

Status Report Synoptic Arctic Survey Workshop Woods Hole Oceanographic Institution, USA May 15-16, 2019

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Motivations for the SAS

1. “Our current view of the Arctic Mediterranean is decidedly ‘*regional*’ because historical efforts have *focused on regions* with the result that we sense the parts but *not the whole*. A synoptic view of the Arctic Ocean is lacking and is sorely needed. “ (*Eddy Carmack*) - **Need for pan-Arctic, International effort**
2. Detecting ecosystem and carbon cycle changes in most regions of the Arctic Ocean is difficult because of a paucity of baseline studies with which to compare present conditions - **SAS provide synoptic view every 10 years**
3. Both **shelf-basin and high Arctic studies included in SAS**

Policy & science

- November 2017: Agreement between USA, Canada, Russia, Norway, Denmark, China, Japan, South Korea, Iceland & the EU: No commercial fishing in the High Sea in the coming 16 years and scientific cooperation
- April 2018: FiSCAO monitoring plan ready (5th FiSCAO Report)
- April 2018: 4 mEUR available from the EU for initiating exploratory fishing in the CAO and High Seas management plan
- 2019-2020: acoustics and fishing with R/V Oden (pelagic) and with R/V Polarstern (sympagic)



In a boon for fish stocks, the Barents Sea last year saw a steep rise in photosynthesis by phytoplankton (blue-green bloom above) and other organisms.

CLIMATE CHANGE

Nations put science before fishing in the Arctic

Historic fishing ban gives scientists time to probe ecology as northern waters warm

By Hannah Hoag

Nine nations and the European Union have reached a deal to place the central Arctic Ocean (CAO) off-limits to commercial fishers for at least the next 16 years. The pact, announced last week, will give scientists time to better understand the region's marine ecology—and the effects of climate change—before reeasing sea ice opens the way to widespread fishing.

"There is no other high seas area where we've decided to do the science first," says Scott Highleyman, vice president of conservation policy and programs at the Ocean Conservancy in Washington, D.C., who was part of the U.S. delegation involved in the negotiations. "It's a great example of putting the precautionary principle into action."

The deal to protect 2.8 million square kilometers of international waters in the Arctic was reached after six meetings over 2 years. The parties include the five nations with Arctic coastlines—Canada, Denmark (representing Greenland), Norway, Russia, and the United States—and others that have fishing fleets interested in operating in the region.

Thus far, thick ice and uncertain fish stocks have kept commercial fishing vessels out of the CAO, but the region is becoming increasingly accessible. In recent summers, as much as 40% of the CAO has been open water, mostly north of Alaska and Russia, over the Chukchi Plateau.

As the summer sea ice becomes thinner and its edge retreats northward, more sunlight is penetrating the water, increasing production of plankton, the base of the Arctic food web. These sun-fed plankton are

gobbled up by Arctic cod, which in turn are hunted by animals higher up the food chain, including seals, polar bears, and humans. Some parts of the Arctic Ocean's adjacent seas, such as the Barents Sea (off the northern coasts of Russia and Norway), saw steep increases in primary production—photosynthesis by plankton and other organisms—in 2016, approaching 35% above the 2003 to 2015 average, according to the U.S. National Oceanic and Atmospheric Administration.

Farther north, the state of fish stocks in the CAO is unknown, but existing international law does not prohibit fishing there. Some researchers, environmental groups, and policymakers fear unregulated commercial fishing in the CAO could harm the fragile and rapidly changing marine ecosystem. In the late 1980s, fishing trawlers from Japan, China, and elsewhere crowded the international waters in the Bering Sea between Russia and the United States and removed millions of tons of pollock. By the early 1990s, the pollock population had crashed. It has still not recovered, says David Benton, a member of the U.S. Arctic Research Commission on Admiralty Island in Alaska.

