NJF conference 497

Nordic Conference on Reindeer Husbandry Research

Jukkasjärvi (Kiruna), Sweden, 29-31 May 2017

The Nordic Conference on Reindeer Husbandry Research 2017 was hosted by NJF (Reindeer section) in collaboration with the Nordic Centre of Excellence ReiGN - Reindeer husbandry in a Globalizing North – resilience, adaptations and pathways for actions. It was the third conference on reindeer husbandry research arranged within NJF, which in turn was a continuation of a series of Nordic conferences, starting in 1981 arranged by the former Nordic Council for Reindeer Husbandry Research (NOR).

The conference brought together 62 participants, mostly from the Nordic countries (Sweden, Finland and Norway), but also from Russia, Canada, France and Italy. Key note speakers had been invited from the Nordic countries as well as from Canada and Germany.

The three-day conference included four scientific sessions:
- *Reindeer health*
- *Sustainable land use, ecological, political and social aspects*
- *Domestication and selection*
- *Herd dynamics and Productivity*

The reindeer health session was opened with a key note lecture by Morten Tryland, veterinary from the University of Tromsø, Norway, who discussed infectious diseases in reindeer and how these may be affected by a changing environment, competing land use and subsequent changes in reindeer husbandry. Other talks within this session dealt with e.g. the increased occurrence of eye infections (infectious keratoconjunctivitis) in reindeer, and CWD (chronic wasting disease), caused by pathogenic prions, that has been diagnosed in wild reindeer and moose in Norway during recent years and may imply a severe threat to reindeer husbandry. Ongoing work including screening and identification of infectious diseases in reindeer within the Nordic Centre of Excellence CLINF was also presented.

Sustainable land use is evidently a key issue for reindeer husbandry and the talks in this session was introduced by a key note lecture held by Roland Pape from University of Bonn, Germany. He presented results from research done together with his co-author Jörg Löffler which illustrate how seasonality and habitat selection may buffer against climate change and weather variability. This session included eight more oral presentations and three posters covering topics related to effects of climatic change, competing land use and human disturbances on the possibility for reindeer to graze and for reindeer husbandry to sustain on the available land resources. Several presentations were related social and political issues like governance, empowerment, learning processes and internal collaboration.

Session three focused on genetic aspects of reindeer, how reindeer have been genetically changed historically through domestication, and the goals and methods of selection of reindeer in present-day reindeer husbandry. In his key note lecture, Ivar Bjørklund discussed domestication from a historical perspective, emphasizing the importance of separating early reindeer husbandry and domestication of reindeer from the transition of a hunting society to the development of pastoralism with large herds of domesticated reindeer. He pointed out that for long (many centuries or even millennia) reindeer were kept by humans for domestic services (e.g. transport) parallel with wild herds that were hunted. When large-scale pastoralism based on reindeer started to be developed there was already a domesticated variety of the species that could be handled and herded. Asko Mäki-Tanlila had the second key-note lecture within this session focusing on the genetic aspects of domestication and the effects of favouring certain traits depending on what the reindeer have been used for. He also discussed how the effects of human selection may be hampered by natural selection. Five additional oral presentations and four posters in this session covered a range of topics from historical development of reindeer herding to the use of pedigree information as well as knowledge on certain genes for breeding and modern techniques like artificial insemination.

Several topics presented in the last session on herd dynamics and production were closely linked to those in session two (sustainable land use). This session started with a key note lecture held by Chris Johnson from the University of Northern British Columbia, Canada. The presentation had a broad focus on the role of predators for Rangifer population dynamics. The examples and challenges discussed referred primarily to wild reindeer (caribou) and the situation in North America, where wolf is usually the main predator, but many of the complex mechanisms involved can nevertheless be applied also on situations in the Nordic countries. The remaining presentations in this session dealt with effects of predation, identification of productivity factors, long-term population dynamics, changes in available grazing resources and collaboration and risk management in reindeer husbandry.

The conference demonstrated the broad spectrum of research linked to reindeer herding that is performed within the Nordic countries. There is hope that the Nordic Centers of Excellence now funded by Nordforsk (ReiGN, which was partly responsible for the conference and

represented by a large number of presentations, and CLINF with focus on infectious diseases in both humans and animals but where reindeer has been selected as a key species, and REXSAC Resource Extraction and Sustainable Arctic Communities) will further develop the research and provide a more holistic understanding of the drivers that affect reindeer husbandry in Fennoscandia.

Scientific committee:
    Birgitta Åhman, SLU, Sweden
    Øystein Holand, NMBU, Norway
    Jouko Kumpula, LUKE, Finland

Organising committee:
    Birgitta Åhman, SLU, Sweden
    Anna Skarin, SLU, Sweden
    Alessia Uboni, SLU, Sweden

Conference program

Monday 29 May

13:00   **Opening of the conference**

         SESSION I - *Reindeer health* (lead by B Åhman and A Uboni**)**

13:15   Key Note: **Morten Tryland** "Reindeer health in perspective"

14:00   **Ulrika Rockström**, "Reindeer health - information and communication with herders"

14:30   **Javier Sánchez Romano**, "Infectious keratoconjunctivitis in semi-domesticated reindeer"

14:50   *Short presentation of posters:* Poster 1: **Mørk**, Poster 2: **Tapio**, Poster 3: **Eilertsen,** Poster 4: **Bolmgren**

15:00   COFFEE BREAK & POSTER VIEWING

15:40   **Morten Tryland**, "Chronic wasting disease – potential implications for reindeer herding"

16:00   **Asgrim Opdal,** "Consequences of CWD – herders´ perspective" (in Norwegian) – Presented by Morten Tryland

16:20   **Anna Omazic**, "Infectious diseases in Fennoscandian reindeer"

16:40-17:00   Concluding discussion on health and diseases in *Rangifer*

         (Internal meeting for ReiGN WP leaders)

19:00   DINNER

Tuesday 30 May

         SESSION II – *Sustainable land use, ecological, political and social aspects* (lead by A Skarin and A Löf**)**

08:15   Key note: **Roland Pape**, "Seasonality of habitat selection shown to buffer reindeer pastoralism against climate variability"

09:00   **Romain Courault**, "Recent past, present and future temperatures for calving area in Gabna community: cross-checking datasets and first results"

09:20   **Hans Tømmervik,** "Landscape transitions from tundra/mountain heaths to forests the last century in northern Norway and the impact on reindeer husbandry: The likelihood for spreading climate sensitive infections (CSIs) in the future"

09:40   *Short presentation of posters.* Poster 5: **Skarin**, Poster 6: Eftestøl & **Eilertsen**, Poster 7: **Johnsen & Berlina**

09:50	COFFEE BREAK & POSTER VIEWING

10:20	**Jukka Käyhkö**, "Fennoscandian reindeer husbandry as a social-ecological system in a warming climate"
10:40	**Camilla Risvoll**, "Flexibility among reindeer herders to climate change and carnivore governance: A case study in Nordland, Northern Norway"
11:00	**Ida Hydle**, "Restoring justice and autonomy in Sámi reindeer husbandry"
11:20	**Jan-Åge Riseth**, "Could the performance of EIAs for Reindeer Herding be improved?"
11:40	**Matthew Thomas**, "The structure of cooperation in reindeer herders' social networks"
12:00	**Annette Löf and Simo Sarkki**, "Searching for fits, learning from failures: Contrasting and comparing problem-solving capacities in the governing systems of reindeer husbandry in Sweden, Norway and Finland"
12:10-12:30	Concluding remarks on Sustainable land use

12:30	LUNCH

SESSION III – *Domestication and selection* (lead by K Røed and A Mäki-Tanila**)**

13:30	Key Note: **Ivar Bjørklund**, "Domestication and selection, some remarks on the development of Sámi reindeer husbandry"
14:15	Key Note: **Asko Mäki-Tanila**, "Domestication and herders' empirical selection from animal breeding perspective"
15:00	*Short presentation of posters*. Poster 8: **Krutikova,** Poster 9: **Riipi,** Poster 10: **Poulin,** Poster 11: **Baranova**

15:10	COFFEE BREAK & POSTER VIEWING

15:50	**Kjell-Åke Aronsson**, "Prehistoric skis and reindeer herding in Eurasia"
16:10	**Kirsi Muuttoranta**, "Prospects for selection in reindeer husbandry"
16:30	**Håkon Holand**, "Non-linear selection in semi-domestic reindeer"
16:50	**Elena Nikitkina**, "Russian experience with reindeer semen"
17:00	**Vasili Goncharov**, "Russian reindeer husbandry: past, present and future"
17:20-17:50	Concluding discussion on *Rangifer* domestication and selection

19:00	CONFERENCE DINNER

Wednesday 31 May

SESSION IV – *Herd dynamics and productivity* (lead by BJ Bårdsen and J Kumpula)

08:30	Key Note: **Chris Johnson**, "Once Abundant now Endangered - the Role of 'Predators' in the Decline of *Rangifer* Across Canada"
09:15	**Antti Juhani Pekkarinen**, "The effects of predation on the management of reindeer-lichen system"
09:35	**Jouko Kumpula**, "Productivity of reindeer herds in the northern part of the reindeer herding area in Finland"
09:55	*Short presentation of poster*: Poster 12: **Kirchner**
10:00	COFFEE BREAK & POSTER VIEWING
10:30	**Bård Jørgen Bårdsen**, "Long-Term Population Dynamics in the Swedish Reindeer Husbandry"
10:50	**Alessia Uboni**, "Major declines in food resources challenge a centuries-old pastoral system"
11:10	**Marius Næss**, "Cooperation and pastoral risk management – reindeer herding in a changing climate"
11:25	Concluding discussion on *Rangifer* herd dynamics and productivity
11:45	Closing the conference
12:00	LUNCH for ReiGN partners participating in afternoon workshops
13:00-15:00	Workshops for ReiGN WPs

