Posterpresentationer – Tauluesitykset - Poster presentations

(Finns i alfabetisk ordning från sidan 55 – Are given in alphabetical order from page 55)

A	Fysiologi och veterinärmedicin / Fysiologia, sairaudet ja terveys / Physiology and veterinary medicine	11 st/pres
B	**B**etesanvändnings- och lavrelaterade studier / Laidunten käyttö, Läkälätutkintoa / Studies on pasture use and lichen conditions	11 st/pres
C	Klimat, väderlek, biologisk mångfald m.m. / Ilmasto, lounon monimuotoisuus, y.m. / Climate, weather and biological diversity a.o.	10 st/pres
D	Produktivitets- och förvaltningsrelaterade studier / Toutanto ja laidunvarojen hoito / Studies on productivity and management	12 st/pres

1-C Sidan/Page

Halgrim Breie, Øystein Holand & Robert B. Weladji:
Effects of the North Atlantic Oscillation on reindeer (*Rangifer tarandus*) body weights in three Sami herding districts in southern Norway. 55
"North Atlantic Oscillation" påvirker høstvekter hos reinsdyrkalv i Rørosområdet.

2-C

Anu Brunila-Kovanen:
The effects of changes in lichen coverage and of microclimatic features of soil on growth of pine in the reindeer husbandry area in the Finnish Lapland. 56
Inverkan av förändringar i lavtäckning och mikroklimat i marken på tallens tillväxt inom renskötselområdet i finska Lappland.

3-C

Kari Anne Bråthen:
Plant composition of summer pastures is related to level of long-term grazing pressure. 57
Sammensetningen av planter i reinens sommerbeiter har sammenheng med nivå av langtids beitepress.

4-D

Benjamin Burkhard & Felix Müller:
Development of a General Indicator Concept for Reindeer Management. 58
Utveckling av ett allmänt indikatorsystem för renskötseln.

5-D

Dag Elgvin:
Control with one's own grazing land: Taking other's animals as control mechanism? 59
Kontroll med eget beiteland på 1960-tallet: "Reintyveri" som kontrollmekanisme? 60

6-A

Hallvard Gjøstein, Øystein Holand, Tore **B**olstad & Knut Hove:
Lactation curves and milk storage capacity in reindeer udder. 61
Laktasjonskurver og lagringskapasitet for melk i reinsjur.

7-B
Berit Inga:
Traditional knowledge on the use of landscape by the reindeer among Sami in northern Sweden. 62
Traditionell kunskap om renens nyttjande av landskapet bland samer i norra Sverige.

8-B
Lotta Jaakkola, Timo Helle & Eero Mattila:
Beard lichen resources in the planning of multiple objective forestry. 63
Luppovarat monitavoitteisessa metsätaloudensuunnittelussa. 64

9-B
Bernt Johansen & Stein Rune Karlsen:
Finnmarksvidda – changes in lichen cover 1987-2000. 65
Finnmarksvidda – endringer i lavdekket 1987-2000. 66

10-A
Roger Kimo Jørgensen & Morten Tryland:
Paratuberculosis in farmed red deer. 67
Paratuberkulose hos oppdrettshjort.

11-D
Ann-Marie Karlsson:
Decision making in reindeer herding. 68
Beslutsfattande innom rennäringen.

12-A
Nicole Kemper, Ansgar Aschfalk, **Mauri Nieminen** & Christiane Höller:
Examination for occurrence of important enteropathogenic bacteria and parasites (*Cryptosporidium*) in faeces from healthy reindeer calves. 70
Viktige patogene bakterier i avføring fra 40 reinkalver.

13-D
Jorma Kemppainen, Juhani Kettunen & **Mauri Nieminen**:
Economic utilization of reindeer. 71
Poron taloudellinen hyödyntäminen. 72

14-B
Heidi Kitti & Timo Kumpula:
Classification of reindeer pastures: Mapping based on Traditional Ecological Knowledge (TEK) and Remote sensing based pasture mapping. 73
Porolaidunten luokittelu perustuen Perinteiseen ekologiseen tietämykseen (TEK) ja kaukokartoituspohjaiseen laidunluokittamiseen. 74

15-B
Jouko Kumpula, Stéphanie C. Lefrère & Mauri Nieminen:
Digging work of reindeer in woodland lichen pasture during winter. 75
Poron talvinen kaivutyö metsäalueen jäkälälaitumella. 76

