Summary of OBAN meeting June 2015

Place: SAMS in Oban, Scotland
Time: Monday 1st of June to Friday 5th of June

Meeting subject: Three projects all funded by the Norwegian Research Council (CircA, Marine Night and Arctic ABC) and one UK-Norwegian workshop aimed at potential new funding opportunities.

Outline of the week:
Monday: CircA and Marine Night
Tuesday: Arctic ABC
Wednesday: Arctic ABC and UK-Norwegian workshop
Thursday: UK-Norwegian workshop before lunch, Marine Night after lunch, afternoon excursion
Friday: Working groups aimed at preparing selected papers

Attachments

1. Overview presentation for Marine Night by Paul Renaud

Participants on the Oban meeting. Photo: Euan Paterson (SAMS)

For an overview of publications and outreach products, see www.mare-incognitum.no

Excursion to Kerrera – Professors Stig Falk-Petersen (APN & UiT) and Asgeir Sørensen (NTNU AMOS). Photo: J Berge

Circadian rhythms of Arctic zooplankton from polar twilight to polar night – patterns, processes, and ecosystem implications (CircA)

The project is within its final year, and this will be the last regular project meeting. Focus for the meeting was therefore on paper-writing and end-products.

Project period: 2012-2015
Funded by *FriPro* (NFR)

Abstract from the proposal:
Marine ecosystem processes are direct consequences of the complex behaviours and interactions between organisms, many of which are driven by the physical environment. Accordingly, the classic paradigm of Arctic marine ecology suggests that most biological processes stop during the polar night at high latitudes due to low food availability and the lack of light (Smetacek 2005, Piepenburg 2005). Recently research carried out in the Svalbard archipelago challenged this assumption by presenting evidence of both **active** and **synchronized** diel vertical migration (DVM) of zooplankton during the polar night (Berge *et al.* 2009, Figure 1). Although the polar night at these latitudes is perceived by the human eye as having continuous and total darkness, the new data indicate that Arctic zooplankton nevertheless respond to variations in the very low light levels. This unexpected behaviour under the extreme conditions of the Arctic winter challenges our fundamental understanding of sensory capabilities of high latitude fauna, and suggests potentially significant consequences of this finding (Søreide *et al.* 2010). Furthermore, a new study (Wallace *et al.* 2010) based on two complete years of acoustic data (2006-2008) from two Arctic fjords in the Svalbard archipelago reported a continuous signal in zooplankton vertical migration that had strong variations in characteristics between both seasons and the two fjords. These findings included very strong and fully synchronized vertical migration signals during polar twilight (October/November – March/April). Based on this, they concluded that current reduction of Arctic sea ice (Comiso *et al.* 2008) is likely to have an indirect, but substantial, impact on zooplankton vertical migration and the associated vertical carbon flux. The core group of PIs within this proposal have carried out these recent studies, through which we have discovered and described new, unanticipated patterns of zooplankton vertical migration behaviour. We now need to establish the basic biological foundation behind the behaviours and their wider ecological impacts, which are still poorly understood. We therefore propose here a genuinely world-leading project that will utilize the team's broad and well documented experience to unravel the biological mysteries connected to these patterns. We seek to elucidate this in a clear four-step process: first we ask **which species are carrying out the DVM during low light conditions? Second, why do these organisms migrate (proximate and ultimate explanations)?** Third, **how important is DVM during the polar twilight/night for Arctic marine ecosystems**. Fourth, we will **develop a new set of tools to set these questions into a Pan-Arctic perspective.**

Primary objective: Determine the primary physical and biological factors that are responsible for the diel vertical migration patterns of zooplankton in the high Arctic during the polar night and twilight period, and to elucidate the resultant ecosystem effects.

Main field campaigns and data sources: Three consecutive polar night campaigns onboard RV Helmer Hanssen, acoustic and sediment trap data from Svalbard moorings (long term since 2002, short term mainly winters 2013 & 2014). In addition samples and data have been collected from several smaller campaigns and using ships of opportunity.

During the meeting eight papers were presented / discussed. The project have so far produced a high number of papers, but we have not yet published papers that resolve two of the key questions – the who and the where. To this end, eight papers were discussed that will be finished by the end of

2015:

1. The who paper – passengers on the noon sinking express. Lead author Julie Grenvald

2. Biological carbon pump – seasonal variations in the active transport of carbon through DVM. Lead author Gerald Darnis

3. Pan-Arctic patterns of DVM. Lead author Laura Hobbs

4. Spatial patterns of zooplankton distribution from a AUV-borne ADCP. Lead author Maxime Geoffroy

5. Zooplankton response to a total solar eclipse in the high Arctic during spring equinox. Lead author Jørgen Berge / Maxime Geoffroy

6. Where the sun doesn't shine: winter moonlight drives oceanic scale mass vertical migration of zooplankton. Lead author Kim Last. Aim to have this submitted to Current Biology during summer 2015.