ABSTRACTS – oral presentations

IN ORDER OF APPEARENCE

SESSION I: Reindeer health

Chairs: Birgitta Åhman, Alessia Uboni

Key note

Morten Tryland	REINDEER HEALTH IN PERSPECTIVE
University of Tromsø, Norway	Infectious diseases represent important health challenges for reindeer. The occurrence of an infectious disease depends on the presence of the parasite, bacterium, virus or prion, but also factors related to the pathogen itself (pathogenicity), the host organism (susceptibility and immunity) and the environment. Disease challenges will thus be different among *Rangifer* subspecies and populations, and will change over time. When reindeer pastoralism gradually replaced hunting in Fennoscandia, reindeer owners became increasingly responsible for the environment for the animals. Reindeer were often kept close at hand, as draft and milking animals. During the 16th and 17th centuries, diseases like the "reindeer pest", anthrax, digital necrobacillosis ("slubbo") and pneumonia could affect hundreds or thousands of animals, and some Sami settlements were abandoned because of reindeer die-offs. A more extensive reindeer herding, with seasonal migrations and the use of vast pasture land probably favoured reindeer health, since descriptions of large disease outbreaks from the past century are scarce. Today, many traditional reindeer pastures are continuously being challenged by forestry and new infrastructure, reducing the pasture land and hampering migration routes. Further, climate change and increased rain-on-snow and freeze-thaw events cause icing and reduces food availability for reindeer in winter. Hence, supplementary feeding is established as a common measure to avoid emaciation and loss, but it has also become more common to feed the animals on a regular basis. Thus, reindeer are again being gathered and kept in enclosures over prolonged periods of time, increasing the animal density and contributing to unfavorable environments. This seems to have increased the incidence of reindeer diseases like alimentary necrobacillosis, contagious ecthyma and transmissible keratoconjunctivitis. Hence, reindeer health is associated with the herding practice, i.e. animal density and the environment the animals are offered. Changed herding practice and disease patterns may necessitate increased efforts on prophylaxis and medical treatment of reindeer diseases, which together with the feeding itself may question the status of reindeer meat as a "product from nature".

Oral presentations

Ulrika Rockström	REINDEER HEALTH - INFORMATION AND COMMUNICATION WITH HERDERS
Farm & Animal Health, Sweden	

Javier Sánchez Romano	INFECTIOUS KERATOCONJUNCTIVITIS IN SEMI-DOMESTICATED REINDEER (*RANGIFER TARANDUS TARANDUS*): MICROBIOLOGICAL STUDY OF ANIMALS WITH AND WITHOUT OCULAR CLINICAL SIGNS

University of Tromsø, Norway

Co-authors: Mørk T, Laaksonen S, Ågren E, Nymo IH, Sunde M, and Tryland M

Infectious keratoconjunctivitis (IKC) is one of the most important ocular diseases in ruminants worldwide. Besides keratitis and conjunctivitis, clinical signs associated to this disease may include ocular discharge, corneal oedema, uveitis, corneal ulcer, and in severe cases, blindness. *Moraxella* spp., *Chlamydia* spp. and *Mycoplasma conjunctivae* have been described as primary causative agents in different species of wild and domestic ruminants, including cattle (*Bos taurus*), sheep (*Ovis aries*), moose (*Alces alces*) and wild Caprinae. Previous studies in semi-domesticated reindeer (*Rangifer tarandus tarandus*) indicated reindeer alphaherpesvirus (cervid herpesvirus 2; CvHV2) as the primary agent associated with IKC in this species, associated with secondary bacterial infections. To address this further, 341 semi-domesticated reindeer, with (n = 108) or without (n = 113) clinical symptoms of IKC, or with no details on clinical symptoms provided (n = 120), were sampled in Norway, Sweden and Finland in 2010 – 2014. Seroprevalence was 37.4 % for alphaherpesvirus (n = 254), 3.8 % for gammaherpesvirus (n = 211) and 7.1 % for pestivirus (n = 211) (ELISA). Swab samples obtained from the conjunctiva of 202 reindeer were subjected to bacteriological cultivation resulting in bacterial growth from 75.2 % of the samples, with *Moraxella* spp. being isolated from 21.6 % of the animals with (n = 51) and 5.6 % without ocular clinical signs (n = 84) as the major finding. DNA extracted from conjunctival swabs was analyzed by PCR, revealing a prevalence of 28.5 % for CvHV2 (n = 200), 11.9 % for *Chlamydiaceae* (n = 135) and 1.0 % for *M. conjunctivae* (n = 197). A significant association (p < 0.001), which existed between the presence of clinical symptoms of IKC and the presence of CvHV2 DNA in affected eyes, was not present for any of the other microorganisms detected. These findings support the hypothesis that CvHV2 is the primary agent of IKC in semi-domesticated reindeer in Fennoscandia. *M. bovoculi* is suggested as the second best candidate of being a primary agent of this disease, or as secondary and opportunistic pathogens. Further studies should be carried out to better understand the infection biology and the pathogenesis of IKC in reindeer.

Morten Tryland	CHRONIC WASTING DISEASE – POTENTIAL IMPLICATIONS FOR REINDEER HERDING

University of Tromsø, Norway

Chronic wasting disease (CWD) was diagnosed for the first time in Europe and in *Rangifer*, in a wild Eurasian tundra reindeer (*Rangifer tarandus tarandus*) in Nordfjella, Norway, March 2016. CWD was further diagnosed in two hunted reindeer bulls of the same population, as well as in two moose (*Alces alces*) in Selbu municipality, Norway, 300 km north of Nordfjella. Histological patterns in brain tissue of the three reindeer were similar to the one seen in CWD diseased cervids in North America, whereas histology in moose suggests a different type of prion. The Nordfjella wild reindeer management zones borders to a herd of semi-domesticated reindeer, and animals are observed moving between these reindeer populations. Until March 14th (2017) 358 wild reindeer from Nordfjella and 506 semi-domesticated reindeer north of Nordfjella had tested negative to CWD. In North America, CWD was diagnosed for the first time in a mule deer (*Odocoileus h. hemionus*) in Coloroado (USA) in the late 1960ies and has since spread to 24 states and to four Canadian provinces. Experience from North America concludes that translocation of wild and captive cervids, shedding pathogenic prions (PrPSc), has been the most important risk factor for spreading CWD to new regions. This is a crucial characteristic of the epidemiology, should CWD be introduced to semi-domesticated reindeer and the reindeer herding industry. Reindeer herding in Fennoscandia is based upon translocation of animals between summer and winter pastures, live animal trade, herders sharing fences and other infrastructure, as well as often long-distance transport animals for slaughter. Further, semi-domesticated reindeer in Norway and Sweden have trans-border pasture rights, with animals in defined regions moving freely between Norway and Sweden/EU. Experimental inoculations of reindeer revealed an incubation period of 18-24 months. CWD is causing reduced production, wasting and CNS symptoms, and is always fatal. There is no immunity, and diagnosis is based on brain tissue (dead animals) or investigation of surgically removed lymphoid tissue from the rectum (live animals). If CWD is introduced to semi-domesticated reindeer, restrictions on animal translocations will be a necessary and important measure to restrict spread of the disease. However, it is crucial that such limitations on animal

translocations are conducted in a way that takes into account animal welfare and the hFHerders' ability to conduct reindeer herding.

Anna Omazic,

National Veterinary Institute, Sweden

Co-authors: Leijon M, Rockström U, Tryland M, Kantanen, J, Åhman B, and Albihn A

INFECTIOUS DISEASES IN FENNOSCANDIAN REINDEER

Temperature and precipitation influence the rate of development, survival, and reproduction of pathogenic microorganisms, and thus the incidence and prevalence of many infectious diseases. Higher temperature and altered precipitation patterns may cause changes in the ecosystems, and could improve winter survival of arthropod vectors and animal hosts, influence their performance, population size, distribution range, etc. Also, reindeer herd management may change, which can influence the spread of infectious diseases. The present study is focused on screening and identification of infectious diseases in reindeer (*Rangifer tarandus*). The aim is to survey known and hitherto unknown pathogens in reindeer. Better knowledge of existing reindeer infections will enable the prediction of future changes as well as suggesting management measures to prevent spread of infections.

Nose and rectal swabs, blood and other biological samples were collected from 180 semi-domesticated reindeer in Sweden, Finland and Norway. Twenty animals were sampled, both calves and adult females, from three herds in each country. The swab samples were pooled five by five and analysed using Next Generation Sequencing (NGS). Also, all samples will be individually PCR-tested for selected pathogens. Blood samples will be used for serological analysis.

Sampling is ended. Analysis is currently running. Preliminary results are to be presented. Present knowledge on pathogens diagnosed in reindeer is inadequate both concerning agents, geography and time-period. Most of the studied pathogens are in some way depending on the natural environment for their spread or persistence, e.g. their transmission to a new host or species uses arthropod vectors, water or soil, or uses wildlife as a reservoir. These infections, will be further studied in reindeer, other animals and humans in Fennoscandia, collection of retrospective data is ongoing. Zoonotic infections, which may be transferred between human and animal hosts, are of particular concern. Also, climate change may cause stress and thereby immunosuppression and easier acquired opportunistic infections e.g. necrobacillosis and orf. Exotic infections, e.g. Schmallenberg and Bluetongue virus infections, require enhanced awareness and preventing measures. Prediction models will be developed as useful tools for new emerging infections that may be challenging if introduced in immunologically naive populations.

