Session report from the «Terrestrial flagship»

Workgroup meeting 25 September 2015

Participants: Bernt Johansen, Vittorio Pasquali, Åshild Ønvik Pedersen, Edda-Marie Rainer, Mette M. Svenning and Alexander Tveit

Åshild Ønvik Pedersen drafted the report 28 September 2015; updated ÅØP 19 October 2015 based on comments from Alexander, Edda-Marie and Vittorio; updated 01 November based on comments from Mette Svenning and Bernt Johansen; Final version based on comments from Maarten Loonen, Eva Fuglei and Virve Ravolainen 08.12.15.

1. Introduction

NYSMAC asked the workgroup to discuss the following topics during our workgroup meeting.

1. Flagship tasks list
   - Scientific topics
   - Activities (SSF funding possibilities!)
2. Organization of flagship
3. Flagship website content
4. Flagship – NYSMAC interaction

In addition to reporting on these topics, we also emphasize the infrastructural and funding needs for the **Terrestrial flagship** at the end of the report.

The participants agreed on that there was a strong need for revitalizing the content of the original **Terrestrial flagship** document and make some suggestions for concrete actions, however, we still acknowledge the content and validity of the former document (Coulson et al. 2009)

The workgroup also agreed on that the **Terrestrial flagship** should focus on the ecosystem food webs above and below ground as illustrated by the figure below (Figure 1).

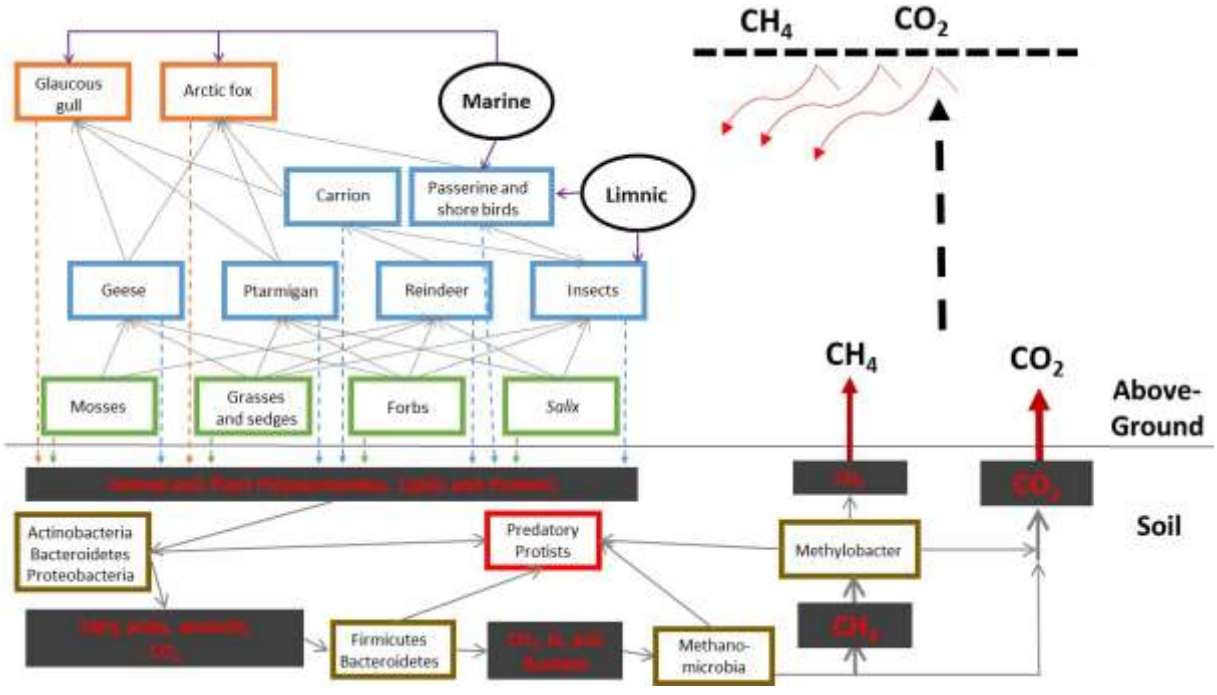

Figure 1. The above ground plant-based food web, with input from marine and limnic ecosystems, and the below-ground soil system, for high-Arctic tundra in Svalbard. The soil microbiota are indicated by key taxonomic units involved in degradation of soil organic carbon to greenhouse gases. The terrestrial food web figure is modified from Ims et al. (2013).

2. Flagship tasks list

Scientific topics

In this section of the report, we outline four scientific topics that capture the current and future direction of the **Terrestrial flagship**. We outline them by keywords below.

