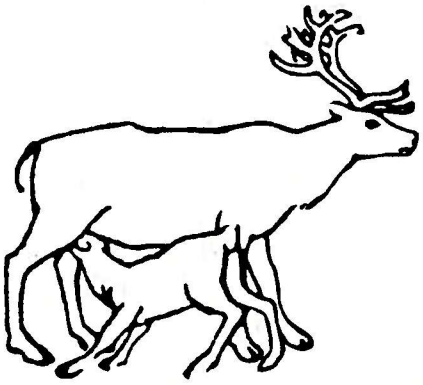
11th Arctic Ungulate Conference, Saariselkä, Finland, 24-28 August 2003

PROGRAMME AND ABSTRACTS



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Nordic Council for Reindeer Husbandry Research (NOR) was founded in 1980 to promoting cooperation in research on reindeer and reindeer husbandry. From 1993 the organisation is under the auspices of the Nordic Council of Ministers (the Ministers of Agriculture). The work of NOR depends on funds from the member governments (Finland, Norway and Sweden).
Nordisk Organ for Reindriftsforskning (NOR)/Pohjoismainen Poronhoidontutkimuselin (NOR) ble etablert i 1980 og har vedtekter vedtatt av Nordisk Ministerråd i 2003. Organet er et samarbeidsorgan mellom Finland, Norge og Sverige med formål å fremme utvikling og samordning av rein- og reindriftsforskningen til nytte for reindriftsnæringen i de nordiske land. Virksomheten finansieres ved direkte bidrag fra deltakerlandene.

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PROGRAMME
AND
ABSTRACTS

11th Arctic Ungulate Conference
Saariselkä, Finland
August 24 - 28, 2003

Editor: Rolf Egil Haugerud

Nordic Council for Reindeer Husbandry Research (NOR), Tromsø 2003

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Background

The 11th Arctic Ungulate Conference (AUC) continues a series of ten conferences devoted to Arctic Ungulates, including five International Reindeer/Caribou Symposia, two International Muskox Symposia and three Arctic Ungulate Conferences. The series began with the First International Reindeer/Caribou Symposium, held in Fairbanks, Alaska, in 1972. The Third International Reindeer/Caribou Symposium was in Saariselkä, Finland, in 1982. First Arctic Ungulate Conference was arranged in Nuuk, Greenland, in 1991, and 2nd in Fairbanks, in 1995. The 10th AUC was held in Tromsø, Norway, in 1999. When returning to Saariselkä, we decided to call our meeting the "11th Arctic Ungulate Conference" to emphasise the tradition and continuity of this series. The Conference's relaxing and friendly atmosphere provides an excellent opportunity to hear the latest developments in various fields of Arctic Ungulates, to share research experience and expertise, and to develop new and closer contacts with colleagues from different countries.

Logo

The logo for this conference was designed by Mauri Nieminen, the research scientist and artist. Its aim is to illustrate the importance of reindeer herding in the scenic Saariselkä area as well as in northern Finland.

Scientific programme

The 11th Arctic Ungulate Conference (AUC) will emphasise all aspects of the management and biology of arctic ungulates, especially reindeer/caribou and muskoxen, and also disciplines traditionally not so well represented in this series of conferences, including animal health and welfare, predation, history and multiple land use, management and marketing, and hunting and reindeer husbandry. We have invited keynote speakers, most of whom do normally work with arctic ungulates. In addition to keynote lectures there will be short oral lectures and poster presentations in different sessions. There are no parallel sessions.

Publication plans

Abstracts will be published in a **Rangifer Report** issued when the Conference opens (this issue). Conference keynote presentations will be published in a **Rangifer Special Issue** after the Conference and articles of participants' oral and poster presentations will be published according to the publication principal of **Rangifer**, included either in ordinary issues, collected in separate ordinary issues or in a special issue. Manuscripts should be completed for the closing of the Conference, or shortly thereafter.

Programme

All sessions will be held in Tunturihotelli. Authors are requested to attend their poster(s) during the official poster session in which their poster(s) are included.

Registration:	Sunday 24th August:	15.00-18.00	in Tunturihotelli
Registration:	Monday 25th August:	08.00-10.00	in Tunturihotelli

Sunday 24th August

15.00-18.00 REGISTRATION in Tunturihotelli, continuing on Monday 25th 08.00-10.00
18.00-21.00 Welcoming reception in Tunturihotelli

Monday 25th August

08.30-09.00 Welcoming addresses (in Auditorium)
Governor Hannele Pokka, State Provincial Office of Lapland
Professor Eero Helle, Chairman of Organizing Committee

Session 1: Range Ecology & Socioeconomy
Chairmen: Eldar Gaare, Norway and Jouko Kumpula, Finland
Keynote speaker

09.00-09.45 Lauri Oksanen, Sweden: *The impact of reindeer grazing on rare arctic-alpine plants in Fennoscandia* (J. Olofsson & L. Oksanen, p. 17)

Oral presentations

09.45-10.05 Otso Suominen, Finland: *The relative importance of disturbance and herbivory by reindeer and microtine rodents for germination and seedling survival of four forest line tree species in Fennoscandia* (O. Suominen, P. Hulme, L. Oksanen & J. Olofsson, p. 18)

10.05-10.25 Anna Skarin, Sweden: *Impacts of topography, weather and tourist trails on reindeer habitat use* (A. Skarin, Ö. Danell & J. Moen, p. 19)

10.25-10.45 Micheline Manseau, Canada: *Critical habitat for woodland caribou: a multi-scale approach* (M. Manseau, A. Fall, D. O'Brien & M.-J. Fortin, p. 19)

10.45-11.15 **Coffee break**

Session 1: Range Ecology & **Socioeconomy**
Chairmen: Jan Åge Riseth, Norway and Berit Inga, Sweden
Keynote speaker

11.15-12.00 Bård A. Berg, Norway: *Effects of different reindeer-management laws on the development of Sami reindeer herding in Norway, Sweden, Finland and Russia* (p. 17)

Oral presentations

12.00-12.20 Jan Åge Riseth, Norway: *Reindeer management in Fennoscandia as a tool for biodiversity in a European policy context. Landscape development, biodiversity and co-operative livestock systems in Europe (LACOPE)* (J. Å. Riseth, G. R. Karlsen & B. Ulvevadet, p. 20)

12.20-12.40 Benjamin Burkhard, Germany: *Systems analysis and modelling of reindeer husbandry in northern Finland* (B. Burkhard & F. Müller, p. 20)

12.40-13.00 Birgitte Ulvevadet, Norway: *Analysis of the different processes having an effect on co-operative livestock system in northern Fennoscandia* (B. Ulvevadet, J. Å. Riseth & G. R. Karlsen, p. 20)

13.00-14.00 **Lunch**

Session 2: Population dynamics & management
Chairmen: Pjotor Danilov, Russia and Michael A. D. Ferguson, Canada
Key note speaker

14.00-14.45 Eigil Reimers, Norway: *Reindeer and caribou (*Rangifer*) - tolerance limits to habitat fragmentation and anthropogenic activities* (p. 33)

Oral presentations

14.45-15.05 David R. Klein, USA: *Arctic ungulates in a changing Arctic: Ecological responses and management needs* (p. 33)

15.05-15.25 Jérôme Théau, Canada: *Spatio-temporal mapping of lichen habitats using Landsat imagery: A tool for caribou herd management in northern Québec, Canada* (J. Théau & C. R. Duguay, p. 34)

15.25-16.05 Michael A. D. Ferguson, Nunavut, Canada: *Detection of recovery of populations of endangered Peary caribou and muskoxen, using distance sampling and skills of Inuit hunters* (M. A. D. Ferguson & the Resolute Bay Hunters and Trappers Organization, p. 34)

16.05-16.25 Robert B. Weladji, Norway: *Climatic influences on the life history and population dynamics of a northern ungulate,* Rangifer tarandus (p. 35)

16.30-19.00 **Coffee break, Poster presentations** (in Tunturihotelli)

Session 1	(Posters 1-23, 90):	Range Ecology & Socioeconomy	(pp. 9 and 21)
Session 2	(Posters 24-37):	Population dynamics & management	(pp. 10 and 35)
Session 3	(Posters 38-40):	Behaviour, genetics & evolution	(pp. 11 and 45)
Session 4	(Posters 41-57):	Nutrition, physiology & body condition	(pp. 12 and 50)

19.30-21.00 **Evening programme**
Director Sakari Kankaanpää: *Urho Kekkonen National Park*
Chief Viljo Huru and Director Jouko Parviainen: *Reindeer husbandry and tourism in Saariselkä area*

Tuesday 26th August

08.45-09.00 Information (in Auditorium)

Session 3: Behaviour, genetics & evolution
Chairmen: Jonathan E. Colman, Norway and Harri Norberg, Finland
Keynote speaker

09.00-09.45 Knut Røed, Norway: *Refugial origin and post-glacial re-colonization of holarctic reindeer and caribou* (p. 43)

Oral presentations

09.45-10.05 Anna Nilsson, Sweden: *Behaviour of reindeer as an indicator of adaptation to feeding* (A. Nilsson, H. Norberg, I. Redbo, K. Olsson & B. Åhman, p. 43)

10.05-10.25 Jonathan E. Colman, Norway: *Reindeer 24-hr within and between group synchronicity versus environmental variables* (J. E. Colman, R. Eidesen, D. Hjermann, M. A. Gaup, Ø. Holand, S. R. Moe & E. Reimers, p. 44)

10.25-10.45 Eigil Reimers, Norway: *Effects of wind turbines on area use and behaviour of semi-domestic reindeer* Rangifer tarandus *in enclosures* (K. Flydal, S. Eftestøl, E. Reimers & J. E. Colman, p. 44)

10.45-11.15 **Coffee break**

Session 4: Nutrition, physiology & body condition
Chairmen: Arnoldus Schytte Blix, Norway and Päivi Soppela, Finland
Keynote speaker

11.15-12.00 A. Reeta Pösö, Finland: *Seasonal changes in reindeer physiology* (p. 47)

Oral presentations

12.00-12.20 Arnoldus S. Blix, Norway: *How reindeer keep cool* (A. S. Blix, L. Walloe & L. P. Folkow, p. 48)

12.20-12.40 Hannele Säkkinen, Finland: *Assessment of ovarian function of reindeer by ultrasonography* (H. Säkkinen, S. Vahtiala, H. Lindeberg, S. M. Aalto & E. Ropstad, p. 48)

12.40-13.00 Monica A. Sundset, Norway: *Rumen bacterial diversity in two different sub-species of reindeer determined by sequence analysis of 16S rDNA libraries* (M. A. Sundset, I. K. O. Cann, S. D. Mathiesen & R. I. Mackie, p. 49)

13.00-14.00 **Lunch**

Session 4: Nutrition, physiology & **Body condition**
Chairmen: Jouni Timisjärvi, Finland and Hannele Säkkinen, Finland
Keynote speaker
14.00-14.45 Robert G. White, USA: *Allometry and variability in body composition in relation to population productivity in arctic ungulates* (R. G. White & D. E. Russell, p. 47)
Oral presentations
14.45-15.05 Eva Wiklund, Sweden: *Connection between physical condition of the animals and meat quality in reindeer (*Rangifer tarandus tarandus*) and red deer (*Cervus elaphus*)* (p. 49)
15.05-15.25 Teresa A. Renecker, Canada: *Comparative sensory analysis of North American reindeer, musk-oxen, caribou, and wapiti meat* (T. A. Renecker, A. L. Schaefer, L. Jerimiah, L. A. Renecker & F. F. Mallory, p. 50)

Session 5: Veterinary medicine, diseases & parasites
Chairmen: Kjetil Åsbakk, Norway and Antti Oksanen, Finland
Keynote speaker
15.30-16.15 Peter J. Waller, Sweden: *Domestication of ruminant livestock and the impact of nematode parasites: possible consequences for the reindeer industry* (p. 59)

16.15-16.45 **Coffee break**

Oral presentations
16.45-17.05 Toomas Orro, Finland: *Time-related changes in concentrations of acute-phase proteins in newborn reindeer calves* (T. Orro, M. Nieminen, T. Tamminen, A. Sukura, S. Sankari & T. Soveri, p. 59)
17.05-17.25 Susan Kutz, Canada: *The role of gastrointestinal parasitism in muskox population dynamics* (S. Kutz, J. Nagy, B. Elkin, E. Hoberg, L. Gasbarre, A. Veitch & L. Polley, p. 60)
17.25-17.45 Jackie T. Hrabok, Sweden: *Macroparasites of reindeer in Fennoscandia: parasite population dynamics, control options, and environmental impact implications* (J. T. Hrabok, P. Waller, M. Nieminen, A. Oksanen, & O. Halvorsen, p. 60)

17.45-19.00 **Coffee break, Poster presentations** (in Tunturihotelli)

Session 5	(Posters 58-73): Veterinary medicine, diseases & parasites	(pp. 13 and 61)
Session 6	(Posters 74-87): Reindeer husbandry	(pp. 14 and 72)
Session 7	(Posters 88-89): Utilization & predation	(pp. 15 and 80)

19.30-21.00 **Panel discussion:**
Arctic ungulates and global changes
Chairman: Alfred Colpaert, Finland
In panel: Michael Ferguson, Canada; Timo Helle, Finland; Christine Cuyler, Greenland; Robert Weladji, Norway; Leonid Baskin, Russia; Lauri Oksanen, Sweden & David Klein, USA

Wednesday 27th August

08.45-09.00 Information (in Auditorium)

Session 6: Reindeer husbandry
Chairmen: Birgitta Åhman, Sweden and Veikko Maijala, Finland
Keynote speakers
09.00-09.45 Leonid Baskin, Russia: Populations of wild and domestic reindeer in Russia: status and trends (p. 69)
09.45-10.30 Jouni Filppa, Finland: *Reindeer husbandry in Finland* (p. 69)
10.30-11.15 Öje Danell, Sweden: *Research challenges within Fennoscandian reindeer husbandry* (p. 70)

11.15-11.40 **Coffee break**

Oral presentation

11.40-12.00 Greg L. Finstad, USA: *Satellites, the internet and safe areas, the current status of reindeer herding on the Seward Peninsula, Alaska* (G. L. Finstad, H. Oleson & D. Blodgett, p. 70)

12.00-13.00 **Lunch**

13.00-18.30 **Guided tours:**
Sami Museum, Siida, Inari
Reindeer Research Station of Finnish Game and Fisheries Research Institute (FGFRI)

20.00-22.0 **Conference Banquet** in Tunturihotelli
Hosted by Director General Kare Turtiainen (FGFRI)

Thursday 28th August

08.45-09.00 Information (in Auditorium)

Session 6: Reindeer husbandry
Chairmen: Birgitta Åhman, Sweden and Veikko Maijala, Finland
Oral presentations

09.00-09.20 Timo Helle, Finland: *Population trend synchrony of semi-domesticated reindeer in northern Fennoscandia* (T. Helle & I. Kojola, p. 71)

09.20-09.40 Lars Rönnegård, Sweden: *Selection and effective population size in reindeer* (L. Rönnegård, J. A. Woolliams & Ö. Danell, p. 71)

Session 7: Utilization & predation
Chairmen: Ilpo Kojola, Finland and Anna-Liisa Sippola, Finland
Keynote speaker

09.45-11.00 Stan Boutin, Canada: *The role of predation in population dynamics of arctic ungulates* (p. 79)

11.00-11.30 **Coffee break**

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Oral presentations

11.30-11.50 Iipo Kojola, Finland: *Wolf predation on European wild forest-reindeer in east-central Finland* (I. Kojola, K. Toppinen, O. Huttu, S. Heikkinen, K. Heikura & S. Ronkainen, p. 79)

11.50-12.10 Harri Norberg, Finland: *Mortality of reindeer calves in Finland: Role of predation in five regions* (H. Norberg, M. Nieminen, I. Kojola, V. Maijala & J. Kumpula, p. 79)

12.10-12.30 Anna-Liisa Sippola, Finland: *Attitudes of reindeer owners towards large predators: Is there room for co-existence?* (A.-L. Sippola & K. Suopajärvi, p. 80)

12.30-13.00 **Closing addresses**: Dr. Mauri Nieminen

13.00-14.00 **Lunch**

14.00-18.00 **CAES-workshop**

Friday 29th August

09.00-13.00 **CAES-workshop**

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CAES-WORKSHOP: The CAES is intended primarily for CAES students.

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Session 1: Range Ecology & Socioeconomy

1. *Grazing Facilitation or Delayed Competition Between Reindeer and Sheep? A Multi-disciplinary Research Project for Optimal Dual-species Management*

   J. E. Colman, S. R. Moe, D. T. Elgvin, Ø. Holand, A. Jensen, M. A. Gaup, F. E. Wielgolaski & E. Reimers

2. *Effects of Forestry and Snow Conditions on the Use of Pastures by Reindeer in the Ivalo Herding District*

   J. Kumpula, A. Colpaert & M. Nieminen

3. *Growth and Recovery of* Cladonia arbuscula *ssp.* mitis *after Simulated Grazing*

   E. Gaare

4. *New Results on Impacts of Reindeer Grazing on Soil Properties*

   C. Uhlig & A. Zink

5. *Multivariate Characterisation of the Swedish Reindeer Herding Area*

   H. Lundqvist & Ö. Danell

6. *Range Suitability Criteria for Reindeer Herding*

   H. Lundqvist & Ö. Danell

7. *At the Threshold of Order: Discourses on Reindeer Management in Sub-arctic Norway*

   A. Marin & Ø. Holand

8. *Factors of Destabilization of the Ecosystem "Pasture - Reindeer"*

   L. A. Kolpashikov, K. A. Layshev & A. D. Muhachev

9. *Remote Sensing Based Change Detection in Reindeer Pasture Evaluation*

   M. Anttonen & J. Mikkola

10. *Tracking Reindeer by GPS-GSM Collars in Finnish Lapland: a Pilot Study with GPS-data Transmission via Mobile Phone System*

    U. Fielitz, J. Kumpula & A. Colpaert

11. *Does High Resolution Satellites Bring New Aspects to the Pasture Research?*

    T. Kumpula

12. *Remote Sensing of Winter Foraging Habitats of Peary Caribou and Muskoen on the Queen Elizabeth Islands, Nunavut, Canada*

    A. I. Maher, P. M. Treitz, P. Budkewitsch & M. A. D. Ferguson

13. *Calibration of Landsat Images for Remote Sensing Based Reindeer Pasture Mapping and Change Detection*

    J. Mikkola

14. *Effects of Reindeer Grazing on Summer Pastures*

H. Kitti, B. Forbes, J. Oksanen, C. Uhlig & P. Soppela.

15. *Reindeer Summer Pastures and Ultraviolet (UV) Radiation*

P. Soppela, M. Turunen, U. Heiskari, B. Forbes, P. Aikio, H. Magga, M.-L. Sutinen, B. Åhman, T. Helle, M. Nieminen, E. Kyrö, K. Lakkala, S. Huttunen & C. Uhlig

16. *One Area, Many Users - Reindeer Husbandry and Other Use of Natural Resources in Finnish Lapland*

J. Mikkola, V. Väisänen, M. Anttonen, M. Mönkkönen, A. Colpaert, J. Kumpula, M. Nieminen & O. Heikkinen

17. *Managing Conservation and Multiple Land Uses: Applications in Urho Kekkonen National Park, Finland*

D. Berrouard

18. *Reindeer Management: a Test Case in Valuing Local Knowledge*

B.C. Forbes

19. *Local People's Perceptions of Environmental Risks and Land use in Vulnerable Tree-line Ecotones*

M. Riipinen

20. *Reindeer (*Rangifer tarandus tarandus*) Feeding on Lichens and Mushrooms: Traditional Ecological Knowledge Among Sami Reindeer Herders*

B. Inga

21. *Defining the Quality of Reindeer Pastures: the Perspectives of Sami Reindeer Herders*

H. Kitti, N. Gunslay & B. Forbes

22. *Inuit Qaujimajatuqangit of Winter Habitat Use and Population Changes of Peary Caribou and Muskoxen on High Arctic Islands in Nunavut, Canada*

A. D. M. Taylor, M. A. D. Ferguson & P. Treitz

23. *Common Livestock Systems: a Comparative Perspectives on Institutional Functions*

G. R. Karlsen & B. Ulvevadet

Session 2: Population Dynamics & Management

24. *Trends in European Wild Forest Reindeer Herds in Finland and Russian Karelia: Potential Reasons for Differences*

J. Bisi, P. I. Danilov, K. Heikura, J. Keränen, I. Kojola & V. A. Markovsky

25. *Wild Forest Reindeer (*Rangifer tarandus fennicus *Lönnb.) in the Russian European North*

P. I. Danilov

26. *Status of Four West Greenland Caribou Populations 2000-2001: Larger Herd Sizes Ever*

L. C. Cuyler & M. Rosing

27. *Peary Caribou of Northern Ellesmere Island: Factors Affecting Current Population Levels*

M. Manseau, L. Dick & N. Lyons

28. *Habitat Segregation Prompts Population Regulation in Islander Sika Deer*

S. Tatsuzawa

29. *Muskox (*Ovibos moschatus*) Survival in Jameson Land, East Greenland*

P. Aastrup

30. *Productivity and Demography of Muskoxen on Wrangel Island*

A. R. Gruzdev & T. P. Sipko

31. *Demography and Productivity of Muskoxen in Taimyr*

T. P. Sipko, A. R. Gruzdev & K. N. Babashkin

32. *Capturing and Reintroduction of Muskoxen in The North Russia*

T. P. Sipko, A. R. Gruzdev, V. G. Tikhonov & S. S. Egorov

33. *Wild ungulates in Taimyr*

L. A. Kolpashikov & K. A. Layshev

34. *The Future of Reindeer Habitat: Using GIS and Remote Sensing to Examine Potential Climate Change Impacts in the Nenets Autonomous Okrug and Barents Sea Region*

F. S. Danks & G. Rees

35. *Influence of Meterological Conditions on the Demography Parameters of the Muskoxen (*Ovibos moschatus*)*

A. R. Gruzdev & T. P. Sipko

36. *Environmental Influences and Population Ecology of a Semi-domesticated Reindeer Herd in Finnish Lapland*

T. Helle, I. Kojola & A. Niva

37. *Livestock Electronic Identification: the IDEA Project*

I. L. Solinas., C. Korn., U. Meloni & A. E. Poucet

Session 3: Behaviour, Genetics & Evolution

38. *Inter Versus Intraspecific Competition – Aggression Amongst Reindeer and Sheep*

J. E. Colman, R. Eidesen, D. Hjermann, M. A. Gaup, Ø. Holand, S. R. Moe & E. Reimers

39. *Diurnal Activities and Feeding Behaviour of Reindeer Females and Their Calves in Corrals*

S. C. Lefrère & M. Nieminen

40. *The Role of the Ungulates in the Paleolithic Migrations of Ancient Human Populations*

A. F. Nazarova & V. N. Orlov

Session 4: Nutrition, Physiology & Body Condition

41. *Animal Performance and Palatability of an Alaskan Produced Reindeer Diet*

    C. Bucki, G. Finstad, K. Moore & P. Bechtel

42. *Phenolic Substances of Mountain Birch Leaves in Summer and Winter Ranges of Reindeer*

    S. Stark, R. Julkunen-Tiitto & J. Kumpula

43. *Moose (*Alces alces *L.) Winter Food in Lower of Vilyui River (Central Yakutia)*

    N. S. Karpov

44. *The Effect of Age and Nutrition on the Epression of Monocarboxylate Transporters in the Rumen and Small Intestine of Reindeer*

    N. M. Koho, M. Nieminen, V. Maijala, H. Norberg & A. R. Pösö

45. *Transepithelial Transport of Energy-rich Short Chain Fatty Acids in the Gastrointestinal Tract of Reindeer*

    P. V. Storeheier, J. Sehested, L. Diernæs, M. A. Sundset & S. D. Mathiesen

46. *Estimation of Energy Costs of Consuming Browse*

    J. P. Lawler & R. G. White

47. *The Effects of Wintertime Undernutrition on Plasma Leptin and Insulin Levels in Juvenile Reindeer*

    P. Soppela, S. Saarela & M. Nieminen

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Session 1 RANGE ECOLOGY & SOCIOECONOMY

Keynote lectures

The impact of reindeer grazing on rare arctic-alpine plants in Fennoscandia

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As all grazing animals, reindeer can inflict large immediate damage on the vegetation. Two aspects of reindeer grazing make the short-term, negative impacts of grazing on all plants especially dramatic. First, reindeer are mobile, move in large herds, and have hooves with sharp edges. Consequently, reindeer grazing is associated with intense mechanical damage, which destroys much more biomass than is being eaten and can lead to pronounced erosion. Second, reindeer are very selective foragers in summertime and focus heavily on nutrient-rich plant organs such as inflorescences. Consequently, the contrast between grazed and ungrazed areas is visible and the negative impact of grazing on seed production can be profound. On the other hand, however, grazing by reindeer reduces the intensity of shoot competition and prepares the ground for seed germination. Moreover, biomass destruction counteracts humification and erosion can spread the impacts of nutrient-rich bedrock to surrounding areas. Hence, ambient nutrient levels can be boosted by the indirect impacts of reindeer grazing. We studied the net effects of reindeer grazing on species richness and on the occurrence of rare vascular plants in northern Fennoscandia. A survey was carried out in eight sites with contrasting reindeer densities but similar geological conditions and altitudes from the timberline. Two sites were situated inside Malla Strict Nature Reserve in northwestern Finland where reindeer grazing have been totally prohibited since 1981, and strongly restricted since 1960s. As a focal indicator group, we used those red-listed plants of Finland, which occur in the Kilpisjärvi area. This group was chosen because it consists of plants, which definitely belongs to the species pool of Malla and because this category could be defined by objective criteria. In addition, we measured the standard biodiversity parameters and studied the occurrences of plants which have clearly arctic-alpine distribution, plants which were defined as Ca favored in Mossberg's Nordic flora and different morphological categories of plants. None of the characteristics indices of biodiversity (species richness, evenness or Shannon-Wiener H') was correlated with reindeer density. However, the local richness of arctic- and alpine plants, Ca favored plants and red listed plants of Finland correlated positively with the intensity of reindeer grazing. Conversely, the richness of tall and medium-sized herbs correlated negatively with grazing intensity and the species richness of graminoids showed a quadratic pattern, with maximum at intermediate grazing pressure. The majority of Fennoscandian arctic alpine rarities are low herbs with basally attached leaves and a vertical rhizome (or a single taproot), which makes them dependent on sexual reproduction. Apparently, the grazing pressure exerted by reindeer varies sufficiently in space and time to make the net impact of reindeer on these plants positive even when the most intensely grazed summer ranges of the northern Norwegian Sami area are included in the analysis. In areas devoted to protection of arctic-alpine rarities, reindeer grazing should thus be encouraged. Moreover, our results warn against using conventional diversity indices or species numbers in the context of biodiversity studies. The essential aspect of biodiversity is the regional species richness, which is primarily influenced by dynamics of the rare species. Patterns in local species richness are strongly influenced by the dynamics of the trivial species, which are in no way threatened in the region. If all species are treated as equal, the conventional indices of local biodiversity can thus give an entirely misleading impression concerning the impact of grazing or some other ecological factor on regional biodiversity.

Effects of different reindeer-management laws on the development of Sami reindeer herding in Norway, Sweden, Finland and Russia

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Before 1751 there were no national borders in Sapmi (north-Sami name of the areas of Norway, Sweden, Finland and Russia that have traditionally been inhabited by the Sami people). The borders in northern Scandinavia were established relatively late: Between Norway and Sweden-Finland in 1751, between Sweden and Finland in 1810,

[1] Lectures are put in chronological order, the order of the poster presentations is after first author's sur name.

and between Norway and Russia in 1826. The relationship between reindeer herding and other resource use (especially agricultural use) in Fennoscandia has since 1751 been regulated through different juridical frameworks, established by the national states. When the border between Norway and Sweden-Finland was drawn the nomadic way of life for reindeer herding Sami was already well established, and in an appendix ("Lappekodicillen") to the border treaty between these countries it was established that the Sami people for all future time would keep their traditional rights to move their reindeer herds across the national borders. When Finland in 1810 was associated with Russia, this practice continued but in 1852 the border between Norway and Finland was closed for reindeer herding as with the border between Finland and Sweden in 1889. The different reindeer management laws within each country and the bilateral conventions between the countries are excellent manifestations of the attitudes of the national states towards reindeer herding at the times they were established. From a historical point of view, they will reflect changes in attitude towards reindeer herding (and the Sami people) during the centuries. But it is also possible to consider the effects of different reindeer management laws on the development of Sami reindeer herding in the four countries in question. In Russia, Sami reindeer management on the Kola peninsula became an integrated part of the Soviet system owned by the State. Control was taken from the Sami reindeer herders and given to political commisars who represented the State. Today attempts are being made to re-establish indigenous rights in Russia but reindeer management on the Kola peninsula is still by no means exclusively a Sami occupation. Also in Finland Sami have no exclusive rights to practise reindeer husbandry and most of the Finnish reindeer husbandry is actually ran by Finns. Reindeer management in Sweden and Norway is, with few exceptions, an exclusive Sami right. The reindeer management systems in the latter countries are also much alike. A bilateral convention – going back to 1751, and re-negotiated in 1919 and 1972 – still states that the Sami reindeer herders have a right to cross the Norwegian-Swedish border with their herds in accordance with old customs. In the presentation I will try to answer the question to what extent and in what sense can the development of Sami reindeer management in Norway, Sweden, Finland and Russia be explained by differences in the legal framework that the national states have forced on their reindeer herders.