SESSION II: Sustainable land use, ecological, political and social aspects

Chairs: Anna Skarin, Annette Löf

Key note

Roland Pape	SEASONALITY OF HABITAT SELECTION SHOWN TO BUFFER REINDEER PASTORALISM AGAINST CLIMATE VARIABILITY
University of Bonn, Germany Co-author: Löffler J	Since climate-driven variability of habitat selection of large herbivores has seldom been explicitly analysed, we aimed to better understand the climate-ecological mechanisms behind geographic patterns of reindeer habitat utilization. We analyzed habitat selection of 20 (± 2) GPS-collared female reindeer in the Filefjell area (Norway) over a period of five years. We examined the mechanistic forces of habitat selection variability by applying a novel stepwise factor analysis approach based on the niche concept. Our results reveal complex spatiotemporal patterns of habitat selection that are driven by seasonality, year-to-year climate variability, and the choice of individual animals. In contrast to expected similarities between conspecifics, our analyses revealed varying degrees of intra-species variability and therefore suggest that responses of individual reindeer to climate variability are inconsistent. Moreover, we found annually reoccurring patterns of habitat selection strength during different seasons that help explain coping capacities of reindeer against climate variability. In contrast with our expectations, we detected a very high inter-annual variability in habitat preferences to be related to governing climatic conditions. Here, we present new evidence for the variability of response mechanisms of reindeer's habitat selection shown throughout different seasons and years that contribute to buffer reindeer pastoralism against climate variability. Our work contributes to a better understanding of alpine ecological response mechanisms as a key for projections of future responses to climate change.

Oral presentations

Romain Courault	RECENT PAST, PRESENT AND FUTURE TEMPERATURES FOR CALVING AREA IN GABNA COMMUNITY: CROSS-CHECKING DATASETS AND FIRST RESULTS
Sorbonne-Universités Paris IV, France Co-author: Cohen M	Global warming and its effects on regional and local scales are more prevailing in arctic and subarctic socio-ecosystems. In northern Scandinavia, semi-domesticated reindeer and pastoralism are part of the tundra-taiga ecotone, dealing now with spectacular changes. Herbivores such as reindeer "promote the expansion and productivity of graminoids while constraining biomass of deciduous shrubs such as dwarf birch (*Betula nana*) and willow (*Salix glauca*)". Here, we wanted to know how much the raise of T°C is expected in May and June for Gabna calving area (RCP8.5; CMIP5). For recent past (1970-2000) and future (2041-2050), we described evolution of monthly mean temperatures. We firstly checked links between past climatological reanalysis (Worldclim, CMIP5) and meteorological records along the Gabna community (Abisko, Kiruna, Vittangi). Then, we drawn the recent past and future mean T°C of the Corine Land Cover ecological habitats composing the calving area. For past temperatures (1970-2000), absolute bias (°C) between WorldClim maps and recorded temperatures (min, max, mean) describe higher total error for min temperatures (total error: 2°C) and lower for averaged ones (0.9°C). For past mean temperatures (1970-2000) of May and June, overall mean is about 4.46 °C. Concerning near future (2041-2050) projected increase is +5.23°C (overall mean: 9.69°C). In particular, low altitudinal ecological habitats such as peat bogs, broadleaved forests and moors/heathlands are likely to rise over 10°C as mean

value for May-June. For higher elevations, natural grasslands and sparsely vegetated areas might exceed 8°C as mean value (respectively: 9.41°C and 8.74°C). High variability is seen among ecological habitats, revealing the wide range of distribution of vegetation, in particular for shrubs and grasslands (SD for 1970-2000 T°C respectively of 0.76 and 0.56).

For past and future T°C, medians and boxplot position for mid- and high altitudes ecological habitats are higher in the future compared to past temperatures. Boxplots presenting low-altitudes habitats (forests, peat bogs) show lower medians and lower Q1 and Q3 positions. These results suggest a more pronounced warming for moors and heathlands, natural grasslands and sparsely vegetated areas. Future T°C, here based on downscaled Global Climate Models (GCM) will be later cross-checked with more accurate datasets.

Hans Tømmervik	**LANDSCAPE TRANSITIONS FROM TUNDRA/MOUNTAIN HEATHS TO FORESTS THE LAST CENTURY IN NORTHERN NORWAY AND THE IMPACT ON REINDEER HUSBANDRY: THE LIKELIHOOD FOR SPREADING CLIMATE SENSITIVE INFECTIONS (CSIS) IN THE FUTURE**
Norwegian Institute of Nature Research, Norway Co-authors: Riseth JÅ, and Karlsen SR	Climate warming is occurring at a greater speed and magnitude in the Arctic than in the rest of the world. These effects are most clearly pronounced in northern communities dependent on natural resource use, like the reindeer husbandry. Our knowledge about climate change effects has increased significantly the last decades, but a large knowledge gap still exists regarding how change in climate will affect climate sensitive infections (CSIs) and hence humans and animals. It is therefore pressing to identify the changes that are most likely to ease the spread of such infections. Such a landscape transition that may ease the spread of such infections is the transition of open tundra or heath to more forested land. In order to predict future development of such transitions we have to identify historical landscape transitions. Therefore, we have conducted a landscape analysis using forest and vegetation maps from 1914 to 2012 over the northern part of Fennoscandia. This analysis showed that total forest cover in Finnmark County, the northernmost county in Norway increased from 7.505 km2 in 1914 to 15.440 km2 in 2012. A prediction analysis using a bioclimatic modelling done on Finnmarksvidda, shows that the area of forests will increase with 70% beyond 2100. This will lead to a reduction of open arctic-alpine (tundra) heaths and it is also expected that the area of forested land will increase in the summer ranges at the coast. Another example is the coastal region of Vesterålen/Lofoten, in which the forest cover increased from 232 km2 in 1949 to 844 km2 in 2012. Due to the topography, the forest cover will not experience a future increase here as predicted for Finnmark. This indicates that open and free reindeer ranges have decreased and that vectors like insects (e.g. blood sucking ticks) associated with forests, scrubs and water bodies are likely to spread diseases (CSIs) like tularemia and borreliosis, and expose both reindeer and humans to increased health risks.
Jukka Käyhkö	**FENNOSCANDIAN REINDEER HUSBANDRY AS A SOCIAL-ECOLOGICAL SYSTEM IN A WARMING CLIMATE**
University of Turku, Finland Co-authors: Horstkotte T, Kivinen S, Vehmas J, Oksanen L, Johansen B, and Forbes B	The Arctic region is forecasted to warm approximately twice as much as the Earth on average. This will cause dramatic transformations in the northern ecosystems. Further pressure to the environment is imposed by changes in land-use. Reindeer husbandry requires large, relatively nonfragmented territories. Land-use conflicts between various livelihoods and activities, such as forestry, agriculture, mining, energy production, tourism, and nature protection are common phenomena in the reindeer herding area. Simultaneously, rapid societal change, urban exodus and fading traditions as well as climate warming and subsequent ecosystem change may put the livelihood at stake. These processes bring about serious challenges to reindeer husbandry. The livelihood is highly dependent on the diverse tundra environment, and deeply rooted in the indigenous Sámi culture. We study various ecosystem interactions in a changing climate and integrate these with reindeer husbandry and the indigenous culture dependent on it. Potential climate impacts include transformation of the arctic-alpine tundra into a dense scrubland with

conceivable consequences to reindeer husbandry, but also global warming due to decreasing albedo. We have probed potential futures of reindeer husbandry in Northern Fennoscandia using the Social-Ecological System (SES) approach, knowledge co-production in stakeholder-scientist workshops in all three countries, and scenario building based on quantitative data and narratives. Regarding the future of the livelihood, we have identified some crucial components in the SES that are influential ones in determining the direction of development. We produced four potential pathways of future development and demonstrate that important factors controlling the direction of development include governance and actor relations. Governance is often considered distant and opaque by local stakeholders, fostering conflicts in land allocation, while unclear regulations at local level reinforce emerging conflict situations leading to distrust and restrained communication between the actors. Regionally, these conflicts may lead to decreased resilience and threaten the future of the livelihood altogether. Therefore, research should focus on supporting the reform process of institutional arrangements and governance mechanisms, and fostering co-design and co-production processes that ease distrust and improve resilience of the livelihood in multifunctional landscapes.

Camilla Risvoll

FLEXIBILITY AMONG REINDEER HERDERS TO CLIMATE CHANGE AND CARNIVORE GOVERNANCE: A CASE STUDY IN NORDLAND, NORTHERN NORWAY

Nordland Research Institute, Norway

This study investigates how changes in pastoral access and flexibility affect the adaptive capacity within reindeer husbandry in Nordland, northern Norway. Large carnivores (wolf, brown bear, wolverine, lynx, golden eagle) that historically inhabited mountain regions were almost eradicated by the beginning of the 20th century. These populations have dramatically increased again in Fenno-Scandinavia due to international and national commitments towards protecting large carnivores. Moreover, climate change has increasingly locked winter pastures for reindeer during the past 30-50 years. The Carnivore management plan for Nordland is presently under revision. Within this plan, new zones prioritizing land for carnivores and for grazing animals are suggested, where inland mountain landscapes are allocated for carnivores and areas closer to the coast are prioritized for grazing animals.

Flexibility to move the herds to different pastures is an important component of adaptive capacity within reindeer husbandry. Increased carnivore pressure together with increased frequency in locked pastures reduce reindeer herders' access to inland pastures and is leading to significant changes in traditional husbandry practices in Nordland. This change in husbandry has potentially large effects on biodiversity, meat production, as well as an increased risk of disease exposure in reindeer. In this study, we analyse how the combined effects of changes in carnivore management and climate change effect reindeer herders' flexibility and pastoral mobility. We draw on observations, interviews, focus groups and document studies. We discuss opportunities and barriers associated with the combined effects of carnivore management and climate change in local pastoral communities in Nordland, and ultimately how this affects pastoralists' flexibility to attain sustainable husbandry and production modes.

Ida Hydle

RESTORING JUSTICE AND AUTONOMY IN SÁMI REINDEER HUSBANDRY - PARTICIPATORY RESEARCH AND EMPOWERMENT?