I. High-Arctic model ecosystem

- Focus research on all trophic levels – from soils microbes to top vertebrate predators.
- Model system to detect changes from external drivers (e.g. climate change).
- Long-term monitoring data time series are present for parts of the system.
- The linkages between marine and freshwater systems are evident.
- Change detection analysis based on photographs (historical) and multi-scale satellite data

II. Terrestrial food webs

- Trophic interactions within the terrestrial food web and between food webs (terrestrial and marine and freshwater).
- Focus on both below and above ground interactions that may impact processes and functions in the tundra ecosystem.
- Focus on tundra processes and functions from local (high-resolution level) to landscape/regional levels that may be affected by trophic interactions within and between the ecosystems.
- Investigate how the links between terrestrial food-webs and soil biogeochemistry affect the carbon cycle and greenhouse gas balance.

III. External drivers (abiotic and biotic)

- Drivers affecting species/communities/populations and their interactions e.g. temperature above/below ground, precipitation (winter rain and snow), snow-pack properties, basal ground ice and permafrost.
- Sea-ice spatial and temporal distribution.
- Contaminants.

IV. Adaptations to changing conditions in the Arctic

- Physiological adaptations of arctic life.
- Behavioral ecology.
- Resilience and resistance of organisms.
- Seasonality, phenology and morphology.
- Mechanisms for coping with extreme events and weather variability.

The group suggest organizing the work into three operational work-packages (WP) with not yet assigned leader structure or working groups. The three work-packages are to some degree overlapping thematically and may be viewed as three integrated components of the revitalized terrestrial flagship program.

WP 1: Ecosystem

The main goal of this work package is to establish replicated long-term monitoring sites in targeted habitat types (e.g. wetlands/moss tundra with high productivity) on the entire Brøgger Peninsula. In

each site we will measure a set of state variables describing e.g. species/communities, ecosystem functions and processes. An important strength of the Ny-Ålesund scientific base is the opportunity to combine observational and experimental studies on different temporal and spatial scales to obtain a mechanistic understanding of long-term stressors and their impacts on the ecosystem. Establishment of replicated sites in the Brøgger Peninsula will enable to understand how small-scale local process applies to the landscape level. Such establishment requires coverage of a sufficient range of biotic and abiotic components of the ecosystem, coordinated monitoring of producers, consumers and predators, as well as weather parameters at the same locations. Some examples of state variables can be: Snow-pack properties, basal ground ice, herbivore exclosures at site to assess impacts from grazing and climate warming, plant biomass, gas fluxes (methane, CO_2), precipitation and hydrology (linked directly to events like methane emissions etc.).

WP 2: Ecosystem-based adaptive monitoring COAT

The Brøgger Peninsula is designated as a COAT-site *(Climate-Ecological Observatory for Arctic Tundra).* COAT is a system for long-term adaptive ecosystem monitoring based on food-web theory, and aims to become the world's most comprehensive and management relevant long-term research enterprise for arctic terrestrial ecosystems (Ims et al. 2013). In this regards reference sites will be designated for monitoring natural changes and will be intensively instrumented to record relevant parameters (cf. WP 1 Ecosystem).

The COAT science plan includes:

- A comprehensive review of the functioning of the terrestrial food webs in the arctic with specific references to science-based knowledge about climate impacts.
- A formulation of climate impact prediction models that define climate sensitive and management relevant monitoring targets, state variables, sampling designs, and mathematical/statistical modeling approaches.
- Protocols for updating prediction models, monitoring design, and methods in response to new knowledge, technologies, and societal priorities according to the paradigm of adaptive monitoring.

We have already established inter-institutional cooperation (NP, NTNU, University of Groningen), that has originated from Ny-Ålesund meetings (e.g. NySMAC). Currently we are planning to combine the long-term monitoring data time-series in integrative studies where we focus on how climate variability (winter rain and summer temperature [e.g. influencing plant biomass]) shape population dynamics across the herbivore (barnacle goose, reindeer) and predator (arctic fox) community in Brøgger Peninsula. COAT-Infrastructure is currently fully funded from 2016 to 2020.

Both WP 1 and 2 may be linked to the ongoing research from other stations (e.g. NL, NERC, Italian and Chinese stations), not participating in this workshop, that are working on interactions between vegetation, soil, permafrost and climate.

WP 3: Adaptations of organisms to Arctic environments and its seasonality

The Ny-Ålesund scientific base and the Brøgger Peninsula provides unique opportunities for in-depth studies of Arctic biota, from unicellular organisms to plants and animals. Living in the high-Arctic demands evolutionary understanding of single species/species groups and ecosystem adaptations to e.g. low temperatures, photoperiod and extreme climate shifts. Moreover, organisms in nature encounter seasonal climatic variation and cope with that variation through physiological, morphological and behavioral adjustments at the behavioral (for the animals), hormonal, cellular, and biochemical levels. Biota responds directly to increasing temperatures e.g. warmer winters, earlier springs, later falls, longer growing seasons, rising sea levels or melting glaciers. Changes both

within and between seasons may cause long-term effects on biological activity, processes and life history of terrestrial organisms.

The biotic world has already responded to recent rapid climate change by expanding ranges poleward and by altering the timing of important events in seasonal life histories, orchestrated principally by light and temperature.

