US Country Report-Research Cruises

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December 5, 2022  
Pacific Arctic Group Meeting  
Victoria, B.C. Canada
# 2022 PAG and DBO Cruise Plan Table (12-01-22)

[will build 2023 PAG and DBO table during the meeting]

## 2022 PAG and DBO Field Season (version 12.1.22): Sampling Contributors

Projects Key: AON—Arctic Observing Network; ArCS II—Arctic Challenge for Sustainability (JAMSTEC—Japan Agency for Marine-Earth Science and Technology); AMOS—Arctic Mobile Observing System; C3O—Canada’s Three Oceans (DFO—Department of Fisheries and Oceans Canada); DBO—Distributed Biological Observatory; EcoFOCI—Ecosystem & Fisheries Oceanography Coordinated Investigations; JOIS—Joint Ocean Ice Study/BGOS = Beaufort Gyre Observatory System (DFO); K-WARE (KOPRI)—Korea- Arctic ocean WARMing & Ecosystem study (Korea Polar Research Institute).

**DBO Region Key:** DBO1=So. St. Lawrence Is., DBO2=Chirikov Basin, DBO3=So Chukchi Sea, DBO4=NE Chukchi Sea, DBO5=Barrow Canyon, DBO6=East Beaufort Sea, DBO7=Beaufort Sea Central, DBO8=Bathurst polynya region.