University of Tromsø, Norway

First author: Henriksen JE

The present general policies in Russia, Finland, Sweden and Norway concerning the indigenous population in Sápmi, i.e. the Sámi population across the four nation state borders, are similar. In spite of huge political and welfare differences between Russia and the other three Nordic countries, their overall neo-colonisation of humans, animals, lands, fjords, rivers, lakes and sea are parallel. In this paper, we link experiences and knowledge from anthropology, medicine and social work with the purpose of creating an alternative basis for questioning present and future policies in Sami areas, taking reindeer husbandry as a signpost. Swedish and Norwegian Sámi and other population groups have demanded their goverments to

establish a truth commision concerning past colonisation of Sámi culture and language. The truth commissions must include the consequences of past and present state governing of Sámi reindeer husbandry, to the damage of shared traditional knowledge and herding practices. From our mixed Sámi/Norwegian background we see conflicts and confrontations in the reindeer husbandry field as signposts for the need of restorative justice, not least comprising reindeer herding. Currently the Norwegian Sámi reindeer government policy is a neo-liberal "self government", resulting in a rise in conflicts at several levels between Norwegians and Sámi and between Sámi. A recent law suit from the Norwegian government, concerning numbers of reindeer, was won by a small Sámi reindeer owner. Although this may seem as a growing Sámi autonomy, we maintain the importance of a broad view upon this conflict field. There is a need to find sustainable solutions, avoiding the state´s new public management. The NPM privatise conflicts that are part of past and present state governing into so-called private civil legal cases, an often extremely costly "solution" for Sámi reindeer owners. In addition our data show that only rarely do court decisions solve these conflicts on the personal or community level. Our work to find new ways to justice and autonomy in reindeer husbandry conflicts may serve as an empirical example for similar conflict fields.

Jan-Åge Riseth	COULD THE PERFORMANCE OF EIAS FOR REINDEER HERDING BE IMPROVED?
Northern Research Institute, Norway Co-authors: Tømmervik H, Winge NK, Danielsen IE	Reindeer herding is a major livelihood for Indigenous peoples of Sápmi and Northern Russia. Both colonization effects and modern land-use conversion have fragmented the landscape and reduced herding flexibility, whereas climate change effects require increased flexibility for coping. We have analyzed the practice of environmental impact analyses (EIA) for reindeer herding in Norway by legal analysis, a survey, cases studies and interviews. The legal analysis finds that the regulations provide reindeer herding some protection, but it is nevertheless to a large degree at the mercy of the relevant administration. Herder representatives mainly find the outcome of the EIAs mediocre and are not satisfied with neither inclusion of herder knowledge nor evaluation of sum effects. Most herders find the main role of the EIAs to be vehicles of getting plans confirmed. Preliminary findings from case studies and interviews are: Though many EIAs include and present herder knowledge satisfactory, some investigators lack sufficient competence while others are not sufficiently independent of their principals. We recommend the establishment of a public register of EIA investigators and that reindeer herding districts get a formal right of prior approval of investigators. In addition law and regulation improvements should be considered.

Matthew G. Thomas	THE STRUCTURE OF COOPERATION IN REINDEER HERDERS' SOCIAL NETWORKS
Norwegian Institute for Nature Research and Norwegian Institute for Cultural Heritage Research, Norway Co-authors: Bårdsen B-J, Næss MW	Social network structure, and the positions of individuals within networks, influence cooperation and reproductive success in many human societies. Pastoralists, such as Saami reindeer herders in Norway's Arctic region, rely on networks of kin and non-kin not only within their herding groups but also across groups. However, little is known about how social networks are associated with herders' cooperation and productivity. Through analyzing reported and experimental cooperative behaviours, we show that cooperation was tightly focused within herding groups (known as 'siidas'), and especially directed towards closer relatives. Individuals with ties to well-connected herders owned more reindeer, and people named more often in cooperative networks received more gifts. Herders who acted as 'bridges' between clusters did not have greater wealth nor did they occupy formal leadership positions. An exploratory analysis suggests that social network position was not associated with a fitness proxy. These patterns suggest that the structure of social networks, rather than individuals' positions within networks, shapes cooperation in this population, whose members

also reported strong norms of equity and reciprocity. Our results shed light on how herders might respond in the face of upheaval from land privatization and climate change.

Annette Löf[1] and Simo Sarkki[2]

SEARCHING FOR FITS, LEARNING FROM FAILURES: CONTRASTING AND COMPARING PROBLEM-SOLVING CAPACITIES IN THE GOVERNING SYSTEMS OF REINDEER HUSBANDRY IN SWEDEN, NORWAY AND FINLAND

[1]Swedish University of Agricultural Sciences and Umeå University, Sweden
[2]University of Oulu, Finland

Designing governing systems that enhance and sustain problem-solving capacity across scales and levels is a very difficult, but increasingly necessary, task. The challenge is even greater for policy areas characterized by high diversity (e.g. competing land users and resource claims), complexity (e.g. resource dependencies and cascading effects) and dynamics (e.g. rapid changes in the environment, resource and/or management). Hence it comes as no surprise that the governing systems of reindeer husbandry in the Nordic countries – where multiple and overlapping land uses, competing rights regimes, a highly adaptive land use and impacts of climate change is now a reality – suffer from many known governing deficits and mounting challenges. Despite the urgency of the issue and the values at stake, these systems remain remarkably inert. What is more, only marginal work has been done from a comparative Nordic perspective. Therefore, using a contrasting approach to enable comparison across countries and developing a multidimensional and systemic perspective on institutional fit where governability, or overall problem-solving capacity is at the center of analytical attention, we aim to contribute to the search for new and improved "fits" by learning from past failures and contemporary applications and designs of governing instruments and solutions.

SESSION III: Domestication and selection

Chairs: Knut Røed, Asko Mäki-Tanila

Key notes

Ivar Bjørklund	DOMESTICATION AND SELECTION, SOME REMARKS ON THE DEVELOPMENT OF SÁMI REINDEER HUSBANDRY
University of Tromsø, Norway	Unfortunately, the debate regarding the development of Sami reindeer husbandry has centered around the concept of *pastoralism*. However, Sámi husbandry has been around long before the development of pastoralism. Some scholars tend to mix these two concepts and have dated the beginning of what they call pastoralism to ca. 1.000 AC. Others have argued that it did not take place before 15-1600 AC. However, both parties do not take into consideration that reindeer husbandry has probably existed in some form from ca. 3-4000 years ago. *Boazu*, the domesticated reindeer have lived side by side with its wild counterpart, the *goddi*. There has always been a need for reindeer for domestic services and these domesticated animals were an important part of a finely tuned adaption based on hunting, fishing and transport. Such an adaption involved strict techniques of selection, culling and castration to prevent the small herds of draught animals to mix with wild reindeer. Such was the situation up to the 16-17 the century when the dwindling supply of wild reindeer and new markets generated a transition to pastoralism, which meant that the Sámi people involved now became dependent upon a herd of domesticated animals for their main subsistence. Recent DNA analyses have revealed that there is no genetic connection between the old stock of wild reindeer and the domesticated animals of today. Thus, the transition to *pastoralism* must either be a result of the expansion of the afore-mentioned old stock of draught animals or due to the import of a foreign breeds, most probably from the east.

Asko Mäki-Tanila	DOMESTICATION AND HERDERS' EMPIRICAL SELECTION FROM ANIMAL BREEDING PERSPECTIVE
University of Helsinki, Finland	Livestock species were domesticated 10000 or more years ago. The oldest domesticated species are sheep and goat, among the most recent ones are fur animals and fish. Reindeer is also quite 'young' amid domesticated animal species. According to historical records reindeer gradually changed from a hunted species to a herded one only few centuries ago.

Genomic analyses are now used for elucidating domestication. Knut Røed's investigations show that like is the case in some farm animal species, also reindeer was domesticated independently in more than one area, at least in Fennoscandia and in Russia.

The outlook of domesticated stock depends on several factors: first of all the founder population(s), subsequent isolation, possible bottlenecks across time, adaptation to local environments, and human selection. Compared to their wild relatives, domesticated animals show brighter colours with possible heterogeneity or even spotting across body. There is much discussion whether this is associated with the genetic changes in behaviour or whether there are special domestication genes. Reindeer colouring differs only little from the wild counterparts as they also have to hide themselves in wild pasture environment. In reindeer, there are not breeds like in sheep or in cattle. Breeds are differentiated – made even more extreme with intentional inbreeding – primarily by exterior traits while in a semi-wild reindeer such deviations are hampered by natural selection.

The purpose in the use of reindeer has varied over time, from transportation to source of hide and meat. Hence over time herders have been favouring different type of animals. Reindeer are constantly dependent on natural pastures and exposed – in particular in the winter – to extreme weather conditions. Therefore human induced selection may be strongly constrained by natural selection. The changes by artificial selection depend very much on the trait and the genetic

potential or variation in the trait and how closely the target features are related to fitness components, such as survival and reproduction rate.

The genetic variation in production and fitness traits is usually caused by a large number of genes with tiny effects. On the other hand, selection may leave a marking in the genome around genes with large effect and with detailed genomic analyses it is retrospectively possible for such genes to find genome areas which have been swept scant of variation possibly due to much favoured variants. Scientific animal breeding has been practiced since 1940s. It is providing a machinery which in pedigree, performance and genome recorded populations can produce substantial changes within a short time period. The sustainability in the livestock improvement schemes is guaranteed by controlled selection including monitoring of fitness and welfare related traits and balanced use of family lines.

Oral presentations

Kjell-Åke Aronsson	PREHISTORIC SKIS AND REINDEER HERDING IN EURASIA
Ájtte, Swedish Mountain and Sami Museum, Sweden	The oldest nearly complete pair of skis in the world (5200 BP) is an archaeological find from northern Sweden. In the oldest (6200-5700 BP) chronological layer of the rock-carvings in Alta, northernmost Norway we can´t find any certain depiction of a skier. Skis were also unknown for the early immigrants to northern America. The conclusion is that the technique of skiing was developed some time after the Bering land bridge was closed about 15 000 years ago. An intense debate about the origin of reindeer herding started in 1917 AD. According to Chinese literature dated to 499 AD deer herding people are described in the northern border areas of China. Laufer (1917) put forward the idea that reindeer herding originated in the areas surrounding Lake Baikal. The theory that reindeer herding was diffused from centres in eastern Eurasia is still current in the debate. Arguments put forward in earlier research that knowledge of skiing is a prerequisite for reindeer herding seem plausible. Archaeological studies of changes in settlement patterns in northern Scandinavia indicate that reindeer herding was introduced sometimes around 500 AD.