In this work package, we will focus on:

- Behavioral adaptations of focal species/species groups in the ecosystem.
- Evolutionary low-temperature adaptations.
- Microbial system adaptations to changing hydrology, temperature and substrate availability.
- Temperature/photoperiodic (light) interactions.
- Comparative adaptations between species/species groups.
- Aline species and ecosystem impacts.

3. Organization of the flagship

We agreed to organize the flagship with a leader (Maarten Loonen, University of Groningen) and a co-leader (Åshild Ønvik Pedersen, Norwegian Polar Institute). The flagship is defined by three work-packages.

4. Flagship website content

We suggest that the webpage contain a contact database. Here we suggest to list information about e.g. name, e-mail, research topic and home-institution's web-page etc. The database may be organized under topics e.g. freshwater, microbiology, plants, vertebrates etc. The contact database will enable both new and established researchers to get a quick overview of researchers/institutions that do terrestrial research in Ny-Ålesund and be a natural first point of contact. We suggest the same simple set-up for the other flagships to ease flow and exchange of information between people.

We also suggest that when new articles based on research from Ny-Ålesund are published a small feature, similarly to the ones that home institutions often make on web-pages, may be posted. Here we suggest to link to the web-pages of the home institutions to reduce the amount of overlapping information.

5. Flagship – NYSMAC interaction

The workgroup briefly discussed *NySMAC Project Information and Discussion forum* and agreed to the importance of using such a fora to address issues regarding project organization and management. It was also mentioned that the web-forum could be used to post questions and information. The group did, however, not see themselves as frequent users of such forum.

6. Infrastructure needs

A. **In situ stations for long-term monitoring of biotic and abiotic state variables** related to tundra species, communities, populations, processes and functions (see WP 1 Ecosystem).
B. **Small-scale terrestrial laboratory** (e.g. a designated room in the marine laboratory or in the «Vaskeri-building») with standardized lab equipment. Such equipment could be: Oven to dry samples (up to 300 ° C), temperature regulated incubators, centrifuges, analytical scale, autoclave, destilled or mili-Q water, vortex etc.
C. **Mobile lab unit** should be further discussed if feasible and realistic given funding.

D. **Organized storage** of field and lab-equipment. Currently several visiting scientist lack a warm space to store equipment. A warm storage would enable scientist to store equipment and reduce transporting of goods from one to another field season.

7. Funding need

We briefly addressed the issue of funding and made some specific suggestions for how funding from SSF can meet the needs of the flagship. We agreed that there is a need for making the flagship more active in funding of common projects, but till now we experience the effect of the flagship on funding to be relatively low.

We need funding to **workshops** that:

1. Generate within and across-flagship scientific publications where long-term existing monitoring data series are utilized (*«paper-writing workshops*»).
2. Generate research proposals within and across flagship to be submitted to national/international funding agencies (*«research proposal writing workshops»*).

We also need funds that give support to:

1. Developing (complementing and sustaining) programs that are sustained over time – given quality assurance through publications and/or scientific review of program or application.

   «Sustaining good robust science is the way to novel contributions from time-series data».

2. Common in-situ monitoring infrastructure for automated field stations/sites at landscape level (coordinated with COAT and under the umbrella of SIOS) where data can be available for flagship members and collaborators.

8. Flagship actions

We suggest the following actions:

A. Common research proposal

Theme: Linking below and above ground trophic interactions that may affect processes and functions in the tundra ecosystem.

Investigate / follow funding resources: National Research councils and International funding programs e.g. EU-funding (Horizon 2020). All members need to follow instruments and calls relevant for Arctic research in their own countries.

Workshop funding to develop a proposal may be sought from SSF in 2017.

B. Integrative papers

We will actively search for funds that can contribute to «paper-writing workshops» that focus on 1) trophic interactions within the terrestrial food web (vertebrate community, plants and abiotic drivers such as snow/ice; WP 2) and 2) linking below/above ground systems (WP 1, 2 and 3) and quantifying the greenhouse gas balance.

C. Establishment of common long-term monitoring sites at landscape level

We will actively work towards establishing common long-term in situ monitoring sites coordinated with COAT and the development of SIOS. Such sites will combine observational and experimental studies to obtain a mechanistic understanding, as well as investigate the generality of patterns in long-term impacts on the ecosystem in the landscape (all WPS), and secure long term monitoring of important state variables related to climate change in the Arctic.

9. References

Coulson, S., G. W. Gabrielsen, C. Hübner, and M. Loonen. 2009. Terrestrial Ecosystems - a flagship programme for Ny-Ålesund : concluding document from workshop 6-8 May 2009. Norwegian Polar Institute, Kortrapport, 20.

Ims, R. A., J. U. Jepsen, A. Stien, and N. G. Yoccoz. 2013. Science Plan for COAT: Climate-ecological Observatory for Arctic Tundra. Fram Centre, Tromsø. www.coat.no

SIOS. ; http://www.sios-svalbard.org/servlet/Satellite?c=Page&pagename=sios/Hovedsidemal&cid=1234130481072)