Oral presentations

The relative importance of disturbance and herbivory by reindeer and microtine rodents for germination and seedling survival of four forest line tree species in Fennoscandia

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Global climate change may impact both the position of arctic treeline and tree species composition in the forested areas. We tested how climatic gradients, forest cover, disturbance and vertebrate herbivores affect the seedling recruitment of mountain birch, the present treeline species in Fennoscandia, and three conifer species, which all are treeline species somewhere in Europe. We had two locations with oceanic and two locations with continental climate situated in northern Sweden and further north in Norway. At each location replicated experiments were set up in birch forest and neighbouring tundra habitat. Seeds of mountain birch, Scots pine, Norway spruce and Siberian larch were sown in disturbed and undisturbed subplots in open reference plot, and separate reindeer and vole exclosures. Seeds were sown in 1999, 2000, and 2001 and seedlings counted 1999-2002. Vertebrate herbivore densities were monitored each year. There was great variation between years and among locations in germinability and seedling recruitment but no clear separation of locations by latitude or continentality. Disturbance increased recruitment in all species the impact being greatest for birch and larch and smallest for spruce. Recruitment was equal or greater in tundra than in forest. Overall, larch had the best recruitment and birch had the lowest numbers of surviving seedlings. Protection from vole herbivory increased the number of seedlings of all conifers especially in forest sites, and there is a trend for increased numbers of conifers even in reindeer exclosures compared to open plots in tundra sites. The vole and lemming peak in the Swedish sites in 2001 had a strong effect on the sowings of that year, at least partly due to seed predation, but also on seedlings sown earlier. In conclusion, disturbance had the greatest effect on seedling recruitment, but also herbivory by voles had a significant impact on seedling regeneration. Reindeer was of lesser importance but they may become more important as the seedlings grow taller. Impacts of disturbance and herbivory are factors that should be taken into consideration when predicting the possible latitudinal and altitudinal movements of tree species in northern Fennoscandia due to climate change.

Impacts of topography, weather and tourist trails on reindeer habitat use

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Habitat use of reindeer is assumed to depend on factors such as the time of the year, availability of forage, and disturbances by insects, humans and predators. Habitat selection can be viewed as a hierarchical process whereby animals make selection decisions at progressively smaller spatial scales (Senft *et al.*, 1987, *BioScience*, 37, 789-799). Habitat use of semi-domesticated reindeer (*Rangifer tarandus tarandus*) was investigated through faecal pellet-group counts and by direct observations of reindeer from helicopter in the Långfjället area in Idre reindeer herding district (62°10'N) and in Mittådalen reindeer herding district (62°50'N, only aerial observations). Pellet-group densities were related to altitude, distance to tourist trails and vegetation type and the aerial observations were related to weather. The aim was to examine to which degree habitat use was affected by these factors. The reindeer pellets were found to be most abundant in habitats at high altitudes, but there was no preference found for any special vegetation type. The pellet-group density tended to be higher near the tourist trails, which tended to follow higher altitudes in the terrain. The aerial observations of reindeer showed that the reindeer moved towards higher altitudes when the wind speed was low and the temperature was high both in June and July in both study areas. In June they also responded in the same way in both areas and walked towards lower areas when temperature was low and the wind speed was strong. High densities of pellets found on summits may therefore have been a result of reindeer seeking relief from insect harassment and/or to thermo-regulate at places where the wind speed is higher during calm and warm weather. One reason why preferences could not be detected for any particular vegetation type at Långfjället may be that the area is relatively homogenous and that several vegetation types, usually regarded as preferred, were missing or rare. The conclusion is that the reindeer use Långfjället to escape insect harassment and warm weather since it's the only place within their summer range where they easily can reach higher grounds.

Critical habitat for woodland caribou: a multi-scale approach

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Across Canada, different provincial and territorial jurisdictions have been tasked to determine the status of the different woodland caribou (*Rangifer tarandus caribou*) populations and to identify habitats deemed critical for the long-term protection of the species. It is generally agreed that the maintenance of viable populations depends on both the availability of adequate amounts of suitable habitat and the spatial arrangement of habitat patches allowing for movements and genetic exchanges. In order to further examine and quantify the habitat requirements of the species at the landscape level, we propose to use mathematical graphs. The mathematical graphs represent the landscape as habitat patches (graph nodes) and movement corridors among habitat patches based on distance and impedance to movement (graph links). The work focuses in commercial forest areas, east and central Manitoba, where populations of woodland caribou are most at risk from habitat fragmentation and increased predation caused indirectly by increased numbers of deer, moose and elk associated with forestry and higher proportions of early stages of succession. Using available forest resources inventory and caribou telemetry points from GPS collars, we derive GIS layers for habitat patches and movement impedance. Based on Keitt et al. (1997), we extract and analyze the resulting graphs and assess the degree of habitat connectivity at various scales in terms of two metrics "number of expected clusters" and "expected cluster size", which represent the number and size of a cluster of patches joined at a given scale for a randomly selected habitat cell. These metrics are both scale-independent and can be reasonably understood as capturing minimal and strength aspects of connectivity. The results assist in defining the spatial characteristics of woodland caribou ranges including the identification of critical habitat patches, movement corridors and core areas, based on their contribution to connectivity at various scales.

Reindeer management in Fennoscandia as a tool for biodiversity in a European policy context. Landscape development, biodiversity and co-operative livestock systems in Europe (LACOPE)

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Biodiversity in Europe is largely contributed by species of open and semi-open landscapes. A variety of different grazing systems gave rise to specific cultural landscapes. As the traditional systems became unproductive in terms of modern economics, landscapes and habitats formed by continuous grazing diminished. The maintenance, restoration and initiation of large-scale grazing systems could contribute to reconcile the conservation of biodiversity with conflicting human activities. To address problems related to property rights and to define appropriate structures for a sustainable, economically sound organisation of large-scale grazing systems, Co-operative Livestock Systems (CLS) is a relevant approach. To evaluate the potential of CLS in a European Conservancy perspective a European consortium of 14 partners from Norway, Sweden, Poland, Germany, Switzerland, UK, Portugal and Spain have joined the EU-financed project Landscape Development, Biodiversity and co-operative Livestock Systems in Europe (LACOPE). The project is an interdisciplinary effort covering ecological and socioeconomical aspects of CLS systems in 6 study areas, where border-crossing Sami reindeer management in northern Norway, Sweden and Finland is one of the cases under study. The project is in an initial phase. Comparisons of grazing systems and policies are made. The presentation will focus reindeer management challenges related to national and over-national policies in a broad perspective.

Systems analysis and modelling of reindeer husbandry in northern Finland

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Reindeer husbandry is a very important and old form of land-use and livelihood in northern Fennoscandia. It is also a basic part of the local communities' cultures. Changing circumstances over the past decades within the northern Finnish region, mainly due to the increased competition for natural resources with the other land-use activities (such as tourism, forestry, hydropower, mining, nature and predator protection) and changed economical conditions, have far-reaching consequences for the reindeer herding people. Effects like financial dependence, pasture degradation or social induration are already visible in some areas and will probably increase if no suitable and sustainable management strategy can be found. One main target of the EU project RENMAN (*REiNdeer MANagement*) is to find ways to intensify the discussion and participation of the involved stakeholders. To support this process it is unavoidable to provide usable data and information and to make them available for all participants. Our contribution to the project includes the integrative analysis of the different demands for landscape utilisation from social, economic and ecological aspects and the analysis of the reindeer husbandry and management system as a whole. We developed a structural model showing important processes in reindeer herding, conceptual models of the socio-economic and ecological interactions and derived 32 indicators for an evaluation system for the ecological, social and economic sustainability of different landscape management regimes. The above components are substantially and organisationally tightly integrated with the other disciplines in RENMAN. For the management, analysis and presentation of the data pool provided by our project colleagues and ourselves we utilise Geographical Information Systems (GIS) and computer based models, which will be applied for the simulation of different scenarios. Those simulations will be interpreted to compare and evaluate different reindeer management systems. Finally we will support the formulation of reindeer management scenarios and plans.

Analysis of the different processes having an effect on co-operative livestock system in northern Fennoscandia

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In this paper, I examine different historical factors that have contributed to stabilise and de-stabilise Sami reindeer herding, and thereby Sami culture as well. During the last centuries, the Sami society is transformed from a society founded on subsistence-based hunting and trapping to a society dominated by market-integrated herding and meat-production. Through time, traditional Sami reindeer herders have developed knowledge and

rules that are used for reindeer management. By way of oral communication and practical teaching, the reindeer Sami has kept most of their traditions alive. The siida constellation, for example, is a complex unit with a well-organized partnership and close social ties. The herders co-operate in a social and labour community and together they keep control of the reindeer herd within the framework of the siida. These social and cultural elements are important stabilizing factors in a modern society with rapid changes. However, even with a strong cultural base in the industry, we find several destabilising factors. Sapmi has gradually been colonised by the nation-states of current Norway, Sweden, Finland and Russia with border closures, and decreasing rights to use natural resources. These closures have inflicted detrimental effects for land use and the migration patterns of reindeer herding. After the industrial revolution, gradually more land has been irreversibly transformed from natural state to development, technical and industrial use, in addition to tourism. These and other policy-oriented changes have contributed to the disintegration of Sami traditions and cultural identity. This can be observed in many social processes. Low income makes it necessary for the family members to achieve a second job outside the industry, most often the wife. In this way, the women become an important financial contributor, but, at the expense of traditional herding and husbandry responsibilities. With the integration into the modern society we also find an increasing cultural gap between generations. Children spend more time in school and are pulled out of the industry. The family, as a co-operative unit, is disintegrating and important traditional knowledge disappear. In an historical perspective, this and other changes are analysed with regard to the relationship between the economic conditions of the industry and the cultural development of Sapmi.

Poster presentations

9

Remote sensing based change detection in reindeer pasture evaluation

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Reindeer pastures have been under change for the last decades, for example forestry, tourism and hydroelectric power development have significantly affected reindeer pastures. Reindeer pastures in Finland have been studied in many ways, *e.g.* the Finnish Game and Fisheries Research Institute and the Department of Geography in University of Oulu, have had a project combining remote sensing, GIS and field measurements in order to get extensive knowledge of the condition of pasture areas and amount of forage plants. Changes in pastures still need to be studied and the aim of our study is to detect changes in land use at the landscape scale. When the areas of change have been detected it is easier to evaluate the effects of change. This study is part of the LUIAS project, which aims to develop a Land Use Interaction Analysis System to valuate and evaluate effect of competeting users of natural resources in relation to reindeer husbandry. Four reindeer herding districts in northern and eastern Lapland are our study areas. These areas differ from each other in natural conditions, *e.g.* topography and vegetation and land use have gone through different kinds of changes during the past few decades. Landsat Multispectral Scanner images from 1970s, Thematic Mapper images from 1980s and Enhanced Thematic Mapper images from late 1990s and early 2000s are used to find large scale landscape changes. Several different change detection algorithms are tested and after observing the changes, they are quantified. In this case GIS and field data are used as reference data to verify results. The most dramatic changes, caused by clear felling and hydroelectric engineering and construction, were easy to locate and evaluate in respect to reindeer pastures. Slower changes, like deterioration or new growth of vegetation, are also possible to detect during the study period, but more field observations are needed to accurately evaluate these changes. As a whole, remote sensing based change detection enhances cost-effectiveness of land use research by giving possibilities to concentrate on areas with certain types of change.

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Managing conservation and multiple land uses: Applications in Urho Kekkonen National Park, Finland

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Assessing park management of integrating multiple land uses increases an understanding of the issues, allowing managers and researchers alike to both enhance conservation and cultivate a consideration for the human component most effectively. It has been seen in various cases that the creation of a national park may arise in circumstances where the intention of nature conservation comes into conflict with local land use practices. Within the context of a national park, nature conservation is a paramount principle of the human/environment interaction. As local support is instrumental to successful conservation initiatives, and in consideration for the people affected by park mandates, it is necessary to integrate certain land use practices alongside park principles. Assessing policies already in place is a necessary process to bring to light new knowledge of what is effective and help identify wherein lies the balance between conservation and the needs of local populations for future

planning. Urho Kekkonen National Park in northern Lapland, Finland, provides an example of such conflict through the management of conservation, reindeer herding and visitor recreation within park boundaries. The position of park managers, reindeer herders and local Finnish and Sami will be observed in terms of each perspective and the historical context of the park itself. The impacts of tourism and reindeer herding upon each other will be assessed, as well as their relation to conservation. Through a comparative analysis, it will be established towards which land use park management leans today. In addition to observing this example, the written thesis will make appropriate connections in an arctic-subarctic context with park management in Canada regarding similar land use issues of native and non-native peoples. Many of the issues within national parks worldwide share commonalities, and useful parallels can be drawn between the Canadian and Finnish experiences. By having a better understanding of the strengths and weaknesses of the issues as a whole, all those involved will be more definitely able to determine how to best accommodate humankind's land needs and uses in all respects.

1

Grazing facilitation or delayed competition between reindeer and sheep? A multi-disciplinary research project for optimal dual-species management

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Sheep grazing may influence the critical autumn, winter, and spring range conditions for reindeer, but the nature of this interaction is not known. Our present data suggests that summer sheep grazing could either improve range conditions for reindeer through grazing facilitation or deteriorate conditions through feces avoidance, over-utilization, or trampling (delayed competition). We aim to 1) experimentally test (*a*) the feeding preference of reindeer in autumn and spring towards summer sheep grazed, human clipped or untreated control plots and (*b*) test for possible effects of grazing facilitation or delayed competition on range production and quality, 2) conduct a social anthropological study of co-operative possibilities for dual-species management schemes between reindeer pastoralists and coastal farmers, and 3) develop a dual management scheme including both ecological and sociological constraints. Establishing this system could ultimately improve reindeer and sheep production and the social-economical and cultural interaction between reindeer pastoralists and coastal farmers.

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Tracking reindeer by GPS-GSM collars in Finnish Lapland: a pilot study with GPS-data transmission via mobile phone system

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The aim of this study is to test if GPS-GSM collars are suitable to deliver current information about the movements of reindeer. The study area is located in the Oraniemi reindeer management district, nothern Finland. The collars take the positions of reindeer with the global positioning system (GPS), store the data on board and transmit it via the global system for mobile communication (GSM) directly from the collar to a groundstation in our office, in Germany. The prerequisite for this system is that the study area is at least partially covered by GSM-net. At the beginning of 2003 we fitted 4 reindeer of different herds with GPS-GSM collars. The selected animals should represent the movements of the main herds. Their spatial behaviour is monitored and presented on the maps on our website (http://www.environmental-studies.de/projects/13/gps-gsm_collar__reindeer.html). These maps let the reindeer herder know where their herds are moving, without permanently need to control it in the field. By this tracking system, reindeer are also found much easier when they are gathered for summer and autumn round-ups. Reindeer can live in a very large area and it may take time and money to find them. For example the total area of the Oraniemi district, where the reindeer are allowed to move, is about 4083 km^2. This pilot study is a part of the longer lasting study on the pasture use of reindeer, in which several reindeer (n=46) have been tracked by GPS-collars since 1995. The most important questions are: which kind of forests (age and structure) are select by reindeer especially in the winter time; what kind of areas are important for the reindeer herding; how large areas reindeer use when they are herded and feeded on field and what is the effect of snow conditions on the spatial behaviour of reindeer.

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Reindeer management: a test case in valuing local knowledge

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REINDEER MANAGEMENT (RM) is a research project funded by the European Commission during 2001-2004. RM aims to address fundamental questions regarding the sustainable utilization of reindeer (*Rangifer tarandus*) in northernmost Europe in order to enhance the quality of life of local reindeer-herding communities and the appropriate management of living resources. Reindeer management is among the most important mutually competing uses of natural resources and the environment in the Barents Euro-Arctic Region. It is also one of the oldest, most resilient forms of livelihood within the region. As competition has increased and the effects have become visible, in particular over the past 25 years, there have been widespread reports of "overgrazing" and calls for significant reductions in the number of animals. The combined effect of these trends is that political discussion about reindeer management policy and its relationship with other uses of the environment (such as tourism, forestry, hydropower, and mining) is intensifying. Until recently, research has been primarily isolated within the different disciplines, with complaints from herders that biological studies have placed too much emphasis on meat production. In Finland, the law defines reindeer herding strictly as an occupational enterprise without reference to its cultural or social significance to the local herding population. As such, herders can feel that socio-cultural imperatives and their 'local' or practitioner's knowledge are undervalued. To address this issue, RM has undertaken a series of participatory workshops, interviews with active herders, participant observation in the field, and detailed biological and geographical studies of representative summer pastures. In this way RM aims to be a test case in valuing local knowledge in the dialogue and production of knowledge pertaining to the 'pasture problem' in northernmost Fennoscandia. In essence, we are seeking a way to incorporate *both* state-of-the-art Western scientific *and* local knowledge into the research and management decision-making process.

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Growth and recovery of *Cladonia arbuscula* ssp. *mitis* after simulated grazing

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There is nearly a complete overlap between reindeer distribution and the distribution of plant communities dominated by ground lichens. *C. arbuscula* spp. *mitis* is highly preferred as winter food on Norwegian reindeer ranges. 80 perforated plastic jars containing this species were placed in natural growing positions in the lichen mat at two different localities in the Dovrefjell area in southern Norway, 1) the western one, 62°29'N, 8°3'E, with 300 mm precipitation from June to September, and 2) a eastern one, 62°15'N, 9°35'E, with 200 mm summer precipitation. Both are placed on wind swept ridges in the lower alpine zone in May 1979. Every May and October in the period from 1980 to 1989, the jars were brought to the lab, dried and weighed before being put back in the experiment enclosures again. In the 1 dm^2 large jars, we put about 7-15 g of the lichen specimen in 5 parallel, each given one of 8 different treatments (clipping and thinning) to simulate reindeer grazing. The relative growth rates (RGR) calculated as an average for all years was, for control jars, 4.7% at the continental site, 8.3%, and 1.7-1.8 times higher at the oceanic. Thinning down to 50% remaining weight increased the RGR at both sites. Even a slight clipping removing only about 10% of the weight retarded the RGR from the oceanic site. On the contrary, a clipping of 50% had little effect on the RGR at the continental site. Except for this, the RGR is improved regardless the precipitation regime if the treatment leaves 50% of the biomass. A removal in excess of 50% invariably decreases the RGR. Winter ranges in southern Norway show large differences in the amount of lichen coverage: at 350 mm annual precipitation (continental) 25-30% of the low alpine area is dominated by lichen mats; only 7% or less at 700 mm (oceanic). For the overall carrying capacity for grazing reindeers the larger area in continental parts more than compensates for the lower lichen RGR at the dryer climate.

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Reindeer (*Rangifer tarandus tarandus*) feeding on lichens and mushrooms: Traditional ecological knowledge among Sami reindeer herders

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The investigation was carried out in four reindeer-herding districts (Sami villages) in northern Sweden. Reindeer-herding Sami, born in 1950 or earlier were interviewed about the reindeer foraging on lichens and

mushrooms, especially relating to winter grazing and how an area should be if it is good for winter feeding. The questions focussed in this investigation were: a) Sami names used by the reindeer herders for lichens and mushrooms, b) When reindeer feed upon lichens and mushrooms, c) Lichens and mushrooms preferred by reindeer, and d) Which are the characteristics of a good winter grazing area? Lichens were said to be grazed preferably in the wintertime, but could be eaten also in summertime when the weather is cold and damp. Mushrooms are eaten during August and September, but according to some informants also during late autumn (from October) when frozen and covered by snow. The reindeer herders had differentiating names for lichens, which describe how they look and were they grow. For mushrooms they only have one Sami name. Among ground lichen reindeer were said to prefer *Cladina* and *Cladonia* species, while nitrogen-fixing lichen species as *Nephroma arcticum* and *Stereocaulon pascale* were said to be avoided. According to three reindeer herders, mushrooms as *Leccinum*, *Boletus* and *Russola* spp. were eaten by reindeer. Avoided species were *Lactarius*, *Amanita* and *Gyromita* spp. *Suillus* sp. were eaten but not *Suillus luteus*. Snow conditions were considered to be important for the attractively of winter areas; the less and smoother snow on the ground, the better. Places where reindeer herders know that snow conditions tend to be problematic, such as in *Picea abies* forests at high altitudes or moist areas with small trees, are generally used before there is too much snow early in the winter (Oct–Jan). A good winter grazing area has lichens, the ground is preferably a dry *Pinus sylvestris* forest heath with old wide-crowned trees. Wide-crowned trees prevent snow to reach the ground and accordingly have an positive influence on snow depth.

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Common livestock systems: a comparative perspectives on institutional functions

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In this paper, some of the institutional features of common livestock systems (CLS) are explored. In general, common livestock systems are co-operative institutions where users share the use of natural resources. Primary examples include the use of grazing-lands and lakes. Apparently, there are some striking similarities between common property systems and common livestock systems. However, whereas common property systems pertain to ownership rights, common livestock systems pertain to use-rights and user organization. This and other similarities and differences are explored by use of an eight-way comparative study with six cases gathered from eight European countries. The institutional features explored focus on the formation of co-operative institutions, and how they have carried momentum from the middle ages and into the current modern world. This may be due to their welfare functions throughout history. Their role as means for the social and economic redistribution of grazing-lands among landless peasants is one of the crucial functions in many of the countries. Another, more culturally oriented feature is the fact that many such systems represents a material manifestation of social identity and thereby serves to maintain specific traditions and cultures. This and other features are analysed with regard to the rich literature available from the analysis of common property systems in order to transfer some of the analytical concepts from common property systems to common livestock systems. This is carried out in order to show some of benefits of co-operative institutions in the management of natural resources from the point of view of modern welfare states.

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Effects of reindeer grazing on summer pastures

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Research on reindeer pastures has mostly concentrated on lichen-dominated winter pastures, while summer pastures have gained less attention. We studied the effect of reindeer grazing on the quality of summer pastures in the Näkkälä reindeer herding district, northern Finland. The study plots on wetlands were established based on reindeer herders' knowledge and are situated on both sides of the border fence that was built between Finland and Norway in the late 1950s. On the Finnish side the pastures are grazed both in summer and winter but in Norway only in winter. This has resulted in a natural long-term experimental design by which differently managed sites with ostensibly similar vegetation, soils and environmental conditions can be compared. The parameters studied were the composition, cover and structure of vegetation, peak season biomass and soil nutrient-content. In addition, minerals, nitrogen and digestibility of green leaf tissues from *Eriophorum angustifolium* and *Salix lapponum* were measured. These were prominent species in the habitats used by animals during summer. The leaves were collected both in the beginning and at the end of growing season. Vegetation composition, cover, structure and species frequencies were measured using standardized protocols and stratified

random sampling methods. Biomass was studied by clipping the plants from the same quadrats after counting. Preliminary results indicate that *Salix lapponum* suffers from summer grazing. Plant cover, biomass and height of *S. lapponum* were significantly lower on the Finnish side compared to the Norwegian side. While the amount of *S. lapponum* available as forage has clearly been reduced by long-term summer grazing under the recent stocking rates, ongoing analyses will determine whether or not forage quality has also been affected. In addition, fenced enclosures will illuminate the resilience of this important forage species.

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Defining the quality of reindeer pastures: the perspectives of Sami reindeer herders

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Biologists have studied the reindeer pastures of northern Fennoscandia since the beginning of the 20th century. Recent studies have provided the basis of the current management plan for the reindeer herding area, which essentially dictates the number of reindeer allowed per district/decade. Reindeer herders have been critical of this practice because they feel this provides one-sided picture of the state of the pastures and that their expertise remains undervalued and unexploited, both in terms of practical planning and the relevant legislation. We investigated how reindeer herders define the pastures, in part to involve local people in the research and thus to value their knowledge. We interviewed 25 reindeer herders in Finland and Sweden during the years 2001 and 2002. We also took part with them in their daily work as a form of participant observation. The main themes of the interviews and field observation centred on the management of pastures, classification of the pastures, and land use. The primary indicator for the condition of the pastures derives from observations of the condition and behaviour of reindeer. When there is a state of *heajos guohtun* (bad condition of pastures in Sami language) the condition of the animals gets worse. Factors affecting the pastures are divided by herders into environmental (biological, geographical and climatic) and anthropogenic (socio-economic, legal and cultural) factors. These factors are often coexistent and changing both in time and space. For example, the term *heajos guohtun* can mean many things; like snow conditions, disturbance, predator threats, location or vegetation. This research provides an opportunity to enhance studies, which rely primarily on vegetation and soils to indicate the quality of the pastures. Our aim is that these different types of knowledge could be evaluated in the search for a more complete understanding of the pastures.

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Factors of destabilization of the ecosystem "pasture - reindeer"

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In Taimyr there are wild (about 1 000 000 animals) and domestic (43 000) reindeer. Wild and domestic reindeer play an important role in social and economic life of indigenous people: Nenets, Dolgans, Nganasans, Evenks. Pollutions of the Norilsk metallurgical factory have destructive influence on vegetation. Lichens in the Norilsk area and to southeast from the city have disappeared. Acid deposits cover about 400 000 km^2. Heavy metals in ground and plants are distributed over 2 000 000 hectares. Pollutions cover territory around Pyasina Lake, Pyasina River, the valley of Norilka river and a deflection between Putorana Mountains and Lantokoisky Ridge. Degradation of pastures changes migratory routes of wild reindeer. Numerous caterpillar vehicles cause negative impact on vegetation. It was found that a double passage of cross-country vehicles destroys lichens on 20-40%, a triple - on 70%. Totally, vegetation cover of Taimyr has been destroyed on the area of about 1 000 000 hectares. The Taimyr pasture capacity has decreased 15-20%. The complex program on maintaining of Taimyr reindeer pastures is necessary.

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Effects of forestry and snow conditions on the use of pasures by reindeer in the Ivalo herding district

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We studied the effects of forestry on the use of pastures by reindeer in the Ivalo herding district, northern Finland during the years 1999-2002 by means of GPS-tracking. Differences in snow conditions between various aged forest classes or parts of district were also studied by making snow measurements on field. Altogether 19 reindeer females were tracked and they were identified in a total of 6314 locations. On the basis of GPS-tracking, the Ivalo district was divided into two pasturage areas. With the exception of late winter, reindeer grazed a lot in sapling stands in both areas. In March-April reindeer mainly used old forests in the northern part

of the district. However, in the central and southern parts of the district reindeer continued to use mainly sapling stands located in dry and very dry pine forests. Grazing in felling areas and young forest classes was very limited in late winter in both pasturage areas. Snow conditions were very different from year to year. There were no essential differences in snow conditions between different forest age classes but snow conditions varied between different parts of district. The altitude of the measurement site to a large extent explained these differences. The higher the altitude of the measurement site, the more difficult were the snow conditions for reindeer. Due to snow conditions reindeer clearly preferred areas at low altitudes during the winter. The greatest amounts of arboreal and other epiphytic lichens growing below a height of two meters in tree stands were measured in mature and old forests. The greatest amounts of arboreal lichens above the height of two meters in tree stands were measured in old forests. Differences in the amounts of pastures, herding systems and snow conditions cause differences in the way reindeer use pastures. In those areas where there is a lack of lichen pastures and where snow conditions are difficult, reindeer compensate for the lack of terrestrial lichens by eating arboreal lichens. Therefore the more limited the lichen pastures or the more difficult the snow conditions in the area are, the more adverse are the effects of forestry on reindeer pastures.

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Does high resolution satellites bring new aspects to the pasture research?

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In this study new high resolution satellite data IKONOS-2 (4 m multispectral resolution) is used to identify and map the vegetation and pasture types. Results from IKONOS-2 images are compared to Landsat TM images with coarser resolution (Landsat TM 30 m resolution). Landsat TM images have been used in many pasture inventories with good results. Although Landsat TM have been critisiced because it hinders the more detailed study of vegetation covers and types. The field sites are used in testing the accuracy of the classification. The coverage and height of different plant species and bare soil have been measured in each site. Preliminary results of IKONOS-2 images classifications indicate that in the Jauristunturit in the Finnish–Norwegian border it is possible to distinguish 4–6 classes of different grazing intensities of lichens. In the treeless Jauristunturit lichen heaths are clearly visible in satellite images also in the Landsat TM image. Because the image resolution is 4 meters it is possible to detect almost the exact pixel of the field site with GPS. Therefore the utilisation of detailed field data in combination with high resolution images will probably lead to better results than solely use of Landsat TM data. The high resolution remote sensing will bring new aspects to pasture mapping and research since the detailed studies of vegetation types and pastures are possible. The high resolution also increases the quality of satellite data applications in the pasture studies. The amount of mineral land and lichen dominated areas can be estimated more accurately. This allows better estimations of degradation, reindeer forage resources and the quality of pastures. Thus more questions as which areas are close to overgrazing and which areas tolerate more grazing can be raised.