Kirsi Muttoranta	PROSPECTS FOR SELECTION IN REINDEER HUSBANDRY
Natural Resources Institute, Finland

Co-authors: Riipi H´, and Mäki-Tanila A | The production potential of a reindeer herd depends on the quality of animals. The quality can be improved by selecting the best calves for breeding. The owners have their personal preferences for selection and rank animals using their own selection criteria. The criteria are similar among the herders and form a firm base for a breeding scheme. Animal identification, measurements of important traits and pedigree information are vital for an effective breeding scheme, but are mostly lacking in the current reindeer management practices. Bookkeeping on animals would improve selection efficiency by improving the accuracy of selection. Accurate evaluation of animals helps in utilizing the genetic potential of a herd as the best animals could be recognised and selected to produce calf generation. Information on pedigree will further improve the evaluation. For example, the information on calves' dam identities would improve the accuracy of evaluation by 20-30%, while adding sire information would have even double the accuracy. The modern technologies used in selecting farm animal species should be remembered in constructing a selection scheme, although artificial insemination, embryo transfer and genomic selection applied in reindeer breeding may sound somewhat futuristic for the time being. These techniques imply the book-keeping on animals' records and the use of elite sires, preferably kept in a nucleus herd or in collaborating satellite herds. The selection schemes exploited in reindeer husbandry are at present under development and need the assessment of costs and benefits. As reindeer roam free in nature during breeding season making systematic data collection difficult, at the |

initial stages a substantial amount of investments and man power are needed. The special nature of reindeer husbandry has to be considered carefully when applying new technologies. However, the herd productivity can be markedly lifted with the utilization of existing genetic variation.

Håkon Holand

Norwegian University of Science and Technology, Norway

Co-authors: Thomas Kvalnes T, Røed KH, Øystein Holand Ø, Kumpula J, and Sæther B-E

NON-LINEAR SELECTION IN SEMI-DOMESTIC REINDEER

Stabilizing natural selection is thought to occur regularly in nature and act as one of the main evolutionary mechanisms to reduce or limit phenotypic variation in populations. Previous studies of stabilizing selection have often used proxies for individual fitness or certain elements of individual fitness (e.g. survival). We use a long time series (1969 - 2016) from a semi-domestic population of reindeer in the north of Finland (Kutuharju, Kaamanen) to investigate the strength and shape of selection on two important life history traits; individual birth date and individual birth mass. These traits are fixed throughout the life of an individual and have been shown to be important life history traits in other species. We used recently developed methods to estimate selection while accounting for the demography/age-structure of the population. We also used observations of survival and fecundity to calculate the fitness of each individual each year. We observed that both the mean birth date and mean birth mass of females had changed significantly throughout the study period. We also found that there was significant directional selection on individual birth date, where individuals born earlier had relatively higher fitness. In addition, we found that there was a significant pattern of stabilizing selection on the birth mass of individuals. Upon further investigation we found that there was significant correlated stabilizing selection on the two traits. This in turn indicated that selection favored a combination of these two traits during the study period. We show that selection may favor a combination of both the value of a given phenotype (birth mass) and the optimal timing of the phenotype (birth date).

Elena Nikitkina

Russian research institute of farm animal genetics and breeding, Russia

Co-authors: Goncharov V, Krutikova A, Sergeeva O, and Musidray A

RUSSIAN EXPERIENCE WITH REINDEER SEMEN

The first experiments on collecting reindeer semen on an artificial vagina were conducted by prof. Preobrazhensky B.V. at the Naryan-Mar Experimental Station in 1959. Later similar experiments were carried out by E. Borozdin in the Institute of agriculture in the Far North, Norilsk. He determined qualitative and quantitative traits of reindeer sperm. Borozdin found that the quantity and quality of the sperm in the epididymides changes significantly in different periods of the year. They reach the maximum values in the breeding season. M.E. Mkrtchyan and V.I. Deryazhentsev collected sperm from reindeer by electroejaculation for the first time in the tundra in 1969. The experiments comparing the quality of sperm collected on the artificial vagina and by electro-ejaculation were conducted at the Murmansk reindeer breeding station in the late 1960s. It was found that the volume of semen collected by electroejaculation more than artificial vagina. At the same time, work on freezing reindeer sperm and inseminating females was begun. In 1971 frozen semen was transported from Irkutsk Region to Murmansk Region. 11 females were inseminated with fresh sperm, 5 healthy calves were born in 1971-1972. Studies of influence of male age on quality of semen are carried out in Murmansk in 1997. Spermatozoa were not found in sperm in males 1,5 years old, the semen motility in males 2,5 years old was up to 60%, 3,5 years and older - up to 80%. Semen from males 3,5 years and older was frozen in pellets and straws, motility after thawing was 20-30%. 1032 doses of sperm from 43 reindeers were collected and frozen in Naryan-Mar in 2003-2006, tundra females were inseminated by reindeer sperm from Kolguev Island. As a result of crossing the tundra females with the reindeer of Kolguev Island, 75% calves were obtained, but there is no exact data on the number of calves from frozen semen. Thus, Russia has accumulated a great experience in working with the reindeer semen. Currently, research on improving the freezing and sperm assessment in reindeer continue in Norilsk and Saint Petersburg.

Vasili Goncharov

Research Institute of Agriculture
and Ecology of the Arctic, Russia

Co-authors: Sergeeva[1] O,
Nikitkina E, and Krutikova A

RUSSIAN REINDEER HUSBANDRY: PAST, PRESENT AND FUTURE

Reindeer husbandry is the leading branch of traditional nature management of indigenous people of the North, Siberia and the Far East. Approximately 2/3 of the world population of domestic reindeer is in Russia. There are four breeds: Nenets, Evenk, Even and Chukchi. The reindeer breeds differ in color and size. The deer of the Nenets breed are not very tall, the color is brown. Animals are used for harnesses. The Nenets reindeer are the most numerous. Deer of the Chukchi breed are not tall. They are gaining a lot of weight for a short period. This ability allows them to easily endure severe frosts and lack of food in the icy conditions. The color is dark brown. Evenk breed is bred mostly for meat and milk. You can meet them in Kamchatka and in the Magadan Region. They have a low population. The Evenk reindeers are large enough and high. They are used to transport heavy loads. They are bred in the taiga in Siberia and the Far East, from the Yenisei River to the coast of the Okhotsk Sea and on the Sakhalin island. Traditional reindeer herding is based on a private-family form of ownership, as a rule, does not set as its main objective commercial profit. In recent years, most reindeer-breeding regions have overcome depression. There was a decline in the number of herds, including losses from predators, reindeer diseases in the taiga reindeer herding. Breeding work was carried out in reindeer husbandry and included selection of animals, exchange of males between herds and farms and actions to improve the conditions for growth of young animals and calves. There is a sharp shortage of young reindeer breeders and a shortage of agricultural specialists in reindeer herding. The development of reindeer husbandry is planned to be carried out mainly by increasing the productive and breeding characteristics of animals, forming the optimal structure of the herd. Several problems can be solved rationally by use of artificial insemination. This will allow the intensive use of the best animals, carry out individual selection, and create a bank of sperm. Search for some candidate genes that may be used as molecular genetic markers for productive qualities of reindeer can be continued. Panel of these marker genes will help make better use of genetic potential of animals, significantly reduce the time spent on the selection process and in the shortest possible time to increase the meat performance in reindeer herding.

SESSION IV: Herd dynamics and productivity

Chairs: Bård-Jørgen Bårdsen, Jouko Kumpula

Key notes

Chris Johnson	ONCE ABUNDANT NOW ENDANGERED - THE ROLE OF 'PREDATORS' IN THE DECLINE OF *RANGIFER* ACROSS CANADA
University of Northern British Columbia, Canada	Globally, Canada has the greatest diversity of *Rangifer* subspecies/ecotypes. The Committee on the Status of Endangered Wildlife in Canada, the nation's conservation assessment organisation, recently recognised 11 extant and 1 extinct conservation unit. Despite that diversity, and the broad distribution of caribou across Canada, we have witnessed steep and rapid declines in the abundance of many populations. From formally abundant and wide-spread migratory caribou to traditionally low-density woodland caribou, wildlife and conservation professionals are now grappling with relatively small populations that are facing endangerment and in some cases extirpation. These herd dynamics are superimposed on once wild landscapes that are rapidly changing as a result of a warming climate and human-caused habitat change. I discuss the challenges of understanding and managing these herds with a focus on the disappearance of small populations of woodland caribou and the steep and unanticipated decline of barren-ground caribou. In particular, I contrast the role of predators, including human harvest, in causing or accelerating population decline for both types of caribou. This includes interactions between industrial activity and predator abundance as well as the controversial practice of wolf control.

Oral presentations

Antti Juhani Pekkarinen	THE EFFECTS OF PREDATION ON THE MANAGEMENT OF REINDEER-LICHEN SYSTEM
Natural Resources Institute and University of Helsinki, Finland Co-authors: Kumpula J, and Tahvonen O	We apply the existing age- and sex-structured reindeer-lichen model to examine the effects of four mammalian predators (wolf, wolverine, brown bear, and lynx) and one avian predator (golden eagle) on sustainable and economically viable reindeer management. The model includes the description of winter pastures, pasture rotation, supplementary feeding and dynamics of the structured reindeer population. In this study we specify age- and sex-class-specific mortality due to predation. The age- and sex-class specific killing rates of reindeer are estimated for each predator species assuming a typical situation in the northernmost Finland. We use the ecological model to study economically optimal reindeer management and the decrease in net income due to predation. The decision variables in economic optimization are the animals chosen for slaughter from each age and sex class and the amount of supplementary food given. We compute the optimal solutions in different predator densities and pasture conditions. According to our solutions the decrease of the annual net income due to predation depends highly on the age-class specific killing rates by different predator species but not on interest rate or pasture conditions. Regarding golden eagle and brown bear the decrease in the net income is almost equal with the net slaughtering value of the predated animals. However, with wolverine, wolf and lynx the total losses of net income are clearly higher since these predators kill also adult reindeer in addition of calves, leading to a decreased reproduction rate in reindeer population. Assuming optimal adjustment of harvesting strategy the decrease in the steady state yearly net income is approximately 20 000€ per wolf and lower for other predator species. However, if the costs for finding predated reindeer (420€ per reindeer found dead) are taken into account, the decrease in net income is 32000€ per wolf. High predation pressure also changes the optimal age structure of the reindeer population and the associated slaughtering strategy as adult males are slaughtered younger.