In 2012, some 2000 scientists called for a fishing moratorium in the CAO to prevent a similar catastrophe. Their efforts were a success: By 2015, five Arctic nations vowed to bar their own fishing vessels from the area. But the moratorium left the area open to other large global fishing fleets. Later that year, delegations from other fishing nations—Japan, China, South Korea, and Iceland—as well as the European Union joined the discussions to negotiate a broader new agreement. "The delegations saw the wisdom in waiting [to start commercial

fishing] until there was enough science and management in place," says David Balton, deputy assistant secretary for oceans and fisheries at the U.S. Department of State in Washington, D.C., who has chaired the negotiations since 2015. The deal will stand for 16 years, and will renew automatically every 5 years after that unless a country objects or until science-based fisheries quota and rules are put in place.

In addition to closing the area to fishing, the delegations have agreed to a research and monitoring program to identify species, their abundance, predator-prey relationships, and the pressures they face, including climate change. It hasn't been worked out yet how the program would be funded and managed, Balton says.

For now, reaching the CAO to study its marine ecology requires significant icebreaking capacity, says Peter Harrison, an Arctic policy and fisheries expert at Queen's University in Kingston, Canada, and former deputy minister of Canada's Department of Fisheries and Oceans. Although the United States and Canada have struggled to maintain and expand their icebreaking fleets, other signatories, including China, have that capacity.

Harrison argues that the signatories should create a new multinational science organization focused on the CAO. It could set science priorities, share and analyze the data collected, and provide advice on the state of the CAO's fish stocks. "If you say commercial fishing will not take place until there is sufficient science, going forward, the science will play a very significant role," he says. □

Hannah Hoag is a science journalist in Toronto, Canada.



What are the present state and major ongoing transformations of the Arctic marine system? (specifically the ecosystem and carbon system)

- Describe the present state of the Arctic Ocean to provide the foundation against which future states can be compared to quantify change.
- Three key foci:
 - 1) Physical drivers of importance to the ecosystem and carbon cycle,
 - 2) Ecosystem response, and
 - 3) Carbon cycle and ocean acidification
- Envisioned to repeat each decade

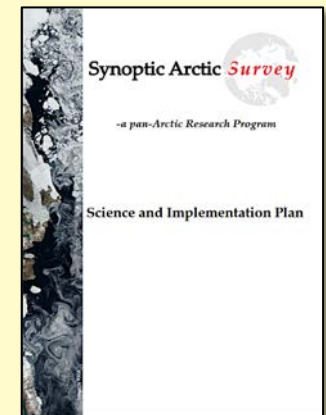
An international, researcher driven, initiative

Leif Anderson, Are Olsen, Øyvind Paasche, Takashi Kikuchi, Carin Ashjian, Peter Schlosser, Jim Swift, Heidimarie Kassens, Sebastian Gerland, Jeremy Wilkinson, Jackie Grebmeier,, Eddy Carmack, Melissa Chierici, Kumiko Azetsu-Scott, Jeremy Mathis, Jackie Grebmeier, Vidar Lien, Lise Lotte Sørensen, Jens Hölemann, Andrey Novikhin, Kyoung-Ho Cho, Karen Edolvang, Motoyoh Itoh, Oleg Titov, Michio Yamamoto-Kawai, Vladimir Ivanov, Colin Stedmon, Bill Williams (and even more people who helped write or reviewed the science plan)



Simplified Timeline

- 2014 Idea conceived, Japan-Norway Marine Science week
- 2015 First international SAS workshop, Washington DC
- 2016 St. Petersburg Meeting
Town Hall, Ocean Sciences Meeting
Gothenburg, start develop SAS Science and Implementation plan
- 2017 First draft of Science Plan Completed
International reviews of science plan solicited
First national group formed, Sweden
Presentation and steering meeting, Prague
Presentation, OCB Meeting, Woods Hole
- 2018 National meeting Japan (ISAR)
National meeting Norway
Reviews of science plan received and plan revised
Updated plan available:
<http://www.synopticarcticsurvey.info/splan.html>
International Scientific Steering Committee Formed
US Scientific Steering Committee Formed (Ashjian and Grebmeier, leads)
International Scientific Steering Committee Meeting, Oct., Woods Hole
Informational Meeting, AGU, Washington DC, December 13
- 2019 **SAS Implementation Workshop, Woods Hole MA (May 15-17)**
Open SAS side meeting, ASSW 2019, Arkhangelsk, Russia (May 26)
- 2020 and/or 2021 Planned year of the Synoptic Arctic Survey



What are the present state and major ongoing transformations of the Arctic marine system?