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Multivariate characterisation of the Swedish reindeer herding area

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The Swedish reindeer herding area covers over 160 000 km^2, with a south-north extension of 900 km between latitudes 61-69°N. The area has a marked gradient from forested lowlands with fairly stable continental climatic patterns in east to barren alpine areas with variable sub-oceanic climate patterns in the west. Anthropogenic factors and competing land use follow largely a east-west gradient with a high degree of range fragmentation and disturbances in eastern parts. The majority of Sweden's 51 reindeer herding districts typically have a northwest - southeast orientation with summer ranges in west, winter ranges towards east, and autumn ranges between these. Distances between summer and winter ranges are 100-300 km. Balances between seasonal ranges vary considerably with typically summer range limitations in south and the opposite in north. A minority of districts have more limited geographic extensions and are thereby exposed to less compound spectra of conditions. Herding districts show large variation in productivity and stability over time: the overall pattern is higher productivity and stability in south compared to north, but with considerable variation between herding districts on a regional scale. These variations are likely attributable to the external conditions interacting with herd density variations, but the extent of their impact and relative importance is unknown. The large number of possible factors involved and their range of variation make informative comparisons of districts or herds difficult. This research aims at revealing common key factors explaining variation among herding districts in reindeer herding conditions, suggestions of models for projection of productivity opportunities, zone mappings

of the herding area, and identification of exceptional conditions or critical deficiencies when district fall out of the common patterns. Spatial and temporal scales of topographic, climatic and anthropogenic impacts are discussed in the poster on the basis of a literature and available data. Data is made spatially explicit using GIS and reduced with multivariate statistical methods to sufficient sets of key factors enabling discrimination among groups of herding districts.

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Range suitability criteria for reindeer herding

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The Swedish reindeer herding area, with a north-south extension of eight latitude degrees and an east-west extension from Gulf of Botnia to the border mountains towards Norway, includes a large variation in reindeer husbandry conditions. The natural attributes for reindeer husbandry in this area could be characterized in terms of topographical and spatial properties of the land, features of the vegetation cover and patterns of climate and weather in conjunction. The topographical features in combination with climate particularly determine the properties of summer ranges via length of growing season, spatial and temporal distribution and quality of forage vegetation, and impacts of insect harassment. Winter ranges are to large extent synonymous with lichen ranges Length of snow covered season and snow depths together with incidences of ice crust formation determine the accessibilities and possibilities for sustainable management of lichen resources. Possible criteria for range quality and suitability are developed from GIS-based topographic information, time series of weather data from 122 meteorological stations within the reindeer herding area and vegetation maps. The relevance of these criteria for describing variability in range suitability or capacity among the seasonal ranges of the 51 reindeer herding districts is analysed with multivariate ordination and clustering techniques. The results constitute a suggested minimum set of key criteria which retain the information about the variability in range suitability for reindeer husbandry in the total reindeer herding area, and by which discrimination among regions and individual herding districts could be done. The appropriateness of these criteria for explaining actual variation in herd productivities will later be correlated with herding district productivity data derived from population dynamic analyses of herd densities and production data.

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Remote sensing of winter foraging habitats of Peary caribou and muskoxen on the Queen Elizabeth Islands, Nunavut, Canada

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During the past 40 years, populations of muskoxen (*Ovibos moschatus*) and endangered Peary caribou (*Rangifer tarandus pearyi*) on the Queen Elizabeth Islands (QEI) have experienced wide fluctuations. One hypothesis attributes the cause of serious declines to severe snow cover conditions. However, research has not yet documented that severe snow cover has extended throughout the winter range of any population, or that similar snow cover conditions did not occur in years of population increase or stability. Furthermore, the proportion of a population's winter range where snow prevents access to forage by these ungulates has not been estimated in winters with either "normal" or "severe" snow cover. Between 1995 and 1998, a dramatic population declines occurred on Bathurst Island during winters that appeared severe. In 1994 Inuit had predicted such a decline because they said that there were "too many" caribou and muskoxen on the island after previous population increases. This prediction raises the question whether density-dependent factors may have been aggravated by weather-related density-independent factors. To adequately assess the roles of such factors, a method for assessing snow cover and winter forage conditions across the potential winter range of such populations is required. As part of an interdisciplinary program needed to conserve Peary caribou and muskoxen, we are using current and historical Landsat and IKONOS data to index and map usable winter foraging habitats of Peary caribou and muskoxen on the QEI, based on the distribution of snow-free patches and associated vegetation. We will also estimate the inter-annual variability in the proportion of snow-free patches where animals may gain access to forage during winter. Landsat images for the study area from 1990 through to 2002 during late winter are being analysed to assess relationships between snow coverage and changes in Peary caribou and muskox populations. During winter 2003, Landsat-ETM+ and IKONOS imagery were captured in conjunction with field validation of snow coverage, depth, and ram and surface hardness. These results were compared with

distributions of caribou and muskoxen during aerial surveys. This allowed us to develop a signature of snow characteristics where these animals forage during late winter.

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At the threshold of order: Discourses on reindeer management in sub-arctic Norway

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Nomadic pastoralism is characterised by flexible patterns of resource use and tenure regimes, as a response to fluctuating circumstances. In sub-arctic Norway, traditional tenure and resource-use regimes of Sami reindeer pastoralism have been replaced by a formalized system reinforced by the State. Today the lichen ranges are highly degraded and the enterprise is sustained by large subsidies, legitimating more control from the Administration and calling for a drastic revision of management approach. Using the framework of political ecology and narrative analysis, the present study addresses the environmental, economic, social and institutional impacts of the present management regime on the common winter ranges in Inner Finnmark. The article contrasts the discourse of the herders with the two meta-narratives produced by the hegemonic discourse of the State and reproduced by society at large: a single, optimum stocking density as a prerequisite for sustainable production; and a need for centrally-controlled, formalised regulation system in order to avoid resource degradation. The paper discusses the received wisdom, simplification, methodological flaws and vested interests inherent in this approach as illustrated by herders' narratives and supported by secondary empirical evidence and scientific theories that acknowledge the influence of various circumstances (climatic, social, economic, cultural) upon the production strategy of the herders. An opportunistic management approach that develops and legitimates local institutions to coordinate the use of common ranges according to ecological variability and customary tenure system is proposed as an alternative.

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Calibration of Landsat images for remote sensing based reindeer pasture mapping and change detection

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Multitemporal Landsat MSS, TM and ETM+ images were calibrated for atmospheric and sensor related effects to enhance remote sensing based reindeer pasture classifications and change detection. Relative calibration using both statistical and empirical methods was applied to make single scenes comparable with each other. Image mosaics were created of adjacent images to cover whole study area, which consisted of four reindeer herding districts in northern and eastern parts of Finnish Lapland. Supervised classification, which based on field observations, was performed to single scenes and image mosaics before and after calibration. Effects of calibrations on reindeer pasture classification were evaluated by analysing changes in classification results and assessing classification accuracies using independent test areas. The calibration, due to its relative nature, did not significantly affect on classification accuracy of single scene if all training areas were located inside the area of the scene. However, visual examination of mosaics made of classified non-calibrated scenes showed dramatic change from one class to another at interfaces of scenes. Such a change could not be seen from mosaic of classified calibrated scenes. The most significant changes in classification results and accuracies were found when mosaics were made before classification. Overall classification accuracy increased up to 20 percentage units due to calibration when 3-6 training areas per class were used for classification of a whole mosaic. Relative calibration of images makes multitemporal scenes taken by different Landsat sensors more comparable, which is important for image mosaic classification and remote sensing based land use change detection. Calibration significantly enhances classifications and thus makes them more reliable for users. Calibration also makes mapping more cost effective, as smaller amount of training areas decreases need for massive field campaigns.

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One area, many users - reindeer husbandry and other use of natural resources in Finnish Lapland

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Changes in reindeer herding and other forms of land use have affected reindeer husbandry in many ways. Intensified utilization of land resources threatens the undergrowth, state of forests and the nature as a whole. Both internal and external development and pressure are a cause of continuous change of reindeer husbandry.

Thus studying pastures is important to maintain sustainable use of pastures. It has recently been stressed in the Finnish media, that studying interactions and linkages between various forms of land use is important as well. The main objective of this study is to analyse interactions between reindeer husbandry and other use of natural resources and to find ways to fit them together in a sustainable way. Study area consists of four reindeer management districts in Northern Finland. The aim is to develop a model for a land use interaction analysis system (LUIAS) to evaluate and valuate the various uses of natural resources in respect to reindeer husbandry. Interactions and conflicts are studied in both physical and socio-economic environment, which gives a firm ground for versatile modelling. LUIAS-model will be extended to fit other forms of land use by changing the key land use in the model, and tested by using empirical data. Geographical Information System (GIS) is an integral tool in data acquisition and description. The practical application of this project is to provide information beneficial to reduce competition and conflicts between reindeer management and other land use administrations and thus help different human activities to adapt to each other and to the carrying capacity of the area. The LUIAS-project is at the moment concentrating on remote sensing based change detection and improving methods for reindeer pasture mapping. A socio-economical database is collected and under analyse. During the year 2003 the socio-economical part of the project is focusing especially on the topic of conflicts and interactions between tourism and reindeer husbandry in Northern Finland.

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Long-term grazing effects by reindeer on alpine heath vegetation in Sweden

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Very little data exists on long-term grazing effects by reindeer in the Swedish mountains. Practically the entire mountain chain is grazed so few comparisons are possible. However, using land use maps and direct information from reindeer herders we selected three sites where it was possible to compare areas with summer grazing with areas with a relaxed grazing pressure (i.e. grazed only during migrations in spring and autumn). The sites were situated in the following herding districts in a gradient from the south to the north: Idre, Kall and Könkämä. At each of these sites we established paired plots in several alpine heath types based on vegetation maps. Within each plot and vegetation type we measured plant species composition and plant biomass in 0.25 m^2 plots. The results show that total biomass was significantly lower in grazed plots in the low productive vegetation types, but also that less preferred plant groups responded to the available resources in more productive vegetation types which resulted in a compensation of plant biomass on a community level. Effects on species richness were fairly small, but large differences in species composition were evident in most vegetation types.

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Local people's perceptions of environmental risks and land use in vulnerable tree-line ecotones

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Environment and climate are factors that set restrictions but also provide possibilities for the land use in any particular area. The decision-making bodies set the rules and regulations by which people living in the area need to operate. It is known that local people do not always agree with the decisions that are made. In northern timberline zone the main means of livelihood (reindeer herding, forestry, tourism and nature conservation areas) are intimately connected with the natural environment and all of them require a lot of space. I have carried out interviews and sent out questionnaires to find out the differences between the opinions of the local people and those of the decision makers with respect to possible environmental risks and land use in northern boreal timberline area. These interviews were transcribed and analyzed in order to provide a range of scenarios. The idea is to find out whether the local people and the decision makers see similar and/or different kinds of environmental risks in the area and what are the possible land use changes linked to them. These environmental risks and changes in land use are studied from the socioeconomic point of view. Since a big part of the people living in the timberline area are representatives of indigenous groups, their traditional knowledge of the natural environment and their culture are also major factors in the research. The study is being carried out in two timberline villages: Nellim in Finland and Jukkasjärvi in Sweden. The study is part of the EU funded PINE (*Predicting Impacts on Natural Ecotones*)–project. Within this project similar socioeconomic research is being carried out in the Alpine timberline area in Austria and in Italy. The PINE–project will produces a model that can be used to predict the spatial patterns of change in vegetation, forest growth and biodiversity under different climatic and land-use conditions.

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Reindeer summer pastures and ultraviolet (UV) radiation

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Stratospheric ozone depletion and increasing levels of ultraviolet (UV) radiation have been found over the Arctic since mid-1990s. Northern ecosystems subsist plants and animals under harsh climatic conditions at or near their adaptation levels, and may be sensitive to additional stress due to increased UV-B radiation. Changes in plant productivity or secondary metabolism may have indirect impacts on northern sources of livelihoods such as reindeer pastures. For reindeer, annual growth occurs primarily on summer pastures, and changes in the quality of summer pastures may affect the feeding behaviour or nutrition of reindeer. The objective of the present research is to investigate whether increasing UV-radiation can pose a threat to the quality of summer pastures of reindeer. This is done by studying the effects of UV-radiation on the chemical composition and digestibility of a few of the most important summer pasture plants of reindeer. The studies are conducted in natural peatland ecosystems in the eastern Lapland, Finland during 2002-2003 with two different approaches: (1) UV filtration experiments: Vuotso, Lappi Reindeer Herding Co-operative, RENMAN (abbreviations, see below) experimental sites (67°N,27°E) and (2) Enhanced UV radiation experiments, provided by UV-B lamps, Sodankylä, Finnish Meteorological Institute, FUVIRC sites. The field experiments started in summer 2001 in Vuotso with the establishment of the plots and determination of plant cover. The most dominant vascular plants in the plots were *Menyanthes. trifoliata* and *Eriophorum. russoleum*. Plant species to be studied include also *Betula nana, E. angustifolium, Rubus chamaemorus* and *Carex* spp. In summer 2002, the UV-filtration experiment was started with three treatments, each replicated in ten plots. The treatment enclosures consist of wooden frames with plastic covers adjusted over a natural peatland ecosystem: (1) UV-B exclusion (a clear polyester plastic), (2) control (cellulose acetate) and (3) ambient plots that have frames, but no plastic filters. Enchanced UV radiation experiments in Sodankylä will start in 2003. Total concentration of soluble phenolics was analysed from plant samples. In addition, essential nutrients, fibers, macro minerals and trace elements as well as digestibility of the plants will be studied. Preliminary findings show a trend towards lower phenol concentrations in *E. russoleum* in UV-B exclusion experiments, but no statistical differences were found. The coming results will be compared with the results of the quality of summer pastures in the related RENMAN project, and with the results of the UV-exposure experiments in peatland ecosystems in the FUVIRC project.
FUVIRC: Finnish Ultraviolet International Research Center (http://thule.oulu.fi/fuvirc/). RENMAN: The Challenges of Modernity for Reindeer Management: Integration and Sustainable Development in Europe's Subarctic and Boreal Regions (http://www.urova.fi/home/renman/).

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Inuit qaujimajatuqangit of winter habitat use and population changes of Peary caribou and muskoxen on high arctic islands in Nunavut, Canada

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During the last 40 years, population fluctuations of endangered Peary caribou (*Rangifer tarandus pearyi*) and muskoxen (*Ovibos moschatus*) living on the Queen Elizabeth, Prince of Wales and Somerset islands have caused concerns at local, national and international levels. Until recently, biologists have largely attributed declines of these populations to density-independent snow cover conditions. On the other hand, Inuit have also attributed some population fluctuations to past seismic exploration, density-dependent population growth, and interactions between the two species. To better understand these fluctuations and conserve these populations, patterns of historic and recent population change and habitat use need to be examined. The best source of long-term information may be from knowledgeable persons who have regularly interacted with these populations over several decades. We are collecting and compiling historical and recent Inuit qaujimajatuqangit (i.e., ecological knowledge of Inuit) regarding long-term patterns of habitat use by Peary caribou and muskoxen on the High Arctic islands. Hunters and Trappers Organizations (HTOs) in Resolute Bay, Grise Fiord and other communities

identify Inuit elders and hunters that can describe spatial and temporal changes in Peary caribou and muskox populations within the study area. Each informant is interviewed to establish his/her biographical map, describe changes in caribou and/or muskoxen seasonal distributions and abundance during his/her lifetime, and discuss ecological, human and other factors that may have caused changes observed in the populations. The geographical information obtained from these interviews is stored in a GIS database. Inuit informants have described massive population changes, seasonal migrations and emigrations over the past 70 years on several islands, and have identified a variety of causes for these changes. The information provided by each informant often overlaps with that of other informants, but several informants provided unique information because of their special interests in certain geographic areas or animal biology. Compiled information will be reviewed at a meeting with all informants to confirm, correct and add information as required The assembled Inuit qaujimajatuqangit will be compared with the results of aerial and ground surveys, remote sensing, satellite telemetry and ecological research.

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New results on impacts of reindeer grazing on soil properties

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Mammalian herbivores generally influence soil properties of pastures significantly. However, rather little is known about impacts of arctic ungulates. The aim of this investigation was to identify possible changes in chemical soil properties due to different reindeer management systems in Fennoscandia: a) year-around used pastures in Finland, and b) winter pastures in Norway. Both managing systems are permanently separated by a fence, which was established during the 1950s. Iron podzol was the dominant soil type at both sides and fruticose lichen dominated dwarf shrub tundra was the typical vegetation type. However, lichen, plant and humus cover could vary greatly within the landscape. It was supposed that these differences were due to differences in grazing intensity. Based on a literature survey and field observations we therefore distinguished between the following four succession/ degradation stages I) thick (>4 cm) lichen cover; II) grazed/ thin lichen cover (<4 cm), but good plant cover; III) fruticose lichen cover almost absent, reduced plant cover and patches with exposed humus; IV) lichen, plant and humus cover almost absent, patches with bare mineral soil. According to this classification a 3 km^2 large area along the boarder fence between Finland and Norway was mapped via a grid of sampling points. To compare soil chemical properties between the different succession/ degradation stages and different management systems, corresponding soil samples were taken from O, E and B-horizons at both side of the fence. Soil chemical parameters determined were pH, soil organic carbon (org.-C), Kjeldahl-N, C/N, cation exchange capacity (CEC), base saturation, and total and plant available P, Ca, Mg, K. During the presentation the first results are presented with emphasis on potential impacts of reindeer on tundra ecosystems in general, and differences in pasture management in particular.

Session 2 POPULATION DYNAMICS & MANAGEMENT

Keynote lecture

Reindeer and caribou (*Rangifer*) - tolerance limits to habitat fragmentation and anthropogenic activities

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Anthropogenic activities have a direct effect on *Rangifer* behaviour through hearing, sight and smell, and all are important registration tools for behavioural risk assessment. Indirect effects, such as habituation, avoidance, and displacement, develop through neutral, positive or negative associations towards stimulus in terms of *Rangifer*'s ability to experience, learn, and remember. A survey of the literature reveals that although *Rangifer* in most cases retreat from anthropogenic activities, comfort distances (i.e. distances beyond which animal behavior or activity are not influenced) are relatively short. Energetic implications appear moderate and small compared to other natural, biotic influences such as disturbance caused by insect and/or predator harassment. Unless obstructing access, constructions of various kinds have limited effects on *Rangifer* behaviour or habitat use. Constructions that do obstruct or limit access and recreational or other motorized and non-motorized activities appear to have the strongest impact on vigilance, avoidance and redistribution of *Rangifer*. Behavioural effects that might decrease chances of survival and reproduction include retreat from favourable habitat near disturbance sources and reduction of time spent feeding with resulting energy depletion over time. *Rangifer* habitat use, habitat avoidance, and feeding preferences are governed by a complexity of natural interacting factors. Habitat avoidance following various human activities is reported, but most studies relied on indirect measurements of range properties to induce only a possible response from the animals and lack alternative hypothesises. Habituation and sensitisation are essential concepts shaping *Rangifer*'s adaptability, and the inclusion of such behaviour challenges general statements on reindeer and caribou behavioural responses to various anthropogenic activities. Although some level of cumulative effects from human activities is likely, it remains difficult to separate these from natural variations in *Rangifer* habitat use and demography.

Oral presentations

Arctic ungulates in a changing Arctic: Ecological responses and management needs

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The Arctic is warming, resource development is expanding into the Arctic, and arctic residents entering the global economy are generating increased pressures on the living resources of the Arctic. Arctic ungulates are faced with the challenges of adapting to the cascading effects on their ecology of the changing climate and associated influences of human activities on their habitats. Adaptability has characterized caribou, reindeer, and muskoxen in the past, else they would not be so successful throughout much of the Arctic today. However, the influences of a changing climate affect the arctic vegetation that supports these herbivores. In summer, precipitation, soil moisture, heat input, and solar insolation ultimately affect plant productivity and less directly, other components of arctic ecosystems. Forage quality is affected by changes in solar insolation via cloud cover, and UV-B radiation. In winter, changing climate affects availability of forage to arctic ungulates through its influence on snow depth and density, icing events, and timing of onset and melt-off of snow cover. Secondary influences of climate change include invasion into the Arctic of boreal/taiga competitors, predators, parasites, and diseases. Increasing human influences on arctic ungulates and their complex ecosystem relationships include, 1) industrial development for energy and mineral extraction and associated development of transportation corridors that result in habitat degradation, contamination, and fragmentation, 2) expansion of tourism and related recreational activities that displace arctic ungulates from seasonally important habitats, and 3) increased pressures for harvest of arctic ungulates by expanding populations of arctic residents, with access to mechanized transportation and availability of markets for wildlife products harvested. Sustained productivity of ungulate populations in a changing Arctic will require adaptability of management systems to include 1) close monitoring of changes in ungulate habitats and populations, 2) assessment of impacts of proposed development projects on arctic ungulate habitats as a condition for granting authorization to proceed, 3) direct involvement of, and shared responsibility for management decisions with local residents, and 4) quick management response to environmental change.

Spatio-temporal mapping of lichen habitats using Landsat imagery: A tool for caribou herd management in northern Québec, Canada

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The George River Caribou Herd (GRCH) increased from about 5000 in the 1950s to about 700 000 heads in the 1990s. This has led to an over-utilization of the summer habitat, resulting in a strong degradation of the vegetation cover. This degradation has had a direct impact on health problems observed in the caribou (*Rangifer tarandus*) population over the last few years and has also likely contributed to the recent decline of the GRCH (404 000 heads in 2000-2001). Lichen habitats are good indicators of caribou herd activity because of their sensitivity to overgrazing and overtrampling, their widespread distribution over northern territories, and their influence on herd nutrition. The study area, located in the northeast Quebec-Labrador peninsula, covers a very large territory, which is not easily accessible. As a result, field studies over the whole territory are limited and aerial surveys cannot be conducted frequently. Satellite imagery offers the synoptic view and temporal resolution necessary for mapping and monitoring caribou habitats. In this paper, we present a new approach for the detection and mapping of lichen habitats using Landsat imagery. The procedure, based on spectral mixture analysis, produces a map showing the lichen proportion inside each pixel. These results provide additional and more detailed information than traditional image classification methods. The procedure was applied on multidate imagery to monitor the spatio-temporal development of the lichen resource over the past three decades and gives new information about the habitat used by the herd in the past, which is very useful for better understanding population dynamics. The approach offers a viable means for detecting future changes in lichen habitats with new and upcoming satellite sensors and, therefore, could be used as a tool for more efficient caribou management.

Detection of recovery of populations of endangered Peary caribou and muskoxen, using distance sampling and skills of Inuit hunters

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Dynamics of most populations of endangered Peary caribou and muskoxen are poorly understood, with the population on Bathurst and nearby islands being the best documented. This population peaked in 1961 and 1994 at about 3000 caribou, but hit lows of about 250 in 1974 and less than 100 in 1997. Since 1975, Inuit have initiated self-regulated actions to conserve this population, but have opposed other initiatives. They have also questioned the reliability of past survey estimates. Since 2000, we have developed a new ground-aerial survey methodology, and implemented it on Bathurst Island in May 2001 and Cornwallis and western Devon islands in May 2002 and 2003. Inuit hunters surveyed large areas by snowmobile to detect watersheds where Peary caribou and/or muskoxen occurred; this ground survey provided Inuit with an independent minimum count for comparison with aerial survey results. Inuit identified extensive areas where neither species occurred or where they were confident that they had counted all animals present. For watersheds where Inuit observed signs of animals, we conducted an aerial survey at 40% coverage, assuming 500-m strips x 2. In areas where Inuit could not adequately conduct a ground survey, we conducted an initial 20%-coverage aerial survey, increasing coverage to 40% for any watersheds where signs of caribou or muskoxen were detected. Using distance sampling from the aerial survey, we determined three population estimates for Bathurst and nearby islands by truncating the maximum distance from transects based on varying criteria. The highest estimate (289, 95% CI: 166-503), with best model fit, yielded coverage of only 21%. Sample size for caribou was adequate, but not for muskoxen on Bathurst Island. Caribou recruitment was good with calf:cow ratios of 44:100. Since 1997, the population apparently has been recovering at a rate at least comparable to the 15-20% annual growth that occurred during 1981-94. Estimates for both species were also determined for other areas surveyed in 2002 and 2003. Evidence of significant interannual changes in Peary caribou distributions was also detected. The implications of these surveys for future recovery of these populations and harvest management are being discussed at local, territorial and national levels.

Climatic influences on the life history and population dynamics of a northern ungulate, *Rangifer tarandus*

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There are increasing evidence that climate influences life history traits and population parameters of ungulates, and thereby their population dynamics. Climate effects on ungulates may be direct (*e.g.* increased energetic costs of moving through deep snow and in accessing forage through snow) or indirect (*e.g.* effect on forage plant biomass and quality, level of insect harassment and associated parasitism). Reindeer inhabit extremely seasonal environment, but has received little attention in the research of climatic effects on large herbivores. Using data from five reindeer grazing districts in Norway, I analysed the relationship between climatic conditions (local and global) and interannual variation in body weight, growth rate and offspring sex ratio in reindeer, controlling for the effect of density. I also tested the prediction that summer, rather than winter grazing conditions, are more important for juvenile body growth in reindeer. An index of the North Atlantic Oscillation (NAO), the dominant mode of winter climate variability in the North Atlantic region, was used as a measure of large-scale climate. I found that autumn body weight of reindeer and sheep, as well as autumn growth rate and offspring sex ratio of reindeer varied between years. Autumn weights of reindeer also varied between populations. Despite sheep being fed indoors during winters, there was a positive relationship between autumn weights of sympatric reindeer and sheep, with no difference in the intrinsic variability of the two co-existing species. Interannual variations in body weight and offspring sex ratio of reindeer were influenced by local weather (winter and summer), global climate (measured by the NAO winter index) and population density. Local summer conditions appeared to be relatively more important than local winter conditions for reindeer body growth. Warm summers negatively affected autumn weight of reindeer calves, suggestively through insect harassment, with females being more vulnerable. The proportion of male calves decreased with increasing summer temperature and precipitation. An increase in the NAO winter index when calves were *in utero*, negatively influenced reindeer body weight (summer and early winter), autumn growth rate and the proportion of male calves in the population, so did increasing population density. Finally, increasing population density amplified the negative effect of climate. Consistently, the negative effect of climate and density was mainly attributed to nutritional stress experienced by the calves (e.g. foetal development, neonatal growth) or their mother (*e.g.* summer condition before rut, winter condition during pregnancy, post-calving grazing conditions). The results support the following views: (i) patterns in life history traits and population parameters of ungulates vary over space and time, (ii) extrinsic climatic fluctuations and density, as well as their interaction, are important causative factors for the reported variations, their effects being mediated through nutritional stress, (iii) although uncertain, global climate change will have considerable ecological implications, including effect on reindeer population dynamics. For example, reduced body size of reindeer may result from the reported warming trend of the globe, especially in areas where winters will be severe, and this may have consequence on reproductive performance and hence their population dynamics. Through its effect on life history parameters, it is concluded that climate affects population dynamics of reindeer. The implications of the findings for reindeer management are also discussed.

Reference: Weladji, R. B. 2003. Climatic Influences on the Life History and Population Dynamics of a Northern Ungulate, *Rangifer tarandus*. Dr. Scient. Thesis 2003:20. Department of Animal Science, Agricultural University of Norway.

Poster presentations

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Muskox (*Ovibos moschatus*) survival in Jameson Land, East Greenland

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Muskox survival in Jameson Land, East Greenland was studied based on a collection of 425 mandibles sampled *ad lib*. in the field. We determined age at death by examination of lines in the tooth cementum of p2 and grouped the mandibles in four age categories according to estimated time of death. The analysis was supplemented by a mark-recapture analysis of recaptures and recoveries of 483 earmarked muskoxen that were marked in 1982 and 1983. Life tables were prepared for both sexes. Average life length for males was 9.5 years while average life length for females was 14.3 years. Time of death did not have a significant influence on life length. Male mortality increased sharply after 6 years while female mortality stayed at a rather constant level.

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Trends in European wild forest reindeer herds in Finland and Russian Karelia: Potential reasons for differences

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There exist altogether 5000-5500 wild forest reindeer (*Rangifer tarandus fennicus*) in Finland and Russian Karelia in seven herds (subpopulations). The herds have been monitored in late winter by helicopter surveys, the last performed in 2003. Regional differences in population trends have been observed during the last 20 years. In Finland wild forest reindeer exist in two geographic regions, two herds in the east-central part of the country (Kainuu, North Karelia) and one in central Finland (Ostrobothnia). The eastern herds originate from Russian Karelia whilst the herd in Ostrobothnia has been introduced from Kainuu in the early 1980s. The populations have increased in Kainuu (now 1500 ind.) and Ostrobothnia (now 1000 ind.); the growth rate has been highest in Ostrobothnia. In North Karelia few, some tens of animals, within the winter range have been crossing the Finnish-Russian border. This presently isolated herd have been gradually decreasing. On the contrary to Finland, major herds in Russian Karelia have been decreasing and the present total estimate (<3000) is only half the estimate for the early 1980s. The predation rate by large carnivores is probably highest in Russian Karelia, and in the eastern Finnish herd it is many times higher than in mid-Finland. Differential large carnivore predation probably explains the observed differences in the proportion of calves in winter herds. We however suggest that this cannot explain the whole loss; some other factors, f. inst. human exploitation, is likely to be involved.