Jouko Kumpula

PRODUCTIVITY OF REINDEER HERDS IN THE NORTHERN PART OF THE REINDEER HERDING AREA IN FINLAND

Natural Resources Institute, Finland

Co-authors: Siitari J, Törmänen H, and Siitari S

We studied factors which explain differences on the productivity of reindeer herds in the 20 northernmost reindeer herding co-operatives in Finland. Data on the productivity of reindeer herds in the study area during 2006–2010 were collected from the statistics of the Reindeer Herders' Association. More detailed data on the body measures, weights and condition of reindeer was collected in six herding co-operatives. The selection of pastures and winter food by reindeer as well as differences in snow conditions were also investigated during two winters in these six districts.

Body weight, size, condition and antler measures of females and calves showed similar systematic differences between districts and years. These measurements also correlated with each other. Calf percent was highest in the districts where the supplementary field feeding in winter was most systematic. However, calf percent was also positively dependent on the proportion of lichen pastures and open mountain heath pastures as well as on the amount of summer food available on the land area of districts. The increase of reindeer densities on the land area affected negatively the slaughter weight of calves. The increase of the proportion of dwarf shrubs and grass-dominated pastures and arboreal lichen pastures on the land area affected, however, positively the slaughter weight. When calf percent increased, the slaughter percentage increased. Meat production per reindeer was highest in the districts where calf percent was highest and the supplementary field feeding in winter most systematic, but it decreased as reindeer densities on land area increased.

GPS tracking indicates that in the coniferous forest area reindeer used lichen and arboreal lichen pastures significantly more than other pastures during winter. In the mountainous area, lichen pastures and open mountain heaths were the most preferred pastures in winter. The proportion of dwarf shrubs in the winter fecal samples was ca. 40 % and lichens ca. 35 % but based on the availability of plants, lichens were the most preferred food items. Snow conditions were most difficult for reindeer in late winter, but differed markedly between districts. In the mountainous high elevation heaths the snow was clearly thinner and harder than in forest pastures, particularly in late winter.

The study showed that the systematic field feeding in winter markedly increases the productivity of reindeer herds, but the amount of winter and summer pastures, as well as reindeer densities on pastures, have still considerable effects on the productivity of reindeer herds in the northern part of the reindeer herding area in Finland. The productivity of reindeer herds is also greatly dependent on the annual weather and snow conditions, effects of which can be mitigated by supplementary feeding.

Bård Jørgen Bårdsen

LONG-TERM POPULATION DYNAMICS IN THE SWEDISH REINDEER HUSBANDRY

Norwegian Institute for Nature Research, Norway

Co-author: Næss MW

Declines have been reported for many reindeer (or caribou; *Rangifer tarandus*) populations across the Circumpolar North, but population dynamics are highly variable as both declining and increasing trends in population numbers are evident. Temporal trends in semi-domestic reindeer number in Fennoscandia seem rather synchronous during 1980-2000. In Sweden the number of reindeer has fluctuated, apparently at the scale of decades, around ~225 000 individuals from 1880-2000, to vary between 240 801 to 261 491 animals from 2005 and onwards. There is currently a debate on whether the reindeer husbandry as a livelihood is threatened, and in Sweden there has been a growing concern of the reindeer husbandry being in a state of crisis due to e.g. land use changes, increased predation and climate change.

Bårdsen et al. (2017) analysed how population dynamics in Swedish semi-domestic reindeer at the herding district-level ('Sameby') changed across two distinct periods covering ~70 years: 1945-65 (past) and 1995-2012 (present). In this study, we fitted second-order autoregressive models (time series analysis) and the Ricker model to each period separately in order to identify population collapses or declines. Both analyses relied on district-level data on reindeer numbers (or inferred quantities: growth and density).

We documented few indications of changed dynamics, but the few differences we documented were that the reindeer husbandry is in better conditions at present compared to the past. First, populations were more regulated in the past than now, as judged from the estimated direct and delayed density dependence. Second, the estimated district-level carrying capacity was positively related to their past values. Third, there were positive relationships between past and present density where low-density districts in the past experienced larger growth from past to present compared to districts with comparable high-density in the past. Additionally, recent trends in the number of reindeer, harvested animals and number of owners from 2000 to present (at the national-level) further indicated a lack of a recent general collapse.

To conclude, we found no evidence of any population collapses (dramatic reductions in reindeer numbers) in the Swedish Reindeer Husbandry since World War II. Our findings were unexpected as the pastoral lifestyle face increased habitat loss, predation, fragmentation and climate change.

Alessia Uboni

Swedish University of Agricultural Sciences, Sweden

Co-authors: Åhman B, and Moen J

MAJOR DECLINES IN FOOD RESOURCES CHALLENGE A CENTURIES-OLD PASTORAL SYSTEM

Rangelands, i.e. natural pastures, extend over larger areas than any other land type in the world and are essential to food production in many pastoral societies. Today, climate change and other land uses are threatening rangelands and consequently the pastoralist societies that rely on them. In the Arctic, where the effects of climate change are most apparent, those threats are of particular concern. In Sweden, reindeer husbandry is an example of a pastoral system that is facing threats related to climate change and competition for resources with other land uses. Those threats are deteriorating the conditions of winter pastures. Indeed, 70 % of the best winter reindeer pastures has been lost in the last sixty years. However, despite that loss the average number of reindeer in the system has not declined. In our study, we investigate the factors that have contributed to this apparent paradox and evaluate if the measures taken by the herders to face those threats have the potential to be long-term solutions.

Marius Næss

Norwegian Institute for Cultural Heritage Research, Norway

COOPERATION AND PASTORAL RISK MANAGEMENT – REINDEER HERDING IN A CHANGING CLIMATE

Cooperation is an integral part of nomadic pastoralism. Reindeer herders in Norway are, for example, organized in groups, called *siida*, that share the workload in connection with herding and other reindeer related work. Globally, the cooperative nature of herding is changing due to privatisation programs changing land tenure systems from commons to smaller and privatised grazing areas. In light of climate change, this represent a significant challenge because reindeer herders with large cooperative networks utilize traditional risk management strategies, such as herd accumulation when facing environmental unpredictability, more efficiently than those with smaller networks.

ABSTRACTS – poster presentations

IN ORDER OF APPEARENCE

1. Torill Mørk	A CASE OF SHEEP-ASSOCIATED MALIGNANT CATARRHAL FEVER IN SEMI-DOMESTICATED REINDEER (*RANGIFER TARANDUS TARANDUS*)

Norwegian Veterinary Institute, Norway

Co-authors: Blomstrand BM, Romano JS, Nymo IH, Britt Gjerset B, and Tryland M

Malignant catarrhal fever (MCV) is a severe infectious disease in both domestic and wild ungulate species. The disease usually appears sporadically and is caused by cross-species infection with ruminant gammaherpesviruses. Ovine herpesvirus 2 (OvHV-2), causing sheep-associated MCV, has a world-wide distribution. Alcelaphine herpesvirus (A1HV-1) is present in Africa and caprine herpesvirus 2 (CpHv2) has more recently been found to cause MCF in certain wild ruminants. These viruses cause a latent, non-clinical infection in sheep, wild boars and goats but may, when transmitted to other ungulates, lead to fatal lymphoproliferative disease.

In Norway, MCV has been reported in cattle and pigs, as well as in wild ruminants, such as moose (*Alces alces*), roe deer (*Capreolus capreolus*) and red deer (*Cervus elaphus*). Screenings of semi-domesticated reindeer from Norway, Sweden and Finland has shown a prevalence of 3,5 – 3,8 %. Studies of DNA-sequences from the virus indicated that reindeer has its own gammaherpesvirus.

In June 2016, a reindeer suffering from reduced vision and ocular discharge was euthanized and delivered for autopsy at the Veterinary institute in Tromsø. The macroscopic findings were corneal opacity, oedema of eyelids, and fibrinopurulent conjunctivitis, as well as hairloss and crusts on the skin on the muzzle, in the axillae and distally on all four legs. The carcass was lean but not emaciated. The superficial lymph nodes and the spleen were swollen. In the kidneys there were multifocal pale foci in the kidney cortex. Histological examination showed perivascular accumulation of mononuclear cells in the dermis, interstitially in the kidney cortex and in the portal triads in the liver. In the brain there were mononuclear cuffing and fibrinoid necrosis of the wall of arterioles.

Brain tissue, blood and swab samples from the conjunctiva of both eyes, nose and tonsils were examined by PCR for gammaherpesvirus. OvHV-2 was detected by PCR in brain tissue and in swab samples from the nose and tonsills.

This is to our knowledge, the first documented case of MCF in a reindeer under normal reindeer husbandry conditions.