<table>
<thead>
<tr>
<th>Dates 2022 (Port calls)</th>
<th>Ship</th>
<th>DBO Region</th>
<th>Projects</th>
<th>PAG contact</th>
<th>Chief Scientist</th>
</tr>
</thead>
<tbody>
<tr>
<td>July 6-26 (Victoria, BC-Utqiagvik, AK)</td>
<td>Sir Wilfrid Laurier</td>
<td>1,2,3,4,5</td>
<td>DBO/C3O (AON/NSF)</td>
<td>Jackie Grebmeier, <a href="mailto:jgrebmei@umces.edu">jgrebmei@umces.edu</a></td>
<td>John Nelson, <a href="mailto:John.Nelson@dfompo.gc.ca">John.Nelson@dfompo.gc.ca</a></td>
</tr>
<tr>
<td>July 14-Aug 30 (Dutch-Dutch)</td>
<td>Healy</td>
<td>-</td>
<td>AMOS</td>
<td>Craig Lee, <a href="mailto:craig@apl.washington.edu">craig@apl.washington.edu</a></td>
<td>Craig Lee, <a href="mailto:craig@apl.washington.edu">craig@apl.washington.edu</a></td>
</tr>
<tr>
<td>July 19-Aug 15, 2022 Leg 1: Nome-Nome)</td>
<td>Norseman II</td>
<td>3,5,6</td>
<td>Harmful Algae Blooms</td>
<td>Robert Pickart, <a href="mailto:rpickart@whoi.edu">rpickart@whoi.edu</a></td>
<td>Robert Pickart, <a href="mailto:rpickart@whoi.edu">rpickart@whoi.edu</a></td>
</tr>
<tr>
<td>July 4-Oct 4 (Incheon-Incheon, stops in Dutch Harbor and Utqiagvik)</td>
<td>Araon</td>
<td>3, Chukchi Borderland, Beaufort Sea</td>
<td>K-WARE (KOPRI)</td>
<td>Eun Jin Yang, <a href="mailto:eiyang@kopri.re.kr">eiyang@kopri.re.kr</a></td>
<td>Eun Jin Yang, <a href="mailto:eiyang@kopri.re.kr">eiyang@kopri.re.kr</a></td>
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<tr>
<td>Aug 12-31 (Utqiagvik-Utqiagvik)</td>
<td>Annika Marie</td>
<td>5</td>
<td>Bio-physical drivers of bowhead whales</td>
<td>Carin Ashjian, <a href="mailto:cashjian@whoi.edu">cashjian@whoi.edu</a></td>
<td>Carin Ashjian, <a href="mailto:cashjian@whoi.edu">cashjian@whoi.edu</a></td>
</tr>
<tr>
<td>Sept 15-25 (Dutch Kodiak); cancelled early, engine issues</td>
<td>Dyson</td>
<td>1,2,3,4,5</td>
<td>DBO EcoFOCI</td>
<td>Jackie Grebmeier, <a href="mailto:jgrebmei@umces.edu">jgrebmei@umces.edu</a></td>
<td>Ryan McCabe, <a href="mailto:ryan.mccabe@noaa.gov">ryan.mccabe@noaa.gov</a></td>
</tr>
<tr>
<td>Aug 12-Oct 6 (Japan-Dutch Harbor-Japan)</td>
<td>Mirai</td>
<td>3,5,6,7</td>
<td>ArCS II (JAMSTEC)</td>
<td>Shigeto Nishino, <a href="mailto:nishinos@jamstec.go.jp">nishinos@jamstec.go.jp</a></td>
<td>Motoyo Ito, <a href="mailto:motoyo@jamstec.go.jp">motoyo@jamstec.go.jp</a></td>
</tr>
<tr>
<td>Aug 17 Sept 6, 2022 (Leg 2: Nome-Nome)</td>
<td>Norseman II</td>
<td>3,5,6</td>
<td>Harmful Algae Blooms</td>
<td>Robert Pickart, <a href="mailto:rpickart@whoi.edu">rpickart@whoi.edu</a></td>
<td>Robert Pickart, <a href="mailto:rpickart@whoi.edu">rpickart@whoi.edu</a></td>
</tr>
<tr>
<td>Sept 4-Oct 28 (Dutch-Dutch)</td>
<td>Healy</td>
<td>4 (CEO mooring only)</td>
<td>SAS</td>
<td>Jackie Grebmeier, <a href="mailto:jgrebmei@umces.edu">jgrebmei@umces.edu</a></td>
<td>Carin Ashjian, <a href="mailto:cashjian@whoi.edu">cashjian@whoi.edu</a></td>
</tr>
<tr>
<td>Sept 8-18, 2022 (Nome-Nome)</td>
<td>Norseman II</td>
<td>3; moorings; CTDs</td>
<td>Bering Strait Mooring Project (AON/NSF)</td>
<td>Rebecca Woodgate, <a href="mailto:woodgate@uw.edu">woodgate@uw.edu</a></td>
<td>Rebecca Woodgate, <a href="mailto:woodgate@uw.edu">woodgate@uw.edu</a></td>
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<tr>
<td>Sept 14-Oct 28 (Nome-Nome)</td>
<td>Sikuliaq</td>
<td>-</td>
<td>AMOS</td>
<td>Craig Lee, <a href="mailto:craig@apl.washington.edu">craig@apl.washington.edu</a></td>
<td>Craig Lee, <a href="mailto:craig@apl.washington.edu">craig@apl.washington.edu</a></td>
</tr>
<tr>
<td>Sept 1-29 or Sept 15-Oct 11 (Kugluktuk, Canada-return)</td>
<td>Louis S. St-Laurent</td>
<td>-</td>
<td>JOIS/BGOS (DFO/NSF)</td>
<td>Bill <a href="mailto:Williams@dfompo.gc.ca">Williams@dfompo.gc.ca</a></td>
<td>Sarah <a href="mailto:Zimmermann@dfompo.gc.ca">Zimmermann@dfompo.gc.ca</a></td>
</tr>
<tr>
<td>Sept 25-Oct 28</td>
<td>Sir Wilfrid Laurier</td>
<td>-</td>
<td>Moorings</td>
<td>Bill <a href="mailto:Williams@dfompo.gc.ca">Williams@dfompo.gc.ca</a></td>
<td>Bill <a href="mailto:Williams@dfompo.gc.ca">Williams@dfompo.gc.ca</a></td>
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<tr>
<td>Nov 1-28, 2022 (Nome-Nome)</td>
<td>RV Sikuliaq</td>
<td>3,5,6</td>
<td>Beaufort Gyre Shelf-Edge Current</td>
<td>Robert Pickart, <a href="mailto:rpickart@whoi.edu">rpickart@whoi.edu</a></td>
<td>Robert Pickart, <a href="mailto:rpickart@whoi.edu">rpickart@whoi.edu</a></td>
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July 2022 CCGC Sir Wilfrid Laurier