7. The Isfjorden "Farm" campaign detailing lunar response in zooplankton with VPR and possibly fecal pellet production (the paper will support paper 6 in high resolution). Lead author Kim Last. Aim to have a first draft ready in July 2015.

8. Polar night DVM seen by VPR. Lead Fredrika Norbin

In addition to these eight papers, both Laura and Julie will finish their PhDs during 2015 / 2016, with other papers included in their theses. In June 2015 Trine Callesen finished her MSc thesis as part of Circa. Combined with the previously published Circa papers (see publication list under www.mare-incognitum.no), this will be the main outcome of the Circa projects.

***Mare incognitum* – ecological processes during the polar night (Marine night)**

The meeting will be the first all-inclusive project meeting after the two large field campaigns. Focus of the meeting is to get an overview of data and plan the next phase of the project; the writing phase.

Project period: 2013-2016
Funded by *Polarprogrammet* (NFR)

Abstract from the proposal:
The primary objective of this project is to achieve a basic understanding of Arctic biodiversity and food web structure during the Arctic polar night, and how reproduction, growth, trophic interactions, and life-history traits during this nearly unstudied time contribute to functioning of Arctic ecosystems. By focusing on three of the main prioritised areas within the call – **processes**, **current state of the ecosystem** and **connections within the polar regions**, we will reach our primary objective while at the same time addressing main gaps in knowledge that have so far hindered a comprehensive understanding of the processes that govern Arctic marine ecosystems. We divide our work into four Units, of which the first entails **synthesis of knowledge** from ongoing projects. The second Unit is devoted to exploration and mapping of patterns and processes that govern the marine habitat during the polar night, first of all the biodiversity, structure and function of benthic food chains. The third Unit is composed of case studies in which effects of **climate change** are at the core, and which will draw upon the knowledge provided through Units 1 and 2. By focusing on **Svalbard and adjacent waters** and the specific adaptations and biology of key organisms living there, we thereby aim at answering important research questions that together will enhance our ability to understand **polar systems at a pan-Arctic scale**. The fourth Unit is exclusively devoted to data management, communication, and outreach, creating **added value** by linking a large portfolio of research projects. Through these projects we synthesize processes across the **cryosphere**, **hydrosphere**, and **biosphere**, and as such, integrate our project in an **Earth System Science (ESS) perspective**.

The primary objective of this project is to achieve a basic understanding of Arctic biodiversity and food web structure during the polar night, and how ecological processes from reproduction and growth to trophic interactions and life-history processes during this nearly unstudied time contribute to functioning of Arctic ecosystems. We will reach this primary objective by addressing three main research questions (research Units 1-3) and a fourth Unit dedicated towards data management, communication and outreach:
UNIT 1: How do physical and biological factors regulate the recently discovered processes occurring among marine zooplankton during the high Arctic polar night (Berge *et al* 2009, 2011)?
UNIT 2: In the absence of light and primary production, are the biodiversity patterns and community structure of benthos during the polar night different from those observed during the polar day?
UNIT 3: Climate change case studies – what are the consequences of a changing climate?
UNIT 4: Outreach, communication and data management.

The project has focused on field campaigns until now, and we have hosted two major campaigns in Kongsfjorden in January 2014 and 2015. The first of these campaigns was in close collaboration with CircA, and both have been coordinated with the new UNIS course AB334 “Polar night biology and underwater robotics”. Field campaigns involved a wide diversity of projects and participants, and were both field- and shore-based. Norwegian, Russian, and Polish researchers led most of the studies, but German and French institutions were also well represented.

The ambition for the meeting was to further prepare an overview and status report for where we stand in related to the outlined research questions (see attached PDF from the presentation by P

Renaud). A summary publication is currently under submission that include an overview of most of the thematic investigations carried out during the two campaigns (see figure below). This publication will be the main synthesis product of Units 2 and 3.

Regarding Unit 4 – outreach – the newly opened Polar night exhibition in Tromsø and Anchorage are major contributions towards the project. See the Mare Incognitum web site for details. The Tromsø exhibit was opened in January 2015 via a video link to Ny-Ålesund where exhibit leaders Jørgen Berge and Geir Johnsen introduced the exhibit. We were joined by a sound artist in the 2014 campaign, and various media outlets (magazines, film documentaries, blogs) were also represented on cruises by writers, photographers, and videographers.