2. Ilma Tapio	COMPARISON OF DIGESTION PHYSIOLOGY BETWEEN REINDEER AND DAIRY COWS

Natural Resources Institute, Finland

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Comparison of digestion physiology between reindeer and dairy cows was carried out as part of RuminOmics project funded from the EU's 7th Framework Programme. The study involved five female reindeer (body weight 77 kg, SD 3.6) purchased from Ranua municipality (65°55′45″N, 026°31′00″E) and five non-lactating multiparous Nordic Red dairy cows (body weight 721 kg, SD 101). To facilitate access to the rumen, animals were fistulated. The reindeer were equipped with small (7.5 cm) and cows with large (10 cm) rumen cannulas. The experimental diet consisted of grass silage and commercial concentrate mixture formulated for reindeer. The feeding level was adjusted to provide nutrients slightly in excess (1.05) of predicted daily energy requirements. The diet crude protein concentration was 134 g/kg dry matter. There were no differences between ruminant species in total tract digestibility of dry matter, organic matter or neutral detergent fiber. However, a clear difference in N metabolism was observed. Reindeer voided proportionally less N in urine (0.58 vs. 0.67 of total N excretion) but more in feces (0.42 vs. 0.33), which resulted in lower apparent N digestibility for the reindeer than cows (0.64 vs. 0.70). Rumen fermentation pattern was also different between species. Molar proportion (mmol/mol) of acetate was higher (769 vs 676), whereas that of propionate (133 vs. 165), butyrate (61 vs. 103) and other volatile fatty acids was lower for the reindeer than cows. There were no differences in rumen ammonia N concentration between species. At the end of the study animals were slaughtered and the contents of the digestive tract were emptied. Distribution of potentially digestible neutral detergent fiber (pdNDF) between different segments within the digestive tract was

different between species. Reindeer retained smaller proportion of pdNDF in the forestomach (0.85 vs. 0.89 of total tract pdNDF). This difference was mainly due to the smaller proportion of pdNDF retained in the omasum in the reindeer than cows (0.01 vs. 0.08). These differences were compensated for by the higher proportions of cecum and colon in reindeer (0.10 vs 0.06). In conclusion, lack of differences in diet digestibility indicates that similar feed table values could be used for both species.

3. Svein Morten Eilertsen	INFORMATION FOLDER ABOUT SUPPLEMENTARY FEEDING OF REINDEER IN NORTHERN-NORWAY
Norwegian Institute of Bioeconomy Research, Norway	Due to unstable winter conditions and high losses of reindeer to predators, many reindeer herding districts in Northern-Norway have started supplementary feeding of the reindeer during whole or part of the winter period. Various types of supplementary feed are available, but there is lack of knowledge/experience among some districts about which quality claim they should demand of the food. Therefore NIBIO (Norwegian Institute of Bioeconomy) have produced an information folder based on user based knowledge from reindeer districts which have evolved experience in supplementary feeding of reindeer for years. I addition, research based knowledge about important quality parameters for the supplementary food for reindeer is referred in the information folder. The folder is written in Norwegian and Saami language. The information folder focuses on the importance of starting supplementary feeding before the reindeer start starving and loose body condition. There are advices on how to use lichen in decreasing amount during the period while the reindeer are adapted to the supplementary feed. The different types of supplementary food are presented. Advantages and disadvantages with the different food items are discussed. For instance, commercially produced reindeer food is of high quality, it is easy to feed out in the herd due to its low water content, but is expensive in use. One important issue in this folder is recommendations on harvest time and quality parameters on grass stored in big bales. If first cut grass harvest from Northern-Norway is used as supplementary food for reindeer, the grass has to be harvested at an early stage at heading of timothy. Grass from second harvest with high amount of leaves is preferred as supplementary food. However, the grass must be pre dried before baled, and dry matter content should exceed 25 %. If dry matter exceeds 40 %, ensiling additives special produced to avoid build-up of fungi must be used. All grass harvested in big bales for supplementary food for reindeer should contain ensiling additives in order to preserve the energy content (water soluble carbohydrates) and the palatability in addition to secure a satisfactory fermentation processes (avoid butyric acid, and other products of low palatability). The folder also includes examples on technical solutions on how to reduce hard labor work connected with feeding baled grass to the reindeer.

4. Kjell Bolmgren	HOW DOES CLIMATE CHANGE AFFECT THE TIMING OF VEGETATION, SNOW AND REINDEER REPRODUCTION?
Swedish University of Agricultural Sciences, Sweden	One of the most obvious effects of climate change is that the biological growing season is changing. However, the start and the end of the growing season as well as different species, phases and events may change in different ways. Thus, we need to consider and learn about these changes, what effects they may have and potentially adjust management to secure long-term sustainable and productive ecosystem services. In reindeer management, this may involve different changes in the timing of snow melt, timing for migration, birch leaf-flush and leaf-fall, gestation period and calving. Nature's calendar (www.naturenskalender.se) is a citizen science network collecting and providing data on seasonal change for any management and ecosystem where we find partners to collaborate with. We are now looking for collaboration on phenology in the mountain and arctic regions and welcome all of you who find these questions relevant to come and discuss with us.

5. Anna Skarin	RENEWABLE ENERGY - AN ADDED EFFECT IN THE REINDEER HUSBANDRY LANDSCAPE
Swedish University of Agricultural Sciences, Sweden Co-authors: Sandström P, Alam M	In the subarctic boreal forest in Fennoscandia there is a massive increase in the planning and construction of wind farms. These ranges represent an important grazing resource for reindeer (*Rangifer tarandus tarandus*) within the Sámi reindeer husbandry system. Thus, increased knowledge of the direct and cumulative impacts is critical in order to mitigate those impacts from work already in the planning phase. Reindeer habitat use in relation to wind farms was studied in a calving range in Malå reindeer herding community, around Storliden and Jokkmokksliden wind farms, and in two different winter grazing areas in Vilhelmina Norra herding community, around Stor-Rotliden and Gabrielsberget wind farms. Reindeer habitat use was assessed with GPS-collars. Data were collected before and during construction phase and during operational phase. We estimated reindeer habitat selection by developing resource selection function models for each area in relation to two of the wind farm areas before, during and after construction. In addition, reindeer use was assessed around Gabrielsberget area when 1) the wind farm was turned off for 40 days, 2) during operation when the reindeer were supplementary fed, and 3) during operation without supplementary feeding. Our results showed that the reindeer in Malå and around Gabrielsberget decreased their use of areas close to the wind farms or avoided grazing in areas where they could see and/or hear the wind turbines and preferred to use areas where the wind turbines were topographically sheltered. In Malå, the reindeer increased the use by 50% of areas topographically sheltered. In winter, around Gabrielsberget wind farm with no supplementary feeding, reindeer largely avoided a 3 km zone. Around, Stor-Rotliden where reindeer main grazing range already before establishment was out sight from the wind farm, the effects were less severe, although the reindeer herders experienced a shift in reindeer habitat use around the wind farm.

6. Svein Morten Eilertsen	CUMULATIVE EFFECTS OF HUMAN ACTIVITIES AND INFRASTRUCTURE ON REINDEER AND REINDEER HUSBANDRY – PRELIMINARY RESULTS FOR POWER LINES
Norwegian University of Life Sciences and Norwegian Institute of Bioeconomy Research, Norway First author: Eftestøl S Co-authors: Tsegaye D, Eilertsen SM, Flydal K, Lifjell T, and Colman JE	In cooperation with Ildgruben reindeer herding district in Nordland county, we are investigating how cumulative and progressively increasing amounts of human activities and infrastructure influence reindeer behavior and area use, as well as the herding activities such as choice of grazing lands, migration routes and potential gathering locations. Using GPS-data spanning from 2011, modeled together with other variables in GIS, and information of the herdsmen's herding activities, we tested the effect of a 420 kV power line crossing three separate mountain ridges. The area use on the three ridges varied, with one ridge in general having less use nearby and/or on the western side of the power line, while the area use seemingly did not depend on distance to the power line on the two other ridges. There was no difference in reindeer area use between nighttime and daytime for any of the ridges. The area use on all three ridges also differed between years, even within the same seasons, underlining the importance of replication in both time and space. Are the effects for the power line crossing this one ridge real, and if so, are they caused by topography, herding practices, varying UV-discharge or cumulative effects? Our results support other studies showing overall limited or no negative effects for reindeer area use and movement patterns towards high voltage power lines when studied over a time period of more than 4-5 years. However, our results also show that there are situations where there will be less use near power lines. Further analyses, which also include other variables, will help us understand these patterns better.

7. Ingrid Johnsen and Anna Berlina	WHAT ARE THE FUTURE TOPICS IN REINDEER HUSBANDRY RESEARCH?
Nordregio, Sweden	This report summarises and categorises existing studies completed within the last 10 years with a focus on socioeconomic aspects of reindeer husbandry. Based on the literature overview, the report will provide a platform for proposals for further research, which may be carried out within the framework of The Nordic Joint Committee for Agricultural and Food Research (NKJ).

The literature overview covers research in English, Norwegian, Swedish, Finnish and Sami languages concerned with reindeer husbandry in Norway, Sweden and Finland. The focus is placed on socioeconomic aspects of reindeer husbandry, including related traditional Sami handicrafts production (e.g. food, tourism, media and design). Socioeconomic implications from climate change are also identified as part of the literature overview. Other themes in the overview include institutional frameworks and the role of subsidy schemes.

Our literature review shows that while numerous studies have been conducted on socioeconomic aspects of reindeer husbandry within the three Nordic countries, there are few studies that provide a joint Nordic perspective, and, hence, there is a potential for comparative research across the Nordic region on this topic.

We invite participants to join us for a discussion and brainstorming about the future topics of reindeer husbandry research!