16-B
Timo Kumpula, Angela Manderscheid & Alfred Colpaert:
Evidence of different pasture use from satellite images: Cases from Lapland and the Tibetan plateau. 77
Laidunnuksen intensiteetin arviointi satelliittiaineistosta: esimerkkinä Lappi ja Tiibetin ylänkö. 78

17-A
Stéphanie C. Lefrère, Jouko Kumpula & Mauri Nieminen:
Hierarchy evolution and diurnal activities of female Reindeer *Rangifer tarandus tarandus* L. in winter time. 79

18-D
Veikko Maijala, Harri Norberg, Jouko Kumpula & Mauri Nieminen:
Study on calf production in the Finnish reindeer herding area. 80
Tutkimus vasatuotosta Suomen poronhoitoalueella. 81

19-B
Roger Malm, **Jon Moen & Öje Danell**:
Non-destructive measurements of lichen biomass. 82
Icke-destruktiva skattningar av lavbiomassa. 83

20-D
Jarno Mikkola, Virve Väisänen, Alfred Colpaert, Jouko Kumpula, Marja Anttonen, Mauri Nieminen & Olavi Heikkinen:
Modelling spatial interaction and conflicts between reindeer husbandry and other use of natural resources. 84
Poronhoidon ja muun luonnonkäytön välisiä alueellisia ristiriitoja ja vuorovaikutusta selvittävä tarkastelumalli.

21-C
Jon Moen, Lars Edenius & Karin Aune:
Potential effects of climate change on tree-line position in the Swedish mountains. 85
Potentiella effekter av klimatförändringar på trädgränsen i de svenska fjällen. 86

22-D
Erling Moxnes, Öje Danell, Eldar Gaare & Jouko Kumpula:
Reindeer husbandry: A practical decision-tool for adaptation of herds to rangelands. 87
Renskötsel: Ett praktiskt beslutsredskap för anpassning av renhjordar till betesmarker.

23-B
Mauri Nieminen, Jouko Kumpula & Alfred Colpaert:
Winter pasture resources of wild forest reindeer (*Rangifer tarandusifennicus*) in Salamajärvi area in central Finland. 88
Metsäpeuran (*Rangifer tarandusifennicus*) talviravintovarat Salamajärven alueella Keski-Suomessa. 89

24-A
Antti Oksanen:
Cervid echinococcosis in Fennoscandia. 90
Hirviekinokokki Fennoskandiassa. 91

25-A
Jani Rytkönen, Kaija Valkonen, Tapani Alatossava & **Mauri Nieminen**
Characterization of betalactoglobulin from reindeer milk. 92
Poronmaidon betalaktoglobuliinin karakterisointi. 93

26-D
Lars Rönnegård, Pär Forslund & **Öje Daneil**:
Life-time patterns in adult female weight, reproduction and offspring weight in semi-domesticated reindeer. 94
Vajvikt, kalvningsprocent och kalvvikt – Vilka samband finns det mellan dem och hur utvecklas de med vajans ålder?

27-A
Sabine Sampels, Jana Pickova & Eva Wiklund:
Fatty acid composition and levels of vitamins E and A in fresh and smoked reindeer meat. 95
Fettsyrasammansättning och innehåll av vitamin E och A i färskt och rökt renkött. 96

28-D
Per Sandström, Leif Hemberg & Tina Granqvist Pahlén:
Project "Renbruksplan" in the county of Västerbotten. 97
Projekt Renbruksplan i två samebyar i Västerbotten. 98

29-C
Anna Skarin, Öje Daneil, Roger Bergström & Jon Moen:
The influence of weather on reindeer habitat choice on the landscape level. 99
Vädrets inverkan på renens habitatval på landskapsnivå.