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Status of four West Greenland caribou populations 2000-2001: Largest herd sizes ever

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Estimates of herd size, structure and recruitment are important for caribou management decisions. As the result of aerial surveys, caribou herd sizes in West Greenland were believed low during the 1990s. This resulted in a 2-year hunting ban followed by several years of low harvest quotas. During March 2000 and 2001 new aerial surveys for animal abundance were completed for 4 caribou populations inhabiting 3 regions in West Greenland. The 2000-2001 surveys differed from earlier ones. Changes included flying helicopters, flying low, slow and at a constant altitude above the terrain. In addition, observation strip width was narrowed by c. 30 to 60%. These changes increased caribou sightability and resulted in radically different population estimates. For the *Kangerlussuaq-Sisimiut caribou population* of region North, the late winter 2000 pre-calving population size was estimated at c. 51 600 (42 664–61 495; 80% CI), with 26.7% calves, and recruitment of 68 calves/100 cows. Caribou density was 2.76/km^2 and 1.19/km^2 for the high and low use areas respectively. Average group size was 2.7. There were 0.8 bulls for each cow. For the *Akia-Maniitsoq caribou population* of region Central, the late winter 2001 pre-calving population size was estimated at c. 46 200 (37 115–55 808; 80% CI), with 17% calves, and recruitment of 31 calves/100 cows. Caribou density was 4.0/km^2 and 1.1/km^2 for the high and low use areas respectively. Average group size was 3.2. There were 0.6 bulls for each cow. For the *Ameralik caribou population* of northern region South, the late winter 2001 pre-calving population size was estimated at c. 31 900 (24 721–39 305; 80% CI), with 18% calves, and recruitment of 40 calves/100 cows. Caribou density was 3.8/km^2. Average group size was 4.3. There were 0.8 bulls for each cow. For the *Qeqertarsuatsiaat caribou population* of southern region South, the late winter 2001 pre-calving population size was estimated at c. 5400 (2864–8244; 80% CI), with 26% calves, and recruitment of 61 calves/100 cows. Caribou density was 1.05/km^2. Average group size was 2.9. There were 0.7 bulls for each cow. The present population estimates are about 5 to 7 times larger than the previous 1996 surveys, and the largest ever obtained for West Greenland. Survey method was likely an important causal factor. Where calf percentage and recruitment are high, the capability for rapid and continued population growth remains. Given the 2000-2001 caribou densities, further herd size increases may cause range degradation, which would have negative consequences for caribou populations in the future.

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Wild forest reindeer (*Rangifer tarandus fennicus* Lönnb.) in the Russian European North

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Viable herds of the subspecies have survived in Finland and Russian Karelia. The taxonomic status of forest reindeer inhabiting parts of the Arkhangelsk region east of the interfluve between Pinezh and Mezen and adjacent areas of Komi republic has not been clarified. Reindeer distribution in the two latter regions is patchy and the number of animals is no more than 15 000 in total. Regrettably, the herd in the west of Archangelsk region that had been in contact with Vygozero and Volodzero herds of Karelia ceased to exist. Until the early 1960s domestic reindeer herding had been practiced in the north of the republic (north of a line joining Kem and Kalevala). The husbandry was neither large nor profitable. Even in the best times, early in the 20th century and in the 1930s, there were just slightly over 11 000 semi-domesticated reindeer in the area. Twenty years later, in the 1950s, only 3000 animals were left, and in 1964 the "Olenevodscheskii" state reindeer herding farm was brought to a close. In the territories of domestic reindeer herding wild animals were not acceptable and were exterminated by herders. That is why few truly wild taiga reindeer survived in the area. The remaining wild animals lived in separate small herds. There were however quite many feral hybrids. Karelia south of the semi-domesticated reindeer herding territory was also inhabited by wild forest reindeer. The largest herds were those in the Nyuk, Leksozero, Vygozero and Volodzero areas. The total number of wild reindeer in the late 1950s was about 2000 animals. The decline of domestic reindeer herding and the inevitably following feralisation of a part of the animals have no doubt contributed to the restoration of the wild reindeer population and range in Karelia. According to aerial count in 1965 the population was slightly over 3000 animals. It reached 6500 animals in 1971 and remained at this level until mid-1980s. In the 1970s the reindeer range extended further south to a line joining Kuolisma village–Porosozero–Segozero southern shore–Tikhvin Bor village–Peschanoye–Kolodozero. Early in the 1990s however a rapid population decline and shrinking of the range began. The principal cause was poaching. The effect of logging, which determined the conditions of winter pastures, diminished since logging volumes in Karelia in the 1990s dropped to a half since the 1970s-1980s. At present, no more than 3000 forest reindeer have survived in Karelia. The distribution of reindeer in Karelia, the genesis and some taxonomic characteristics of animals from various subpopulations provide strong evidence that the Vygozero (Segezha district), Vodlozero (Pudozh district), Lekzozero (Muezerka district) and Nyuk (southern Kalevala district) herds belong to the pure forest reindeer subspecies. The forest race predominates in the part of Kalevala, in the Loukhi and Belomorsk districts, with only a minor part of the population represented by the progeny of domestic/wild reindeer hybrids. However the farmed animals in the areas were also the progeny of the same wild taiga reindeer. Only the Kem district is populated with descendants of the Izhma tundra reindeer brought there in 1950s from the Kola Peninsula. Judging from the decreasing number of animals with hybrid features the tundra reindeer are being eliminated by natural selection. Current status of the reindeer population in Karelia causes serious concerns about the future and calls for the total ban of reindeer hunting.

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The future of reindeer habitat: Using GIS and remote sensing to examine potential climate change impacts in the Nenets Autonomous Okrug and Barents Sea Region

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Geographical Information Systems (GIS) and remote sensing techniques will be used to examine reindeer herding areas in the Barents Sea region (northern Norway, Sweden, Finland and European Russia) and to model reindeer habitat, incorporating important ecological shifts such as potential climate change. Semi-domesticated reindeer are a critical component of arctic ecosystems: they influence the ecological balance through their impact on vegetation and provide a way of life for many peoples of the circumpolar Arctic. Over-grazing, shifts in land management and pressure for resource development threaten the sustainability of these traditional systems. Global climate change could further alter the situation. The key objectives of this research are to 1) provide information that will aid in making sound land management decisions, helping to ensure the future sustainability of reindeer herding regions, and 2) to advance our knowledge and ability to respond to potential climate impacts. Analyses in this project will be conducted on two scales. A general assessment of the Barents Sea region will be carried out on a coarse scale (20 km grid for example) with reindeer herd numbers and locations described at the county/Oblast level as a minimum. A detailed analysis of reindeer habitat will be conducted in a specific study area within the Nenets Autonomous Okrug in Russia at a fine scale (100 m grid for example). Habitat and ecological shifts, derived from modelled climate changes over a series of defined time scales, will be examined within the developed GIS database. Potential impacts on habitat and herding regions will be described. Methodology will consist of both fieldwork and desktop GIS and statistical analyses. Fieldwork will involve

vegetation analyses, possible ground-truthing of remote sensing data, and research on reindeer land-use and herd composition details for example. Field, geophysical and other relevant data will be compiled, processed and analysed within the multi-layered GIS to create appropriate habitat models and maps. This research is prerequisite to understanding some of the increasing stresses on arctic ecosystems and is critical if we are to preserve the way of life and health of the reindeer herding regions.

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Productivity and demography of muskoxen on Wrangel Island

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First successful calving after reintroduction took place in 1977 and in the next ten years the population increased slowly. In 2001and before calving 2002 the numbers were 650 and 684 respectively. The counting data showed 156 newborn calves in 2002, and we expect a total population of 750 muskoxen in spring 2003. There were 3,9 calves on average per herd (4,.8 in Taimyr). Age composition of the population stabilized within the first ten years and was by the end of 2002 29,9% bachelors, 10,9% harem bulls; 35,7% adult females, 5,9% one year old calves and 17,6% calves. Mean number in a harem herd is 15,5 (Taimyr 19,8). The sex distribution depended on the composition of introduced and surviving animals the first few years; later, though, bulls prevailed. During the 2002 calving bulls' rate was 46,9%. After a big population increase (until 30% in selected years) the population trend was slowed down by the lack of pastures. Productivity has stabilized at the rate of 13%-15% per year. A similar trend was seen in Nunivak Island, where the quantity of muskoxen called for human management. Thus, measures for regulating the Wrangel population should be taken and probably up to 60 animals have to be taken away per year. Translocating the excessive animals to other areas might be a useful measure.

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Influence of meteorological conditions on the demography parameters of the muskoxen (*Ovibos moschatus*)

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We have tried to analyse the impact of weather conditions [*e.g.* min., max. and mean temperature and precipitation in different seasons (Nov-Mar, Apr-May, Jun-Aug, Sep-Oct)] on the demography parameters of the muskoxen population in Wrangel Island and Taimyr Peninsula. Taimyr had lowest average and winter temperature but the highest summer ones. The both sites had the same amount of precipitation in summer but Taimyr had more precipitation in other seasons. We studied changes in animal number, proportions of calves and fawned females and death rate. Precipitation in summer period, minimum and average temperatures in winter (for Wrangel Island–in autumn as well) influenced negatively on the growth rate in both populations. Number of fawned females in Wrangel Island demonstrate negative correlation with precipitation level in autumn. Most of the year precipitation falls in summer, and high level of humidity or snow in this period leads to increasing death rate of calves and high negative correlation between the growth rate and the precipitation. Similar trends, though in a smaller degree were found in Taimyr. Temperature influence on muskoxen is higher in winter. Significant influence of temperature on the demography parameters of the muskoxen population in Wrangel Island starts one month earlier than in Taimyr and the muskoxen population on the island was most influenced by climate conditions in autumn. In general, this season can be characterized as the most important for the population. The Taimyr population is influenced mostly in winter and partly in spring. Obviously, the population of Wrangel Island suffered from increased precipitation level in autumn, the Taimyr population was influenced by the temparature regime in spring.

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Environmental influences and population ecology of a semi-domesticated reindeer herd in Finnish Lapland

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We studied the relative importance of density dependent and density independent factors on reproduction, winter mortality and population growth rate of semi-domesticated reindeer in the herding association of Käsivarsi, North-West Finnish Lapland in 1960-2000. Reindeer data was extracted from the official statistics and annual

reports of the herding association and meteorological data from the Kilpisjärvi weather station of Finnish Meteorological Institute. The number of semi-domesticated reindeer ranged between 4500 and 20 000 animals in summer herd with population high in late 1980s and low in the early 1990s. The main determinants of population growth rate were harvest rate, reproduction and winter mortality, from which only winter mortality was (slightly) density-dependent. Reproduction correlated negatively with winter precipitation, the snow depth index, frequency of heavy winds (hardening the snow) and the time of snowmelt. In Anova estimated by GLM, the snow depth sum, ice formation in early winter (received from the annual reports of the herding association) and the inter-action of them explained a total of 57% from the variation in reproduction. Due to obvious sampling errors winter mortality did not correlate with the snow characteristics and weather variables, but when the index of Arctic Oscillation (2 years moving average) was used as a proxy of winter weather, the correlation was significant with a time lag of 1 year. In general, Arctic Oscillation described local winter weather better than the North-Atlantic Oscillation. The over helming importance of winter weather on population parameters in comparison to density is likely due to the fact that no any drastic changes took place in winter range condition (range conditions were poor already in the late 1950s) during the study period reflecting circumstances where climatic variability masks the impacts of density dependencies.

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Wild ungulates in Taimyr

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Four species of wild ungulates live in Taimyr, reindeer (*Rangifer tarandus* L.), muskoxen (*Ovibos moschatus* L.) moose (*Alces alces* L.), and the snow sheep (*Ovis canadensis* Shaw). Reindeer. In Taimyr the largest population of wild reindeer exists. According to our estimations its number is about 1 million. The main feature of the Taimyr reindeer population is its spatial unity and geographical integrity. It is not divided by natural barriers into a number of local populations. The Taimyr reindeer population is characterized by high concentrations in summer, and also mass character and broad range of seasonal migrations. From the beginning of the 1960s, a growth of wild reindeer number was found. The reindeer number was in 1966–252 000; 1972–386 000. Since 1972, a hunting husbandry was created. In the beginning of 1960s only about 6000 animals have been slaughtering annually. By 1988, 130 000 reindeer have been harvested. Totally, during 40 years 1.5 million of reindeer were hunted. The population number was in 1975–449 000, 1980–485 000, 1985–590 000, 1990–625 000, 1993–670 000, 2000–1 million. The growth of reindeer number was accompanied by expansion of the populations range which exceeded 1.5 million km^2. In summer time most of reindeer occupy Central and Eastern Taimyr, in winter the population migrates in southeast direction. During winter period a basic part of reindeer population lives in northern Evenkia and in the west of Yakutia. Large groups of reindeer migrate to Olenek and Vilyui Rivers. Some reindeer move to Yamal and Gydansky Peninsula, and in southern direction. Because the growth of reindeer number separate groups stay during winter period in tundra near Taimyra River. Muskoxen. Muskoxen were introduced at Taimyr in 1974-1975 (30 animals from Canada and Alaska). By 2001, the population number has achieved 3500-3600 heads. Now, all territory of mountain Arctic tundra of Eastern Taimyr is rather densely populated by muskoxen. Studies of 2001 have confirmed that two subpopulations of muskoxen united in Byrranga mountains in the single group. The growth of muskoxen number allowed to start their settling in Polar Ural Mountains and Yakutia. Snow sheep. They occupy Putorana mountains (about 120 000 km^2). After 1988 when the "Putoransky" Nature Reserve was established a number of snow sheep has increased up to 6000 animals. Moose. A number of moose remains within the limits of 800-1000 heads. To the north moose penetrate up to 70°N. Protection of moose in Taimyr is necessary.

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Peary caribou of northern Ellesmere Island: Factors affecting current population levels

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Over the past four decades, the Peary caribou (*Rangifer tarandus pearyi*) of the Queen Elizabeth Islands have suffered declines of more than 90%; from a population of 26 000 in 1961 to as few as 2000 animals. These declines can be attributed to a number of factors and their intensity and inter-relations vary among different caribou populations. Some of the primary factors include 1) availability of forage which can be influenced by climate or competition within or between grazing species and 2) predation which comprises natural and human sources of mortality. Since limited information is available on distribution and movement of Peary caribou, undetected movements of caribou or distribution shifts may also be mis-interpreted as declines or die-off. In order to better understand the dynamic of the northern Ellesmere Island endangered Peary caribou population,

we recognized the needs to use different sources of information, to seek for the observations and understanding from Inuit hunters, to search archeological evidences and historical documents and to further analyse population data collected by biologists of Quttinirpaaq National Park over the last decades. Moreover, we examined similar data available for muskoxen (*Ovibos moschatus*), a more abundant species, in order to gain additional insights into the population ecology of the species.

- Archaeological data providing information on Peary caribou and muskoxen harvest sites by native populations over the past 4000 years;
- Historical data (ca. 1850-1970), primarily based on the diaries and other records produced by Elisha Kent Kane, Robert E. Peary, Donald B. MacMillan, and the American Museum of Natural History, NYC, enabling historical population levels to be charted and potential impacts of the explorers' activities on the two species to be assessed; and,
- Recent biological data including wildlife surveys (1988 to present), satellite telemetry work, remote sensing and climate data providing information on the animals' movement patterns, seasonal distribution and population estimates.

From these complementary sources of information and in collaboration with Inuit hunters, ecological and population parameters are derived, critical areas for Peary caribou and potential population limiting factors are discussed.

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Demography and productivity of muskoxen in Taimyr

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Capturing muskoxen in Taimyr allowed us to obtain new data on the population. However, the capturing was done in two of three sub-populations, determined by G. D. Yakushkin (1998), thus the data obtained was extrapolated with due amendments. The population reached 2250 in 2001, and exceeded 2500 species in 2002. In the course of capturing only younger animals were taken from the population, leaving adult and the most productive part of population intact. The yearly percentage of capturing was no more than 1% - 3,5% (average 2%). Such a loss is harmless for the population, and can be increased 2 to 3 times with no consequences for the growth of the population. Yearly capture of about 30 younger calves will provide the data on sex ratio in this age segment. For the last 7 years average male - female proportion for the younger calves has amounted to 1,01:1, though significant divergence could be seen in some years. Males contributed 72,2% to the general quantity of calves in 2002. Bachelor males amounted to approximately 30% of the population. They often choose distant locations, and can only partly be observed. Consequently, this impedes the correct evaluation of the sex proportions for the adult part of the population. Average quantity in a harem herd is 18,5 and changes only slightly from year to year. Average number of calves in a harem herd differeed between years with mean number 4,4, (lim. 3–6,3). The bulls in harem herds contribute 17% to the total quantity, and females 42%; the said proportion is quite stable. Ordinary portion of 1-year old calves is 16,6% (lim. 10,1%–20,7%); portion of the younger calves 24% (lim. 20,1%–26,1%). Female productivity was evaluated for the age of 2 years and older. For the last 7 years average productivity was 59,2% and remained stable for all the years with the exception of year 1997. The lowest productivity rate for East-Siberian muskoxen was found in 1997.

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Capturing and reintroduction of muskoxen in the north Russia

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The authors developed technology of capturing of the muskoxen with the use of land or air means of transportation and their reintroducing to the tundra and mountain biocenosis. The capturing has been performed starting form 1996 in one of the populations of Wrangel Island and Taimyr Peninsula. Totally more than 200 animals were translocated. General loss rate during capturing, transportation and reintroduction has not exceeded 8%. Animals were delivered in Yakutia and spread as follows: Bulun area – 24; Anabar area – 41; Allaikhov area – 11; Begichev Island – 25. First calving in the new areas took place in 1999. Thirtytwo calves were born in Bulun area; 28 – in Anabar area. 48 animals were delivered to the Polar Urals, where calving also have taken place. A program for the use of muskoxen as agricultural animal have started. Fiftyfour animals were captured to be held and breed on farms of Yakutia. The closest perspectives include: delivery of muskoxen to Nizhnekolymsk area, and, an extra delivery to Allaikhovsk area of Yakutia; development of new re-introduction centers on the shore of Chuiskaya inlet and in Schmidt area of Chukotka, as well as in the Magadan area. Plans

for the translocation of muskoxen to the Western Taimyr have been developed. Our aim to rebuild solid populations of muskoxen in the northern Asia is not too long away in perspective. In spite of the fact that only small quantity of animals were spread in Russia from the island populations, no signs of inbreeding depression were seen by us neither in Wrangel Island, nor in Eastern Taimyr. Animals are successfully adapting to the new habitat areas. The muskoxen have high ability of adaptation to the mountain terrain and give good perspectives for reintroduction in spacious areas of Siberia and Far East.

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Livestock electronic identification: the IDEA Project

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After the successful results obtained from the European projects FEOGA and AIR 2304, in 1996, the Directorate General for Agriculture (DG Agri) and Joint Research Centre (JRC-Ispra) of the European Commission set up a large scale project on animal electronic identification called IDEA (Identification Electronique des Animaux). The project was launched in March 1998 and lasted four years (1998-2001). The study has been carried out with two objectives: 1) to study the performance and feasibility of the electronic identification system in ruminant (cattle, buffalo, sheep and goats); 2) to study the necessary organizational structure needed for any eventual future implementation of such a system on the European Union livestock. The participants to the IDEA Project were the European Commission and 10 National and/or Regional Authorities (subprojects) from six European countries. Approximately eight hundred thousand animals of four species (in particular 370 000 bovines, 15 000 buffalos, 500 000 sheeps and 29 000 goats) have been identified applying 3 types of electronic identifiers (ear-tag, ruminal bolus and injectable transponders). The JRC was in charge of the testing, certification and quality control of the devices, the set up of the data dictionaries and the central database, the in field intervention and the overall evaluation of the project including the performance of identification, control readings, slaughterhouse recovery and the data transmission and the overall organizational structure. The IDEA project has demonstrated that a substantial improvement can be reached for identification, registration and management system of European livestock by using electronic identifiers. The positive results obtained during the IDEA project allow the Directorate General for Health and Consumer Protection (DG Sanco) to prepare a new regulation proposal for individual identification of sheep and goat including Electronic Identification (proposal of the Council Regulation – No. 3508/92).

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Habitat segregation prompts population regulation in islander sika deer

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We have many island deer populations all over the world, which are exceptional in large-sized mammals. It is also remarkable that they have been often maintained for a long while, with being free from their potential predators. From ecological thoughts, it is expected that some strictly density-dependent mechanism has developed in such populations to regulate themselves, and the mechanism probably occurs evolutionally through bottom-up (resource-limited) manners. To study this mechanism demographically, a long-term seasonal census has been carried out for more ten years on a Mage sika population *Cervus nippon mageshimae* of Mage-shima island (31°N, 131°E, 12 km^2), which has been maintained at least for 1000 years without predators, competitors, snowfall, nor human disturbances. The points for discussion are as follows; 1) key factors, density-dependence, and regulatory function in demographic parameters, 2) spatial distribution of demographic parameters and effect of habitat segregation on it. In result, this population showed an agile density-dependent regulation through drastic changes in natality and mortality of yearling males. Meanwhile the strict spatial segregation between sex-age classes were recognized all through the years, and its intensity was negatively correlated with the extent of the spatial skew of the two key factors, and with the population density. Consequently, it is considered that spatial segregation brought higher sustainability to the demographic process of this small insular deer population.

Session 3 BEHAVIOUR, GENETICS & EVOLUTION

Keynote lecture

Refugial origin and post-glacial re-colonization of holarctic reindeer and caribou

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The phylogeography of reindeer and caribou (*Rangifer tarandus*) was inferred from sequence variation in the control region of the mtDNA. The data demonstrates that the current subspecies designation does not reflect the mtDNA phylogeography of the species, but rather suggests that a combination of glacial and interglacial effects have been important in shaping the recent evolutionary history of reindeer. Three major haplogroups were detected, presumably representing three separate origins of the species during the last glaciation. The most influential origin has contributed to the gene pool of all extant populations, suggesting the existence of a large and continuous glacial population ranging across extensive areas of tundra in Eurasia and Beringia. Another small and isolated refugium seems to have arisen in western Eurasia in close connection to the extensive ice sheet that covered Fennoscandia. A third distinct and geographically well-defined refugial area, most likely comprising several subrefugia, was probably located south to the extensive North American continental ice sheet. A significant demographic population expansion was detected for the two haplogroups representing the Eurasian glacial populations. The smallest one appears to have expanded when the ice cap retreated by the end of the last glacial. The expansion of the large continuous one, on the other hand, apparently occurred by the end of the last interglacial.

Oral presentations

Behaviour of reindeer as an indicator of adaptation to feeding

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Although reindeer are well adapted to limited food resources during winter, critical situations arise when the ground vegetation becomes unavailable due to deep snow or formation of ice crust. It may then be necessary to rapidly start feeding the animals in order to prevent starvation. Emergency feeding often results in health problems and even losses of animals, as both changes in feed and in environment necessitate time for proper adaptation. In a more comprehensive experiment (Nilsson *et al.*, 2000), the adaptation of reindeer calves to feeding was studied. The aim of the present part of the study was to assess if and how the behaviour of the reindeer was affected by nutritional deprivation and by adaptation to various feeding strategies used in the experiment. The activity pattern of five groups of penned and fed eight months old female reindeer calves (up to 13 per group) was observed during two sessions per day, morning and afternoon, on 20 of the total 42 experimental days. The activities were defined as: standing, locomotion, intake of food or water, seeking, snow eating, agonistic behaviour, lying, lying curled up, ruminating and others. According to preliminary analyses of the data, restricted feed intake (half the *ad lib.* ration of a lichen-based diet in four pens) affected the reindeer, with more animals standing and fewer lying compared to a control group (given the lichen-based diet *ad lib.*). Subsequent to the restriction period each pen was given different feed. The dominant activities were lying, eating, ruminating and standing (>10% each) throughout the experiment. There tended to be differences in frequencies of intake of feed or water and ruminating depending on the diet composition and the initial phase of feeding resulted in more animals lying curled up (with the nose close to the back-bones) compared to the control group. Few recordings of agonistic behaviour or snow intake were made. In conclusion, the amount of feed and the diet composition affected the behaviour of reindeer calves.

Reference: Nilsson, A., Danell, Ö., Murphy, M., Olsson, K. & Åhman, B. 2000. Health, body condition and blood metabolites in reindeer after sub-maintenance feed intake and subsequent feeding. *Rangifer* 20: 187-200.

Reindeer 24-hr within and between group synchronicity versus environmental variables

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The impact of abiotic stimuli on the circadian activity rhythm of *Rangifer* has long been debated. Their highly gregarious and mobile behavior presupposes synchronized behavior within a group, while a predominant abiotic influence would be expected to synchronize separate, independent groups subjected to the same environment. We tested within and between group synchronization of semi-domestic reindeer observing 6 independent groups located in close proximity to each other. We also tested how some external environmental factors affected the animals' behavior. Activity of all individuals (3 females in 6 groups = 18 reindeer) was recorded every 10 minutes 24-hrs a day, along with weather variables and biotic factors such as insect harassment. Data were divided into two periods of 8 and 6 days, respectively, separated by a period of 6 days. Animals within a group showed highly synchronized behavior, reflected in overlapping periods of grazing and ruminating. There was little or no synchronization between groups, reflected by little or infrequent overlapping of activities amongst some of the groups. Rarely were all 6 groups active or inactive simultaneously. There was no consistent or significant influence on the reindeers' behavior by any of the environmental variables recorded. Thus, and as expected, in the absence of external environmental stimuli, the activity of individuals within a group was synchronized. However, there was no synchronization amongst independent groups. This supports the claim that reindeer have a 24-hr polycyclic activity rhythm independent of climatic variables and in the absence of disturbance from stimuli such as insect harassment or anthropogenic activities.

Effects of wind turbines on area use and behaviour of semi-domestic reindeer *Rangifer tarandus* in enclosures

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In recent *decades*, industrial developments have expanded into reindeer ranges in the arctic and adjacent higher latitudes in search for energy, minerals, timber and other resources. Several wind turbine parks are under planning in reindeer ranges in Norway, and there is concern about possible negative effects on behaviour and area use of wild and semi-domestic reindeer. We tested whether a wind turbine and its rotor movement had any effect on area use, activity changes, vigilance bouts, and restless behaviour like running, walking, and standing for enclosed semi-domestic reindeer. Five different groups of reindeer in a 450 m long, 8 hectare, enclosure close to a wind turbine were manipulated by turning the wind turbine rotor on and off, and compared with reindeer in a control enclosure without wind turbine exposure. When exposed to rotor movement, two groups of reindeer showed a shift towards use of locations at longer distance from the wind turbine, two groups showed no shift, while one group moved closer to the wind turbine. The reindeer showed no systematic differences in behaviour between the two enclosures that could indicate fright or stress as a consequence of the wind turbine or rotor movement. We conclude that semi-domestic reindeer in an enclosure showed no negative behavioural response and little or no aversion towards a wind turbine. The possibility of rapid habituation in a small enclosure with continuous wind turbine exposure suggests that effects on area use should be studied at a larger scale with free-ranging reindeer.

Poster presentations

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Inter versus intraspecific competition – aggression amongst reindeer and sheep

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Foraging competition amongst ungulates has been claimed to be stronger for animals within a species than between species. However, such complex interactions have been difficult to enumerate. We tested whether direct interference competition, measured by recording threatening and aggressive behaviour among individuals, will increase with increasing density, and whether such behaviour is influenced by species composition. We used an enclosure experiment using three semi-domesticated female reindeer as our control group (CG) and two treatment groups (introduction of new reindeer (ReindeerTreatmentGroup, RTG) or sheep (SheepTreatment Group, STG)). There were two replications of each group type. Three time periods of approximately one week each were used; pre-treatment, treatment and post-treatment. Both differences in treatment groups between and within periods were analysed. In the treatment period, restless behaviour increased in all groups, but was significantly higher in RTG and CG compared to STG, indicating that introduction of new reindeer influenced the resident reindeer's restless behaviour more than the introduction of sheep. Amongst the resident reindeer, there was a constant decrease in aggressive behaviour from pre-treatment to post-treatment period for all treatment groups, with the largest decrease in STG. When comparing between resident reindeer and visiting animals, significantly more aggressive behaviour was recorded in RTG than in STG, with 187 and 144 encounters, respectively. For both treatments, the visiting animals won more encounters than the resident reindeer. Our results support the theory that competition is more prevalent amongst reindeer than between reindeer and sheep.

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Diurnal activities and feeding behaviour of reindeer females and their calves in corrals

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The aim of this study was to analyze the diurnal activities and food selection behaviour of female reindeer and their calves in corrals. The studied group was composed of ten females, five female and five male calves. Their activities were recorded from the end of July up to the end of October 1999 for a length of 15 weeks. Animals were kept within a 5 ha enclosure divided into 7 corrals, in the experimental station of the Reindeer Herder's Association. Time-budget used in activities was analyzed with individual focus lasting 15 minutes in 2 hours phase from three to six times a day. Individuals were weighed every week. Temperature was recorded hourly and insect density was estimated qualitatively with a code. In parallel to grazing, reindeer were also fed with fodder, in average daily 57.3 ± 8.6 kg (for ten females and ten calves). There was a synchronization of the activities with a grazing behaviour significantly higher at sunset ($P<0.001$) while the artificial feeding fluctuated irregularly. Reindeer spent more time in laying or standing on the afternoon than morning or evening. The average proportion of grazing and artificial feeding did not differ between weeks ($P>0.05$). However, we notified a gradual decrease of feeding behaviour of females from first to 12 weeks, followed by an increase up to the 15th week. Feeding and resting activities were more important for calves (35%) than for females (28%) in all the study period. Body weight did not vary according to artificial feeding or grazing ($P>0.001$). Temperature affected grazing ($P=0.034$), resting behaviour ($P=0.001$) and also the artificial feeding ($P=0.046$). Rain did not have any effect, but insect harassment constrained reindeer to stay inside a shelter. This study emphasizes feeding selection of reindeer in corrals, showing that artificial feeding does not disrupt normal grazing and diurnal rhythm. Key words: activities, feeding behaviour and time budget.