How does primary production and associated availability of nutrients vary between Arctic regions?

What are the changes in water mass sources, sinks and transformations?

Does northward range expansion of subarctic species vary regionally and are any of these species likely to establish permanent populations in Arctic regions?

What are the states of, and changes in, heat and freshwater budgets in the Arctic regions?

Ecosystem Response

Physical Response

How does biomass flow vary across regional ecosystems of the Arctic?

How are Arctic Ocean water masses and circulation responding to changes in sea ice properties, and atmospheric, advective and freshwater forcing?

Rq6

Rq4

Rq3

Synoptic Arctic Survey

Training, education and outreach are integral

What is the contribution of the Arctic Ocean to maintaining the global ocean carbon dioxide reservoir and uptake?

Rq8

Carbon Cycle & Acidification

Rq9

What are the magnitude, drivers, and impacts of Ocean Acidification in the different regions of the Arctic Ocean?

What are the input and fate of terrestrial and subsea carbon to the Arctic Ocean?

Recommended Set of Measurements

Variable	Sampling
<i>Physical and chemical measurements</i>	
Pressure	CTD
Temperature	CTD
Salinity	CTD + Niskin
Dissolved Oxygen	CTD + Niskin
Nutrients (NO ₃ /NO ₂ , PO ₄ , SiO ₃)	Niskin
CFCs and SF ₆	Niskin
Dissolved Inorganic Carbon	Niskin
Total Alkalinity	Niskin
pH	Niskin
δ ¹⁸ O of H ₂ O	Niskin
Methane	Niskin
Dissolved Organic Carbon (DOC)	Niskin
Particulate Organic Carbon (POC)	Niskin
<i>Water column ecosystem measurements</i>	
Chlorophyll	Niskin
Primary production	Incubation
Viruses	Niskin
Bacteria	Niskin
Phytoplankton composition	Niskin
Microzooplankton	Niskin
Meso-and Macro- zooplankton	Bongo nets, Multinet, Optical Instruments, Acoustics
Icthyoplankton	Aluette or Tucker Trawls, Acoustics
Fish	Trawls, Acoustics
Marine mammals	Passive acoustics, Visual observations
Other Carbon transformation rates	Selected process studies (e.g., grazing, reproduction, sinking, respiration)
<i>Benthic measurements</i>	
Meio- and Macro- fauna	Box Core or Multicore or other corers
Epifauna	Benthic camera, Beam trawl
Other Carbon transformation rates	Selected process studies (e.g., grazing, reproduction, sinking, respiration)
<i>Other</i>	
Epontic Communities	Under-ice imaging, ice cores, sub-ice sampling
Seabirds	Visual Observations

- Physics, carbon chemistry, nutrients, and oxygen following GO-SHIP practices
- Include ecosystem measurements
- Tailored to Arctic science



AGENDA

Synoptic Arctic Survey (SAS) Open Planning Workshop

Dates: May 15-16, 2019

**Venue: Clark Building, 5th Floor, Woods Hole Oceanographic Institution Quissett Campus
360 Woods Hole Rd. Woods Hole Massachusetts USA**

Sponsors: US National Science Foundation and the International Arctic Science Committee



Day 1 (May 15)

8:30 Welcome and logistics - Carin Ashjian and Laurence Madin, Deputy Director and Vice President for Research, WHOI

8:40 Overview of the SAS Program – Øyvind Paasche, Chair of the International SAS Science Steering Committee

- Motivation
- Timeline of program development
- Program Components (Physical Oceanography, Carbon Cycle, Ecosystems)
- International Science Steering Committee Members
- Core questions
- Introduction to core measurements
- Status of the field program – confirmed and planned cruises
- National efforts

9:15 Five minute Country Updates

Korea – Kyong-Ho Cho (presented by Jackie Grebmeier)

Russia – Alexander Polukhin

Canada – Bill Williams and Kumiko Azetsu-Scott

Japan – Shige Nishino

China - Jianfeng He (presented by Jackie Grebmeier)

