mooring site up to the M8 mooring site or the ice edge which continues the long term monitoring of the Bering Sea Ecosystem. The Unimak box was a lower priority.

All CTD stations including the boxes at M2, M4, and M5 up to station 70M50 were occupied. Looking at satellite imagery and with darkness approaching and foggy conditions it was decided not to proceed any farther north as the ice was nearby and was visible on radar. In addition, ctds were performed at all the stations on the Unimak box and Bering Canyon line AW and AE. Due to exceptional weather throughout the cruise, the Bering Canyon lines were added towards the end of the cruise as time allowed for the completion of these lines. The following table is a list of all the stations occupied and the water samples that were taken at each station,

**Summary of all CTD Sampling for Cruise DY21-03**

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Station Number** | **No. of Nutrients** | **Sal. Samples** | **O2 Samples** | **Chl Samples** | **Number of DIC** | **Gann Samples** | **Abs. Sample** | **FCM Sample** | **Size Frac Chlor** |
| s1h4 |  |  |  |  |  |  |  |  |  |
| s2h1 | 7 | 1 | 1 | 6 |  | 1 |  | 2 | 2 |
| s3h1 | 7 |  | 1 | 6 |  | 1 |  | 1 | 1 |
| s4h1 | 7 |  | 1 | 6 |  | 1 |  | 1 | 1 |
| s5h1 | 7 | 1 | 1 | 6 |  | 1 |  | 1 | 1 |
| s6h1 | 7 |  | 1 | 6 |  | 1 |  | 6 | 6 |
| s7h1 | 7 | 1 | 7 | 6 | 7 |  |  |  |  |
| s8h1 | 7 |  | 1 | 6 | 1 |  |  | 1 |  |
| s9h1 | 7 |  | 1 | 6 | 1 | 1 |  | 1 | 1 |
| s10h1 | 7 |  | 1 | 6 | 1 |  |  | 1 |  |
| s11h1 | 7 | 1 | 1 | 6 | 1 | 1 |  | 1 | 1 |
| s12h1 | 7 |  | 1 | 6 | 1 |  |  | 1 |  |
| s13h1 | 7 |  | 1 | 6 |  | 1 |  | 1 | 1 |
| s14h1 | 7 |  | 1 | 6 |  |  |  | 1 |  |
| s15h1 | 7 | 1 | 1 | 6 |  |  |  | 1 | 1 |
| s16h1 | 7 |  | 1 | 6 |  |  |  | 1 |  |
| s17h1 | 7 |  | 1 | 6 |  | 1 |  | 1 | 1 |
| s18h1 | 7 | 1 | 1 | 6 |  |  |  | 1 |  |
| s19h1 | 7 |  | 1 | 6 |  | 1 |  | 1 | 1 |
| s20h1 | 7 |  | 1 | 6 |  |  |  | 1 |  |
| s21h1 | 7 |  | 1 | 6 | 1 | 1 |  | 1 | 1 |
| s22h1 | 7 |  | 1 | 6 | 1 |  |  | 1 |  |
| s23h1 | 7 |  | 1 | 6 |  | 1 |  | 1 | 1 |
| s24h1 | 7 | 1 | 1 | 6 |  | 1 |  | 1 | 1 |
| s25h1 | 7 |  | 1 | 6 |  | 1 |  | 1 | 1 |
| s26h1 | 7 |  | 1 | 6 |  | 1 |  | 6 | 6 |
| s27h1 | 7 |  | 1 | 6 | 7 | 1 |  | 1 | 1 |
| s28h1 | 7 |  | 1 | 6 |  | 1 |  | 1 | 1 |
| s29h1 | 7 |  | 1 | 6 | 1 | 1 |  | 1 | 1 |
| s30h1 | 7 | 1 |  | 6 | 1 |  |  | 1 |  |
| s31h1 | 7 |  | 1 | 6 | 1 | 1 |  | 1 | 1 |
| s32h1 | 7 |  | 1 | 6 | 1 |  |  | 1 |  |