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The role of the ungulates in the paleolithic migrations of ancient human populations

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Probably the migrations of paleolithic human populations started about 50 000 years ago from a great region including Altay mountains and some neighbouring territories as Tuva and others. The ancient populations of Amerinds migrated across Siberia and the Bering Istmus to America following the predecessors of the caribou and bisons. There is paleozoological evidence of ancestor caribou and bisons living in the paleolithic in south Siberia. The ancient Caucasoid populations migrated following the populations of reindeer. The ancient Finnish-Ugric populations probably migrated from south Siberia across Ural mountains following the reindeer. The glaciers in North Asia (Siberia) were only in the mountains about 20 000 years ago; the great Siberian plains were free of glaciers in the paleolithic (Velichko *et al*., 2001); the conditions facilitated the migration of ancient animal and human populations.

Session 4 NUTRITION, PHYSIOLOGY & BODY CONDITION

Keynote lectures

Seasonal changes in reindeer physiology

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The seasonal changes in the photoperiod, temperature and availability of food induce adaptations in the physiology of the reindeer. To be effective these environmental signals need to be converted to hormonal signals. The most reliable of the seasonal changes in the environment is the photoperiod, which affects the reindeer physiology through the pineal gland and its hormone, melatonin. Usually there are large diurnal changes in the concentration of melatonin, but in the reindeer the daily rhytm disappears during the arctic summer to return again in the autumn. Seasonal changes in melatonin secretion are involved in the regulation of reproduction, the growth of pelage, thermogenesis, body mass and immune function. Melatonin may exert its effects through gene activation, but the mechanisms are not completely understood. Other hormones that show seasonality are thyroid hormones, insulin and leptin. Thus the observed physiological changes are a result of actions of several hormones. Appetite, energy consumption and thermogenesis are all vital for survival. During winter, when energy balance is negative, the reindeer uses mainly body fat for energy production. The use of fat stores is economical as the rate of lipolysis and the use of fatty acids in tissues such as muscle decreases, because the activities involved in these tissues decreases. Thus the lipolysis is controlled and only in severe starvation the rate of lipolysis increases enough to give rise to accumulation of ketone bodies. The protein mass is maintained and only during severe starvation is muscle protein is used for energy production. The winter feed of the reindeer, the lichens, is poor in nitrogen and the nitrogen balance during winter is negative. Reindeer responds to limited availability of nitrogen by increasing the recycling of urea into rumen. In general the adaptation of reindeer physiology enables the reindeer to survive the winter and although several aspects are known many others require further studies.

Allometry and variability in body composition in relation to population productivity in arctic ungulates

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Mean species estimates of protein, fat and minerals for caribou, reindeer and muskoxen scale allometrically to body weight on a common regression with other north temperate ungulates (moose, deer) and domestic species. However, distinct seasonal differences (residuals) from these interspecies lines are characteristic of the Arctic and north temperate species, which illustrates well-documented strategies of survival and reproduction in the Arctic. Likewise, strong allometric equations relate protein, fat and minerals [or muscle, bone and fat] to body weight from birth to maturity on an individual species basis. Seasonal effects are significant for fat, and less so for protein and minerals [or muscle and bone]. Extremes in seasonal fat cycles are reported for arctic island populations, *e.g.* Svalbard and Coates Island, compared with mainland reindeer and caribou. However, do significant differences in fat and protein cycles [or residuals] associated with season represent endogenous regulation or environmental controls such as plane of nutrition? Understanding regulation and control over body condition is important to interpreting field data and to management, particularly if it can be shown that body condition indices relate to population productivity. Since body weight and fat at conception appear to influence probability of conception, and body protein reserves appear important to fetal development and to birth weight, a link between condition and productivity is expected. On the other hand, it has been argued that some cohorts, *e.g.* non-pregnant females, lose weight over winter even under good feeding conditions, and pregnant females appear to defend retention of fat for post-calving use; these phenomena could mask a simple linkage of body condition to productivity. An analysis of body composition data from 5000 caribou in 16 herds in arctic North America was used to demonstrate that trends in seasonal fat and protein cycles are similar among herds, but that the relative amounts of gain or loss is herd specific. This comparative assessment will be used as baseline information for measuring the relative resilience of populations as they respond to drivers of global climate change. Preliminary results support hunter estimates of body condition as a protocol to monitor trends in condition and herd health of caribou.

Oral presentations

How reindeer keep cool

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Reindeer (*Rangifer tarandus*) are protected against the arctic cold by thick fur. The high thermal resistance of the coat makes heat stressed reindeer resort to panting. Moderately heat stressed reindeer usually display closed-mouth panting, whereby blood is cooled in the mucosa of their nasal turbinates. This blood is drained via the dorsal nasal veins and the angular oculi veins (AOV) to the cavernous sinuses for selective brain cooling (SBC). During severe heat stress, however, reindeer use open-mouth panting (OMP), and evaporation then occurs mainly from their richly vascularised tongue. Under these conditions the efficiency of SBC is reduced due to reduced air flow through the nose (Aas-Hansen, Folkow & Blix, 2000. *Am. J. Physiol.* 279: R1190-R1195). We have surgically instrumented adult female reindeer to allow continuous recordings of brain (T_b), jugular vein, carotid artery (T_a) and rectal temperatures, as well as of AOV, carotid and lingual artery blood flow, and respiratory rate, with the animal standing in a climatic chamber at temperatures ranging from –20 °C to 40 °C. We also could occlude both AOVs, and thereby prevent SBC. We observed that upon occlusion of both AOVs, T_b increased significantly, even in situations where T_b was maintained 0.5 °C higher than T_a before the occlusion. This shows that reindeer employ SBC long before $T_b < T_a$. Moreover, AOV occlusion also resulted in significantly increased respiratory rates, particularly at high ambient temperatures, at which OMP occurred most of the time. Such periods of OMP were consistently associated with a significant drop in T_a. *Post mortem* examination revealed that the jugular veins and the common carotid arteries run in close association for a distance of 15-20 cm. We conclude that counter-current heat exchange between cold venous blood from the tongue and warm carotid artery blood explains the OMP-associated drops in T_a, and that this is sufficient to prevent a further rise in T_b, even when SBC is compromised due to OMP.

Assessment of ovarian function of reindeer by ultrasonography

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Ovarian function of five multiparous reindeer was monitored with transrectal ultrasonography from 2nd Sep until 1st Nov. The ultrasonography examinations were performed on standing animals with a 7.5 MHz linear transducer (Aloka SSZ-300). The examinations were recorded simultaneously with a VCR and a data logger connected to the ultrasonography device. The ultrasonography examinations were performed three times a week from 2nd Sep to 14th Oct. Blood samples were collected from the jugular vein at the times of ultrasonography examinations. On 16th of Oct, the animals were given 0.25 mg cloprostenol (Estrumat®) for synchronization of the oestrus cycle, and ultrasonography was performed daily and blood samples collected every three hours through cannulae inserted to jugular veins until 22th of Oct. After this the examinations were performed three times a week until the end of the study. The females were penned with a vasectomized male in the first part of the study (2nd Sep - 16th Oct). A final examination by ultrasonography and blood sampling was done on 12th December, after which the animals were culled and their ovaries examined. Following measures were recorded during ultrasonography examinations: ovarian size, the number and diameter of ovarian follicles, and the presence and diameter of corpus luteum. We were able to locate both ovaries in 67% of altogether 165 ultrasonography examinations (33 examinations per animal), and one of the ovaries in 21% of the examinations. We failed to locate both ovaries in 12% of the examinations. Preliminary results based on the ultrasonography recordings indicate that each female had 2 or 3 ovulations during the study period of 61 days. The largest measured follicles and corpora lutea were 0.8 cm in diameter. In December, four of the culled animals still had active ovaries with either large ovarian follicles (diameter up to 0.9 cm) or corpus luteum (diameter up to 1.2 cm). The ultrasonography findings will be compared to individual hormone profiles of plasma progesterone, estradiol, LH and FSH, presently on analysis, which probably gives additional information to the discussion whether ultrasonography can be a useful tool to monitor ovarian function of reindeer.

Rumen bacterial diversity in two different sub-species of reindeer determined by sequence analysis of 16S rDNA libraries

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Microbial symbiotic digestion of plants and lichens in reindeer is essential to the survival of both the symbiotic microorganisms and their ruminant host. We propose that reindeer since their appearance about 15 million years ago have developed a unique microbial rumen ecosystem influenced by nutrients and seasonal factors not yet understood. Furthermore, we predict that the rumen ecosystem varies between different sub-species of reindeer and that it differs from that of domestic ruminants like sheep and cattle. To test this hypothesis we have employed molecular techniques based on sequence heterogeneity of the 16S rDNA. These molecular techniques can be used to classify microorganisms into a meaningful phylogenetic system and enable us to study microbial ecology within complex natural communities like the rumen. Molecular diversity of rumen bacteria was analysed by PCR amplification and sequencing of 16S rDNA clone libraries prepared from whole rumen contents from Svalbard reindeer (*Rangifer tarandus platyrhynchus*) on late summer pastures on Svalbard and semi-domesticated reindeer (*R. t. tarandus*) on natural summer pastures in northern Norway. A total of 99 clones from the two libraries, containing almost full size 16S rDNA sequences (about 1.5 kb), were completely sequenced and subjected to on line similarity search and phylogenetic analysis using the neighbour-joining method. In the library from Svalbard reindeer (28 clones), 43% belonged to the *Cytophaga-Flavobacter-Bacteroides* bacteria and 57% to the low-G+C Gram-positive bacteria. In the library from Norwegian reindeer (71 clones), the sequences were affiliated with the following phyla: *Cytophaga-Flavobacter-Bacteroides* (30%), low-G+C Gram-positive bacteria (69%) and *Proteobacteria* (1%). The 16S rDNA sequences analysed in this study represents novel rumen bacteria not previously isolated or characterised and different from those reported in domestic ruminants. Their functional role therefore still remains unknown.

Connection between physical condition of the animals and meat quality in reindeer (*Rangifer tarandus tarandus*) and red deer (*Cervus elaphus*)

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The term 'meat quality' is widely used and often means different things to different people, e.g. safety, healthiness, tenderness, texture and flavour are all important aspects of meat quality. One way to measure meat quality is to measure muscle pH values. The pH value, which is dependent on the amount of energy (glycogen) stored in the animals' muscles at slaughter, affect shelf life, tenderness, colour and water-holding properties of the meat. After slaughter, glycogen is metabolised to lactic acid and the pH value drops from about 7.0 in the living muscle to about 5.5 in the meat. The rate of the pH decline varies between animal species. In carcasses from reindeer and red deer ultimate pH values have been measured in the meat at 15-20 h *post mortem*. If there is not enough glycogen in the muscles at slaughter the pH value will not drop down to 5.5 but stay on a higher level. A value above 6.2 is generally known as a quality defect called DFD or dark-cutting meat. DFD shortens shelf life especially for vacuum-packed meat, and is most commonly found in meat from ruminants like cattle, sheep, reindeer and deer. There are mainly two reasons for low glycogen levels at slaughter, i.e. poor physical condition of the animals and thereby no - or low - energy stores in the muscles and pre-slaughter stress, which consumes muscle glycogen. Animals in good physical condition will consequently be better equipped to deal with the stress involved in normal pre-slaughter handling. In two comprehensive studies from Sweden (reindeer, n=3400) and New Zealand (red deer, n=3600) high ultimate pH values (DFD meat) was found in both species. In these two studies, very poor physical condition of the animals, stress during pre-slaughter handling and the combination of these two factors were related to the frequency of DFD. Feeding reindeer and deer commercial feed mixtures (pellets) have been demonstrated to improve muscle glycogen stores and thereby lower ultimate muscle pH. However, the feeding also affected other characteristics like nutritional composition and flavour attributes of the meat from both reindeer and red deer.

Comparative sensory analysis of North American reindeer, muskoxen, caribou, and wapiti meat

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Consumer demand for leaner, healthier meats has become apparent in North America. However, choice will be a combination of comparison among species, as well as the effects that age and sex may have on quality. During the previous ten years, we have studied meat production and sensory quality in reindeer (*Rangifer tarandus*), muskoxen, (*Ovibos moschatus*), caribou, and farmed North American wapiti (*Cervus elaphus*). Animals were either slaughtered in federally-inspected abattoirs or under inspected field conditions (temporary abattoirs). Although wild species are generally leaner than conventional livestock species, older animals do become fat prior to rut with their meat remaining almost void of marbling. The quality of meat from loin roasts of these species were compared in professional, trained taste panels for colour, taste, texture, and smell. Meat fiber and particle type tended to vary between the four species and influenced the panelist's appraisal of tenderness. Sensory characteristics appeared to vary with type of slaughter process and ante mortem handling and nutrition.

Poster presentations

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Animal performance and palatability of an Alaskan produced reindeer diet

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The lack of a regionally produced diet and the high cost of shipping feed to Alaska have prohibited the development of an intensively managed reindeer industry. A diet developed from locally grown barley (80%), chopped brome hay, *Bromus intermis* (10%), and fishmeal (3%) was fed to a reindeer herd at the Agricultural and Forestry Experiment Station, University of Alaska Fairbanks. Production of animals fed this diet was determined. Average birth weights were 6.53 ± 0.17 kg for females and 6.83 ± 0.21 kg for males and growth rates were 0.34 ± 0.01 kg/day for females and 0.33 ± 0.01 kg/day for males. Maximum female bodyweights from six months to 5.5 years were 62.85 ± 1.57 kg, 93.73 ± 1.52 kg, 106.89 ± 2.61 kg, 108.38 ± 3.08 kg, 115.85 ± 3.31 kg, and 114.73 ± 2.46 kg, respectively. Nutrient and fiber concentrations, digestibility, palatability, dry matter intake (DMI) and animal performance of diets using barley varieties, Thual, Finaska and Albright were evaluated for cost effectiveness while maintaining adequate animal performance. During winter, reindeer fed a Finaska-based diet maintained a higher winter weight than on a Thual-based diet (P=0.000), but there was no difference in DMI (P=0.297). During summer, reindeer demonstrated greater DMI on the Finaska-based diet than on the Thual-based diet (P=0.000). Reindeer typically show a strong seasonal variation in nutritional requirements where maximum productivity can be achieved by the addition of rumen undegradable protein (RUP) or escape protein. Alaska's fishing industry caught 2.2 million metric tons of fish and the fish processing industry produced 70 000 metric tons of fishmeal in 2000 from pollock, cod, and salmon, which have RUP properties. Utilizing this locally available protein in reindeer diets may have significant effects on animal performance while reducing the risk of transmissible animal product diseases. Whitefish meal, salmon meal, and soybean meal based diets were tested for preference, animal performance, DMI, nutritional characteristics and digestibility. In winter, the reindeer preferred diets containing salmon meal (P=0.025) and soybean meal (P=0.000) to whitefish meal. The same group showed greater DMI for the diet containing whitefish meal during the summer (P=0.000).

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Milk production and composition in reindeer

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Milk yield and composition of major milk constituents were measured in captive reindeer nursing young. Milk production in respectively 5 and 6 does was measured during the lactation cycle of 2001 and 2002. The milk yield was significantly affected by week of lactation (P<0.0001) and by individual (P<0.0001). The individual variation in milk yield could not be explained by effect of age (P=0.24), weight (P=0.69) or dominance rank (P=0.53). The lactation curve had an asymmetrical peak three weeks post partum and the milk yield at peak lactation was 1037 g/day (range 595–1239). From peak lactation the milk production decreased linearly (P<0.0001) until week 25 post partum where milk production was terminated. Mean values for content of major

milk constituents were 14.6% fat, 9.5% protein and 2.5% lactose. The content of fat and protein increased markedly throughout the lactation cycle ($P<0.0001$), while lactose content decreased ($P<0.0001$). The milk composition was significantly effected by week of lactation ($P<0.0001$). Milk yield, corrected for week of lactation had no significant influence on milk composition ($P=0.29$) and sex of the calves had no significant effect on either milk yield ($P=0.9141$) or milk composition ($P=0.32$). The relationship between protein (P) and fat (F) was: P = 3.34 + 0.43 F, and the slope of the regression equation was highly significant ($P<0.0003$, SE±0.05). The caloric value of the milk energy content at peak lactation was 6.65 kJ/g and increased linearly during the course of the lactation ($R^2=0.96$, $P<0.0001$). From peak lactation the total energy output was negatively correlated to stage of lactation ($R^2=0.91$, $P<0.0007$). In a life history perspective the development of a viable calf during the short summer is essential, and the high protein and fat content probably represent an optimum to meet both the growth and energy requirements of the calf. However the maternal investment must be traded against own requirements to replenish body reserves in this period. It is in the mother's interest to invest heavily in the early lactation to maximize calf growth and secure calf survival at the early phase of life, and then restricting the suckling frequency and milk production to encourage the calf to evolve the ability to achieve solid food on their own. Hence, decreasing rate of maternal energy transfer during the course of lactation is a balance between the present and future calves.

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Moose (*Alces alces* L.) winter food in lower of Vilyui River (Central Yakutia)

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The ecology of the moose population in Yakutia is not studied well enough, particularly moose nourishment during the severe winter conditions. Earlier it has been considered [Egorov (1965); Mammals of Yakutia (1971); Popov (1982)] that the moose were feeding on shoots of willow in the winter period. Since that time there were much changes in moose ecology owing to sharp increase of all-terrain transport belonging to local people. In winter because of much disturbance the animals that earlier have grazed in the willow woods in large and middle rivers valleys now prefer grazing in dwarf shrub birch thickets situated in watersheds. In 2001-2002, according to an initiative of the Department of Biological Resources of the Ministry of Nature Protection of the Sakha Republic (Yakutia) studies of moose winter feeding in the lower of Viluyi river were carried out. Like all other territory of Yakutia larch forests (*Larix gmelini*) prevail here. They are not much important for moose winter feeding but after forest restoration after fire when the undergrowth of birch and willow appears these places become favorite for moose grazing. In pine forests (*Pinus silvestris*) shoots and needles of young pines are edible. The thickets of willow and birch woods are very important for moose nourishment. It was revealed that in early winter (the first half of November) moose prefer to browse shoots of willows (*Salix*) in the burned out places and along creeks. Due to reasons mentioned above willow woods along the large rivers are not often visited by a moose. In shallow creeks intensity of grazing is so high that many branches of willows (higher than 1 m) are semi-dried. In 2001, because the high snow cover (65-80 cm) small willows of 60-70 cm height were not grazed. In 2002, the height of snow cover was 20-25 cm and consumption of small willows was registered. From the second half of November (the temperature is lower than -40 °C) moose prefer to browse shoots of *Betula fruticosa* in birch thickets. Shoots of 4-6 year age of *Betula fruticosa* with diameter of 1.5-3.0 mm and from 20 up to 40 cm in length are more consumed by moose. Moose can feed off two, up to seven shoots simultaneously that decreases energy expenditure when getting food. Polar hare (*Lepus timidus*) should become a food competitor of moose during the next peak of polar hare number that is expected to happen in the nearest future.

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The effect of age and nutrition on the expression of monocarboxylate transporters in the rumen and small intestine of reindeer

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In ruminants short chain fatty acids (SCFA), mainly acetate, propionate and butyrate, are produced by fermentation of carbohydrates in the rumen. SCFA are absorbed transcellularly across the gastrointestinal epithelium, but the mechanisms for transport are not completely understood. The Na^+/H^+ exchange, which acidifies the vicinity of the luminal side of the epithelium, may explain the diffusion of SCFA into the epithelial cells but not the transport from the cells into the blood. A possible carrier system for SCFA is the family of monocarboxylate transporters (MCT), which co-transport non-protonated forms of SCFA, lactic acid and ketone bodies together with a proton. To study the expression of different MCT isoforms, samples were taken from the rumen and small intestine of 16 female reindeer and 16 calves. Half of the reindeer belong to the group that had

been grazing freely and the rest fed a commercial feed. Samples were also collected from the rumen of 10 young calves that died violently at the age from 2 to 37 days. MCT1, MCT2 and MCT4 and in the young calves also CD147, a chaperone protein needed for the full activity of MCT1 and MCT4, were detected by Western blot. MCT1 was present in both tissues studied and the amount was significantly higher in the rumen than in the small intestine (P=6.6x10^{-10}). MCT2 was not found in the rumen at all and in the small intestine the expression was low. MCT4 was found in both tissues. There were no differences between the adults and the calves. MCT1 and MCT4 were also detected in the rumen of young calves. The expression of CD147 was lower in newborn calves than in the calves over 10 days of age and there was a positive correlation between MCT1 and CD147 (r^2=0.471; P=0.0285). In the adult reindeer the expression of MCT1 in the rumen and MCT2 in the small intestine was higher in the grazing group (P=0.005 and P=0.0009, respectively). The data suggest that MCT may be inactive in newborn calves but in ruminating reindeer it may facilitate the transport of SCFA from the gastrointestinal epithelium into the blood.

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Estimation of energy costs of consuming browse

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Both summer leafy browse and winter woody browse contain plant secondary compounds (2°) that deter herbivory directly through toxicity and indirectly via post-ingestive feedback. Nevertheless, browse is an important constituent of diets and its consumption likely has negative dietary consequences. Some 2° compounds lower digestibility; others could possibly increase the heat increment of feeding (HIF) (White & Lawler, 2002. *Comp. Bioch. Physiol.* Part A 133: 849-859). Thus, post-ingestive effects of browse could lower the net energy (NE) value of a meal. There are no estimates of energetic consequences of consuming plants high in 2° compounds in arctic ruminants. We recently developed a technique to determine the HIF of a single meal using the muskox (Lawler, Bowyer & White, in review. *Br. J. Nutr.*), and we now report preliminary estimates of the effect of woody and leafy willow, *Salix alaxsensis* (*S.al*), and birch, *Betula nana* (*B.na*), on HIF and NE value of mixed browse-hay meals. Using indirect calorimetry and a standard meal size (10 g·kg$^{-.75}$), we found mean (± sem) HIF (kJ·kg$^{-.75}$) of hay at 29±1.3 (n=11) in winter and 30±1.5 (n=8) in summer and these values were within 1 and 5% of expected values based on diet composition. Mean HIF of *S.al*-hay mix in winter (26±2.0, n=16) was equivalent to hay and was less than summer (41±2.3, n=4). Likewise, mean HIF of *B.na*-hay in winter (31±1.1, n=9) was less than summer (41±3.7, n=4). On a dry matter basis, the woody twigs of *S.al* and *B.na* were not associated with an increase in HIF, however, when expressed per unit digestible dry matter (DDM, g) HIF of woody *S.al*–hay (5.7 kJ·g^{-1} DDM) was equivalent to hay (5.0 kJ·g^{-1}DDM), whereas leafy *S.al*-hay and woody and leafy *B.na*–hay were higher (respectively 7.0, 11.0 and 10.3 kJ·g^{-1}DDM). Thus mixing browse with hay lowered the NE of hay (43% GE) both in winter (*S.al* 34% GE, *B.na* 11% GE) and summer (*S.al* 26% GE, *B.na* 10% GE). Theoretically, woody and leafy *S.al* contribute NE to the mixed diet, whereas the high HIF of *B.na* per se yielded no NE.

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Study on calf production in the Finnish reindeer herding area

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While >70% of reindeer slaughtered in Finland are calves it is obvious that calf production is an important measure affecting total productivity and profitability of reindeer husbandry. In the present study, factors affecting calf production with respect to maternal and offspring characteristics were investigated. The study was carried out in nine reindeer herding districts in Finland in 1999-2001. The reindeer studied were marked individually: hinds with numbered plastic collars and calves with ear-tags and/or mortality indicating radio-collars. The total number of hinds in the study was 1371, 1960 and 1491 in 1999-2001, respectively. During the study altogether 3400 calves were marked and their survival was followed. Weighing and measurements of study animals were carried out before and at calving in spring, during earmarking in summer and at round-ups during autumn and winter. Condition of hinds was grouped focally in three classes. Pregnancy of hinds was monitored with transrectal ultrasonography in January 2000 the average pregnancy rate of study hinds being 92.8% (n=1265, range by districts 85.2-97.4%). Young hinds (2-3-year old) had lower pregnancy rates (87.0%) compared to older hinds (4-10-years old: 94.1%; >10-years old: 94.6%). The calf-% of collared hinds in the ear-marking of the subsequent summer in 2000 was on average 83% (n=1373 hinds, 7 districts; range by district 61-91%), and 85% (n=803 hinds, 4 districts; range 72-90%) in 2001. The calf-% in early winter round-ups was on

average 76% (n=1315, 8 districts; range 49-89%) in 2000 and 73% (n=634, 4 districts; range 57-83%) in 2001. Both live and slaughter weights of calves in the group of young hinds were significantly lower (P<0.001) compared to calves of older hinds. The autumn weights of calves reared by hinds in good body condition during previous autumn were higher compared to calves of hinds in intermediate/weak body condition (P<0.01). Calves born earlier and with higher birth weight had higher autumn weights and better survival compared to calves born later and having lower birth weight. The hinds in good body condition were heavier compared to hinds in weaker body condition (P<0.001). In conclusion, body weight, condition and age of hinds affected pregnancy rates and calf rearing success of female reindeer.

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Size in disguise: Discrimination against large size individuals

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The effect of environment on size and growth rate of large herbivores has long been recognized, and intraspecific differences in size due to variation in habitat quality has been documented. The relation between a population and its environment can be measured by means of the size and condition of individuals. Within a generation a decrease in habitat quality can produce smaller individuals with equal body condition, because selective phenotypic pressure for an optimum adult body size reduces growth. The present study investigated by means of mandible length and dressed carcass weight the growth dynamic and body condition of female reindeer in a relocated population in South Greenland. I compared growth curves for total mandible length and the anterior and posterior parts of the mandible and weight from female reindeer. Compared to the population of origin the average mandible size of relocated female reindeer has decreased since relocation as has average weight. Observed skeletal growth period (5 years) was longer than seen in other wild reindeer populations, and terminated later than muscular growth (age 4). Growth of anterior and posterior part of the mandible may indicate potential of compensatory growth from *post partum* stage to age 2.5 years, if habitat improves. In spite of the reduced body condition, there was an ovulation rate close to 100% (yearlings and adults) in autumn and three out of 55 yearlings were lactating, indicating conception as calves. The reduced skeletal growth in relation to the reduced weight is not sufficient to maintain the same condition index, so if habitat quality does not improve, a further reduction in skeletal size may be necessary to maintain adequate condition index.

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"When it rains on the vicar some drops fall on the parish clerk" *or* Reindeer and their skeletal ratio – effect of climate on cohorts

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The development of different body tissues in-utero and post-partum in Cervids is strongly related to the conditions experienced by the mother, which in turn is dependent on temporal variation in climate and thus variation in quality and quantity of forage plants. The effect of adverse environmental conditions experienced by cohorts before birth persist through lifetime although some compensatory growth occurs. The present study investigated the effects of temperature and precipitation in the year of birth on the variation of two phenotypic traits - skeletal ratio and dressed carcass weight - among cohorts of reindeer in South Greenland. Variations in skeletal ratios of cohorts correlated with mean temperature in February and with precipitation in April and May in the year of birth. Variation in mean cohort weight correlated with precipitation in winter. Reindeer born following warm winters with less precipitation were bigger than reindeer born following cold winters with more precipitation.

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Calving in captivity: Protocol and efficacy of a field application to raise recruitment of a threatened woodland caribou population

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The Chisana herd of western Yukon Territory and Wrangle-St. Elias area of Alaska is the latest threatened woodland caribou (*Rangifer tarandus caribou*) population (Farnell & Gardner, 2003). This genetically distinct

population (Zittlau *et al*., 2000) currently numbers less than 350 animals and annually recruits only 0-14 calves per 100 adult cows. Thus, the population is ageing, has a highly skewed sex-ratio (17-23 m: 100 f), suffers high neonatal predation, and is subject to extirpation. Managers and stakeholders agree the population should be protected. Management approaches include: encourage predator control by local people through trapping and hunting, a complete hunting closure on this herd in the Yukon and Alaska, and use of a predator exclosure for captive calving to increase neonatal calf survival. In March 2003 we enclosed 8 ha of white spruce woodland and open upland tussock tundra using a 1.5 m fence of geocloth as a visible barrier. The enclosure was adjacent to preferred post-calving habitats, close to a lake for transport and water, and situated on a side hill for ease of visibility. From 25-27 March 2003, 20 cows were net-gunned and individually transported inside a helicopter to the enclosure. They were weighed, ultra-sounded for pregnancy and to measure rump-fat, and examined for overall body condition. Blood was collected to confirm pregnancy status, and a radio-collar with visual band was fitted. Natural forage in the enclosure was supplemented with moistened lichens (*Cladina* sp.) and a commercial pelleted reindeer ration (15% CP: Unifeed, Okotoks, Alberta). Seventeen cows were pregnant and gave birth between 13 May and 7 June. Cows and calves were released 13 June, when the median age was 3 wk. Cows and calves moved 20 km to their typical range in Alaska, and were joined by other caribou. As of 24 June, all calves were alive. This compares with 23 radio-collared cows in the wild, 16 were pregnant and calved during late May and 5 calves were alive as of 20 June.