Sweden – Sten-Åke Wangberg and Leif Anderson

Norway – Øyvind Paasche

Denmark – Karen Edelvang presented by Carin Ashjian

UK – Carin Ashjian

USA – Jackie Grebmeier and Carin Ashjian

Germany – Heidi Kassens

10:00-10:20 Coffee break

10:20 Goals and Outcome of the Workshop – Carin Ashjian and Jackie Grebmeier



- Overall Objectives
- Planned Products
- Review of workshop structure and strategy
 - Review of planned breakouts/discussions needed to accomplish workshop goals (not in order; not all require a breakout group)

1. Discipline specific methods and measurements including questions of spatial and temporal scale
2. Data management
3. Blueprint for nurturing next generation of international Arctic scientists
4. Elements missing from present SAS science plan (e.g., modeling, synthesis, molecular survey for bar coding, satellite data)
5. Additional possible measurements outside core program components (e.g., atmospheric, cryospheric, geological)
6. Review of planned and potential transects and scientific justification for each
7. Non-ship assets (e.g., satellites, AUVs, submarine data collections) including questions of spatial and temporal scale
8. Achieving cross-calibration between programs/ships
9. Indigenous communities: engagement and participation
10. Identify potential overlapping interests with other international efforts such as Mosaic and YOPP mentioning but two
11. Education – developing collaborative platforms (focus on PhDs)
12. Outreach. Identify target groups, messages and opportunities.
13. Funding opportunities. Public and Private?

10:35-12:30 Attendees present research areas of interest

Attendees will be asked if they want to present 2 slides in 3 minutes describing their research interests or specialization (e.g., data management) and how they envision contributing to the SAS. Not all attendees need to do so, only those who wish to.

12:30-1:15 Lunch (served) and synergizing

1:15 Working Groups I - Discipline specific methods and measurements – Carin Ashjian

3 groups (physical oceanography, carbon cycle, ecosystems)

Carbon - Clark 509: Leif Anderson and Lisa Bröder

PO – Clark 237: Mary-Louise Timmermans and Maria Pisareva (PO),

ECO - Clarke 507: Carin Ashjian/Jackie Grebmeier and JP Balmonte

Review the discipline specific scientific questions (modifications possible!) and the measurements identified in the science plan. Identify and codify common methods, methods





that intercalibration between ships, and additional measurements to add (e.g., ecosystem samples for molecular barcoding). Workshop goals to address:

- 1) Discipline specific methods and measurements including questions of spatial and temporal scale
 - 8) Achieving cross-calibration between programs/ships
- and also consider but note there are dedicated breakout groups for these topics:
- 4) Elements missing from present SAS science plan (e.g., modeling, synthesis, molecular survey for bar coding, satellite data)
 - 5) Additional possible measurements outside core program components (e.g., atmospheric, cryospheric, geological)
 - 6) Review of planned and potential transects and scientific justification for each
 - 7) Non-ship assets (e.g., satellites, AUVs, submarine data collections) including questions of spatial and temporal scale

3:00 – 3:20 Coffee Break

3:20 Return to Group to pull together conclusions

3:45 Working Groups I Report

- Each working group will present a synopsis of findings
- Group discussion

5:00 – 7:00 Reception – Clark 5 Foyer (outside meeting room)

5:00 - 8:00 Shuttle bus to hotels available

Day 2 (May 16)

8:30 Welcome, logistics, summary of Day 1, and schedule - Carin Ashjian

8:45 Working Groups II

Pre- and Post-fieldwork synthesis –Clark 507: Carin Ashjian, Jackie Grebmeier, and Astrid Pacini
Workshop Goal 4: Identify elements missing from present SAS science plan (e.g., modeling, synthesis, molecular survey for bar coding, satellite data). SAS2030.
Workshop Goal 10. Potential overlap with other international efforts (e.g., MOSAiC, Nansen Legacy, YOPP, Decade of the Ocean)

Next Gen Arctic scientists- Clark 201: Øyvind Paasche and Jennifer Questel

Workshop Goal 3: Blueprint for nurturing next generation of international Arctic scientists

Workshop Goal 11: developing collaborative platforms (focus on PhDs)



Indigenous communities- Clark 237: - Seth Danielson and Kaare Erickson
Workshop Goal 9: How to engage indigenous communities and identify potential participation

Modeling – MRF 204: Jackie Clement-Kinney and Zhixuan Feng
What can modeling do for the SAS and vice-versa?

