Herbivory Network meeting 2016

Reykjavík 15.-16.09.2016

The Herbivory Network meeting was organized in September 15-16, 2016, in Reykjavík, Iceland. The goal of the meeting was to bring together relevant experts from different Arctic and alpine regions and connect researchers with different backgrounds and expertise, to consolidate the Herbivory Network (http://herbivory.biology.ualberta.ca). The meeting provided an overview of activities developed so far, discussed research priorities and defined new initiatives of interest to the Arctic research community. A total of 35 participants from 9 different countries attended the meeting (see list of participants at the end of this document).

The meeting was celebrated at the Rannís offices and counted with support from the International Arctic Science Committee (IASC) and the FRAM Centre in Norway.

Overview of ongoing work

The meeting started with a short introduction to the Herbivory Network, and an overview of ongoing work. Isabel C. Barrio summarized the development of the network since its foundation at a workshop held during the ITEX meeting in Bergün (Switzerland) in September 2013. Back then it was stated that the main goals of HN would be to:

1. integrate sites and methods to assess the effects of herbivory in tundra
2. develop common protocols for herbivory assessments
3. facilitate communication between researchers
4. design long term experiments and observational studies

A general introduction of all workshop participants followed. Participants represented a broad spectrum of scientists working on the topic of herbivory in Arctic and alpine tundra. Areas of expertise represented among participants covered broadly animal and plant ecologists and soil scientists, and all the range in career stages from undergraduate students to senior researchers. In the following, several workshop participants presented ongoing work on papers and protocols that had been developed up to the current meeting:

Virve Ravolainen presented ongoing work on “How to formalize the use of expert knowledge in making study designs for plant-herbivore interactions”. A main message from her summary was the necessity to overcome context dependencies when developing study designs for plant-herbivore interactions. Such context dependencies are often posed by the variety of spatial scales at which vegetation and feeding patterns of

herbivores can be assessed. Virve outlined an approach to combine different information layers of abiotic conditions, vegetation and grazing patterns as a possible way to overcome those context dependencies. The outcome of this work is to be published as a scientific paper, which is currently in preparation.

Ingibjörg Svala Jónsdóttir presented a summary of how the HN was initiated, emphasizing the development of protocols to assess herbivory within the ITEX network. She outlined briefly the three levels of herbivory assessments which were published in Barrio et al. 2016 (Polar Science). She also presented the first outcomes of herbivory assessments within ITEX sites which were conducted using the HN protocol. The first trials of the protocol were implemented in summer 2014 at 8 ITEX sites. The results showed a large variation of herbivore species and abundances between sites. In addition, herbivory seems to be higher within artificially warmed plots ("Open Top Chambers") than within control plots. Another preliminary outcome of this first implementation is that invertebrate herbivory seems generally low across sites (< 10%). Although the protocol seems to work fairly well in capturing variation in levels of herbivory, Ingibjörg Svala highlighted difficulties when comparing herbivore loads based on pellet counts, which may be due to different decomposition rates of pellets at different sites or in different habitat types. Decomposition rates of pellets depend on site specific environmental conditions and the herbivore species present in a site. A common currency to compare droppings from different herbivore species is therefore needed. She also presented ideas for a minimum amount and minimum length of transects, which are required to capture the herbivore presence within a site. Based on those experiences an updated version of the ITEX herbivory protocol was produced in 2016.

Virve Ravolainen addressed the question of "What is an efficient design for pellet counts of vertebrate herbivores?" She outlined the results of an extensive pellet count study which was conducted in Svalbard and Yamal during the summers 2015 and 2016. The aim was to assess levels of herbivory based on the densities of herbivores present over a range of tundra sites, relating pellet counts to animal densities. One challenge is that most tundra sites have no information on animal numbers at all, which makes the establishment of this relationship difficult. Together with Dorothée Ehrich, Virve presented dependencies of pellet counts in terms of spatial autocorrelation within sites. It was shown that different ways of counting pellets, within plots or along whole transects, may affect density estimates for different animals (specifically for small rodents). In addition, an extensive analysis was presented on how different numbers and length of transects affects the outcome of animal densities within a site. Recommendations for the number and length of transects differed depending on site characteristics (homogeneous vs. heterogeneous landscapes) and animal species present. Sites that represent heterogeneous landscapes require generally more transects than homogenous sites. To achieve a representative sample of heterogeneous sites, a minimum number of 30 transects was recommended. Some further improvements were discussed such as using a common currency for pellet counts, or whether it would be better to use presence/absence information on pellets rather than absolute abundances. Further conceptual challenges were discussed. The results presented are part of a scientific paper which is currently in preparation.