Farnell, R. & C. L. Gardner. 2003. Status of the Chisana Caribou Herd 2002. *Yukon Fish and Wildlife Branch Report* TR-03-01, Whitehorse, Yukon, Canada.

Zittlau, K., J. Coffin, R. Farnell, G. Kuzyk & C. Strobeck. 2000. Genetic relationships of three Yukon caribou herds determined by DNA typing. *Rangifer* Special Issue No. 12: 59-62.

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Restoration of forage storage in ecosystems of reindeer ranges

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Possibilities of speeding up restoration of forage plant storage were investigated on overgrazed, burnt and mining-destroyed reindeer ranges. Experiments were conducted in the zone of mountain-taiga Larch open forests. The following methods were used: sawing of grasses and lichens, including using of fertilizers and growth stimulators. The results were:

1. The plots of former mining land are colonized during the first 5-10 years by forbs, during next 10-20 years grasses dominate, bush and tree canopies are formed. In 30-35 years tree-bush canopies become dense and depress forbs that are replaced by mosses and lichens. Restoration of vegetation on overgrazed and burnt reindeer ranges happens by the growth of remaining plants including some species of forbs and grasses. Herbs can dominate during 15-20 years gradually replacing by close to original vegetation.
2. The directions and duration of vegetation successions can be regulated, for example they can be speeded up using simple methods of agronomic technique: For example sawing *Bromus inermis* (30 kg per ha) with mineral fertilizers promoted the crop of green mass 9-10 tons per ha. Reindeer ate fresh herbs and hay from this plot willingly. Experiment with lichens was conducted in 3 variants:
   on the experimental plots (1 m^2) plants were eliminated by fire, trampling and artificially removed until mineral layer. Lichen particles (100 g air dry weight) were sawn on the plots. In one year 70-80% of these lichens died: these are mostly middle and low parts 0.5-1 cm long. Upper parts 1.5-2 cm long attached to substrate started to grow. During further 10 years continuous vegetation cover formed gradually where lichens comprised 70-80%. This is two times more compared with natural growing control plots (without lichens being sawed out).

Influence of growth stimulators (gibberelic acid, indolyl acetic acid, cartolin-2) and mineral fertilizers on *Cladina rangiferina*, *C. stellaris*, *Cetraria cucullata* was investigated. Natural lichen cover was totally removed on 450 plots (0.25 m^2) and lichens were sawn. Only living parts of lichens 3-6 cm long were used for sawing (30 g air dry weight per plot). There were no positive results using mineral fertilizers (pure and mixture with stimulators). In all variants of using mineral fertilizers growth rate was less compared to control. After 3 vegetative seasons lichen storage on control plots stabilized. In variants with growth stimulators lichen mass growth continued. Investigation of influence of growth stimulator gibbersib on overgrazed plot (3000 m^2) showed the following: during two growth seasons the lichen mass increase without treatment was 0.442 tons per ha, with treatment the increase was 0.996 tons per ha or 225% compared to control.

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Effects of rapid changes in temperature on fluid balance in reindeer

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Reindeer is well adapted to seasonal changes in temperature, but much less is known about the acute changes in temperature during summer season. We studied fluid balance in 7 reindeer that were transferred from ambient temperature of about 10 °C into the climate room where temperature was either +20 °C, 0 °C or -10 °C. The reindeer were kept at each temperature for 48 hours and there was one week interval between the three temperature tests. Light:dark cycle in the climate room simulated the conditions outside. Each animal served its own control and the control samples were taken during a 48-h period prior or after the temperature trial. Blood samples from the jugular vein were taken at 0, 24 and 48 h. Body temperature, respiratory rate, water and food consumption were recorded and the blood samples were analysed for lactate, cortisol, nonesterified fatty acids (NEFA), osmolality, Na, K, Cl, Mg, Ca, total protein, urea and packed cell volume. Respiratory rate was lower in the climate room than in the pens, but this may be due to environmental factors. Also body temperature tended to be lower in the climate room. Reindeer reduced their consumption of water and feed at every temperature and this was reflected in the body weight and also in the serum concentration of protein. Lactate concentrations were at the same level (4-5 mmol/l) both in the pens and in the climate room and the high level probably reflects the stress of sampling. Cortisol and NEFA concentrations were highest at +20 °C when the reindeer were taken to the climate room for the first time. The subsequent decrease may indicate adaptation. There were no changes in packed cell volume, which may also be due to the strugling during sampling. Urea concentration tended to be lower in the samples taken at the climaroom. There were no systematic changes in the electrolyte concentrations. It can be concluded that the reindeer tolerates well acute changes in temperature, but it is rather difficult to estimate the stress, because blood sampling appears to be too stressful.

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Selfish mothers: Density related changes of maternal investment in reindeer

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Investment in reproduction may compromise future survival and reproductive performance. Having a long life span and giving birth to maximum one calf each year, reindeer (*Rangifer tarandus tarandus* L.) are expected to favour own survival over investment in reproduction under severe conditions. We investigated how variation in density and climate affected live body mass of adult females and calves, and how the environment altered females' relative investment in reproduction. A total of 714 semi-domesticated calves and 1422 adult females with known reproductive status were weighed in the autumn from 1992-2000. Density showed different effect on the body mass of adult females and calves. While body mass of calves decreased with density, the body mass of adult females increased with increasing density. Two mechanisms may explain the opposite response in body mass for adult females and calves. Firstly, the positive effect of density on adult females was accompanied by an increase in the threshold body mass required for females to successfully wean a calf. Hence, only the heaviest females reproduced when densities were high. This implied a cost of reproduction, in terms of mass loss, only on the heaviest females, thus increasing the average body mass in the herd. Secondly, the relationship between the body mass of the mother and her calf was weaker at high densities, suggesting a reduction in relative investment in the calves' growth by the mothers. The results indicate that adult female reindeer favour own mass gain during the summer over reproduction at high density both through a lowered probability of weaning a calf and by reducing the investment in the calves' growth.

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Lipid quality changes in fresh, smoked and dried reindeer meat

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Processing is known to influence different quality attributes of meat products. Lipids oxidize easily, for example when exposed to light or heat. In special products, like dry-cured ham or dry cured salami, a certain amount of volatile lipid oxidation products is desired since they are responsible for the particular taste of these products, but too high amounts will give off-flavours and rancid taste. Some lipid oxidation products are even known to show adverse health effects. Enzymatic activity can lead to high amounts of free fatty acids, which also can produce various off-flavours. The aim of this study was to analyse thiobarbituric acid reaction products as parameter for

oxidation and lipid class composition as an indicator for lipolysis to learn more about the effects of traditional ways of processing reindeer meat. All samples were taken from *M. semimembranosus*. Before smoking, a salt solution was injected into the meat and the curing period lasted for 3 days. Then the meat was rinsed and dried at 40 °C, before it was smoked at 80 °C until a core temperature of 65 °C was obtained. For drying the meat was dry-salted for 4-5 days. Afterwards the meat was rinsed with water, cold-smoked and then dried at 17-18 °C in a well-ventilated room for about 1-2 weeks. A significant change in the amount of free fatty acids (FFA) was shown. Low amounts of FFA in fresh meat, and about 30% FFA in the dried meat were found. The amounts of polar lipids and triacylglycerols were decreased after drying. The smoked meat had intermediate values of FFA. In fresh and smoked meat we found low values of thiobarbituric acid reacting substances but high values for the dried meat. In general, it can be concluded from the present study that the smoking process slightly changed lipid class composition resulting in a small increase of free fatty acids. The drying process gave a high amount of free fatty acids and thiobarbituric acid reacting substances, which indicates greater lipolysis and oxidation. We concluded that the way of processing in this study had a large impact on the investigated quality parameters.

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The effects of wintertime undernutrition on plasma leptin and insulin levels in juvenile reindeer

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The factors that regulate feed intake and cycles of body weight and body fat in animals are poorly known. The species that have clear seasonal cycles in body weight, such as the reindeer, decrease their feed intake voluntarily during winter even if the have free access on high quality food. The effect of a short day-length mediated by hormones such as an insulin-like growth factor or insulin have been proposed to be involved in the endemic regulation of seasonal feed intake and body weight in reindeer and other seasonal species. Leptin, a secretory product of adipose tissue, is believed to play a role in the control of feed intake and body weight cycles in rodents and humans. Studies in highly seasonal species have suggested that plasma leptin is modified by photoperiod, and that low leptin may play a role in saving energy during the long periods of food deprivation during winter. We examined the effects of a prolonged undernutrition on plasma leptin and insulin levels in male reindeer calves (<1 year) during winter and spring. The reindeer were fed their major winter feed, lichen (*Cladina* spp., 3% crude protein in dry matter) *ad lib.* for 5 wks, followed by 40% restriction of metabolizable energy for 8 wks and refeeding for 6 wks. Plasma leptin decreased by 46% and insulin by 54% already during the *ad lib.* period between Jan and Feb with a parallel decrease in body weight (reduction 8%). Leptin remained low during most of the restriction period in Mar and Apr while body weight decreased by further 8%. However, at the end of Apr leptin increased by 54% while insulin decreased by 25%. During the refeeding period in May and Jun, leptin was unchanged but insulin increased two-fold. Similar but smaller reductions in plasma leptin in Jan and Feb as in the lichen-fed reindeer also occurred in the control reindeer fed with high-quality reindeer feed *ad lib.*, although their feed intake and body weight remained unchanged. The results show that plasma leptin decreases in young reindeer during winter irrespective of feed intake. The results suggest that leptin may be downregulated by seasonal factors such as short light period. Low leptin, in turn, may downregulate energy expenditure and inhibit body weight increase during winter.

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Phenolic substances of mountain birch leaves in summer and winter ranges of reindeer

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Plants defend themselves from herbivores by synthesizing secondary metabolites such as condensed tannins and other polyphenolics in the plant tissue, which affect digestibility of the plant. We analyzed effects of reindeer (*Rangifer tarandus*) summer grazing on secondary compounds in mountain birch (*Betula pubescens* ssp. *czerepanovii*) by comparing leaves in summer and winter reindeer ranges in mountain birch forests in Finnish Lapland. In summer ranges, leaves are efficiently consumed up to height where reindeer reach, but in winter ranges, birch canopies are intact. Leaves were analyzed for phenolics using HPLC and condensed tannins using butanol assay. Information of soil and plant N analyses was used for assessing importance of soil fertility and birch nutrient status on phenolic concentrations. Condensed tannins constituted a high proportion of mountain birch leave dry weight, being 185 mg/g d.w.t. in summer ranges and 208 mg/g d.w.t. in winter ranges. There were significantly less tannins in leaves from summer than winter ranges. Concentrations were lower during early than middle of growing season. Phenolic concentrations did not directly correlate with soil fertility. We

infer that reduction in polyphenols as a result of grazing is due to decrease in plant carbon allocation to plant secondary compounds, which in turn is caused by larger need for allocation of photosynthetic compounds to compensatory growth rather than secondary compounds, and by reduced carbon fixation due to reduction in the volume of the canopy.

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Transepithelial transport of energy-rich short chain fatty acids in the gastrointestinal tract of reindeer

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Ruminants produce short chain fatty acids (SCFA) through the process of microbial fermentation of forage plants in their reticulorumen and hindgut. SCFA are the main source of energy for ruminants and cover approximately 70% of their energy requirements. Free-living ruminants such as reindeer (*Rangifer tarandus*) experience large seasonal variations in the quality and availability of forage plants. The seasonal changes in the environment of reindeer have prompted inherent seasonal cycles in their appetite, and pronounced seasonal changes are found in both their ruminal composition of microorganisms and their ruminal surface area. In domestic ruminants, the reticulorumen effectively absorbs SCFA by passive diffusion of the undissociated form and by carrier-mediated transport of the dissociated form. It was recently shown that butyrate also is transported *in vitro* across isolated epithelium of reindeer and that this transport is interacting with the transport of Na^+. Furthermore, it was demonstrated that seasonal changes in the ruminal transport capacity of butyrate exists in free-ranging reindeer and that these changes were related to seasonal changes in forage quality rather than food intake. Absorption of SCFA across the caecal epithelium of Arctic ruminants has never previously been studied. The aim of the present study was therefore to determine the effect of season and feeding on the transport capacity of caecal epithelium in reindeer. Caecal epithelium from free-ranging reindeer taken directly from natural summer and winter pasture and caecal epithelium from captive reindeer fed a concentrate diet (*ad libitum*) in summer and winter was used in the present study. The transport capacity of ^{22}Na and ^{14}C-butyrate across isolated sheets of caecal epithelium was measured in Ussing chambers. Results are currently being processed and will be presented at the conference. Data will be discussed comparatively both between segments in the gastrointestinal tract of reindeer and between species.

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EUROP carcass grading and sensory quality in meat from reindeer (*Rangifer tarandus tarandus*)

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Improved meat production in the reindeer herd is an important subject in today's Swedish reindeer industry. The herd structure can be influenced by different slaughter strategies, where an increased percentage of calf slaughter is a commonly used method to increase the meat production from the reindeer herd. A total of 20 reindeer calves (10 males and 10 females) were included in the study to compare carcass characteristics and sensory quality of various sex and weight. All animals were slaughtered at a commercial slaughter plant, Arctic Deli AB, Harads, Sweden, following the normal slaughter protocol. The carcasses were divided in two groups; light (<20 kg) and heavy (>20 kg). Before cutting, all carcasses were graded for body conformation and fat content according to the EUROP grading system. At 2 days *post mortem*, the weight of the whole saddle (both *M. longissimus* with bone) was registered and *M. longissimus* from the left side was excised, vacuum packaged and frozen at -20 °C. The samples were then transported frozen to the Department of Domestic Sciences, Uppsala University. The meat was prepared in a conventional oven at +150 °C to a core temperature of +68 °C. A descriptive test was carried out by a selected and trained sensory panel, all with previous experience in assessing reindeer meat. The following attributes were selected and unanimously agreed upon during panel training; odour, juiciness, tenderness, flavour intensity, liver flavour, sweet flavour and bitter flavour. The heavier carcasses (>20 kg) had significantly better ($P<0.001$) carcass conformation grading, higher fat content and heavier saddles compared with the light carcasses (<20 kg) for both sexes investigated. There were no significant effects on eating quality of the meat from the different groups. When comparing heavy and light female calves, there was a tendency ($P=0.062$) for the heavy calves to produce meat with a stronger odour. Together with earlier results within this project, the present information will provide a basis for a full economical evaluation of a production model including reindeer in better physical condition and an increased percentage of calf slaughter in the herd.

Session 5 VETERINARY MEDICINE, DISEASES & PARASITES

Keynote lecture

Domestication of ruminant livestock and the impact of nematode parasites: Possible consequences for the reindeer industry

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In a balanced ecological system, both host and nematode parasite populations are firmly controlled by a complex array of interacting factors. However domestication of livestock has tipped the balance in favour of the parasites. This is due to increasing the proportion of susceptible animals in the herd or flock (lactating females and weaned young animals), increasing stocking rate, increasing productivity demands and decreasing the movement of the animals. In contrast with microbial infections, where multiplication takes place entirely within the host, metazoan parasites have both a parasitic phase and a free-living phase. Every worm present has been separately acquired by the ingestion of free-living stages on pasture. Immunity to nematodes develops slowly, it is labile, and its maintenance is dependent upon a good nutritional state of the animal. Consequently, worm parasites are ubiquitous wherever livestock are kept and they impose a constant and often a high infectious pressure on grazing animals. Nematode infections in grazing livestock are almost always a mixture of species. All have deleterious effects and collectively lead to chronic ill thrift. Economic evaluations repeatedly show that the major losses due to parasites are on animal production, rather than on mortality. This paper will focus on the problems of nematode parasites; problems associated with drug use (anthelmintic resistance, environmental impact) and ways towards sustainable nematode control for the common ruminant livestock industries (cattle, sheep, goats), with possible analogies for the semi-domesticated reindeer industry.

Oral presentations

Time-related changes in concentrations of acute-phase proteins in newborn reindeer calves

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At birth, the neonate is rapidly exposed to large numbers of potential pathogens and resistance to infection is determined by the immunity status of the host. Although immunocompetent, the neonate is immunonaive, with immune state being largely dependent on colostrum intake. The protective role of maternal immunoglobulins in colostrum is well known, but many other mechanisms are likely involved in protection of neonates during the first weeks of life. The acute phase response (APR) is a very important host defence mechanism. The exact biological function of acute phase proteins (APP), such as haptoglobin (Hp) and serum amyloid A (SAA), which are produced by hepatic cells during this response, remains obscure. They are believed to play an important role in host protection, and synthesis of these proteins may be involved in the non-specific immunity of neonates. This study was conducted to obtain basic information about immunological and host defence response parameters of newborn reindeer calves in field conditions. Blood was collected from 49 healthy reindeer calves of both sexes at weeks 1, 2 and 4 of life. We found concentrations of serum globulins (non-direct measurement obtained by subtracting the serum albumin value from the serum total protein value) to decrease dramatically in the first two weeks, followed by a further smaller decline. Serum SAA concentrations had large variability among calves, but a clear increase was observed during the first two weeks of life. However, by week 4, SAA concentrations had decreased to levels below those of the first week. Serum Hp concentrations increased throughout the observation period. In conclusion, these time-related changes of APP concentrations in neonates may indicate that they have a role in the defence and adaptation mechanisms of newborn reindeer calves. Possible reasons for these changes include the presence of APP mediators in colostrum, exposure to environmental pathogens after birth and age-related changes in hepatic synthesis of APP.

The role of gastrointestinal parasitism in muskox population dynamics

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Muskoxen on Banks Island, Northwest Territories were nearly extirpated by the early 1900s. In the years following a hunting ban, muskoxen flourished and the population expanded continuously from a few hundred in the 1950s to approximately 65 000 non-calf animals in the 1990s. During the last decade this population appears to have attained a fluctuating equilibrium (65 000 in 1994, 45 000 in 1998, 69 000 in 2001). We examined gastrointestinal (GI) parasitism to determine if this could be a factor contributing to regulation of the population and a driver of apparent population cycles in these muskoxen. To assess the distribution of parasites relative to host age and sex we examined abomasa and fecal samples from animals taken during a commercial muskox harvest in November 1999. Feces collected monthly from free-ranging herds for one year (2000/2001), and monthly collections of adult female muskoxen from March through May, were used to assess seasonal parasite abundance, life history patterns, and abomasal pathology associated with parasitism in the spring. Abomasal parasitism, caused primarily by the nematode *Teladorsagia boreoarcticus,* was severe and was associated with notable pathology, particularly in May. Parasites recovered on fecal examination included *Eimeria* spp., *Marshallagia* spp., Nematodirines, and other trichostrongyles (most likely *T. boreoarcticus*). Based on previous reports from commercial muskox harvests on Banks Island in the early 1980s the levels of parasitism have increased considerably, paralleling the host population increase. Additionally, in general, levels of GI parasitism were substantially greater on Banks Island than in mainland muskoxen in the Inuvik and Sahtu regions at comparable times of the year. A greater abundance of parasites in this island population of muskoxen coincides with considerably greater density and population size for hosts when compared to the mainland. Such may be indicative of a positive linkage between parasite abundance and density of muskoxen. Preliminary evidence of parasite abundance and associated pathology, together with life history traits of muskoxen suggests that abomasal parasitism may be an important regulating factor for muskoxen on Banks Island.

Macroparasites of reindeer in Fennoscandia: parasite population dynamics, control options, and environmental impact implications

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With the aim of determining the seasonal dynamics, impact, and identification of the best time for treatment intervention, a long-term (2002-2005) study has commenced on the gastro-intestinal and pulmonary nematode parasites of semi-domesticated reindeer at the Kaamanen Reindeer Research Station and Experimental Station in northern Finland (69°N,27°E). The population dynamics of roundworms is being monitored by monthly faecal egg counts in two age classes of reindeer and by estimating the pick-up of infective larvae from the grazing environment by the sequential use of 4 worm-free ('tracer') reindeer calves, every 8 weeks. Since June 2002, the mean number of nematode eggs$\cdot$g^{-1} faeces (mEPG) was higher in calves (mEPG=47) than in adult female reindeer (mEPG=29). In adult animals, *Capillaria* spp. was prevalent in December (mEPG=120), although it was not detected in February, March, or in June. *Ostertagia* spp. eggs were ubiquitous in adults, with a major peak in September (mEPG=90). Nematodirinae were not detected in adult reindeer. *Capillaria* spp, *Ostertagia* spp, and the Nematodirinae were present every month in calves, although mixed infections were rare. *Capillaria* was most abundant in December (mEPG=103), *Ostertagia* in September (mEPG=88), and the Nematodirinae in November (mEPG=97). Female calves (mEPG=79) excreted more eggs than male calves (mEPG=61), especially *Capillaria.* From December 2002 through March 2003, tracer tests illustrated that larval pickup from pasture was highest in December (x=343) and lowest in March (x=100). Male calves (x=276) harboured marginally more nematodes than female calves (x=229). The predominant taxa were *Ostertagia* spp of the abomasum and the Nematodirinae of the small intestine. A previously unreported feature of these infections is the high level of inhibition of the early fourth larval stage of development, suggestive of a survival mechanism to enable the parasite to escape adverse environmental conditions in the external environment.

Poster presentations

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Use of jugular vein cannulation in frequent blood sampling of reindeer hinds: a case report

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In relation to the experiment described elsewhere in this abstract book by Säkkinen et al., blood samples were collected every three hours from five multiparous reindeer (altogether 41 samples per animal) between 17 Oct (9 a.m.) and 22 Oct (9 a.m.) to determine the concentrations of plasma estradiol, progesterone, LH and FSH around ovulation. To facilitate blood sampling, 16 G cannulae (Venflon, Ohmeda) were inserted into the jugular veins of the animals on 16 Oct. About 10 x 15 cm area of hair was clipped short from the middle third of the neck around the jugular vein for insertion of the cannula. The cannula was inserted caudocranially into the vein and fixed with layers of duct tape placed on each side of the cannula. Finally the neck and the cannula were covered with VetFlex cohesive bandage. The cannulae were closed with a compatible plastic mandrin. The animals were allowed to move freely outdoors in their pen between the blood samplings. At blood sampling, blood was first let to flow for a few seconds after removing the mandrin to guarantee a good quality of the sample. If blood did not start to flow, 0.1-0.5 ml of heparin (Heparin Leo 5000 IU/ml, Leo Pharma AB) was injected into the cannula. After collecting a 10 ml blood sample, a new, disinfected mandrin was dipped into the heparin, and placed into the cannula. In one animal, a cannula, which was located rather caudally, broke from the joint of its shaft, and had to be changed on day three of frequent blood sampling. The new cannula, still located too caudally, had to be changed on day four of frequent blood sampling. In another animal, the cannula was changed on day two for the same reason. The remaining cannulae worked without problems for the period of five days despite of cold outdoor temperatures (-15.7–+2.8 °C). The intravenous cannulae were found suitable when the animals were allowed to move freely in their pen between sample collections, on condition that the location of the cannulae was not too caudal. The cannulae also enabled frequent blood sampling without repeated injections with needles.

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Evolutionary and global change implications of the occurrence of two nasal parasites in caribou on Baffin Island?

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Discontinuous distributions of parasites among host species may be caused by the evolutionary history of host populations, and ecological factors that independently affect the parasites. Anthropogenic climate change and other types of global change may cause changes in distributions of parasites among wide-ranging hosts, but unequivocal conclusions will be difficult because of the array of influential ecological factors, and gaps in our knowledge of pre-historic and historic distributions of the parasites. The sinus worm (*Linguatula arctica*) has been reported in reindeer (*Rangifer tarandus*) in Europe and Asia, but has been reported only once in a caribou in North America (i.e., in western Alaska in 1925). In 1996, a parasite, known locally as taagijuk, was reported in a caribou (*R. t. groenlandicus*) on southern Baffin Island, and later the parasite was identified as *L. arctica*. Although previously unknown among biologists on Baffin Island, Inuit qaujimajatuqangit (IQ) indicates that taagijuk has been common in Baffin caribou at least throughout living and parental memory. Although 550 Norwegian reindeer were moved to southern Baffin Island in 1921, IQ about taagijuk appears to pre-date this introduction. In contrast, the nasal bot fly (*Cephenemyia trompe*) has been described in scientific literature as being circumpolar among caribou; however, neither biologists nor Inuit reported evidence of this relatively detectable parasite in caribou on southern Baffin Island until spring 1997 near Iqaluit. The nose bot has subsequently spread across southern Baffin Island into adjacent hunting areas. The apparently unique historical occurrences of these two nasal parasites may suggest a distinct evolutionary history of Baffin caribou within North America. Although these parasites may have been introduced with Norwegian reindeer, it is unlikely that the nose bot could have gone undetected for 76 years. In the absence of a clear summer warming trend on southern Baffin Island, the recent introduction and spread of the nose bot suggests that another type of global change (i.e., accidental transport) could have significant impacts on the health of wildlife in remote Arctic regions in the future.

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Epizootic outbreaks: a heavier burden on the Komi reindeer herding system than that of the Nenets?

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Diseases such as *sibirka* (Siberian anthrax) have in the past been responsible for significant disruption of Komi reindeer herding, even forcing herders to abandon infected land. We compared the frequency and intensity of epizootic outbreaks among reindeer herded by Komi and Nenets in Russia. We examined, in particular, whether higher incidence of disease among Komi herds might be related to differences in herding practices between the two groups, especially the Komis' unusually long and narrow migration corridors and large herd sizes. The Komi migrate up to 1000 km in a nine month period whereas the Nenets remain more sedentary and move very little for long periods in each season. Our analysis was based on herders' knowledge and published empirical data. Komi reindeer suffer higher incidence of disease and higher rates of mortality from disease compared to Nenets reindeer. It appears that long migrations may (a) weaken reindeer and (b) make it more difficult for herders to identify sick animals and (c) to treat them adequately. Moreover, Komi herders have few options for avoiding poor pastures because they are obliged to move along traditional migration routes over which particular families have more or less exclusive rights. Consequently, they are rarely able completely to avoid ground infected by *sibirka* for the recommended two to three year period following an outbreak, which was a significant problem prior to the availability of inoculations. Despite the higher levels of mortality from disease in Komi herds, there appears to be little difference in overall rates of loss (death and other losses) between the two groups.

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Examination on the occurrence and prevalence of enteropathogenic bacteria and *Cryptosporidium* in semidomesticated reindeer and their zoonotic potential

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The information about pathogens excreted by semidomesticated reindeer (*Rangifer tarandus tarandus*) that might represent a health risk to humans is insufficient. Infections may be accomplished through consumption of contaminated reindeer meat or through contamination of the environment due to faecal shedding. The objectives of this study are to figure out the occurrence and prevalence of important enteropathogenic, zoonotic bacteria and parasites in reindeer and to provide recommendations for human health risk calculations. Faecal material from 2243 clinically healthy, semidomesticated reindeer from northern regions of Finland and Norway was sampled, considering parameters such as age, degree of intensification of husbandry, location and season. Subsequently, samples were examined for important enteropathogenic bacteria (*Campylobacter* spp., *Enterococcus* spp., *Escherichia coli*, *Salmonella* spp. and *Yersinia* spp.) and parasites (*Cryptosporidium*) following standard procedures. Enteropathogens were found in 2224 (99.2%) reindeer faecal samples. *Escherichia coli* were isolated in 2168 (96.7%), *Enterococcus* spp. in 2041 (91.0%), *Yersinia* spp. in 139 (6.2%) and *Campylobacter* sp., identified as *C. hyointestinalis*, in one sample only (0.04%). There was no evidence of the occurrence of *Salmonella* spp. and *Cryptosporidium*. All enteropathogenic organisms examined in this study were found before in faecal material from semidomesticated reindeer in Fennoscandia (*Yersinia* spp. being isolated for the first time from reindeer in Norway). *Cryptosporidium* has been reported only from reindeer in North America. This study clearly shows that *E. coli* and *Enterococcu*s spp. belong to the normal intestinal flora of healthy reindeer. However, only certain strains possess the ability to cause severe health problems in humans and also animals, and thus, further analysis of virulence factors is required and ongoing (*e.g.* for genes encoding *E. coli eae, hly, stx1,2*); as done as well to determine pathogenic strains of *Yersinia* spp. (PCR, biochemical reactions). As all organisms examined in this project may also be found in the environment in aquatic, terrestrial and animal reservoirs, one has to regard the epidemiological impact of transmission of these infectious agents from the environment to reindeer and man and vice versa. Even though the public health risk due to reindeer shedding *Campylobacter* spp., *Salmonella* spp. and *Cryptosporidium* has to be considered very low at present – as proven in this study-, a putative epidemiological threat to human health exists through important potentially zoonotic, enteropathogenic bacteria excreted by reindeer in Fennoscandia.

