

# Arctic Submarine-Based Science Workshop: Interim Report

28-29 April 2010

The Scottish Association for Marine Science  
Scottish Marine Institute, Oban, Scotland

The present document constitutes an interim report only, and as such does not necessarily represent the complete consensus of all the conveners. A full report on the topics and issues discussed is in preparation, with proposed structure in Sections II – VI, and will be subsequently published on the SAMS and Oceans 2025 websites.

## **I. Executive Summary**

### ***1. Purpose of the Workshop Report***

- The intended audience: UK marine scientists, military, and government policy makers
- To inform policy and decision makers of the unique capabilities of submarines to provide critical data on rapidly changing Arctic environmental conditions and the important role UK submarines can play in providing such data.
- To inform the UK marine science community of the significant contributions of RN and USN submarines to current understanding of Arctic environmental conditions and history.

### ***2. Main Findings***

1. There is urgent and continuing need for improved assessment, understanding, and prediction of Arctic environmental conditions
  - Drivers: security, economics, international relations
2. Submarines have made significant contributions to the current state of understanding of:
  - Sea ice properties (thickness, extent, distribution of ridges, leads, etc)
  - Upper ocean properties (temperature, salinity, tracer distributions)
  - Oceanic microbial diversity
3. Submarines are underutilized resources
  - The demand for Arctic submarine-based measurements is high
  - Submarines are a source of unique data; they can provide:
    - the most accurate transects of ice thickness measurement
    - valuable calibration/validation of other (e.g. satellite altimetry) methods
    - the only source of synoptic in-situ ocean measurements
    - the only year-round access to some areas
4. Arctic submarines provide opportunities for international collaboration.  
Through the US SCICEX program there is:
  - A history of significant contributions through dedicated science (1993-1999) and ongoing opportunistic sampling
  - A new science plan with expected future investment
  - Tie-in to the USN Arctic roadmap (Section 4.5 Environmental Assessment and Prediction; Objective 5): “To provide Navy leadership and decision makers a comprehensive understanding of the current and predicted Arctic physical environment on tactical, operational, and strategic scales in time and space.”

Through the further use of UK submarines, there will be opportunities for:

- synergistic sampling: (through simultaneous use of multiple platforms)

- expanded sampling windows (as a result of different US and UK data collection times and areas)
- deployment of different measurement systems (e.g. multibeam sonar, pCO<sub>2</sub>)

### 3. *Main Recommendations*

1. Establish a Submarine Science Advisory Committee, which would
  - Act as a liaison between the RN and marine science communities to:
    - Formulate plans for sampling opportunities
    - Advocate for increased funding to cover sampling needs
    - Act as conduit for sampling ideas/plans/resources to the RN
    - Announce sampling or data opportunities
  - Coordinate the collection, vetting, and release of data (work with UKHO, BODC)
  - Advocate for sampling opportunities
  - Coordinate with the US SCICEX community
2. Establish a data release policy for scientific data collected on UK submarines:
  - Scientific data should be released to the public at the earliest possible time
  - BODC should archive and provide access to data
3. Request the release of historical data
4. Initiate a staged investment in submarine-based science
  - i. Immediately: rapidly release data that is currently collected (T,S,Chl-a,sea-ice) into the public domain – this is least expensive, most easily accomplished, and most important as these are many of the variables directly related to important drivers (e.g. bathymetry, sea-ice thickness, ocean temperature and salinity) and are of greatest importance to the modelling communities.
  - ii. In the short term: modernize and standardize submarine environmental sampling sensors for use by Arctic subs – this is more involved, more expensive
  - iii. In the longer term: deploy bespoke sensors and extend enhanced sampling packages/data requests to the sub fleet, and transition to permanently on board
5. Develop community consensus on best practices and standardize processing of submarine-based data (in conjunction with US SCICEX community)
6. Develop a Memorandum of Understanding between the UK marine science community and the Royal Navy to facilitate the collection and rapid dissemination of data from submarines on deployment in the Arctic.

### 4. *Action Items*

1. Inform military and government policy makers of:
  - i. the continuing need for submarine environmental data
  - ii. the potential for further unique contributions by UK submarines to understanding of Arctic change
  - iii. the benefits of submarine-based Arctic sampling to the RN: better sensors for safer, better submarine operations (e.g. more complete environmental, or ‘battlespace’, awareness); better understanding of the Arctic Ocean on strategic timescales (i.e. change of Arctic climatology with respect to ocean and sea-ice properties); international recognition for the RN as a positive contributor to developing a response to Arctic climate change
2. Inform the UK and international marine science communities of the history of UK submarine contributions to detection and understanding of Arctic change, and mobilize support for enhanced future sampling.