30-C
Päivi Soppela, Minna Turunen, **Ulla Heiskari, Bruce Forbes**, Pekka Aikio, Hannu Magga, Marja-Liisa Sutinen, **Birgitta Åhman, Timo Helle, Mauri Nieminen**, Esko Kyrö, Kaisa Lakkala, Satu Huttunen & **Christian Uhlig**:
Reindeer Summer Pastures and Ultraviolet (UV) Radiation:
A Research Proposal. 100
Poron kesälaitumet ja ultravioletti (UV) -säteily: tutkimus-suunnitelma. 101

31-A
Morten Tryland, Øivind Ødegaard, Terje Josefsen, Karen Sørensen, Torill Mørk, Rolf Sarre, **Herdis Gaup Aamot** & Kathrine Ryeng:
Virus infections among semi-domesticated reindeer in Finnmark, Norway. 102
Virusinfeksjoner hos rein i Finnmark. 103

32-C
Hans Tømmervik & Kjell Arild Høgda:
Changes in the start and length of the growing season in Fennoscandia in the period 1981-2000 and the implications for the reindeer husbandry. 104
Endringer i start og lengde av vekstsesongen i Norden i perioden 1982-1999 og hva det innebærer for reindriften

33-C
Christian Uhlig, Tore E. Sveistrup & Ivar Schjelderup:
Impacts of reindeer grazing on soil properties on Finnmarksvidda, northern Norway. 105
Innvirkning av reinsdyrbeiting på jordegenskaper på Finnmarksvidda. 106

34-A
Se**ija Vahtiala, Hannele Säkkinen**, Eija Eloranta, & Erik Ropstad:
Ultrasonography in pregnancy diagnosis and measurements of fetal growth of reindeer. 107
Porojen tiineyden toteaminen ja sikiön kasvun mittaus ultraäänen avulla. 108

35-**B**
Ingunn Vistnes, Christian Nellemann, Per Jordhøy & Olav Strand:
Infrastructure as barriers to wild reindeer migration. 109
Infrastruktur som barrierer for villreintrekk.

36-D
Virve Väisänen, Jarno Mikkola, Alfred Colpaert, Jouko Kumpula, Mauri Nieminen & Olavi Heikkinen:
Spatial interactions between reindeer husbandry and other forms of land use. 110
Poronhoidon ja muiden maankäyttömuotojen alueellinen vuorovaikutus.

37-C
Ragnhild Walde & Kari Anne Bråthen:
Plant biomass and flowering in relation to weather in reindeer summer pastures. 111
Plantebiomasse og blomstring i relasjon til været i reinens sommerbeiter.

38-**B**
Johanna Wallsten, Birgitta Åhman & Öje Danell:
Time integrated digestibility of grass silage and lichens in reindeer rumen fluid.
Tidsintegrerad smältbarhet av ensilage och lav i vomvätska från ren. 112

39-C
Robert B. Weladji, Øystein Holand & Ansgar Kosmo:
Phenotypic variation among reindeer calf cohorts is affected by density and weather. 113
Tetthet og klima påvirker kroppsvekt og gevirlengde blant årsklasser av kalv.

40-D
Robert B. Weladji, Øystein Holand, Geir Steinheim & Helge Hansen:
Effect of "owners" selection strategies on autumn calf weight in reindeer (*Rangifer tarandus*). 114
Utvalg av avlsdyr påvirker vektene på reinsdyrkalver (*Rangifer tarandus*) hos individuelle reineiere.

41-A
Eva Wiklund, Ingemar Hansson & **Birgitta Åhman**:
Sensory quality of meat from reindeer bulls, cows and calves. 115
Sensorisk kvalitet i renkött från sarvar, väjor och kalvar. 116

42-**B**
Erik Wilhelmsson, Miriam Nordh & **Öje Danell**:
Reindeer grazing adapted to coming clearcuts. 117
Renbete anpassat till kommande slutavverkningar. 118

43-D
Tomas Willebrand, **Öje Danell & Anders Esselin**:
The Swedish Mountain-MISTRA programme – interdisciplinary research around resource use conflicts. 119
FjällMistra-programmet – tvärvetenskap om resurskonflikter. 120

44-A
Erik Ågren, **B**irgitta Essén-Gustavsson & Kristina Karlström:
Prevalence of *Sarcocystis* in reindeer calves. 121
Prevalens av *Sarcocystis* hos halvårsgamla renkalvar.