10:00-10:30 Coffee break

10:30 Working Groups Report Out

11:30 Working Groups III

Additional measurements outside core program – MRF 204: Carin Ashjian and Anouk Beniest
Workshop Goal 5) Additional possible measurements outside core program components (e.g., atmospheric, cryospheric, geological) including any identified in the discipline specific groups (e.g., molecular)

Non-ship assets – Clark 201: Seth Danielson and Jessica Cross
Workshop Goal 7) Non-ship assets (e.g., satellites, AUVs, submarine data collections) including questions of spatial and temporal scale

Planned transects and scientific motivation - Clark 507: Jackie Grebmeier and Yana Bebieva
Workshop Goal 6

12:30 Lunch (served)

1:15 Data Management – Clark 507: Jackie Grebmeier and Jim Swift

2:00 Working Groups III continued
Additional Measurements – MRF 204
Non-Ship Assets – Clark 237
Planned transects – Clark 507

3:00 Coffee Break

3:30 Working Groups III Report Out and discussion

4:00 Perspectives and future outlook/What we decided and where do we go from here (next international workshop) – Carin Ashjian, Jackie Grebmeier, and Øyvind Paasche
Also: Workshop Goal 12: Outreach – Target Groups, Messages, and Opportunities

5:00 Adjourn. Shuttle buses to hotels.

Post-workshop: Summarize findings in a report that will be made available to funders etc.

SAS 2020/2021 Field Program – Planning and Current Status

Canada, USA (white lines) -

pending collaborations:

JOIS/AON-BGOS

(Williams/Proshutinsky, *Louis*)

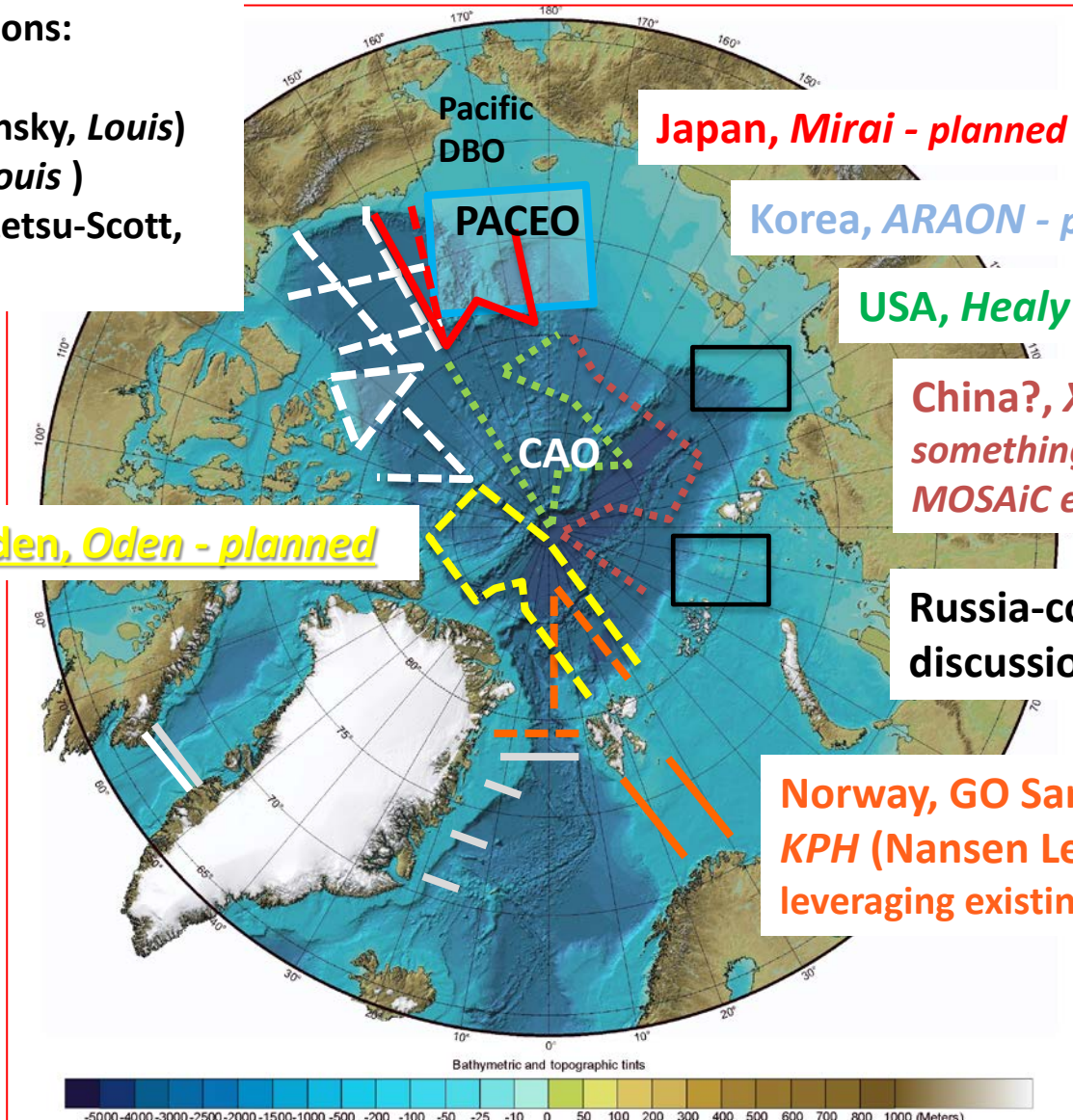
LIA-MPA (Michel, *Louis*)