| s33h1 | 7 | 1 | 1 | 6 | 1 | 1 |  | 1 | 1 |
| s34h1 | 7 |  | 1 | 6 | 1 |  |  | 1 |  |
| s35h1 | 7 |  | 1 | 6 | 1 | 1 |  | 1 | 1 |
| s36h1 | 7 |  | 1 | 6 | 1 |  |  | 1 |  |
| s37h1 | 7 | 1 | 1 | 6 |  | 1 |  | 1 | 1 |
| s38h1 | 7 |  | 2 | 6 |  |  |  | 1 |  |
| s39h1 | 7 |  | 1 | 6 |  | 1 |  | 1 | 1 |
| s40h1 | 7 |  | 1 | 6 |  |  |  | 1 |  |
| s41h1 | 7 |  | 1 | 6 | 1 | 1 |  | 1 | 1 |
| s42h1 | 7 |  | 1 | 6 | 1 | 1 |  | 1 | 1 |
| s43h1 | 7 |  | 1 | 6 |  | 1 |  | 6 | 6 |
| s44h1 | 7 |  | 1 | 6 |  | 1 |  | 1 | 1 |
| s45h1 | 7 | 1 | 1 | 6 |  | 1 |  | 1 | 1 |
| s46h1 | 7 |  | 1 | 6 | 1 |  |  | 1 |  |
| s47h1 | 7 |  | 1 | 6 | 1 | 1 |  | 1 | 1 |
| s48h1 | 7 |  | 1 | 6 |  |  |  | 1 |  |
| s49h1 | 7 |  | 1 | 6 |  | 1 |  | 1 | 1 |
| s50h1 | 7 | 1 | 1 | 6 |  |  |  | 2 |  |
| s51h1 | 7 |  | 1 | 6 |  | 1 |  | 1 | 1 |
| s52h1 | 7 |  | 1 | 6 |  |  |  | 2 |  |
| s53h1 | 7 |  | 1 | 6 |  | 1 |  | 7 | 7 |
| s54h1 | 7 |  | 1 | 6 | 7 |  |  | 1 |  |
| s55h1 |  |  |  |  |  |  |  |  |  |
| s55h2 |  |  | 2 |  | 7 |  |  | 1 |  |
| s56h1 |  |  |  |  |  |  |  |  |  |
| s57h1 | 7 | 1 | 1 | 6 | 7 | 1 |  | 1 | 1 |
| s58h1 |  |  | 2 |  |  |  | 1 | 1 |  |
| s59h1 |  |  |  |  |  |  | 1 | 2 |  |
| s60h1 | 10 | 1 | 1 | 6 |  | 1 |  | 1 |  |
| s61h1 | 10 |  | 1 | 6 |  | 2 |  | 2 | 1 |
| s62h1 | 10 |  | 1 | 6 |  |  |  | 1 |  |
| s63h1 | 11 |  | 1 | 6 |  | 1 |  | 2 | 1 |
| s64h1 | 10 | 1 | 1 | 6 |  | 1 |  | 2 | 1 |
| s65h1 | 10 |  | 1 | 6 |  | 1 |  | 1 | 1 |
| s66h1 | 10 |  | 1 | 6 |  |  |  | 1 | 1 |
| s67h1 | 10 |  | 1 | 6 |  |  |  | 1 |  |
| s68h1 | 11 | 1 | 11 | 6 |  | 1 |  | 1 | 1 |
| s69h1 | 10 |  | 1 | 6 |  |  |  | 2 |  |
| s70h1 | 8 |  | 1 | 6 |  |  |  | 1 |  |
| s71h1 | 11 |  | 1 | 6 |  | 1 |  | 1 | 1 |
| s72h1 | 11 |  | 1 | 6 |  | 1 |  | 1 | 1 |
| s73h1 | 11 |  | 1 | 6 | 1 |  | 1 | 1 |  |
| s74h1 | 10 | 1 | 1 | 6 |  | 1 |  | 1 | 1 |
| s75h1 | 9 |  | 1 | 6 |  | 1 |  | 6 | 6 |
| s76h1 | 9 |  | 1 | 6 | 1 |  |  | 1 | 1 |
| s77h1 | 9 | 1 | 1 | 6 |  |  |  | 1 |  |
| s778h1 | 9 |  | 1 | 6 |  | 1 |  | 1 | 1 |
| s79h1 | 8 |  | 1 |  |  |  |  | 1 |  |
| s80h1 | 8 |  | 1 | 6 |  | 2 |  | 2 | 2 |
| s81h1 | 8 |  | 1 | 6 |  |  |  | 1 |  |
| s82h1 | 7 | 1 | 1 | 6 |  |  |  | 1 |  |
| s83h1 |  |  |  |  |  |  |  |  |  |
| s84h1 | 9 |  |  | 6 | 9 |  | 1 | 6 | 6 |
| s85h1 | 5 |  |  | 5 | 5 |  | 1 | 1 | 1 |
| s86h1 | 9 | 1 |  | 6 | 9 |  |  | 1 |  |
| s87h1 | 9 |  |  | 6 | 9 |  |  | 1 | 1 |
| **Totals** | **630** | **20** | **97** | **479** | **88** | **47** | **5** | **123** | **83** |