Canada’s Three Oceans (C30) and the DBO: *CCGS Sir Wilfrid Laurier*, July 6-25, 2022 (planned 2023); Victoria, BC, Canada or Dutch Harbor, Alaska to Utqiagvik, Alaska [Jackie Grebmeier: PAG DBO talk/DBO data workshop]

**DBO data collections**

- Seawater temperature and salinity; currents
- Nutrients, chlorophyll, carbon products, dissolved carbon
- Phytoplankton, zooplankton and macrobenthic abundance, biomass, community structure
- Marine mammal and seabird surveys

**Contacts:** John Nelson
John.Nelson@dfo-mpo.gc.ca
and Jackie Grebmeier
jgrebmei@umces.edu
Craig Lee, University of Washington
[will give PAG talks on these projects]

Stratified Ocean Dynamics of the Arctic (SODA)
https://apl.uw.edu/project/project.php?id=soda

Moored and Mobile Instruments Maintain Focus on Fixed Domain

• Understand how the upper Beaufort Sea, particularly stratification and sea ice, responds to changes in inflow and surface forcing.
• Mobile instruments operate within broad field of moored (fixed) assets that provide acoustic infrastructure and sampling.
• Ice-based instruments deployed to drift through mooring array.
• Good for sustained focus on fixed geographic sites.

Results include new understanding of...
• Ice-ocean drag parameterizations.
• Role of sea ice melt water in modulating freeze-up.
• Seasonal modulation of near-inertial motions within mixed layer.
• Episodic offshore heat transport within filaments.
Long-Endurance Gliders

Arctic Mobile Observing System (AMOS)

Persistent, year-round monitoring, event-driven sampling/response

- Data exfiltration and control for instruments operating under ice through ‘gateway’ buoys that bridge ice-ocean interface.
- Store and forward network of mobile instruments.
- Persistent presence, multi-scale sampling – gliders, floats & fast UUVs operating with ‘gateway’ buoys.

- Robust, broad acoustic navigation:
  - Long-range (trans-basin) very low frequency (35 Hz) beacons – ‘underwater GPS.’
  - 900 Hz broadband beacons.
- Situational awareness and control center – in situ environmental data, remote sensing, numerical predictions inform decisions.

Ongoing-completed 2022 and planned for 2023
Tech Development
- New low-power, low-cost real time clock.
- New low-power, low-cost acoustic navigation receiver.
- Hardening and under-ice functionality for SOLO-2 float, build on Seaglider under-ice experience.

Acoustic Geopositioning in the Beaufort Sea
Use ONR Arctic Mobile Observing System (AMOS-INP)
- 7-element 900 Hz array (2018-2025)
- 2-element 35 Hz array (2023-2025)

SOLO-II Pilot Deployments
- Fabricate 30 SOLO-II floats (10 per year).
- Arctic deployments begin in autumn 2023 (coincident with deployment VLF array).
- Data will flow to Argo DAC.