Effects of the North Atlantic Oscillation on reindeer (*Rangifer tarandus*) body weights in three Sami herding districts in southern Norway

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The relevance of large-scale climatic fluctuations in the northern hemisphere, and especially the North Atlantic Oscillation (NAO), has during the last years been emphasised as ecologically significant for several populations of northern ungulates. For the climate in northern Europe and Scandinavia the NAO has been found most relevant from December through March, as high NAO values has often been followed by warm, moist weather and low NAO values has been followed by cold, dry weather. In this study we used carcass weights from three herds of semi-domestic reindeer (*Rangifer tarandus*) in southern Norway, sampled during the years 1992 to 2000. In this period we found a positive relation between the NAO winter-index and late autumn calf weights. Nevertheless, pregnant females probably experienced more nutritional stress during high than low NAO winters due to increased amounts of snow, but this negative influence was either being ruled out by consecutive high quality summer forage or acted on other population parameters than body weights. We also found differences in the NAO influence on calf weights between the three study populations. Even though they all exploited the same winter range, each population exploited different summer ranges along a climatic and geologic gradient. The influence of the NAO-index, both on the locally received winter precipitation and the calf weights, decreased from the poor continental to the rich coastal summer grounds. We emphasise the importance of NAO as a governing factor that has more impact on the quality and quantity of the summer forage in arid than in wet reindeer summer habitats in South-Norway.

"North Atlantic Oscillation" påvirker høstvekter hos reinsdyrkalv i Røros-området

I det senere har det blitt påvist at "North Atlantic Oscillation" (NAO) kan påvirke flere livshistorieparameter og dermed populasjonsdynamikken til nordlige store planteetere. I Nord Europa gir en lav NAO-indeks mindre tilførsel av fuktig luft fra vest og dermed normalt kalde og tørre vintre, mens en høy NAO-indeks gir mye regn og mildt vintervær. Hvordan nedbøren fordeler seg som snø og regn er imidlertid avhengig av høyden over havet og dominerende vindretning. Undersøkelsen tok utgangspunkt i rundt 20 000 innsamlede slaktevekter fra årene 1992 til 2000 i Sør-Trøndelag/Hedmark reinbeiteområde. I denne perioden fant vi en positiv effekt av NAO på kalveslaktevektene om høsten. Klarest utslag gav dette i Elgå reinbeitedistrikt med relativt tørre og skrinne sommerbeiter. I Elgå med begrensede mengder snøleier kan den positive effekten av høy NAS-indeks skyldes at utsmeltingen av sommererbeitene vil gå saktere grunnet mer snø. Reinen vil derfor ha tilgang på frisk groe lenger utover sommeren som vil gi seg utslag i bedre tilvekst og høyere kalveslaktevekter. Forsommeren er en svært viktig beiteperiode for rein, og simlene har høyt energi- og proteinbehov i den tidlige dieperioden. Dette indikerer at denne positive effekten av snømengde på forsommerbeitene i Femundtraktene i perioden overskygget den forventede negative effekten av mer snø på vinterbeitenes tilgjengelighet.

The effects of changes in lichen coverage and of microclimatic features of soil on growth of pine in the reindeer husbandry area in the Finnish Lapland

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A significant differences have been noted in the lichen coverage between the reindeer breeding areas in the Finnish Lapland and the Kuola Region, which is not used for reindeer breeding. This has been detected in many accounts, e.g. in studies on the satellite images during the recent years. Intensive reindeer breeding in the Finnish Lapland has changed the amounts of ground level vegetation on the forest floor so that especially reindeer moss has reduced and been replaced by other species of moss. Many recent accounts show that reindeer breeding is significantly changing the natural forest ecosystem in Lapland
The lichen coverage affects the temperature and the moisture on the ground and therefore affect how well the roots cope with frost For example sandy areas the top soil might be 3-4 degrees lower, if lichen is missing. The importance of the lichen isolation is accentuated by the decreasing temperatures in late summer and early winter as there is no snow coverage yet. Porous snow coverage replaces the lichen as insulation, but in certain conditions the insulation from snow might be rather minimal.
Reindeers use up the lichen coverage, thus changing the amounts of different species on the ground. At the same time, the reindeers affect the amount and the chemical consistency of the material that end up to the decomposers in the soil. The differences in temperature and moisture in the soil have also an effect on the decomposing activity of microbes. These conditions are more stable in the less used up areas. Therefore reindeer breeding affects indirectly on the nitrogen cycle and possibly on the productivity of the forest.