Sarah Rheubottom addressed the question of "What is the level of background invertebrate herbivory in tundra?" She outlined challenges posed by the assessments of invertebrate herbivory (outbreaks vs. background levels) and highlighted the importance of having a protocol for comparing invertebrate herbivory among sites. She presented data collected from 22 study sites around the Arctic during summer 2015. Leaves of the dominant plant species were collected at each site and recorded for invertebrate damage. Biomass of plant material was also compared to recordings using the Point Intercept Method. Her work on this data is connected to her Master's thesis at the University of Alberta, which is co-supervised by HN members, David Hik and Isabel Barrio.

Guillermo Bueno summed up the aims and most recent activities of the soil working group (SWG) of the HN and focused in one of them, which addresses the question of "What herbivory related soil measurements are suited for the pilot soil protocol in the tundra?" He firstly introduced the importance of understanding herbivory impacts on soil properties, especially with respect to ecosystem processes and plant community succession. He also outlined the potential mechanisms of how herbivores may affect soils and *vice versa,* and presented an approach based on herbivore and soil traits. In this assessment is essential to consider animal

characteristics (size, type and behavior) and soil traits (chemical, physical and biotic soil properties). The aims of the recently launched pilot soil protocol are to: 1. to assess the spatial variability of eas-to-measure soil traits, such as soil pH, bulk density, litter and organic matter depth; 2. to address the effects of herbivores on soil traits by comparing soil measurements inside and outside established fenced experiments. Both aims were further discussed in depth. The first outcomes of soil assessments within two tundra sites (Auðkúluheiði, Iceland and Abisko, Sweden) showed a need to further discuss and polish the exact procedure and tools to use. In the near future, other study sites and potentially additional soil traits, such as chemical analyses (using NIRS) will be considered. Further details can be found in the workshop summary of the group. Other contact persons within the working group are Maria Vaisänen and Maria Tuomi.

Isabel Barrio presented a summary of the article on herbivore diversity in the Arctic, published in Global Ecology and Biogeography (Barrio et al. 2016). Future work within the same framework will be continued adding the concepts of functional group and phylogenetic diversity. Further details can be found in the workshop summary on "The functional diversity of herbivore assemblages across the Arctic".

Strategies for organization of the Herbivory Network

Virve Ravolainen led a meeting discussion on the organization of the network. The HN started as a grassroots-initiative and has substantially grown in terms of members and activity over the last two years. The main aim of the network, as stated at the foundational workshop in 2014, is to serve as a communication platform to researchers interested in herbivory. Over this two years, the development of standardized methods have been a main aim, as well as to facilitate collaborations that lead to synthesis publications across the topics the members have an interest in. At the beginning of HN, a broad conceptual model of the role of herbivory in the Arctic was made and two questions intended to guide the work of the network were formulated: "How do herbivores modulate the responses of tundra environments to rapid environmental change?" and "How does the temporal and spatial variability in plants and herbivores affect each other?"

HN has been organized in an open manner, so that anyone with an initiative they would like to work on, be it a project proposal, a publication or a specific protocol, could start and find interested colleagues. This openness has been central to bringing together early career scientists so that they could take active roles in developing the different initiatives. The group that started the HN in 2014 has been termed "steering group", and has in practice been responsible of calling in for meetings, getting funds to organize the meetings, communicating via newsletter and webpage/mail, as well as discussing the different projects that have been started so far. The Reykjavik 2016 meeting revisited this model and discussed what has worked well and what needs to be improved.

The general opinion of the Reykjavik 2016 meeting participants was that the simple and flexible organization of the network serves its purpose. No major needs for formalizing the structures around the organization of the network were identified. It was suggested that the network continues to have a steering group where the members' responsibility is to maintain activity, and to "retire" when appropriate. New members that want to become more active in organizing the network are encouraged to take contact with the steering group and take part in the organizational work. Likewise, all HN members are welcomed to become active in any of the on-going working groups, and to suggest new ones. Some of the projects are long-term and require a continued effort (e.g. protocol development) while others may result in one or a few publications, which is a model that works.

The first two years of the network have been a successful proof of concept in the sense that several early career scientists, from masters to post-doc level have taken active roles in working on the circumpolar protocols and have been involved in papers. Three peer-reviewed publications have been produced, as well as 10 conference contributions. With the support of the Terrestrial Working Group of IASC, CAFF, Fram Centre, Rannís and the Spanish Ecological Society (AEET) two workshops, 1 conference session and two network meetings have been organized.