8. Anna Krutikova	CANDIDATE GENES FOR MEAT PRODUCTIVITY TRAITS IN REINDEER
Russian Research Institute of Farm Animal Genetics and Breeding, Russia Co-authors: Dementeva N, Churkina I, Mitrofanova O	The marker-assisted selection (MAS), based on use of molecular genetic markers, is a promising direction for improving the productive traits of reindeer. The markers can be of various types in terms of genetic polymorphism: microsatellites, INDEL, SNPs. For reindeer breeding, genes influencing the formation of muscle mass in animals (myostatin *MSTN*, calpain *CAPN,* growth hormone *GH*, calastatin *CAST* and stearoyl-CoA-desaturase *SCD*) are perspective candidates. Myostatin (MSTN) belongs to the family of transforming growth factors (TGF β), is a negative regulator, and slows down the growth and development of muscle tissue in higher vertebrates. Calpain (*CAPN*) - has a significant effect on the growth of muscle tissue and the quality of meat. Growth hormone (GH) is an anabolic hormone that stimulates the synthesis of protein in the body and inhibits its breakdown, positively influences the formation of muscle mass, regulates the metabolism of carbohydrates, and helps in reducing subcutaneous fat deposits. We sequenced a 422 bp fragment containing exons 2 and 3 of the GH of reindeer, two perspective SNPs (G140A and A253G) were identified. Enzyme stearoyl-CoA-desaturase (SCD) - a factor in the metabolism of lipids, affects the increase in live weight and the quality of meat. Deficiency of SCD leads to a impairing of thermoregulation and resistance to low temperatures. Sequencing of 163 bp fragment of the gene *SCD* in reindeer did not reveal any variants of genetic polymorphism. Perhaps this is due to the high degree of conservatism of the gene involved in the vital process of thermoregulation for the inhabitants of the Far North. Mutations in this gene could have negative consequences for animals and therefore were removed from the population by natural selection. However, the amount of the sequenced samples was small (n = 10), and the fragment itself was very short, therefore it is necessary to continue researching the *SCD* gene as a promising one. Kalpastatin (CAST) is a specific inhibitor of calcium dependent proteolytic enzymes, it monitors the entire enzyme system of the body, affects the quality of meat production, affects the tenderness of meat and increases the speed of gaining of live weight. We sequenced 636 bp fragment of the gene *CAST* of reindeer and identified an INDEL mutation. Currently, these studies are still on-going.

9. Heini Riipi	PEDIGREE INFORMATION IS ESSENTIAL FOR SELECTION IN REINDEER
University of Helsinki, Finland Co-authors: Muuttoranta K, Pietarinen J, and Mäki-Tanila A	Profitability of reindeer husbandry is gradually declining. Selection of breeding animals is a sustainable way to improve profitability as it results in permanent changes in animals' performance. Reindeer herders are using (empirical) selection which could be strengthened by systematic book keeping on animals' pedigree and performance. Thereby we have information for understanding the genetic variation of important traits and for constructing tools to detect genetically superior animals for growth, survival, maternal care and other traits affecting animals' biology and production quality and profitability. The outcome of selection depends on the number of animals with pedigree and performance records. We used pedigree and multi-trait selection indices to different recording schemes and family information. The analytical tools were extended to cover

pedigree information across generation and thereby we were able to proxy the consequences of the use of BLUP type methodology in genetic comparison of selection candidates. These compact tools allowed studying a whole range of cases with differing amount of genetic variation (heritability, h^2) and relationship (genetic correlation) between traits and the number of (half-sib type) offspring per dam and of dams per sire with single and two-trait situations. The results were calculated by R program.

We assume that a dam had a life time crop of 2-5 calves while a sire could be mated to 5-30 dams. Pedigree information will markedly improve the efficiency of selection. Benefits from the identification of the calves' dams and sires were highest for low-heritability traits. Compared to selection based solely on (calf) individuals' own performance, adding information on the identities of calves' dams and using pedigree based selection the efficiency gains (depending on the number of progeny) were 3-20 % for h^2=0.05 and 2-10% for h^2=0.2. Adding sire information, the efficiency gain was with low h^2 even 38 % and 16 % with high h^2. When the pedigree information was accrued across generations (BLUP selection), the gains with the female-side pedigree information were 16-34% with low h^2 (10-17% with high h^2) while the efficiency was doubled (1.5 fold) when also sires were known. The use of information on correlated traits had rather modest benefits. In conclusion, the highest priority is to develop methods to assign sires for the reindeer calves. Such tools could be constructed by resorting to genomic information. The bed rock of a selection programme is the phenotype recording on individuals.

10. Marie-Pier Poulin	A MORPHOMETRIC AND PHYSIOLOGICAL ANALYSIS OF EPIDIDYMAL SEMEN OF THE MIGRATORY CARIBOU FROM RIVIÈRE-AUX-FEUILLES IN NORTHERN QUEBEC, CANADA
Université Laval, Canada Co-authors: Guillemette C, Castonguay F, and Richard FJ	For several years, the populations of woodland caribou (*Rangifer tarandus caribou*) are constantly decreasing in the province of Québec, Canada. The isolated herds located in three specific regions are currently threatened with extinction. In addition to the established protective areas developed by the provincial government, other conservation strategies should be considered for the survival of these small herds, such as artificial insemination. However, in this ungulate species, the research effort in evaluating the semen quality and the cryopreservation strategies is minimal. The objective of this project is to carry out morphometric and physiological analyses of epididymal semen derived from a migratory wild woodland caribou subspecies. 29 pairs of testes of the migratory caribou from Rivière-aux-Feuilles in northern Quebec, Canada, were collected during the autumn hunting season and were stored at 4°C for less than 50 h before being analyzed. The epididymal spermatozoa were collected, washed and incubated in Sp-Talp at room temperature. The spermatozoa viability was measured by eosin-nigrosine differential staining. The fertilizing capacity of spermatozoa was assessed in presence of heparin (12 μg/ml). The testes weights oscillate between 20.0 g and 50.0 g. The sperm count ranged from 0 to 850 million with an average of 296.7 ± 245.8 million. No relationship has been established between testes weight and epididymal sperm count. The morphometric analyses have shown that at 0 h, 38.3 % of spermatozoa had an intact acrosome, a straight flagellum with a symmetric insertion and owned a cytoplasmic droplet, while 16.7 % had a deformed acrosome. Interestingly, more than 80 % of spermatozoa still had a cytoplasmic droplet. Before the incubation, 87 % of spermatozoa were alive and after 4 ± 2 h of incubation, 73 % of spermatozoa were still alive. Total motility analysis has revealed that after 3.6 h of incubation, 47.5 % of spermatozoa were still motile. This motility was transitory. In addition, in the presence of heparin an increase in total motility of 42.5 % was observed after 15 minutes of incubation suggesting that epididymal spermatozoa have acquired a certain level of maturity. In conclusion, our study draws a first outline on the viability, motility, morphology and maturity of epididymal semen from Canadian migratory caribou.

11. Anna Baranova	THE SIMILARITIES AND DIFFERENCES IN THE GENE POOLS OF DOMESTIC AND WILD REINDEER

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Co-authors: Kholodova M, and Severtsov AN

Reindeer (*Rangifer tarandus*) is the only species among recent ruminants that simultaneously have wild and domesticated forms occupying one ecological niche. During the artificial selection, the domestic reindeer acquired a number of features, including genetic ones.

However, the lack of territorial and reproductive isolation can lead to mixing of gene pools of wild and domesticated forms of the reindeer. The similarities and differences in the gene pools of domestic and wild reindeer we analyzed comparing mtDNA control region sequences (389 bp) of 454 wild and 155 domestic reindeer from a number of regional groupings inhabiting the territory of Russia. We also conducted an analysis of the variability of reindeer (more than 200 samples) in 16 microsatellite loci. We used for analysis samples of wild reindeer from the regions: Arkhangelsk region (including Novaya Zemlya Island), Komi Republic, Krasnoyarsk Territory (Taimyr Peninsula and central part), Kemerovo Region and Khakassia (reserve "Kuznetsk Alatau"), Yakutia, Chukotka, Kamchatka Peninsula. Samples of domestic reindeer were obtained from Murmansk region, Komi Republic, Nenets Autonomous District (Kolguev Island), Yamalo-Nenets Autonomous District, Yakutia, Chukotka (including Wrangel Island) and Kamchatka Peninsula.

A total of 197 haplotypes of the mtDNA control region were identified. Of these, 21 were described only for domestic, 105 only for wild, and 13 were common to wild and domestic reindeer. The rate of common haplotypes between wild and domestic was < 10%. It is noted that haplotypes common to wild and domestic reindeer include sequences from different parts of the range, including from regions that are far from each other geographically. Most haplotypes of wild reindeer mostly combine sequences obtained for animals from one or from neighboring regions.

Analysis of the variability of reindeer at microsatellite loci showed a clear separation of reindeer from the mainland part of the Eurasian area and the Arctic islands, as well as isolation into a separate group of domestic reindeer.

12. Stefan Kirchner	CONTAMINATION OF REINDEER FORAGE DUE TO WATER POLLUTION: HEALTH EFFECTS AND CROSS-BORDER COMPENSATION/LITIGATION STRATEGIES

University of Lapland, Finland

In Northern Europe, the long-term effects of the 1986 nuclear accident in Chernobyl are still felt. One example was the large-scale growth (and subsequent consumption by *Rangifer tarandus*) of the mushroom *Cortinarius caperatus* in 2014. This kind of mushroom takes up radioactive cesium-137 fairly easily. Cesium-137 has a half-life of just over thirty years. Hence half the original radioactivity levels caused by the Chernobyl incident is still present. In 1990, the problem has already been dealt with scientifically in a special issue of the journal Rangifer. Today, many other forms of environmental pollution threaten the health of reindeer through the contamination of forage. What many of these threats have in common is that the contaminants, just like cesium-137, are transmitted through water. This is a major issue for example for the mining industry, which plays an important economic role in Northern Sweden, where it competes directly for land with reindeer herding. While the Nordic countries have provided some compensation for reindeer herders, the economic importance of activities such as mining and limited government finances can make it necessary for reindeer herders to go to court in order to obtain compensation. This can be particularly difficult if the damage has been caused across on the other side of an international border. Combining practical experiences in international litigation with academic research in Indigenous Rights Law and Arctic Law, it is the aim of this presentation to show ways for reindeer herders to obtain compensation for economic and cultural damages suffered because of the effects of water-borne contamination on the health of reindeer.

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