**3)  Bongo/CalVET tows**: Dave Kimmel, Deanna Crouser:

Zooplankton samples and water profiler data were collected simultaneously at 52 sites.  These sites were along the 70-m isobath, at and around the M2, M4, and M5 moorings, in Bering Canyon, and in the Unimak Box. At each site, a bongo-profiler array was used to sample from the sea surface to 10 m off bottom. Samples were collected with a 20-cm bongo (153-µm mesh) and a 60-cm bongo (505-µm mesh) net on the wire just below a Sea-Bird Electronics Fastcat profiler (SBE-49). The profiler was used to indicate net depth in real time and measured temperature and salinity. During Bering Canyon sampling, the Fastcat profiler termination failed and could not be repaired, so the stations within Unimak Box have no associated Fastcat data.   Net 1 of each bongo net (20 and 60 cm) was preserved (5% formalin-buffered seawater solution) for quantitative analysis. Both Net 2 samples were used for Rapid Zooplankton Assessment (RZA, RCountZ) at 29 stations. At mooring sites M2, M4, and M5 a California Vertical Egg Tow (CalVET) net (53-µm mesh) was used, along with the profiler, to collect triplicate samples of microzooplankton from the upper 60 m of the water column. For a total of 9 samples.

Zooplankton from Net2 were processed to fulfill several special requests. Large copepods and euphausiids were separately picked, photographed, and frozen for later lipid analysis at RZA stations where abundance was sufficient (Suryan, ABL/AFSC). Large copepods and euphausiids were separately picked and frozen for later Harmful Algal Bloom toxin analysis (Lefebvre, NWFSC). Finally, at stations around and north of the M4 mooring site, contents of Net 2 were preserved in formalin for larval crab analysis (Fedewa, Kodiak Laboratory/AFSC). In addition to these special requests, the zooplankton team also tested a new plankton imaging system, the CPICS. The CPICS camera collected data on 60 casts for a total of 965,532 total images. The majority of images collected were of phytoplankton and this was likely related to the vertical mount used for testing the camera.