Logistics
- AMOS-INP cruises and/or ice camps.
- Collaboration with other Beaufort Sea programs.
Goals of the project

- Improve our understanding of phytoplankton dynamics in the Chukchi Sea
- Identify locations and quantify the magnitude of harmful algal blooms (HABs)
- Map the distribution of HAB cysts in the sediments
- Understand how the circulation and water properties influence these things
Extensive physical and biogeochemical sampling of the water column and sediments, including 435 CTD stations, 120 surface sediment grabs, 15 multi-cores, and 47 phytoplankton net tows.
Bio-physical drivers of bowhead whale distribution on the Alaskan Beaufort Shelf during a period of rapid environmental change

Carin Ashjian (WHOI), Bob Campbell (URI), Steve Okkonen (UAF), Mei Sato (WHOI), Kate Stafford (UW)

Funded by the US Bureau of Ocean Energy Management Award M21AC00015 to the University of Alaska Fairbanks

Photo: Kate Stafford
WDD Mooring and Transect
PB Mooring and Transect
BC Mooring and Transect
Line 4 and Short-term Mooring

Data collection
• Vessel-based sampling of currents (2021; ADCP), hydrography (CTD), zooplankton (nets), bioacoustics (2022)
• 3 year-round moorings at Prudhoe, WDD, Barrow Canyon equipped with ADCP, CTD, acoustic recorders (2021 and 2022)
• 2 year round moorings at WDD and Barrow Canyon equipped with AZFP (2022)
• 1 short-term (~2 weeks) mooring deployed (20-m isobath)
• Krill/copepods collected for C:N, morphometrics, genetics
• Marine mammal and bird distributions

8/20-9/10/21
8/14-9/2/22

200 kHz backscatter across Barrow Canyon -8/19/22
Bering Strait Mooring Project

Pls: Rebecca Woodgate & Cecilia Peralta-Ferriz
woodgate@uw.edu
psc.apl.washington.edu/BeringStrait.html

1990 – present (32+ years)
== year-round moorings
mid channel (e.g., A1, A2, A3, A3‘)
== mostly near bottom
== 2001 started measuring the
Alaskan Coastal Current with A4

To 2022: Physical data:
- hourly (or better)
  - temperature (T)
  - salinity (S)
  - velocity (ADCP)
after 2007 also
  - ice
  - upper “ISCAT” TS

[will give PAG and
DBO workshop talks]

New NSF-OPP-AON funding:
- Continues moorings from 2022-2026
- Adds
  Biooptics on moorings (A3 and A2):
  - hourly
    - SUNA nitrate
    - Fluorescence
    - Dissolved Oxygen
    - Turbidity
SUNA nitrate & nutrient sampling to annual cruises

Thanks to Seth Danielson (UAF) and
Sinhue Torres-Valdes & Daniel Scholz
(AWI) for SUNA discussions

Interested in having a
SUNA user group?
Email Rebecca

We are interested in
collaborations on all
these – please get in touch
Bering Strait Mooring Project
2022 Cruise

8th – 19th Sept 2022 (Nome to Nome)
- recovered moorings (other than A2-21)
  A3-21 dragged 1nm SEward by ice
  A2-21 still missing
  (Thanks to ** for helping in search)
- deployed new moorings with biooptics
- water sampling (on some lines)
  nutrients (green)
  salinity (cyan)
  trace metals (pink) (PI Laramie Jensen)
- sections with profiling SUNA for nitrate
All despite - 1 weather day Tin City
- 3(!!) weather days Port Clarence

** Steven Roberts, Bob Pickart, Ethan Roth on the Sikuliaq
  Luc Rainville, Ben Jokinen on the Sikuliaq
  Motoyo Itoh on the Mirai
  Ryan McCabe, Catherine Berchok, Phyllis Stabeno on the Dyson
  Carin Ashjian, Seth Danielson, Jackie Grebmeier on the Healy
  Mike Dempsey on the Laurier
  Robert Levine, Erica Escajeda, UW students

2023 current planning:
~4th-14th July Norseman2,
Nome to Nome
Annual mean transports still have increasing trend, - 2020 and 2021 still high, though less than 2019 (Still no significant trend in Alaskan Coastal Current)

2021 remarkably COLD (2018 was warmest), - 2021 annual mean as cold as any in the record

2021 & 2020 remarkably SALTY, though still < early 90s - 2020, 2021 & 2022 show return of winter high salinities