Inverkan av förändringar i lavtäckning och mikroklimat i marken på tallens tillväxt inom renskötselområdet i finska Lappland

Tydliga skillnader i lavtäckning har konstaterats mellan renskötselområdet i finska Lappland och Kola-området, som inte används för renskötsel. Detta har kunnat konstateras bl.a. vid studier av satellitbilder de senaste åren. Intensiv renskötsel i finska Lappland har förändrat mängden bottenvegetation i skogsmarken så att t.ex. renlav minskat och ersatts av mossarter. Flera nyare undersökningar visar att renbetning påtagligt förändrar det naturliga skogsekosystemet i Lappland.
Lavtäcket påverkar markens temperatur och fuktighet och därmed rötternas frosttolerans. Om laven saknas är temperaturen i det översta marklagret 3 – 4 grader lägre i t.ex. sandiga områden. Betydelsen av lavens isolerande förmåga accentueras av de sjunkande temperaturerna under sensommar och förvinter p.g.a. det ännu inte finns ett täckande snölager. Porös snö kan ersätta laven som markisolering, men under speciella förhållanden kan isoleringen vara tämligen liten.
Renar förbrukar lavtäcket och förändrar därigenom mängden av olika arter i bottenskiktet. Samtidigt påverkar renar mängden och den kemiska sammansättningen av det material, som tas omhand av nedbrytande organismer i marken. Skillnaden i temperatur och fuktighet i marken påverkar också mikrobernas nedbrytningsaktivitet. Förhållandena är mer stabila i de mindre betade områdena. Därför påverkar renskötseln indirekt kväveomsättningen i marken och eventuellt skogens produktivitet.

Plant composition of summer pastures is related to level of long-term grazing pressure

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The coastal location and rich bedrock makes most summer pastures of Western Finnmark, Norway, nutritious and productive. However, reindeer (*Rangifer tarandus*) are unevenly distributed throughout these pastures, and despite that summer pastures have been considered as good pastures, a negative correlation has been found between the density of reindeer and the live weight of the animals.
In order to assess the effect of increasing grazing pressure from reindeer on summer pastures, the vegetation of six grasslands with differing histories of grazing pressure have been compared, while controlling for other ecological factors.
Higher long-term grazing pressure from reindeer was related to grassland composition through: 1) decreased species richness, 2) decreased proportion of herbs, 3) increased proportion of graminoids, 4) decreased flowering frequency and 5) decreased biomass. However, there was no effect from an exclosure experiment that was carried out in the same grasslands over four years. My results thus suggest that the long-term level of reindeer grazing pressure influence pasture composition in grasslands, while a timespan of four years of no grazing is too short for these grasslands to counteract the effects from their long-term history of grazing. The identified changes in pasture composition indicate that higher long-term grazing pressures from reindeer might reduce pasture quality.

Sammensetningen av planter i reinens sommerbeiter har sammenheng med nivå av langtids beitepress

Den kystnære beliggenheten og næringsrike berggrunnen gjør reinens sommerbeiter tilhørende Vest-Finnmark næringsrike og produktive. Tettheten av rein er imidlertid svært ujevnt fordelt i disse beitene, og selv om sommerbeitene er vurdert som gode for reinen, er det funnet en negativ korrelasjon mellom tetthet av rein og reinens levendevekt.
For å kunne vurdere betydningen av ulikt beitepress på sommerbeitene, har vegetasjonen i seks graminoide-dominerte områder med ulik beitehistorie men ellers liknende økologiske faktorer, blitt sammenlignet.
Høyere langtids beitepress av rein var relatert til plante sammensetningen i graminoide-dominert mark i form av: 1) nedgang i artsrikdom, 2) nedgang i andel urter, 3) økning i andel graminoider, 4) nedgang i blomstringsfrekvens og 5) nedgang i biomasse. Det ble imidlertid ikke målt noen effekt etter et bureksperiment i de samme områdene over fire år. Mine resultater antyder således at nivå av langtids beitepress påvirker plante sammensetningen i graminoiddominerte beiter, mens en periode på fire år er for kort til å slå tilbake disse langtids effektene av beite. De påviste forandringene i plante sammensetning i sommerbeitene indikerer at høyere langtids beitepress av rein kan redusere beitekvaliteten.