Table 1.  Bongo, CalVET, and special sample request totals

|  |  |  |
| --- | --- | --- |
| Samples Collected | Tows | Number |
| Quantitative tow preserved in formalin | 52 | 121 |
| Rough Count Zooplankton for Rapid Zooplankton Assessment | 52 | 29 |
| CalVET samples | 9 | 9 |
| Crab samples for Erin Fedewa | 52 | 20 |
| Lipid samples for Rob Suryan | 52 | 23 |
| HAB samples for Kathi Lefebvre | 52 | 44 |
| Gears Used |  |  |
| 20BON - 20cm bongo | 50 |  |
| 60BON - 60cm bongo | 52 |  |
| CALVET - CalCOFI vertical egg net tow | 9 |  |
| CAT - Seabird SeaCAT CTD | 50 |  |

**4) Passive Acoustics Marine Mammal Ops:** Jessica Crance.

Long-term recorders:

Seven long-term marine mammal passive acoustic recorders were recovered during the survey. Of these, five were on MML marine mammal moorings and two were on PMEL moorings. All seven recorders lasted the full expected time. A total of five recorders were redeployed during the survey. Of these, three were MML marine mammal moorings and two were on PMEL moorings. An attempt was made to drag for one long-term recorder that was deployed in 2017. The release on this mooring was not responding during a 2019 survey, indicating either the release batteries were dead, or the mooring was no longer in the original position (a result of being fished up). During this DY21-03 survey, the vessel drove over the original deployment position in the hopes of detecting the mooring on the echosounder, but it was not visible, nor was the release responding. Dragging hooks were deployed to attempt to hook the mooring and retrieve it, but the attempt was unsuccessful.

Short-term monitoring:

Passive acoustic monitoring was conducted opportunistically during the survey using sonobuoys, which were deployed approximately every 2.5 hours as ship operations, depth, and vessel traffic permitted. Sonobuoys are short-term, expendable, listening devices which transmit the acoustic signals in real-time via VHF to an antenna on the ship. A total of 60 sonobuoys were deployed for a total of over 66 hours of acoustic monitoring. Of the 60 sonobuoys, 48 were 2014 Sparton 53F DiFAR directional buoys, and 12 were 1991 Magnavox 57B omnidirectional buoys. All 48 of the Sparton buoys transmitted successfully, while 6 of the 12 older omni buoys transmitted successfully, for an overall success rate of 90%. The most commonly detected species was fin whales, detected on 19 buoys (35%), followed by killer and humpback whales (9 buoys each, 17%), bowhead whale and bearded seals (5 buoys each, 9%), ribbon seals (4 buoys, 7%), sperm whales (2 buoys, 4%), possible gray whales and gunshot calls (3 buoys each, 5%), two unknown signals (4%), and one low moan call that is not yet attributed to species. Stephanie Grassia (CICOES/MML/PMEL) is attempting to determine what species is producing this unique, stereotyped call.

**5. Bird Observations:** Marty Reedy.

Bird observations were performed throughout the cruise. Observations were done over 1570 nm totaling 134.5 hours.

**6. Special Projects:**

Special projects consisted of 6 items.  Four items are described above in the bongo section: the trial of the CPICS camera, zooplankton preserved for lipid analysis (Suryan, ABL/AFSC), Harmful Algal Bloom toxins (Lefebvre, NWFSC), and larval crab identification (Fedewa, Kodiak Laboratory/AFSC).

We also compared the Rinko O2 sensor to the Aanderaa optode and the Seabired SBE43.  While the preliminary data looks promising, the two-layer system was not yet set up in the Bering Sea to fully test the Rinko.  This will be further tested on the Fall Mooring/DBO cruise.

The TDGP was also brought along to hook up to the pCO2 system.  This worked well for about 6 days before the pCO2 system failed.  The data will soon be evaluated to measure its success.

**Summary**:

The 2021 Spring Mooring Cruise departed Kodiak AK on May 1st after all the scientists scheduled to depart on the cruise completed their SIP and tested negative for Covid19.  The ship in consultation with the scientist decided to bypass the moorings near Unimak Pass on the way to the Bering Sea in favor of reaching station M2 early to take advantage of a good weather window. Shortly after passing through Unimak Pass we became aware of a medical issue within the science party and the ship diverted to do a medivac in Dutch Harbor.

Upon leaving Dutch Harbor the ship headed to Site M2 to turn around all the moorings at site M2 and complete the M2 box.  All moorings were successfully deployed and recovered with the caveat that the 19BSP-2A mooring had to be recovered with the dragging hooks as the mooring did not release.