Combined: - heat flux down, as low as prior lowest years - freshwater flux down, though still higher than 2000s
Synoptic Arctic Survey Cruise on USCGC Healy: Sept 4-Oct 28, 2022

- To/from Dutch Harbor
- ~60 days in length

Transit north of 82°N

[Carin Ashjian: PAG SAS talk]
Synoptic Arctic Survey Cruise on USCGC Healy: Sept 4-Oct 28, 2022

Synoptic Arctic Survey 9/9/2022 to 10/25/2022

[courtesy Seth Danielson]
Arctic Marine Biodiversity Observing Network: Aug-Sept 2022 collaboration for field collections
(field program facilitated on NSF funded HLY2202)

Chukchi Ecosystem Observatory (CEO)

- Year-round data collection in one location
- Long-term environmental context
- AMBON-supported instrumentation:
  - Marine mammal sound
  - eDNA water collections
  - Phytoplankton species (sediment traps)
- New AMBON-leveraged instrumentation from AOOS: Benthic time-lapse camera
  - Year-round benthic biodiversity
  - Migration patterns of benthic fisheries species, e.g., snow crab

[courtesy Seth Danielson and Katrin Iken, UAF]
Monitoring the Western Arctic Boundary Current in a Changing Climate:
A late-season cruise on R/V Sikuliaq

Principal Investigator: Robert Pickart, Woods Hole Oceanographic Institution

Funded by: the National Science Foundation – Office of Polar Programs, Arctic Observing Network

Goals of the project

• Service the long-term mooring located in the Beaufort Sea boundary current east of Pt Barrow

• Carry out a hydrographic/velocity/tracer survey of the boundary current system from Bering Strait to the Canadian Beaufort

• Provide a platform for ancillary programs, including underway biogeochemistry, HABs, oxygen isotopes in the water column and air, sediment coring, and black carbon
• The AON DBO6 mooring was successfully turned around
• Physical/biogeochemical sampling of the water column and sediments
• 169 CTD stations, 69 surface sediment grabs, and 10 long cores
• Most of the sampling in the Beaufort was done in 90-100% ice cover (newly-forming ice)
• Saildrones sampled across DBOs in the Pacific Arctic: July-August 2022
Seawater warming and declining sea ice cover are impacting ecosystem components, from prey in the water and sediments to marine mammal and seabird consumers. Food security, harmful algal blooms, and ocean acidification are impacted by changing environmental conditions that influence the health of the marine ecosystem.

**Research questions:**
- What ecosystem changes are occurring in the northern Bering and Chukchi seas?
- What conditions cause marine animal populations to vary?
The NOAA annual research cruise, collaborative with AMBON and CEO, will occupy five DBO and EcoFOCI time series stations, along with turning moorings.

**Measurements will include:**
- Seawater temperature and salinity, currents
- Water column measurements: chlorophyll, nutrients, eDNA, phytoplankton type, organic carbon
- Zooplankton and larval fish type
- Harmful algal bloom collections
- Bottom sediments and animals living on and in the sediments
- Seabird and Marine mammal surveys
Microalgae generate most of the food that supports Arctic Ocean food webs

- How abundant are these organisms around sea ice and in open water?
- How do microalgae and sediments move in Arctic Ocean environments?
- Understanding this behavior will help us better understand Arctic food webs as sea ice decreases

Core measurements

- Temperature, salinity, chlorophyll - water mass characteristics
- Fast repetition rate fluorometer - measures phytoplankton health
- HAPS corer - collects seafloor samples of hard and soft sediments
- Sediment traps - measures sinking particles
- FlowCAM - takes images and counts individual algal cells
- Standard suite of oceanographic instruments

Photo courtesy of Kevin Arrigo.
Thank you for your attention.

Questions and comments?

Thank you to all Pacific Arctic Region science colleagues and DBO collaborators, field and laboratory technicians over the years for the time series efforts. Financial support for the science provided by the US NOAA, NSF, BOEM, NASA, NPRB, and ongoing national and international science partners in the Pacific Arctic Group.

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