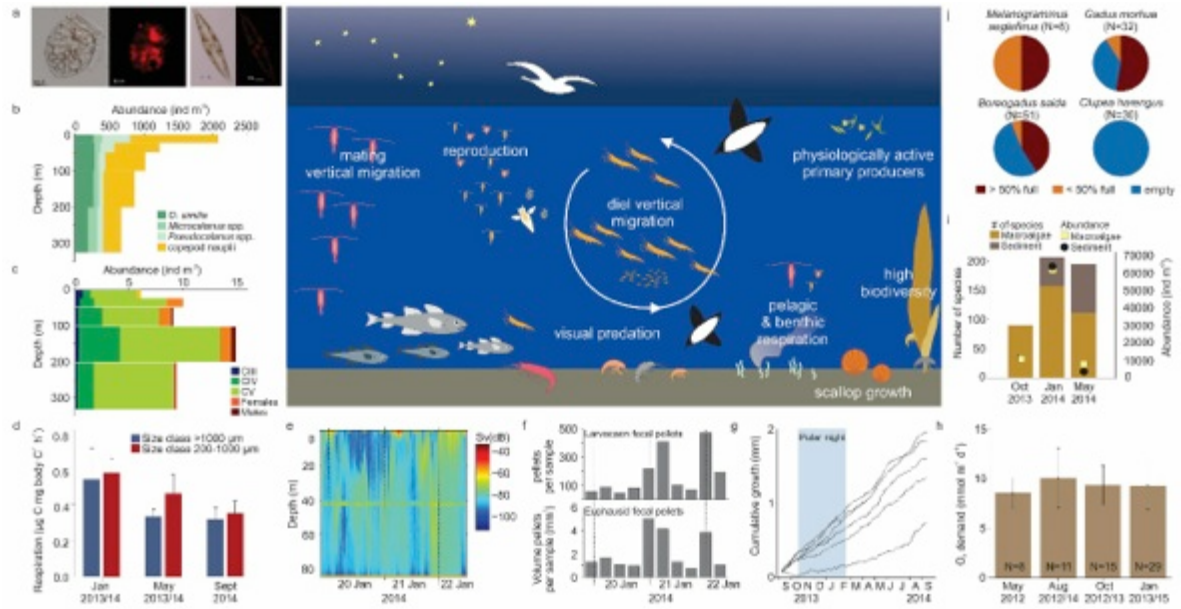
Studies discussed in detail include:

1. Spatial and temporal variation in diets of fish (primarily gadoids) around Svalbard. Marine Cusa, lead.

2. Size-spectra of zooplankton communities during winter. Sünnje Basedow, lead.

3. Life-histories of mesozooplankton during the Marine Night. Malin Daase, lead.

4. Predation on copepod nauplii by krill during the polar night. Malin Daase, lead.



From Berge et al subm

Arctic Ocean ecosystems - Applied technology, Biological interactions and Consequences in an era of abrupt climate change (Arctic ABC)

This is the kick-off meeting of the project, where the main aim was to discuss and agree upon a plan for the ice-tethered observatories planned through the project. After a long and careful discussion, we arrived at the conclusion that we should not plan to make one platform for all instruments, but rather divide the sensors into four units (that will all four be deployed close together, but at the same time be fully independent of each other). The platform is renamed *ICE POPEs*

ICE-POPEs: **ICE** tethered **P**latform-cluster for **O**ptical, **P**hysical and **E**cological **s**ensors

Dividing the initial single buoy system into 4 units (ICE POPEs) is used to obtain an early starting point, reduce risks and to learn about float characteristics and communication. In general we expect that ICE POPEs 1-3 will be deployed in Jan-June 2016 (incl AB323/823 course in May 2016). Winter/spring 2017 will be used for first deployment of POPE 4 (optical platform) with POPE 1-3 for fast ice deployment in Van Mijenfjorden. Winter 2018 will be used for polar ice sheet deployment of POPE 1-4.