The general conclusion is that the Herbivory Network should continue to be an open, active network where members are encouraged to take active roles in developing new initiatives, and with a clear identification of contact persons and responsible members for particular activities such as publications, protocols, meetings and organizational tasks.

Sharing the work load

An improvement that is necessary is sharing the tasks, especially in relation to communication of HN activities and organization of meetings and workshops. Several tasks and responsible persons were identified. The main communication channels of HN are the website, and messages sent via email or the newsletters. The website will be updated and include more visual materials to make it more appealing. It is important to clearly identify contact persons for the ongoing projects, as well as to highlight past and future projects. The specific projects likely to result in publications should also be given visibility on the webpage in the same way as protocol groups have today. With respect to the protocols, it is essential to highlight that most of them are still trial versions under development. There could be feedback forms (e.g. Google forms) so that users can respond and comment on the working versions of the protocols. Field videos and cost estimates of each protocol would be very valuable additions. It is also important that the website shows clearly how potential new members could join and facilitate contact. The University of Alberta, through David Hik as the main contact person, will continue to host the webpage and Katie Christie volunteered to work on updates. HN will continue to send a newsletter when there are news to tell, but trying to do so at least once a year. It is important that several members contribute to the production of the newsletter (Bryndís Marteinsdóttir, Henni Ylänne, Nicolas Lecomte, Virve Ravolainen, Martin Mörsdorf etc.). Eventually, social media (Facebook, Twitter) could help to enhance the visibility of the network, but these should not be the main channel of communication.

The Reykjavik meeting discussed the frequency of future meetings, and agreed upon having a general meeting every second year, with more frequent working meetings related to on-going papers and protocols. These working meetings can happen once or even twice a year, and can preferably be back-to-back with larger conferences or other meetings that many of the involved HN members will attend. An option for future meetings, especially the general meetings, could be to have them longer (several days) and presenting results from the different study sites where HN members are currently working. Funding opportunities for meetings should be sought for actively by all HN members.

For the organization of general meetings, inspired by the “ITEX viking”, a sheep figure will be passed on to the next general meeting organisers, as a reminder of their commitment. The HN sheep is now on its way to Yamal, where the next general meeting will be organized tentatively during fall 2018 by Alexander Sokolov.

The next working meeting (intended as a 1-2 day workshop for groups to work on specific projects) will potentially be organized in parallel to the Arctic Science Summit Week 2017 in Prague (http://www.assw2017.eu/). Petr Macek will be the local host.

Sasha and the HN sheep

Workshops

Four workshops were held that led to start of a tentative number 6 new collaborative publications.

The functional diversity of herbivore assemblages across the Arctic

The workshop led by James Speed presented the initial work on patterns of phylogenetic and functional diversity. This work follows from the Barrio et al. (2016) data material expanding from species richness to functional groups of herbivores and phylogenetic diversity. Ideas for addressing the diversity of herbivores in the Arctic based on other concepts of diversity was inspired by work of Hempson et al. 2015 (Science) who showed the effects of different functional groups of herbivores on ecosystem function throughout Africa. Mishler et al. 2014 (Nature Communications) showed for Australia that species richness patterns may not necessarily reflect the phylogenetic diversity either. The species richness patterns found in Barrio et al. (2016) should therefore be compared to other concepts of biological diversity. Phylogeny is based on the *citb* marker, while the classification of herbivores based on traits will be a first attempt to use functional traits of herbivores in the Arctic to look at diversity patterns. James Speed and Ina Skjelbred presented preliminary maps and phylogenetic trees, assessing phylogenetic diversity and species richness of herbivores in the Arctic. Both concepts showed similar geographical patterns, revealing a strong distinction of herbivore diversity between North America and Eurasia. Another preliminary outcome is that areas with lower species richness seem to have high phylogenetic diversity. However, certain species can be phylogenetically similar but functionally very different and details of the analyses were discussed among workshop participants. Eeva Soinen presented tasks that need to be addressed when defining functional traits of herbivore diversity in the Arctic. Workshop participants discussed requirements for defining functional traits in three separate groups. The likely outcome of this work is the first analysis on patterns of phylogenetic and functional diversity related to the available environmental drivers, and a continuation as more conceptual work on how to characterize herbivores using functional traits. While functional trait characterization of plants has a long history, much less has been done on herbivores. Contact persons: James Speed, Eeva Soininen, Ina Skjelbred.