## II. Introduction: Climate change in the Arctic

Intro		(<1 page + 1 figure)
Sea-ice		(1-2 pages + 1 figure)
Ocean		(1-2 pages + 1-2 figures)

## III. History of science from UK submarines in the Arctic

Sea-ice measurements	(Wadhams)	(2-3 pages)
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## IV. History of US SCICEX contribution to Arctic change understanding

Sea-ice measurements	(Wensnahan)	(1-2 pages + 1 figure)
Physical Oceanography	(Boyd)	(1-2 pages + 1 figure)
Geophysics	(Coakley)	(1-2 pages + 1 figure)
Biology and Biogeochemistry	(Sambrotto)	(1-2 pages + 1 figure)

## V. Scientific thrust of future submarine missions: the present need for future sampling

Summary of white papers in agenda	(2-3 paragraph summary each)
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## VI. Future UK submarine science missions

What, where, and how can the UK submarine force contribute to better sampling of crucial variables in the Arctic (results from the disciplinary and interdisciplinary discussions)?

What: disciplines, measurements

Where: geographic regions

How: methods, but also how to coordinate scientific community involvement in data sampling and usage

**Appendix 1. White Papers** (2 pages + 2 figures each; in preparation)

## **Appendix 2. Workshop Agenda**

### **Day 1 (Wednesday 28 April)**

09:30 Welcome/Introduction - Tim Boyd

#### **Past Results**

#### **US Submarines in the Arctic: History and Science**

09:40 Introduction - Tim Boyd

09:45 History of SCICEX - Jeff Gossett

#### **SCICEX Science Results**

10:35 Introduction - Jeremy Wilkinson

10:40 Sea-ice - Mark Wensnahan

11:00 Coffee Break

11:30 Physical Oceanography - Tim Boyd

11:50 Biology and Biogeochemistry - Ray Sambrotto

12:10 Geology and Geophysics - Bernie Coakley

12:30 Lunch

## **UK Submarines in the Arctic: History and Science**

- 13:20 Introduction - Jeremy Wilkinson  
13:25 History of UK Arctic Submarine Science - Peter Wadhams  
14:15 Results from the 2004 and 2007 Royal Navy Arctic Cruises - Joao Rodrigues

### **Future Plans**

#### **Future of SCICEX**

- 14:45 Introduction - Tim Boyd  
14:50 The new SCICEX science plan - Jeff Gossett  
15:30 Tea

#### **Future of UK Arctic Submarine Science: 'White Paper' contributions**

- 16:05 Introduction - Peter Wadhams  
16:10 Products from the Continuous Plankton Recorder survey and potential application on submarines in the Arctic - Chris Reid  
16:25 Marine scientific research in the Arctic: The impact of Article 76 - Roland Rogers  
16:40 Satellite determination of sea ice thickness and ocean topography in the Arctic - Seymour Laxon  
16:55 Arctic Ocean Modelling at NOC - Miguel Morales Maqueda  
17:10 Moving from small to large scale studies of ice biogeochemistry - David Thomas  
17:30 Adjourn for the day

Workshop Dinner (19:30 Eeusk, North Pier, Oban)

## **Day 2 (Thursday 29 April)**

09:10 Welcome/Introduction - Peter Wadhams

### **Future Plans (continued)**

#### **Future of UK Arctic Submarine Science: 'White Paper' contributions (continued)**

- 09:15 Using observations to assess climate models in the Arctic Ocean - Helene Hewitt  
09:30 Observations remote sensing and models for operational sea ice forecasting using submarine data - Nick Hughes  
10:00 Ice camps: it's not just about the submarines - Jeremy Wilkinson

### **Discussions**

#### **Breakout Discussion Session 1**

- 10:30 Disciplinary sampling issues (sea-ice, PO & tracer chemistry, biogeochemistry, geology & geophysics)  
Desired outcomes:
- prioritized list of sampling needs
  - areas for development
  - areas for potential collaboration with RN

11:15 Coffee

#### **Panel Discussion**

- 11:50 Quick re-cap of disciplinary sampling issues from rapporteurs  
12:10 Practical considerations for science sampling: Q&A with representatives of navy submarine groups
- RN representatives: Lt Cdr Jeeves Toor, Cdr Chris Groves
  - USN Arctic Submarine Laboratory: Jeff Gossett

13:00 Lunch

#### **Breakout Discussion Session 2**

- 14:00 Introduction - Tim Boyd  
14:10 Interdisciplinary groups
- Recommendations for future sampling
  - Strawman for future sampling program
  - Roadmap to future funding opportunities
  - What ideas can be imported from the SCICEX model to: 1) broaden involvement and data access; 2) improve communication of sampling priorities to the RN and opportunities to the community; and 3) get the necessary resources into the hands of groups that are in a position to conduct the sampling (RN MWC, small science group representing the community, etc.)
- 15:00 Tea Break

### Wrap-up

- 15:30 Quick re-cap of inter-disciplinary discussions from rapporteurs  
Summary of workshop: Tim Boyd
- Workshop outcomes: report
  - What's next?
- 16:00 **Conclude**

## Appendix 3. Participants List

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