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The hygienic quality of raw reindeer milk

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The purpose of the study was to get a picture of the total bacterial count (tbc) and somatic cell count (scc) of raw reindeer milk and also to look into its microbial flora in general and mastitis pathogens in particular. The information would be useful in the enforcement of hygiene requirements and in searching for ways to improve and promote milk production in reindeer. Two groups of 4 animals were milked on alternate days at the research station in Kaamanen, Finland between 1 July and 9 August 2002. A milk sample from each quarter was taken at milking and a sample of the bulk milk at the end of milking. The quarter samples (n=318) were examined for aerobic bacteria causing mastitis. *Micrococcus* sp. growth was observed in one, *S.aureus* (1100 cfu/ml) in one and coagulase-negative *Staphylococci* in 5 samples. The tbc in the bulk milk (n=20) varied between 700 and 1 700 000 cfu/ml (average 294 000, median 110 000 cfu/ml) and the scc of milk from healthy animals between 52 000 and 183 000 cells/ml (average 111 000, median 109 000 cells/ml). No *Bacillus cereus, Staphylococcus aureus* or *Listeria monocytogenes* were detected in the bulk milk, but there were *E. coli*-bacteria (320-52 000 cfu/ml) and bacteria of the family *Enterobacteriaceae* (370-47 000 cfu/ml) in 5 samples. According to the bacteriological examination the udder health of the reindeer was good. One exceptionally high scc (211 000 cells/ml) reflected the only case of mastitis. The study gave representative information on the scc of healthy machine-milked reindeer. None of the common potential food-poisoning bacteria were found in raw milk. There was great variation in the bulk milk tbc and the average tbc was rather high. The high counts of *E. coli* in 2 bulk milk samples indicate fecal contamination. These counts do not correlate with tbc, which should be taken into account in quality control. Raw reindeer milk is well suited for food manufacture due to its hygienic quality. However, the results indicate that the milking conditions may be a crucial factor affecting the quality of raw reindeer milk. Milking a semi-domesticated animal is no easy task and warrants more attention. Milking should take place in a peaceful atmosphere that makes it possible to keep the animals, the floor and equipment clean.

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Ungulate parasitology in the Canadian north

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Beginning in 1994, parasitologists, biologists and veterinarians comprising the Research Group for Arctic Parasitology (RGAP) have investigated parasites of muskoxen, thinhorn sheep, caribou, mountain goats, black and grizzly bears and lynx, in northern Canada. Efforts have focussed on biodiversity assessment, emphasizing host and geographic distribution, biogeography, life history, epizootiology, effects on hosts, and the potential influence of climate change on host-parasite ecology. We have described one new genus and two new species of nematode (*Umingmakstrongylus pallikuukensis* in the lungs of muskoxen; *Teladorsagia boreoarcticus* in the abomasa of muskoxen and caribou), and recognized new host and geographic records for protostrongylid nematodes (*Parelaphostrongylus odocoilei* in the skeletal musculature, and *Protostrongylus stilesi* in the lungs, of thinhorn sheep; and *P. stilesi* in muskoxen). We have completed serosurveys for *Toxoplasma gondii* in caribou and muskoxen. We have elucidated the life histories of *U. pallikuukensis* and *P. odocoilei* and assembled epi-zootiological data on *U. pallikuukensis*, *P.odocoilei*, *P. stilesi*, and *T. boreoarcticus*. Since 1998, we have examined more than 5000 fecal, abomasal and tissue samples from northern ungulates from Alaska, the Yukon, the Northwest Territories and Nunavut to determine baseline, geographic and seasonal patterns of parasite distribution. We have used sequence analyses of mitochondrial and nuclear DNA to confirm the geographic distributions of *P. odocoilei*, *P. stilesi* and *U. pallikuukensis* (using live larvae in feces), and to investigate the systematics of *Besnoitia* in caribou and reindeer. Parasite-induced pathology and host ecology suggest that *U. pallikuukensis* and *T. boreoarcticus* have potential to affect population dynamics for muskoxen. Using a 1970s collection from Dall's sheep in the Mackenzie Mountains, NT, we have sought to establish historical baselines for helminth diversity to assess the potential for ecological perturbation linked to global climate change. Climate-based predictive models are in development to further investigate the possible effects of global warming on the ecology of *U. pallikuukensis* and *P. odocoilei* and their hosts, in particular on the seasonally-defined

windows for parasite transmission. These studies will be discussed within a context of host and parasite ecology, and the impacts on the northern environment resulting from resource development and climate change.

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Diseases of northern deer and rational use of reindeer pastures in a reindeer-herder's view

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It is well-known that rational use of pastures is a main condition of the further development of reindeer herding. During all seasons it is necessary to change pastures, to alternate periods of feeding and rest. It is necessary to follow the carrying capacity of each plot of pastures. I have experience in reindeer husbandry for more than 23 years as the manager of Adychyunskaya farm located in mountain taiga zone. In this farm there are four reindeer brigades keeping about 3200 reindeer each. Total number of reindeer in the farm is 11 266 animals. During my work a very strong reduction of the reindeer number has occurred. The causes of the reduction were economic instability, wolf predation, diseases, and also human factor. The most dangerous disease is necrobacillosis, arising because of weather conditions in early autumn, overdue spring, hot summer. In hot summer days reindeer can not normally feed and have no rest. They are circling by hours on the same place because of insect harassment. They strongly loose weight, injure hooves. In such cases we try to be on high windy places, we choose the best places for circling and rest of the deer, more often we use smoke-fires and ice-places. Our parents looked for reindeer in equal, dry, pure, elevated places with rather firm ground near good water reservoirs. They avoided stony places where the animals could wound legs. In this period it is better to refuse using dogs that disturb the animals by barking. There is another hoove disease, we name it «кобот». In an initial stage a deer begins to limp, during three days we let stay. In the fourth day the hooves are cleaned by a knife up to that place where is a center of illness. Then we carefully process by potassium permanganate and close the wound by viscous pitch. If in time and carefully to process the wound, in 6-7 days the animal will be healthy. The illness «кобот» differs from necrobacillosis, any healthy, well-fat deer can fall ill, in particular transport deer.

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Endotoxin-induced acute-phase response in reindeer

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Defence reactions that take place in the host at the early stages of infection or inflammation and in response to tissue damage are known as acute phase response (APR). One of the main changes during APR is hepatic production of acute phase proteins. The serum concentrations of two acute phase proteins, haptoglobin (Hp) and serum amyloid A (SAA), were monitored in reindeer after challenge with endotoxin. Four adult female reindeer received either 0.1 µg/kg *Escherichia coli* 0111:B4 lipopolysaccharide B (LPS) or saline solution via the jugular vein. At the second challenge, treatments were reversed. Blood samples were taken before treatment and after 1, 4, 8, 12, 24, 48, 96 and 168 h. In addition to acute phase proteins, changes in blood chemistry and rectal temperature were monitored. Differences between the LPS and control group were analysed by repeated measures analyses of variance, with treatment and time after challenge as within factors. Some of the reindeer showed clear clinical signs of illness, such as depression and tremor of legs, during the first hours after LPS administration. The endotoxin challenge caused a significant increase of serum SAA (peak 48 h) and a sharp decrease (8-12 h) of serum iron concentrations in all animals. Mean Hp increased in LPS-treated animals at 8 h and staid elevated until 48 h, but individual variation was great and no statistically significant differences were found. Serum urea values began to increase after treatment, but after 4 h, concentrations steadily decreased until 48 h. These changes, identical in both groups, were possibly due to handling stress. Treatment or time effects in other measured parameters (rectal temperature, serum total protein, albumin, cortisol, ASAT, CK, GT, and SDH) were not significant. This investigation demonstrates that challenge of a single bolus dose of *E. coli* endotoxin activates APR and that this model can be used for studying pathophysiology of inflammation and infection in reindeer. SAA seems to be a more sensitive indicator of APR than Hp during infection, and measuring both of these proteins provides optimal information on APR.

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Inventory of ^{137}Cs levels in reindeer summer fodder in the Finnish reindeer management area

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Samples taken by the Reindeer Research Station of the Finnish Game and Fisheries Research Institute during the 1997–1998 summer pasture inventories, and covering the whole the reindeer management area, were delivered to STUK for the determination of ^{137}Cs concentration. The aim of STUK's analyses is to determine which plant species accumulate the highest radiocesium concentrations, and which reindeer herding co-operatives would be most vulnerable to heavy radioactive fallout owing to the type of soil and vegetation. The Chernobyl fallout was low enough, even in most parts of the Finnish reindeer management area, to allow this kind of assessment. Because of the decreasing availability of lichen pasture, the importance of summer fodder is also having an increasing effect on the concentrations measured in reindeer meat during winter. Before gammaspectrometric measurement, all the samples of the same plant species collected from the same reindeer co-operation were pooled to form one sample. The analysed material covers more than 20 plant species, and all of the 56 Finnish reindeer-herding co-operations. The plant species included birch (*Betula*), dwarf birch (*Betula nana*), willow (*Salix*), blueberry (*Vaccinium myrtillus*), bog bilberry (*Vaccinium uliginosum*), cloudberry (*Rubus chamaemorus*), forest wiregrass (*Dechampsia flexuosa*), cow-wheat (*Melampyrum*), willow-herb (*Epilobium*), horsetail (*Equisetum*), bogbean (M*enyanthes trifoliata*), sedge (*Carex*), *Eriphorum*, *Eleocharis*, *Scheuchzeria* etc. About 60% of the more than 1000 samples have currently been measured. The ^{137}Cs concentration appears to vary from a few Bg/kg to 700 Bq/kg dry weight. The results will be presented on maps.

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Pathology of reindeer at slaughter

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Brains from about 50 reindeer slaughtered at the Karasjok reindeer slaughterhouse, Finnmark, Norway, in March, 2003, were screened for pathological lesions indicative for scrapie and other pathological changes, *e.g.* those caused by *Listeria* bacteria and the brainworm *Elaphostrongylus rangiferi*. This is a pilot study to initiate a larger project to elucidate the possibilities of the existence of a prion disease (Transmissible Spongiform Encephalopathy), such as is known from bovines, ovines, caprines, and several cervid species (American deer of the genera *Odocoileus* and *Cervus*), and humans. Although there is no indication of the existence of such a disease in the reindeer in Fennoscandia, it is considered to be wise to have some experience to answer the question even before it is raised by reindeer meat consumers. In Iceland, several hundreds of brain samples have already been tested, all with consistently negative results. However, in Iceland there was strong suspicion of clinical scrapie in two reindeer being in close contact with heavily infected sheep flocks. Unfortunately, the brains of these two animals could never be examined pathologically.

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Experiences about the pregnancy diagnostic with a ultrasound scanner

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The presentation shows experiences about the pregnancy diagnostic of a reindeer *(Rangifer tarandus*) with a real-time ultrasound scanner. A part of the presentation is in digital form (video files, pictures). Some anatomical data are also explained. The pictures show typical findings of the scanning procedure. Instructions for practical scanning will be given. The ultrasound scanner makes the picture using the reflecting echos from different tissues. Soundwaves are sended and received continually, the result is a living video. Depending on the content of fluid in the object (tissue), the picture is showen in gray-scale. Fluids (urin, embronal fluid) are dark, hard tissues (tendons, peritoneum) are whiter. Details of the fetus can be seen, they can also been measured.

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Pb-210 and Po-210 in two Norwegian reindeer herds

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Lead-210 and polonium-210 are natural radionuclides present in lichen due to washout of ^{210}Pb (a radon daughter product) from the air with precipitation. Since the 1960s it has been known that reindeer may contain relatively high concentrations of these radionuclides, especially during winter grazing. Studies on these nuclides in the lichen – reindeer/caribou food chain have been reported from Finland, Sweden, Russia, Alaska, Canada and Greenland. No Norwegian studies on these radionuclides in reindeer have yet been reported. Polonium-210

accumulates predominantly in soft tissues. In the present study, samples of muscle and liver of 10 calves and 10 elder does (mostly 10 years old) from each of the Vågå and Østre Namdal reindeer herding districts were collected during ordinary slaughtering in early December 2002. These reindeer herds were also significantly affected by the Chernobyl fallout. The study aims at studying age effects on levels of the radionuclides in reindeer and compare levels in the two herding areas with those reported elsewhere. The study also assesses to what extent intake of ^{210}Pb and ^{210}Po via reindeer constitute a source of ionizing radiation to reindeer consumers.

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Cs-137 contamination in *Lynx* in relation to reindeer predation

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The Eurasian lynx (*Lynx lynx*) is found over large parts of Norway. Since the mid 1990s annual harvest of lynx has been approximately 100 animals. The majority of bodies are routinely examined at the Norwegian Institute of Nature Research (NINA). Stomach contents have been identified in animals culled up to 1997. In addition lynx muscle samples of animals culled since the 1986 Chernobyl accident have been analysed for ^{137}Cs contamination. The vulnerability of the lichen – reindeer food chain to radioactive fallout will be reflected in the radiocaesium contamination of lynx predating upon reindeer. The current study focuses on ^{137}Cs contamination in muscle of lynx, and describe variations geographically and with time. The analyses of stomach content will help identify the importance of different prey in determining the radiocaesium content of lynx, as deer species like roe deer (*Capreolus capreolus*) and reindeer (*Rangifer tarandus*) are preyed upon in more or less separate districts. Together with the location of for instance reindeer herding districts, emphasis will be given to study the importance of reindeer in the lynx diet in different areas of Norway.

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Contagious ecthyma in semi-domesticated reindeer (*Rangifer tarandus tarandus*): an experimental infection with parapoxvirus obtained from a clinical outbreak in Norway

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The aim of the study was to see whether semi-domesticated reindeer (*Rangifer tarandus tarandus*) were susceptible to experimental infections with parapoxvirus isolated from reindeer with contagious ecthyma, to establish the incubation period, and to look for indications whether a commercial orf-virus vaccine for sheep may prevent the disease. Fourteen one-year-old semi-domesticated reindeer, seven males and seven females, were corralled in mid-April. During an adaptation period of 14 days, the animals were accustomed to a commercial pelleted feed (Reinsdyrfôr, Felleskjøpet, Trondheim, Norway). In addition, they were fed lichen (*Cladina* spp.). After 6 days, two animals were vaccinated with a commercial vaccine (Scabivax®, Schering Plough Animal Health Corp. Norway), based on live orf-virus (strain NZ7) obtained from clinical cases of contagious ecthyma in lambs. The vaccine was applied by a cross-scarification on a close-cropped area medially on the thigh. Twenty-eight days post vaccination, the two vaccinated animals and 6 others, randomly picked, were infected by applying virus on a scarified area, approx. 2x2 cm, of the mucosa of the lower lip. Live parapoxvirus had been isolated from scabs of a reindeer with contagious ecthyma and purified by a Metrizamide-gradient ultra-centrifugation. Virus in TE-buffer was introduced on the scarified area with a cotton stick. Six animals received no treatment and were kept as sentinels, sharing feed and water with the infected animals. Five days post inoculation (p.i.) a small whitish lesion appeared on the infection site in two of the animals. After 12 days p.i., typical ecthyma lesions were visible on the inoculation site in 6 of the 8 infected animals, included the two vaccinated animals. In some animals the lesions had spread from the inoculation site and were present as big continuous processes covering the inside of the lower lip. Twenty days p.i. secondary lesions were seen on other parts of the lips and the gingiva, and in one animal also on the dermal part of the lip. No lesions could be found on any of the sentinels. The experiment revealed that apparently healthy and fit animals might be susceptible to the virus and that the incubation time was only a few days. Although the sentinel animals were taking feed and water from the same troughs as the infected, they did not show clinical symptoms 3 weeks p.i. Immunological analysis may reveal whether they were exposed to the virus or not, and whether the vaccination contributed to a relevant immunological response.

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Intrauterine artificial insemination in the reindeer

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During autumn 1999, estrus cycles of 17 multiparous reindeer were synchronized using intravaginal CIDR devices (Eazi-breed CIDR) for 14 days. The females showed signs of estrus approximately 2 days after the removal of the devices. A vasectomized reindeer stag fitted with a mating harness was used for estrus detection. The crayon marks left by the male on the backs of the females were recorded twice a day to confirm the matings. Semen was collected from three stags under anaesthesia using electroejaculation on the same days the females were in estrus. Inseminations were performed on three successive days with fresh, diluted (once) or undiluted (twice) semen. Each female was inseminated only once. At insemination, estrus, i.e. a slightly open and swollen portio vaginalis with mucous discharge, was confirmed by vaginoscopy. For insemination, unsedated females were restrained in a small crate. First a lubricated speculum was inserted into the vagina. Then an optical fibre (Gourley-Scope) containing an insemination catheter was inserted into the vagina through the speculum. Portio vaginalis was viewed with the optical fibre. Finally the catheter was guided through the foldings of the cervical channel. The passage of the insemination catheter through the cervical channel into the uterus was observed with changing colour of the cervical mucous membrane from pink into a brighter red as the catheter entered the uterus. At the same time the tip of the catheter was released as it arrived into the cavity of uterine body, where an amount of 19-78 million live spermatozoa in an 0,15-0,8 ml (undiluted) or 0,75-1,0 ml (diluted) insemination dose was released. Pregnancies were diagnosed using transrectal ultrasonography and a 5 MHz linear probe (Scanner 450, Pie Medicals). Five of the 12 inseminated females were confirmed pregnant and calved during spring 2000.

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Antibodies against the reindeer warble fly, *Hypoderma tarandi*, in reindeer calves

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Serum samples collected monthly or each second month over a period of up to 26 months (July 1998 - September 2000) from fourteen reindeer calves of the Kaamanen Experimental Reindeer Herd, were assayed for antibodies against Hypodermin C by an ELISA. The first samples were from calves a few days after birth. In addition, samples from eight other calves, of which two were taken few hours after birth, were assayed. Also samples from the mothers of all of the fourteen calves were assayed. Hypodermin C is a serine protease secreted into the surrounding tissue by the *Hypoderma tarandi* larva as it migrates in its reindeer host. Antibodies against this enzyme have been demonstrated to give a certain degree of protection against warble fly larvae in cattle. Anti-*Hypoderma* (Hypodermin C) antibodies are transferred to the newborn calf via the colostrum. The level of antibodies diminished rapidly during the following weeks and was generally at level zero, as in the newborn calf, at the time when the major flying activity of the reindeer warble fly starts in early July. Infestation leads to a rapid increase of antibodies, which diminish during the winter and are at a low level before the next warble fly flying season set in. New infestation the second year after birth leads to higher levels of antibodies than after the first year of infestation. The mother reindeer had high levels of anti-*Hypoderma* antibodies during the whole year, but there is some seasonal variation with a somewhat higher level after each new infestation.

Session 6 REINDEER HUSBANDRY

Keynote lectures

Populations of wild and domestic reindeer in Russia: status and trends

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In 2002, 882 000 of wild reindeer existed in the Russian Federation (RF) according to official data based on air counts since 2000: in Murmansk oblast 7000; in Arkhangelsk oblast 20 000; in Taymyr 350 000; in Evenkia 60 000; in Yakutia 250 000; in Chukotka 90 000; in Kamchatka 5500; in southern Siberian mountains 45 000; in other areas 55 000. In some areas data on reindeer numbers are contradictory: in Taymyr, local scientists believe that there are more than 1 million (Yakushkin *et al.*, 2002); in Chukotka, where thousands of tame reindeer were "stolen" by migratory wild reindeer during the last year the local scientists believe there are 140 000 of wild reindeer. In Yakutia, according to Safronov information, there is a decline of wild reindeer numbers. Up to now, reindeer marking and satellite (or radio) tracking have not been used in RF, causing a gap in knowledge of actual reindeer populations (herds). An archaic paradigm has predominated yet: there is a continuum of reindeer, there is no fidelity of reindeer at localities, and the populations are intermixing. Thus, ceasing of mass reindeer migrations in western Taymyr is explained by displacement of reindeer towards eastern Taymyr and Yakutia (Kolpashchikov, 2000). From my point of view, this decline can be explained by the slaughter of 1.5 million of reindeer in the area during 25 years (Pavlov *et al.*, 1993). The accidents in Chukotka are explained by arrival of reindeer from Eastern Yakutia (Nuvano, 2003). Rather, the Chukotka populations of wild reindeer gave increase followed the catastrophic decline of tame reindeer number and releasing most part of the pastures. We used data on calving and summer grounds, migratory routes, topographic and vegetation maps to predict ranges of reindeer populations. Probably, there are 50-70 reindeer populations (herds) in the territory of Russia. In 1990s, decline of reindeer husbandry was observed in most parts of the RF excluding Nenetsky okrug and Yamal Peninsula where gas and oil development stimulated venison market and reindeer husbandry was flourishing. Destruction of management systems and absence of the State financial support were main causes of the decline. Since 1998, in tundra areas where solid national traditions of reindeer herding existed the husbandry has stabilized because of the state and local supports by money, goods and transportation. For example, in Chukotka, there were 550 000 tame reindeer in 1985, only 80 000 in 1995, but in 2003 there are about 120 000 tame reindeer (Etylin, 2003). In Yakutia, the decline has become slower: in 1992–343 000; in 2000–162 000; in 2002–140 000 (Popov & Alexeev, 2003). However, Yakutia is the only taiga area where a positive trend is observed. In most parts of the taiga zone indigenous people have abandoned herding. Now they practice only hunting wild reindeer.

Reindeer husbandry in Finland

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In Finland, reindeer husbandry is practised in a region that comprises the Province of Lapland and parts of the Province of Oulu. The reindeer husbandry region is situated in the northernmost part of the European Union and its surface covers 114 000 km^2 which is a bit over one third of the Finland's surface. Reindeer husbandry is governed by the herding co-operative system. There are 56 reindeer herding co-operatives (districts). Each co-operative has its own administration, defined borders and area. The number of reindeer and the size of the area vary. All reindeer owners are members of the herding co-operative and their respective rights and responsibilities are determined on the basis of the number of reindeer owned by them. All herding co-operatives are members of the Reindeer Herders' Association which is the central body for them. The number of reindeer is regulated by the Ministry of Agriculture and Forestry through the maximum numbers of reindeer that each herding co-operative can own in a decade. During the current decade maximum revised number of reindeer is 203 700. There are 5485 reindeer owners in Finland of which 800-1000 are Sami. During the reindeer herding year 2001/2002 the total number of reindeer living over winter was 199 708. Reindeer husbandry produced about 2400 tons of meat, 90 000-110 000 skins and 100 tons of antler material. The income of meat production was 13,2 million €. One third of the slaughtered reindeer and the slaughtering income are from the Sami region. The economical turnover of reindeer husbandry amounts to 55-60 million € annually when foodstuffs, souvenirs and reindeer travel services are included in the calculations. About 690 families live from full time reindeer husbandry and about 850 families practises reindeer husbandry as a secondary occupation. The membership of EU from 1995 brought

heavy investments into the reindeer husbandry caused by renewing the network of slaughterhouses. Reindeer husbandry became also liable to VAT (Value Added Tax). Damages caused by predators and the eagles have shown a growing trend. The present number of predators and eagles should be reduced because the compensation systems do not cover all the losses for the herders. Finland has obtained an approval from EU for the reindeer husbandry aid paid from the Northern aid fund that is based on the number of the reindeer. The maximum aid is 27 € per head. The economic situation of reindeer husbandry has gotten worse. The costs of the production have increased faster than the income. The higher costs arise from the price of gasoline and equipment used in herding (snow-scooters, cars etc.). The Reindeer Herders' Association created their own website in 1999 to serve information dissemination better. It is developed continuously side by side with the projects which give new information and bring up new questions. International co-operation should also be developed in a manner where the results would lead for example to common international predator-policy, quality of the reindeer meat and other products, struggle against production costs etc. Please find more information about the Finnish reindeer husbandry from our website: http://www.paliskunnat.fi/.

Research challenges within Fennoscandian reindeer husbandry

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During its development, the Fennoscandian reindeer husbandry has experienced dramatic changes regarding its importance for the subsistence of Sami people, the availability of resources and the relations to the surrounding world. Over time it has responded to these changes with considerably altered husbandry and management solutions. Although the forms of reindeer husbandry have varied, its social and cultural importance for the Sami society has remained. Nowadays it is also the principal upholder of Sami indigenous rights to land and water. Secured sustainability in all its aspects is therefore a necessity by many other reasons than solely providing a livelihood. Reindeer husbandry has to build primarily on general sustainability and adaptability principles because of limited opportunities for artificial reinforcements by external inputs. A hindrance in the continued evolvement and adaptation is that the divergent conditions and roles of reindeer husbandry seem to be poorly understood by the surrounding world. The bulk of research within reindeer husbandry and the applicable research on wild *Rangifer* have been focussed on biological and ecological aspects of animals. To a lesser degree reindeer husbandry has been studied as an integrated human ecological system. More integrative research approaches are needed in the future in order to gain understanding of the evolvement possibilities and difficulties for reindeer husbandry under different scenarios. Among the major challenges for reindeer husbandry today we have a progressing loss and degradation of ranges due to the increasing disturbances and competitions from other land uses such as forestry operations, infrastructural development, recreation activities etc., largely unknown consequences of ongoing climatic change and an increasing pressure on multipurpose indigenous livelihoods and indigenous rights and life-style from the modern industrialized society. Coping with these challenges calls amongst others for the development of adaptive (co)management approaches in various fields, where more than ecologic and economic aspects are considered and scientific knowledge is combined with traditional and local management experiences. Crucial knowledge in these contexts is how various aspects of reindeer husbandry are valued within the Sami society in order to facilitate projections about the kinds of developments we may expect under different external conditions for the industry.

Oral presentations

Satellites, the internet and safe areas, the current status of reindeer herding on the Seward Peninsula, Alaska

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Herding methods have changed considerably since reindeer were introduced to the Seward Peninsula, Alaska in the late 19th century. Initially, Siberian, then, Sami reindeer herders were brought to Alaska to teach Alaska Natives methods of herding. During the 1960s, the introduction of the snow-machine greatly transformed traditional herding practices. Because reindeer ranges were remote, mountainous and road less, an extensive management system developed where herders monitored their herds by traveling considerable distance during winter but maintained sporadic and minimal contact during snow free periods. The population of the Western Arctic Caribou Herd increased from 75 000 animals in the 1970s to 465 000 animals by 1999. During this time the herd extended its fall and winter range to include reindeer ranges on the Seward Peninsula. Unsupervised

reindeer commingled and traveled with caribou as they left the Seward Peninsula. Herders could no longer establish the locations and movement patterns of previously predictable reindeer during snow-free periods when overland travel was difficult. Herders lost significant numbers of reindeer and, in some cases, their entire herds. With the introduction of satellite telemetry, reindeer herding practices are being transformed yet again. We developed a "near real time", web-based, mapping system that reindeer owners can access from their home or village to monitor locations of their herds and emigrating caribou. Satellite telemetry data is received via file transfer protocol, archived, loaded into a MySQL™ database which is used to generate location maps using Generic Mapping Tools and posted to a designated website. The web-based maps are generated automatically to expedite delivery of location data. Herders use this information to monitor herd locations, to reposition animals or hold them in Safe Areas when caribou are nearby. Herding reindeer during snow free periods is often done using helicopters, an expensive herding technique, or by difficult All Terrain Vehicle travel. Locally accessible "near real time" location data allows herders to optimize their management resources and segregate reindeer from migratory caribou herds.

Population trend synchrony of semi-domesticated reindeer in northern Fennoscandia

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We studied population trends synchrony of semi-domesticated reindeer in Finland (12 northernmost herding associations), Norway (West-Finnmark) and Sweden (Norbotten, Västerbotten and Jämtland) in 1961-2000. In overall, herds increased from the mid 1970s until the late 1980s, after which they substantially declined. Correlation coefficients in time series between herds were highly significant, ranging between 0.60 (Norbotten-Västerbotten) and 0.96 (Finland-West-Finnmark), without any common reindeer policy. Explanations for these population trends have been highly variable. Calf harvest, supplemental feeding and anti-parasite treatments were considered as main reasons for the increase in Finland, whilst in Norway it was related to wrong subsidy policy of the state or competition between herders (tragedy of commons). Some sources mention that high figures in Finland in the late 1980s were resulted by lowered demand due to Chernobyl nuclear disaster and bankruptcy of Poro ja Riista, the greatest slaughterhouse. Most commonly, the decline has been related to deterioration of winter ranges as a result from over-grazing. Our results, combining population dynamics and winter weather in Finland, indicate that winters from the mid 1970s until the late 1980s were exceptionally favourable for reindeer according to snow characteristics, whilst during the 1990s occurred several winters with an exceptionally deep snow cover and late snow melt decreasing reproduction and increasing mortality. Relevant winter weather variables correlated with the Arctic Oscillation describing large-scale climatic variation. Therefore, we suggest that these same factors have shaped population trends in a wide area in northernmost Fennoscandia, although some of reasons mentioned above might have exacerbated population up and down.

Selection and effective population size in reindeer

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Since 1986 several reindeer owners in the herding district of Ruvhten Sijte, Sweden apply selection based on calf weight. Their reindeer make up approximately half of the total herd (approx. 5000 animals) within the herding district. The other owners in Ruvhten Sijte did not use individual ear-tags, nor did they weigh their reindeer, and therefore did not select on calf weight. The calves from these non-selected flocks were weighed in 1996 and in 1997. The comparison showed that the owners applying selection had 0.7 kg heavier calves in autumn (before selection). Furthermore, a gene flow model developed for this comparison showed that the total genetic gain in calf weights over the period 1986 to 1997 was approximately 1 kg. If all owners had applied selection, however, the genetic gain had been 2 kg over the same period. The reason for this discrepancy was the mixing of genes between the non-selected and selected flocks because they are on the same grounds during rutting. In future situations where a selection programme is to be introduced in a herding district, it may be difficult for all reindeer owners to begin participating simultaneously. An alternative solution could then be to communally administrate all males within a herding district, such that owners not applying selection based on weights cull all their male calves. This would hinder gene flow from the non-selected flocks to the selected flocks, and at the same time the non-selected flocks would passively gain from selection since their females mate with the selected males. It is important to realise that herd structure, selection and isolation of gene flow may increase the rate of inbreeding (ΔF) within a reindeer population. ΔF can be expressed in terms of effective size (N_e), where $N_e >$ 500 is recommended in conservation biology. It was shown that an actual population size of 2000 is sufficient to

have N_e > 500, with the herd structure and selection procedure applied up to date, even if the non-selecting owners cull all their male calves.