Davis Strait (Lee/Azetsu-Scott, *Armstrong*)

Sweden, Oden - planned

United Kingdom -
Planned/proposing
ongoing (NERC
highlight topic)

Note: we are
developing maps to
identify international
shelf programs, too



SAS International Science Steering Committee

Canada	Kumiko Azetsu-Scott (DFO), Bill Williams (DFO)
China	Jianfeng He (Polar Research Institute of China, Shanghai)
Denmark	Karen Edelvang (DTU-AQUA), Lise Lotte Sørensen (Aarhus Univ.)
Germany	Heidimarie Kassens (GEOMAR), Sinhué Torre-Valdes (AWI)
Japan	Takashi Kikuchi (JAMSTEC)
Norway	Are Olsen and Øyvind Paasche (both UiB/Bjerknes Centre)
Russia	TBD
South Korea	Sung-Ho Kang (KOPRI)
Sweden	Sten-Åke Wängberg (University of Gothenburg)
UK	Toby Tyrell (University of Southampton)
USA	Carin Ashjian (WHOI), Jackie Grebmeier (CBL/UMCES)



Open SAS Meeting, Arctic Science Summit Week, May 26, 2019; Arkhangelsk, Russia

- The **Synoptic Arctic Survey (SAS)** is an initiative that seeks to define the present state of the Arctic Ocean and understand the major ongoing transformations, with an emphasis on water masses, the marine ecosystem and carbon cycling
- The rapidly changing sea ice conditions and linkage to atmospheric and oceanographic components, accelerated opening of the Central Arctic Ocean for human use (e.g., transportation, potential fisheries) as well as the potential for cascading ecosystem changes in the high Arctic and girdling Arctic seas highlight
- We propose that a pan-Arctic, multi-ship, multi-disciplinary study to collect standard environmental data to determine status and trends of the opening Arctic Ocean
- Planning is underway for multi-ship operations (confirmed and planned) from the shelves into the Arctic basin in 2020/2021
- All interested participants welcome to this open discussion period

Synoptic Arctic *Survey*



Thank you for your kind attention

Questions?

<http://www.synopticarcticsurvey.info/splan.html>

<https://web.whoi.edu/sas2019/>

**ATTENTION: Open SAS Meeting, Arctic Science Summit Week, May 26, 2019
Arkhangelsk, Russia – Northern Arctic Federal University, Rm 402, 0900-1300**