Assessment of herbivory effects on soils in arctic tundra ecosystems

The workshop led by Maria Tuomi and Guillermo Bueno, and co-organized by Maria Vaisänen and Francis Brearley, presented the preliminary results of a literature review on the effects of herbivores on soil processes in tundra ecosystems and discussed the further development of the circumpolar soil protocol. The aim of the review is to summarize what is known already and identify knowledge gaps on the effects of herbivores on tundra soils. Using common search terms and filtering based on geographical location and the co-occurrence of measurements of herbivory and soil traits, over 25 papers have been identified. A systematic review approach will be used. Expertise among workshop participants and other experts that could be involved in this work were identified. A conceptualization of known herbivore-soil relationships was developed. Direct effects of herbivores (trampling, grazing, excrements) on soil affect nutrient concentration, bulk density, water holding capacity and soil compaction, and ultimately temperature, moisture and pH. These properties directly affect the processes of soil stability (erosion) and the surface and groundwater flow of carbon and nutrients (leaching). Effects on vegetation have implications through root biomass and turnover, and litter quantity and quality, which in turn affect the above mentioned soil properties, but also the biota living in soil. Activity of soil biota governs the rate of soil processes (mineralization, carbon and nutrient cycling) that feedback to vegetation (and soil properties). The workshop ended up with a discussion about which soil traits considered in the workshop, should be included in the HN pilot soil protocol (launched summer 2016). The challenge was to identify which traits would be easy to measure, "low cost", highly sensitive to herbivore activities and with direct implications on ecosystem functions and plant community changes. General information about the progress of the literature review and the pilot soil protocol will be posted on the soil working group page at the HN website (http://herbivory.biology.ualberta.ca/soil-working-group). Contact persons: Maria Vaisänen, Guillermo Bueno and Maria Tuomi.

Monitoring initiatives of tundra herbivory – where are the data gaps?

The workshop organized by Eeva Soininen started by discussing the data gaps in herbivory studies. The discussion quickly pointed towards the need to assess systematically which questions are being asked and where, regarding herbivory in the Arctic. The workshop suggested to develop two (or three) parallel publications. One initiative will develop a systematic protocol that will lead to a systematic map of the field of herbivory research. Using as a starting point a broad research question (e.g. what are the effects of herbivores on tundra?), systematic maps allow for quantitatively and qualitatively map the knowledge available. The first step is to clearly define a protocol for the systematic literature search, and secondly, to conduct the search itself. This initiative will be taken further by James Speed, Eeva Soininen, Virve Ravolainen, Dorothee Ehrich et al. The second initiative, led by Jennifer Forbey et al. will review what kind of paradigms have been prominent in herbivory research the last decades. The idea is that by looking at what questions have been asked and how they have been answered we can identify conceptual/general advances that have been made, and identify future needs. A logical starting point for this effort will be to look at large, well-established projects to identify keywords, processes, major factors and drivers. The initial question of where are the data gaps will be answered by the combination of these publications. In addition, questionnaires to HN members and other experts could help identify ongoing initiatives that due to the long-life of ecological data may not have been published yet.

How to assess the effects of historical grazing impacts within tundra sites

In the workshop led by Martin Mörsdorf the group discussed methods of how to work on historical grazing effects within tundra study sites. He started by repeating one of the main goals of HN, which is to develop standardized sampling schemes for herbivory in order to overcome context dependencies between study sites. Ongoing work within HN focusses strongly on assessments of contemporary herbivory densities, but potential effects of herbivore impacts during the past have been so far ignored. He exemplified the importance of addressing historical herbivory, since herbivores can push tundra vegetation into different states, which may be persistent depending on 1) the apparent environmental conditions, 2) present grazing intensity, and 3) grazing history. Approaching the question of how to assess historical herbivory within study sites, the workshop participants started by creating a list of potential information sources that can be used. Information sources on the list covered a broad spectrum, implying the usage of paleo-ecological information (e.g. lake sediment cores and traces of human land use), exploration of public data bases (e.g. hunting statistics, livestock numbers) and the recording of plant community characteristics (e.g. architecture of shrubby species, investigations of annual rings in woody species and bite marks). The group discussed that the listed information sources had different characteristics in terms of their common availability, temporal scales that can be captured and their "directness" in terms of grazing impacts. Certain information sources were thereby discarded because of obvious difficulties when aiming at including them into a protocol for assessing grazing history within study sites. Information sources which are possible to implement into an assessment protocol were further discussed and sorted in terms of whether information provides direct evidence for historical grazing impacts (mostly related to impacts on the vegetation), or indirect evidence whether historical herbivory was apparent or not. Clearly, some information can be directly assessed in the field whereas other relies on external information sources. The work so far will be further discussed during future HN workshops and active participants will be welcome to form a new working group within HN. The aim of this working group will be to develop a protocol scheme to assess tundra sites in terms of their historical herbivory.

List of participants

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