The development of the ICE POPEs is a stepwise process - see implementation plan:

Activity	**2015**				**2016**				**2017**				**2018**				**2019**			
	1	**2**	**3**	**4**	**1**	**2**	**3**	**4**	**1**	**2**	**3**	**4**	**1**	**2**	**3**	**4**	**1**	**2**	**3**	**4**
PIanning meeting NTNU																				
Polar Night cruise																				
vMf POPEs 1-3																				
POPE 4 testing																				
POPE com testing																				
ICE POPEs fjord																				
ICE POPEs Arct.Ocean																				

ICE POPE 1: The existing SIMBA system (sea ice mass balance bouys)
Communication: Using existing “SIMBA” system.
Responsible institution: SAMS

ICE POPE 2: This is the physical platform. Contains a string of temperature, irradiance (possibly RGB sensors instead of white light (400-700 nm sensors) and salinity sensors to measure the water column close to the sea ice. Potentially also a current meter.
Communication: Using existing “SIMBA” system.
Responsible institution: SAMS

ICE POPE 3: This is the ecological platform. Contains 2x AZFPs and simple ct(d)s w/ light and chl a, O_2-optode sensors
Communication: Using existing “SIMBA” system.
Responsible institution: UiT and SAMS

ICE POPE 4: This is the optical platform that contain the UHI and camera installations. It will be a prototype development with respect to function and application with focus on Underwater Hyperspectral Imager (UHI), time-lapse camera system and CTD with EcoPuck (Chla, cDOM and TSM) and scalar irradiance sensor.

The Arctic ABC buoy has now been divided into four separate buoys that will be deployed together (but importantly, not connected to each other). The four platforms have an increasing level of

complexity / challenges, with ICE POPE 1 already fully operational. ICE POPEs 2-3 contain already existing and tested instruments, and will be ready for a first test-deployment in vanMijen fjorden in Jan-Feb 2016. ICE POPE 4 will be the most demanding in terms of development, and we will not have a test version of this ready until January 2017.

Tentative overview of deployments:
Jan-Feb 2016: We aim at deploying POPE 1-3 in Van Mijenfjorden and eventually in open waters for check of communication systems and sensor function. The deployment in van Mijenfjorden might be without communication except on ICE POPEs 1 (and potentially 2).

Winter 2017: Full deployment of all ICE POPEs in van Mijenfjorden. This include a full check of communication for 1-3 and a check of prototype ICE POPE 4.

Winter 2018: Deployment of POPE 1-4 in the Arctic Ocean (ice station close to North Pole).

Further details regarding development circulated among the Arctic ABC team. The next milestone is a scheduled meeting at NTNU 19-20 August, during which we will go in detail on the development and implementation plan for ICE POPEs 1-4.

Arctic ABC team visiting the robotics lab at SAMS. Photo: G Johnsen (NTNU).

UK-Norwegian collaborative workshop

Purpose: To use the opportunity of key Arctic researchers from other nations being in the UK to share networks, science interests and collaborative actions.

Participants from the UK were invited from a range of institutes and research areas, but all having a link into marine biology, biogeochemistry and application of technologies. Staff from SAMS were also included. The program began with a series of 5 minute talks covering:

- Current scientific interests/activities/techniques
- Science ambitions, future areas for working
- Information on current networks, research partnerships, etc

Talks were received from:

Jørgen Berge (University of Tromsø)
Angus Atkinson (PML)
Neil Banas (UW)
Heather Bouman (Oxford)
Andrew Brierley (St Andrews)
Thomas Brown (Plymouth)
Rosie Chance (York)
Elizabeth Cook (SAMS)
Keith Davidson (SAMS)
Sophie Fielding (BAS)
Helen Findlay (PML)
John Howe (SAMS)
Geir Johnsen (Trondheim/UNIS)
Dan Mayor (Aberdeen/NOC)
David McKee (Strathclyde)
Bhavani Narayanaswamy
David Pond (SAMS)
Paul Renaud (Akvaplan)
Paul Wassmass (University of Tromsø)

This was followed by three focused discussion groups with each group facilitated by a Norwegian and a UK contributor. Activities within the groups would include:

- More detail on current research activities
- New opportunities on the horizon
- Potential sharing of resources/techniques/skills/data
- Possible review paper on that topic
- Are there useful funding routes
- Cruise opportunities for data gathering etc.
- Identify 1 thing to follow through with.

Groups (and facilitators) were as follows:

Bioacoustics: (Brierley and Geoffroy)
Primary Productivity & Optics (Bouman and Johnsen)
Biogeochemistry and Carbon Fluxes (Findlay and Renaud)

The workshop continued on Thursday 4th June with a focus on research opportunities using the Arctic in Rapid Transition Priority Sheets. Helen Findlay from PML gave an introduction to these sheets that had been prepared after a conference in Brest in October 2014 and presented to the International Conference on Arctic Research Planning (ICARP) in Japan in April 2015. Links to the priority sheets are here:
Oceanography and Biogeochemistry
Biodiversity

The workshop closed at 1200 on Thursday 4th.