With weather setting in that might have halted operations, it was decided to head south to deploy a PUF at site PUF\_2 and use the wind to push the ship back up to MML site BS3.  The BS3 mooring was recovered and a dragging operation was attempted for a lost MML mooring from 2017 but this was unsuccessful.  Upon completion of the work at site BS3, the Dyson returned to site M2 to do a calibration cast and to start up the 70m line doing bongos and ctds towards site M4. On the 70m line, the CPICS plankton imaging camera was attached to the ctd frame and collected images as we did ctd casts up the line. Rapid Zooplankton Assessment was conducted at each bongo location along the 70m line and zooplankton were collected for later lipid analysis and Harmful Algal Bloom toxin analysis.

Upon reaching site M4, the subsurface mooring was recovered and the new moorings were deployed.  The M4 box was completed and the ship continued work up towards the M5 box. From M4 to the ice edge, we preserved the second net of the bongo for later enumeration of crab larvae. About half way between sites M4 and M5 the ship diverted east to drop off a PUF at site PUF\_16 and then returned to the 70m line to continue north.  This process continued up to site 70M50 doing the M5 box along the way.  With extra time, several ctd cast were taken in this area looking for possible currents along the face of the ice edge.

Upon completion of the 70m line, the vessel headed west, dropping PUFS at sites PUF\_14 and PUF\_15.  From there the ship headed south towards MML mooring site BS10 and dropping PUFS at sites PUF\_11, PUF\_10, PUF\_6, and PUF\_5.  Upon arrival at MML site BS\_10, the mooring was turned around in gale winds and the ship continued south to the MML site in Umnak Pass dropping a PUF at site PUF\_3 on the way.  Upon arriving at Umnak, the MML mooring was turned around.

Due to good weather and no equipment downtime, we were able to add two additional ctd/bongo lines to the list of operations, AE and AW, these were both across Bering Canyon and were up to 500m deep.  Due to this, the fast cat cable failed on the last deep cast.  Proceeding to the Unimak box, we did a quick termination for the fast cat, however it failed right away on the first bongo tow.  We were able to complete the Unimak box tows flying the bongo blind along with its accompanying ctd casts.

The final MML mooring turnaround was done in the Unimak box and mooring UPP was deployed as we started towards Kodiak.  The ship docked in Kodiak on May 20th.

The cruise enjoyed favorable weather throughout most of the cruise and with near zero equipment downtime, we were able to accomplish 110% of the objectives as laid out in the project instructions. This comes from the added Bering Canyon lines and the line NW of St Mathew Island looking for the current at the ice edge.  The cruise was considered a success due to all objectives being accomplished and the large number of samples taken.

**Oscar Dyson daily schedule for DY21-03**

01 May, depart Kodiak

02 May, transit to the Bering Sea

03 May, test cast, head to Dutch Harbor to drop off Sarah for medivac

04 May, Mooring recoveries and deploy prawler at M2, Box at night

05 May, Deploy Peggy, M2C station, run to PUFF2

06 May, deploy PUFF2, run to MML BS3, recover and drag, back to M2C for cal cast.

07 May, 72M isobath

08 May, BS4 moorings, complete, continue 70m

09 May, Puff16 and M5 box

10 May, end 72 m at 70M50, do puff14

11 May, puffs15, 11, 10

12 May, puffs 5 and 6

13 May, BS10 MML mooring and puff3

14 May, Umnak MML mooring, UT3, and AW line

15 May, AE line. Reterminate bongo wire. Start Unimak box, UBW line.

16 May, UBN, UBE and start UBS line. Turnaround MML mooring in Unimak Pass.

17 May, finish UBS line and deploy UPP mooring. Start transit to Kodiak.

18 May, transit to Kodiak.

19 May, transit to Kodiak

20 May, Dyson docks in Kodiak

**Plot of Cruise Track:**