Poster presentations

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State of domestic reindeer husbandry in the Republic of Sakha (Yakutia), Russia

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A number of laws and measures for restoring the herds of domestic reindeer have been passed in the Republic of Sakha (Yakutia) during the last years. But despite this fact the reindeer herds are steadily declining (se table), and the socio-economic situation of the small peoples (nations) of the North has become severely aggravated in the years of transition to market relations. Today reindeer husbandry obviously needs modernization of socio-economic life. Degradation of reindeer herding reflects deep socio-economic crisis in modern conditions. It was found that the reindeer-herding peoples are unprepared in every respect to market economy. Nor is there a market of selling products of reindeer husbandry and neither is there technology of processing the reindeer production.

Reindeer number in Yakutia 1996-2003

		Number by 1st January					% of reindeer number in 2003
		1996	1999	2001	2002	2003	
	REINDEER	**246850**	**177141**	**156237**	**141540**	**136993**	**100**
1	Agricultural enterprises	122550	84563	84497	75434	76073	55.5
2	Subsidiary farm	784	948	887	861	742	0.5
3	Peasant (farming)	217	738	753	660	854	0.6
4	Tribal communities	81008	59340	40885	38688	34860	25.4
5	Subsidiary small-holding	42291	31552	29215	25897	24464	17.9

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The status of the reindeer farm "Yuchyugeisky" in Sakha Republic (Yakutia)

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The experimental reindeer herding farm "Yuchyugeiskii" with more than 6000 reindeer is located in a mountain and forested area in the northern part of Sakha Republic. The reindeer are devided into six herds. They migrate along special routes along the main rivers. They move to highland pastures and upper reaches of the rivers in summer and to lower reaches of the rivers in winter. Now when the farm is faced with the free market economy it has to plan the output and sale of products. Breeding reindeer and sale of animals are promising acticities for the farm economy. Effective and timely struggle against predators would increase the total amount of reindeer. The farm aims are production of food and cloth, preparation of medicines and bio stimulants.

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Economic research programme of the Finnish reindeer husbandry 2003-2007

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The main purpose of the economic research programme 2003-2007 is to give structure, focus and added impact to economic and social research on reindeer husbandry. The programme has three main themes: the production of reindeer meat, reindeer and tourism, and reindeer husbandry as an aspect of society. These have been subdivided into a total of ten interlinked subject categories. The reindeer has had an important role in development of tourism in northern Finland. In the past the explorers and adventurers travelled often by sleigh pulled by reindeer. Gradually the network of roads developed and in 1930s also the northern fells began to attract tourists. Since then the tourism has been grown rapidly and is nowadays one of the main industries in northern Finland. The reindeer is in many ways attached with that development. Various exotic tourist activities can be built around the reindeer, such as rides and safaris made by reindeer sleigh, introduction of reindeer and reindeer

management and service of reindeer-based foods. Nowadays there are already about 70 firms, which afford this kind of activities. The value is about 10 million euros. The tourist seasons coincide conveniently with the annual rhythm of reindeer management. The tourists are important for reindeer husbandry, because they buy a lot of reindeer-based products: foodstuffs, clothes, handicrafts, souvenirs etc. Also, the reindeer is very important aspect of the image of northern Finland. For example the reindeer is used commonly in the marketing of tourist services to increase the attraction of the far north.

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Mapping of reindeer fence between Finland and Norway and around Kaamanen field station using mobile GIS-technology

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There is an agreement between Finland and Norway regarding reindeer fences between these countries. Reindeer fences between Finland and Norway and around Kaamanen field station were mapped during 1997-2002 using an R22 helicopter with GPS-instrument and SkyPower-system. Flying altitude was 20 metres and speed 80 km/h. Results were recorded on the maps (1:200 000 and 1:20 000). The length of reindeer fences and areas between reindeer fence and borderline (>50 meters from borderline) in Finland and Norway were calculated by digital SkyPower-system. The length of the reindeer fence around Kaamanen field station was 27,27 km and fenced area 4380,00 ha. The total length of reindeer fence between Finland and Norway was 717,68 km. The length of reindeer fence on the borderline was 158,84 km. The length of reindeer fence on the Finnish side in Inarijoki and Tenojoki areas (not belonging to the reindeer convention between Finland and Norway) was 198,05 km, and 172,05 km in the convention area. The total length of reindeer fence on the Finnish side was 370,10 km. The calculated area between the reindeer fence and the borderline in the convention area in Finland was 6724,40 ha. The area in Inarijoki and Tenojoki totalled 10 746,90 ha. Norwegian reindeer had so totally 17 471,30 ha reindeer pasture in Finland. The length of the reindeer fence on the Norwegian side was 189,73 km. The calculated area between the reindeer fence and the borderline in Norway was 10 336,50 ha. Finnish reindeer had 7134,80 ha less pasture in Norway than Norwegian reindeer in Finland. However, in the convention area, Finnish reindeer had 3612,10 ha more pasture in Norway than Norwegian reindeer in Finland. The 3 largest pastures from the Finnish reindeer co-operatives of Vätsäri (1213,30 ha), Sallivaara (955,40 ha) and Muotkatunturi (734,40 ha), were given to Norway. The 3 largest pastures from Norway were given to the Finnish reindeer herding co-operative of Näkkälä (3438,80 ha), Käsivarsi (1846,00 ha) and Näätämö (1772,50 ha).

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Norwegian reindeer husbandry: Administration and management

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The Norwegian Reindeer Husbandry Administration (NRHA) is the governmental institution responsible for the implementation of the Reindeer Husbandry Agreement and for the management of the natural resource upon which reindeer husbandry depends. Reindeer are herded over an area of approximately 140 000 km^2 equivalent to about 40% of the mainland area of Norway. Northern and central Norway is divided into reindeer pasture areas that, in turn, are divided into 90 reindeer pasture districts. Reindeer pasture districts are divided into herding units consisting of one or more reindeer owners. Today there are 577 herding units that fully or in part employs about 2800 people. There are today approximately 200 000 semi-domesticated reindeer in Norway, most of these (*ca.* 150 000 animals) in the north of the country. Approximately 1700 ton of reindeer meat was produced in 2002/03 at a value of US$ 12.2 mill. NRHA routinely collects information on a variety of statistics, such as live body mass, carcass mass, birth rates, loss and pasture conditions. About 0.7 mill. US$ a year is administered by the NRHA to research projects concerning reindeer husbandry. The money is mainly divided between scientifically and socially oriented research projects, but some is directed towards intermediary projects as well. A strategical plan sets the rules for the division of these means. Projects that are headed directly towards the reindeer herding industry, and that are to be accomplished in cooperation with reindeer herders, are prioritized. Moreover, emphasize is given to projects which deal with problems that the reindeer herders themselves point at. Knowledge and competence are important premises to meet the challenges of the reindeer herding industry. The development of society and the demand for documentation have led to a situation where knowledge based on research is becoming increasingly important. NRHA is an active user of such knowledge as a basis for administration and decisionmaking. NRHA is also an initiator of research projects that shed light upon especially important challenges of the current reindeer herding industry. A conscious and deliberate aim at research is concidered essential to develop and increase the formation of values in the reindeer herding industry.

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Reindeer husbandry on the north of the Russian far east

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North of the Russian Far East is a vast area with the following administrative units: Chukotsky and Korjaksky autonomous districts, Magadan and Kamchatka regions. Until 1990s this area was a center of reindeer husbandry. More than 1 000 000 reindeer grazed here. All reindeer belonged to the state agricultural enterprises. Most part of Native people, Chukchi, Korjaks, Evens, Etelmens, were engaged in reindeer husbandry, processing and using the products of reindeer: meat, young antlers, hides etc. After implementing market reforms in Russia all reindeer were transferred to private ownership of reindeer herders. But economic program of supporting the herders was not elaborated. After 10 years of reforms reindeer husbandry on the North of the Russian Far East have declined. Currently there are about 150 000 reindeer in the area and the decreasing tendency continue. At present all reindeer are sustained in municipal agricultural enterprises and some support from the state is added. Reindeer herders have necessary medicine for treatment of the animals but still have problems in keeping reindeer. Annual losses due to wolf predation are heavy. Free reindeer ranges are occupied by wild reindeer (caribou), their number increased 5 times and reached 125 000 in 2002. Reindeer herds also followed the big herds of migrating caribou. Monitoring the conditions of reindeer range is stopped in the region, earlier funded by the state. There is shortage of scientists working on reindeer husbandry. Currently the priorities are inventories and investigation of migration routes of caribou as well as using GIS technology for mapping reindeer ranges of Chukotsky and Korjaksky autonomous districts and Magadan region in a map scale of 1:200 000.

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Natural mortality in a selected reindeer herd

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Lifetime survival and reproduction is related to early development in large mammals. Furthermore, survival of prime-aged females is stable and varies little from year to year, whereas juvenile survival may be highly variable. The objective of this investigation was to test the hypothesis that age and initial weight (at 7 months of age) influence natural mortality in female reindeer. The use of lifetable analysis was inadequate because a varying part of the population was gathered and recorded each year, and also because most adult animals were culled at different ages by the herders. However, since the animals in this study were individually marked and recorded it was possible to use the more powerful technique of capture-recapture analyses. The computer programme SURGE v4.2 was used. Female calves retained after the autumn slaughter (~50%) were defined as marked. The data from calves marked in 1986 to 1997 (n=646) were examined by studying recaptures in the winters of 1987 to 1999 (no. of resightings: 2649). By the year of 1999, 31% of the animals older than 1 year had been slaughtered. These were treated as censured data after the year that they had been culled. The proportion of the herd recaptured each year was above 90% (except in 1992 when the recapture was 80% due to poor weather conditions). Annual survival after 19 months of age did not vary among age classes and was 97%. The estimated survival among calves from 7 months to 19 months of age varied between years (mean 87%, range 72-98%). Survival was not found to be dependent on initial weight, which was maybe not surprising since the calves with lowest weights had been culled and were not part of the analyses. However, it has been suggested that heavy female calves reproduce immaturely and may have a greater risk of dying thereafter. This hypothesis could not be supported from our analyses.

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Research needs to support reindeer industry

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The present Swedish reindeer industry is confronted with great challenges, and it is necessary to bring out knowledge and competence which can strengthen and develop reindeer herding and husbandry further. Most of reindeer research of today is also oriented towards solving applied problems or questions. Still, many reindeer herders experience a large distance between reindeer management and reindeer research. This contradiction is partly due to the fact that reindeer herders believe they lack information about ongoing research, and simultaneously the herders feel they have difficulty in expressing their needs for research results. This distance between reindeer management and research is also due to the fact that reindeer herders think the research results which reach them, are of no practical use for them. From the reindeer herders' point of view, it is therefore desirable as well as a necessity that the researchers direct even more attention to the present problems which exist both within the reindeer management and in its surroundings. Reindeer industry of today includes different combinations of a profitability-aiming/technique-oriented reindeer husbandry, and a more labour-intensive, ecologically and traditionally oriented Sami reindeer husbandry. Often this implies a clear – and yet unsolved – goal conflict between business rationality and a management as upholder of Sami culture. In addition to this inner clash of interests, the reindeer herders are facing problems they do not own, and over which they have no control. The problems are almost exclusively connected with other land users and are being classified by reindeer herders as the most serious threats against reindeer husbandry in the long term. Among these we have:

- Shrinking pasture land as a consequence of changed methods in forestry, accelerating peat- and mineral harvesting, roads and other forms of infrastructure.
- Dramatically increased snow mobile traffic, including commercial entrepreneurs with snow mobile safaris as an essential part in their market offer.
- Increasing demands for land to use for establishments and recreation within the tourism industry.
- Increasing recreational hunting and fishing quite regardless of ongoing reindeer management.
- Unacceptable damages caused by predators, which obstruct the profitability within the private, reindeer husbandry enterprise.

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Reindeer management in Salla municipality – comparing two management systems

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Municipality of Salla is situated in north-eastern Finland near Russian border. There are about 4900 inhabitants in Salla. Over 60% of them get their livehood from services, only 24% from primary production. In Salla there are two separate reindeer co-operatives; Pohjois-Salla and Salla. The land area of Pohjois-Salla reindeer co-operatives is 2130 km^2 and Salla 4265 km^2. The share of arable land in Pohjois-Salla is 0,4% and in Salla 2,4% of total area. The condition of lichen ranges in both reindeer co-operatives was not good in the mid-1990s. The amounts of lichens in Pohjois-Salla reindeer co-operatives were 311 kg/ha and in Salla 119 kg/ha. The maximum number of reindeer in Pohjois-Salla is 4800 reindeer and in Salla 5500 reindeer in year 2001-2002. The reindeer density per land area is in Pohjois-Salla 2.1 reindeer/km^2 and in Salla 1.2 reindeer/km^2. There are 124 reindeer owners in Pohjois-Salla and 187 in Salla. The average age of reindeer owners is approximately 42 years. The total income of reindeer management in year 2002 was 25,10 €/living reindeer in Pohjois-Salla and 3,3 €/living reindeer in Salla. There are many reasons for so big difference between these reindeer co-operatives. Winter supplementary feeding and farming is much more common in Salla than in Pohjois-Salla. In the 1990s the farming increased in Salla so much, that today about 60% of reindeer is farmed. In Pohjois-Salla, reindeer are farmed and fed only before slaughtering. The professional status of reindeer management is more important in Pohjois-Salla than in Salla. In 2001 almost 50% of taxable incomes in Pohjois-Salla come from reindeer management, in Salla only 3%.

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The Circumpolar PhD Network in Arctic Environmental Studies (CAES) – a new 'reindeer course' under planning

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The CAES Network (Circumpolar PhD Network in Arctic Environmental Studies) is a multidisciplinary research education network in the circumpolar North. The CAES was established and started its activity in 1999. It is addressed to PhD students and post-doctoral scientists, with emphasis on Nordic countries and northwestern

Russia. The purpose of the Network is to foster interdisciplinary research and partnership between young researchers engaged in natural, cultural and socio-economic aspects of arctic environmental studies. The main activity of the CAES Network is to conduct a series of interdisciplinary research education courses overing important topics of the arctic environment such as reindeer husbandry, industrial impacts, sustainable development and tourism. The courses are conducted annually in various regions of the northern countries and linked to each other. Complementary activities of the Network are an electronic network, workshops and mobility of young researchers. Activities of CAES encourage students for multi- and interdisciplinary approach and communication in their studies. CAES PhD courses include lectures and seminars. However, they are not just classroom courses but combine theory and practise, including observations and discussions on-site in local and regional contexts, doing things together across discpline and other borders, visits and excursions and creating common points of reference. A particular attention is paid to active communication with local people, researchers, local authorities and other stakeholders. Each intensive course (2 weeks in duration) is designed around a key topic that is examined at different viewing angles. The course program started in 2000 with the PhD course "Reindeer as a keystone species in the North: biological, cultural and socio-economic aspects". The preparative workshop for the course, 'Reindeer 2000' was held in the connection with the 10th AUC in Tromsø, 1999. The PhD course was held at several locations in Northern Finnish Lapland, Finmark in Norway and Kola Peninsula in Russia. The CAES Network plans to hold a comparable course focusing on the topical research questions in reindeer husbandry and related issues in autumn 2005 in the northern Fennoscandia. As a preparative phase for the course, CAES organises an open workshop 'Reindeer 2005' in the connection with the 11th AUC 28-29 August in Saariselkä to all interested participants.

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Educational centre of Sami area

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The purpose of the Educational Centre of Sami Area (ECSA) is to provide education mainly for the needs of the Sami Area, to maintain and develop Sami culture and nature-based occupations. The ECSA can also conduct research and provide services that support or are closely linked with the education. The administrative centre of the ECSA is situated in Inari. The education provided in reindeer husbandry has been concentrated to the estate of Toivoniemi, Kaamanen since 1996, situated 25 km north of Inari. In the immediate vicinity of the estate there are Finnish Game and Fisheries Research Institute's Reindeer Research Unit as well as the Finnish Reindeer Herders' Association's experimental reindeer farm in Kutuharju. The ECSA has premises for 50-60 students in Toivoniemi. That includes places for accommodation and dining, as well as social and teaching premises. Most of the premises have been completed during 1999. In addition, there are excellent premises for teaching technical works. There are also a slaughterhouse for reindeer and meat handling and further processing premises. The teaching slaughterhouse that covers approximately 400 m^2 was completed in 1998. It meets even the strictest EU regulations considering slaughtering and meat handling. There is also a meat smokehouse. In 2003, the construction of extension part and renovating the old premises, with a budget of approx. 1 mill. €, will be started. In addition to Finnish, also Norwegian and Russian reindeer herders and veterinarians have been trained at the ECSA in Toivoniemi. The school has the right of use of neighbouring water areas and forests in approx. 1000 hectares of land area. The vocational qualification in reindeer husbandry has been a 2-year-study program since 1981. In 2001 the study program changed into 3-year-studies. The ones graduating from this study program are entrepreneurs in reindeer husbandry. The apprenticeship contracts in reindeer husbandry have been in use since 1985. This kind of studying is suitable mainly for the young people who have a chance to get work instruction in their own reindeer herding co-operatives. The adult education in reindeer husbandry has been given since 1970s. The ECSA organises also short courses on current subjects in various locations around the Finnish reindeer herding area.

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Tourism and reindeer husbandry in Saariselkä area, Finland

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Finnish Lapland offers plenty beautiful and special sceneries and attractions for tourists. Like all around the world, the fastest growing tourism sector is nature-based travel including recreational activities such as skiing, hiking, camping, hunting and fishing. During the last 50 years, tourism has become increasingly important in Lapland. Tourism brings welfare and revenue to Lapland but what tourists may not see, however, is the crucial function of these northern areas as reindeer pasture. The total area of pastures has decreased, fragmented and the quality of pastures has suffered because of intensifying land use. Tourism is, nevertheless, one but the fastest

growing form of land use in Lapland. Aim of this study is to focus on the topic of conflicts and interaction between tourism and reindeer husbandry in Northern Finland. The study is pointing out both the positive and the negative impacts of tourism on reindeer husbandry in Finnish Lapland, especially in the Saariselkä area, which is one of the largest and the most famous tourist centres in Finland. The study evaluates also the role of reindeer as a tourism product image in Finnish Lapland. The study is a part of the research concerning *Land Use Conflicts in Northern Nature*. Land use conflicts in northern nature have become contentious and topical questions during last decades. To solve these conflicts and to reach for sustainable use of natural resources, a holistic approach is required. The objective of this study is to examine from the spatial, environmental and socio-economical point of view interaction and dynamics between different forms of land use. The study focuses on reindeer husbandry in Northern Finland, especially in four selected reindeer herding management districts. Progression of interactions is studied from the 1950s up to the present. The *Land Use Conflicts in Northern Nature* – research is part of the LUIAS (*Land Use Interaction Analysis System*) – project funded by the Academy of Finland, the Ministry of Agriculture and Forestry and the National Technology Agency.

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Interrelations of wild and domestic reindeer in northern Asia

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In Chukotka there is a problem with wild and domestic reindeer interrelations. In 1975-1978 the number of domestic reindeer number was 560 000, at present domesticated reindeer do not exceed 120 000 ind. The main causes of the decline were lack of personnel, bad discipline and hard drinking among the herders. There are two intraspecific problems of wild and domestic animals; 1) food competition on pastures, 2) wild reindeer take away the domestic ones. Pastures can be trampled down only if high number of wild reindeer exists, also in areas of low carrying capacity. However, the latter problem can be withdrawn in habitats where wild herds are considerably dispersed. An average size of wild reindeer herds does not exceed 29.2 heads (n=1375) in summer pastures, and 85 heads (n=1470) in winter. Wild reindeer use winter pastures rationally due to their dispersal and absence of food competition. As my investigations demonstrated there were 13.4% of domestic animals in herds of wild animals. In spring their number reduced to 2.1%. Domestic reindeer served as buffer prey of large predators, their elimination was considerably higher than wild animals.

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Reindeer herders' nomadic schools of Sakha Republic (Yakutia)

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The Ministry of Education supports an initiative to open nomadic schools to train and educate children without separation them from their parents. If children are separated from their parents, they are not able to be acquainted with traditional activity of their parents. The Ministry has confirmed a status of nomadic schools elaborated by the Scientific Research Institute of National Schools. During 1993-2001, nine nomadic schools have been opened in Sakha Republic. In 2002-2003, five nomadic schools have been operating in indigenous settlements as branches of education schools. 35 pupils have been trained there. To-day nomadic schools are of great demand everywhere in areas of reindeer herding. It is necessary to take measures for financial and legal support of nomadic schools. Problems of organization of training in nomadic conditions are closely connected with socio-economic difficulties in reindeer husbandry. It is necessary to invest money, to improve social service in reindeer herding brigades. The nomadic schools need a state support in financing educational charges both payments of work of staff and teachers by allocation special subvention to the local budgets. A nomadic school should function as a separate legal person with independent budget.

Session 7 UTILIZATION & PREDATION

Keynote lecture

The role of predation in population dynamics of arctic ungulates

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It has been roughly ten years since the flurry of predator-prey studies published in the early 90s that sparked interesting debate about the importance of predation in northern ungulate dynamics. I will review the work that has occurred since then and attempt to critically evaluate progress made toward our understanding of these northern systems. I will also discuss how indirect human effects may further complicate matters. Finally, I will outline some future studies that could address key uncertainties that remain.

Oral presentations

Wolf predation on European wild forest-reindeer in east-central Finland

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It is generally accepted that wolf (*Canis lupus*) predation is one of the major factors limiting population densities of woodland caribou (*Rangifer tarandus caribou*). Almost nothing is however known about the role of European wild forest reindeer (*R. t. ifennicus*) as prey of wolves or the influence of wolf predation on populations of this rare subspecies. In our study area in east-central Finland where increasing wild forest reindeer population coexists with moose (*Alces alces*) with approximate 1:1.5 ratio in numbers, reindeer was an important part of wolf diet in summer, autumn and early winter while practically absent in mid and late winter (January-March). In overall moose was the primary prey but wolves preferred reindeer for moose during early winter (November-December) when reindeer were gradually moving towards their winter ranges. Within their winter range reindeer outnumbered moose but were not preyed by the wolf pack hosting the only territory that was located in the mid and late winter range of reindeer. When the approximate wolves per reindeer ratio increased from 0.004 (1998) to 0.02 (2000) wolf predation came the most common cause of death, 50% of all cases recorded. Annual net increase in population size of wild forest reindeer lowered from 13 to 7% owing to increased wolf predation.

Mortality of reindeer calves in Finland: Role of predation in five regions

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Predation is considered as a major source of mortality in juvenile ungulates. Owing to the crucial importance of calf survival for the reindeer husbandry, we studied calf mortality rate and causes of death by using mortality radio-transmitters with altogether 2435 calves in five study areas (herding associations of Ivalo, Lappi, Oivanki, Poikajärvi and Käsivarsi) during 1997-2002. The proportion of open alpine terrain and the density of different predator species varied between these areas. Calves were marked partly at 1-5 days of age and partly at 2-8 weeks of age. Survival was followed until round-ups taking place in October-January when calves aged 5-8 months. Mortality rates ranged from 0.02 to 0.16, depending on the region and the study year. In Lappi, eastern Lapland, (1997-1998) mortality rate from 2-8 weeks old was 0.08, of which predation comprised 55-79%. The main predator was golden eagle (*Aquila chrysaetos*) that killed 3% of all radio-collared calves. In the

neighbouring region, Ivalo (1999-2001), mortality rate was 0.07 in 1999-2000 while only 0.02 in 2001. Predation constituted 51% of total mortality and golden eagle killed 2% of all marked calves in Ivalo. In Oivanki (2000-2002), southeast near Russian border, mortality rate was in average 0.12, of which predation constituted at least 21%. Major predator was brown bear (*Ursus arctos*) that killed 2% of all radio-marked calves and killed or only scavenged additional 6%. In Poikajärvi (2001-2002), southwest, mortality rate was 0.03 and no predation was detected. In Käsivarsi (2002), northwestern arm of Finland, mortality rate was 0.04, which of predation comprised 70%. Golden eagle killed 2% of radio-calves. Overall, calves killed by predators were lighter than calves that survived. The difference in body mass was most significant in regions with golden eagle as main predator compared to a region with the highest density of brown bear (Oivanki). Regional differences in the density of different predator species accounted for spatial variation in mortality rate and landscape structure was probably also involved. Annual variation appeared to be connected to foraging conditions.

Attitudes of reindeer owners towards large predators: Is there room for co-existence?

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Attitudes of reindeer owners towards large predators (LP) and golden eagle (GE) were studied by a questionary sent to 2000 reindeer owners in 2002. Altogether 904 (about 80% males) from all Finnish reindeer districts responded. 42% had experienced losses due to predators in 1999-2002. The majority (80%) were willing to accept the existence of predators in the reindeer herding area, if the losses were fully compensated. Most of the owners (88%) wanted to regulate predator populations as they wished, 16% wished predators should be exterminated from the country but 70% had the opinion that predators were important part of the cultural inheritance of Finland. There was, however, some inconsistency in the answers, because many agreed either completely (22%) or almost completely (25%) that no predator populations should be maintained within the reindeer herding area. Seemingly both utilitarian and humanistic attitudes prevail among the herders. They criticized the existing LP compensation systems; 8% were completely satisfied with the present compensation system, 43% were quite satisfied, but wanted the system to be developed, and 35% were completely unsatisfied. Criticism was also towards inspection fees and excess (mentioned in 23% of the answers). The low amount of compensation and the underestimation of the lost reindeer were the next often mentioned problems (11%). Many herders wished that expenses caused by seeking dead reindeer and guarding herds should be compensated. About half of the herders were satisfied with the compensation system on the losses caused by GE, which is based on the number of eagles within herding districts. The major criticism was towards young eagles (18%) and eagles visiting from other areas (16%), the losses by which were insufficiently compensated according to the herders. The weaknesses in co-operation and checking of nests were also mentioned relatively often (18%). Even though the majority of herders seemed to tolerate predators relatively well, almost half of the respondents (47%) wanted to reduce the number of brown bears or exterminate them (21%), and also about half (46%) wanted to reduce the number golden eagles or exterminate them (20%) within their own herding associations.

Poster presentations

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Decline in abundance of muskoxen in the Arctic National Wildlife Refuge, Alaska

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Numbers of muskoxen (*Ovibos moschatus*) in the Arctic National Wildlife Refuge, Alaska, increased rapidly for over a decade and were relatively stable for 12 years as this reestablished population expanded into new regions. Between 1998 and 2002, numbers of muskoxen in the Arctic National Wildlife Refuge declined sharply and numbers in adjacent regions increased. This study examined rates of successful calf production (number of calves present in late June) and adult mortality as well as shifts in distribution and dispersal that likely affected changes in animal abundance. In the Arctic National Wildlife Refuge, only 1-2% of all animals classified were calves in 2000 and 2001. No yearlings were seen in 2001 and 2002. In 1998-2002, 3-4% of muskoxen in the Arctic National Wildlife were killed by hunters each year. During this same period, at least 41 muskoxen older than calves died from causes other than hunting. These included 24 muskoxen killed by grizzly bears (*Ursus arctos*) and one killed by a wolf. Seven were eaten and possibly killed by predators, 2 died from winter starvation, 1 died of old age and 5 died of unknown causes. Mortalities attributed to grizzly bears included several incidents of multiple kills. At least 5 mixed-sex groups containing radiocollared muskoxen left the Arctic National Wildlife Refuge between 2000 and 2002. Weather conditions including icing, deep snow and a

prolonged snow season may have influenced rates of successful reproduction, survival and predation as well as shifts in animal distribution.

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Radiocaesium in *Lynx* in relation to the presence of reindeer

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European lynx (*Lynx lynx*) in the Swedish reindeer herding area largely prey on reindeer (*Rangifer tarandus tarandus*). Reindeer in areas contaminated by radiocaesium from the Chernobyl accident in 1986 have high activity concentrations of radiocaesium in their muscle compared to other prey. The purpose of this study was to find out if the activity concentrations of radiocaesium in lynx were related to the presence of reindeer and thus be an indicator of the diet of lynx. Fresh muscle samples from 569 lynx were collected from northern and central Sweden from January 1996 to April 2002. Most samples were collected during winter. The activity concentration of ^{137}Cs in lynx muscle was compared to ground deposition of ^{137}Cs and to activity concentration in reindeer from the same areas. The activity concentrations of ^{137}Cs in lynx muscle samples ranged from 20 to 14791 Bq kg^{-1} fresh weight. The highest activity concentration was found in a lynx sample collected within a county (Västernorrland) which had the highest ^{137}Cs deposition and is situated within the reindeer herding area. Low activity concentrations in lynx, relative to ground deposition, were found outside the reindeer herding area. In the most northern part of Sweden (Norrbotten) the ground deposition of ^{137}Cs was low. The activity concentrations in lynx were however relatively high, both in relation to ground deposition and to reindeer. In the more southern parts of the reindeer herding area, activity concentrations in lynx were generally lower, but considerably more variable, in relation to ground deposition and reindeer. This indicates that many lynx from these areas feed on other prey than reindeer.

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