Development of a General Indicator Concept for Reindeer Management

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To develop particular indicators regarding the ecological, social and economic sustainability of reindeer management in northern Scandinavia means to create a useful tool to assist the formulation of landuse scenarios and plans. These indicators can be aggregated to a set that landusers and decision makers can understand and utilise. Working in the multidisciplinarian EU project RENMAN[1] our goal is to interpret the results from our collaborators and "to feed" our indicator system by the data collected. Indicators range from ecological data as matter flows or biotic diversity to social data concerning life quality or ethnological identity. In the "amoeba" diagrams the current states are indicated as 100% and the future states, conceived to follow a certain simulated scenario, are represented by modified scenario values. While for certain indicators (landuse intensity and ecological integrity) we will be able to find/measure/model data, some other components (e.g. economic and social welfare) will be more fuzzy. Thus we have to discuss them intensively with the stakeholders and use the results of the interviews carried out among reindeer herders, researchers and decision makers. Scientific measurements have to be combined with sociological and medical assumptions.

Utveckling av ett allmänt indikatorsystem för renskötseln

Att utveckla enstaka indikatorer rörande den nordskandinaviska renskötselns ekologiska, sociala och ekonomiska uthållighet menar att skapa ett användbart verktyg för att stöda formuleringen av markanvändningsscenario och -planeringar. Dessa indikatorer kan sammenfattas till en sats vilken markanvändare och beslutsfattare kan förstå och använda. Under arbetet i det multidisciplinära EU projektet RENMAN[1] är vårt mål att interpretera våras medarbetarnas resultaterna och att "föda" vårt indikatorsystem med de samlade data. Indikatorerna når från ekologiska data liksom ämnesflödet eller biotiska diversiteten ända till sociala data angående livskvaliteten eller den etnologiska identiteten. I de "amöba"-formade diagramena motsvarar de nuvarande tillståndena 100% medan framtidens tillstånden, antagligen följande ett visst simulerat scenario, visas med de modifierade scenariovärdena. För vissa indikatorer (markanvändningens intensitet och ekologisk integritet) är det möjligt för oss att hitta/mäta/modellera data medan några andra komponenter (t.ex. den ekonomiska och sociala välgången) kommer att vara mera oskarpa. På grund av detta är det nödvändigt att diskutera dem intensivt med de berörda och dra nytta av intervjuerna vilka genomfördades bland renskötarna, forskarna och behöriga myndigheterna. Vetenskapliga mätningar måste kombineras med sociologiska och medicinska antaganden.

[1] The Challenges of Modernity for Reindeer Management: Integration and Sustainable Development in Europe's Subarctic and Boreal Regions, http://www.urova.fi/home/renman/

Control with one's own grazing land: Taking other's animals as control mechanism?

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In my work as a helper for reindeer Sami in Western Finnmark from 1979 and onwards, I became acqainted with an *honesty culture*. In winter time one kept to one's own grazing land. To avoid mixing of flocks one talked with other owners about the location of the flocks. This was of special importance before and during the migrations. If animals from other flocks intermingled with one's own, one took care of them, until one could deliver a message to the other owner.
In "*Acta Borealia*" no. 1-1999 professor Robert Paine argues for what he calls a *message system* in the 1960s. If animals from another flock came onto one's own grazing land, one would kill an animal and let the carcass behind, as a message to the other of trespass. Similar action was taken to claim rights to new grazing land. This system, "or the awareness of its possible use, had an important role in the regulation of relations *between camps*" (p. 71). This was a "regulatory system, [-] ensuring the filling of all pastures --" (p. 73), a system that "envelops all practitioners in competitive relationships" (p. 74). Paine argues against calling a message system like this 'theft'; "as opposed to theft, you 'win' (or 'lose') something more than the animal which is taken" (p. 66). "They mediate relations of trust and mistrust, of good and ill will; they mediate social distance and personal reputation" (p. 66).
When I read about a practice so different from my own experience, I wanted to investigate the matter more closely. I knew several reindeer Sami of age 60 or older; i.e. they were 20–30 years old in the 1960s and I interviewed them about a possible practice like the one Paine describes. Seven of them belong to the middle range in Western Finnmark, one to Eastern Finnmark. Only one, from Western Finnmark, says he had heard about this practice in the western range of Western Finnmark, but not in the middle range. All the others denied this had been a practice, adding that *if* this had been common, they *would* have heard of it. They stressed that in the 1960s there was much open (free) grazing land, so there was no need for such a system.
Such contradictory information about a phenomena raises both substantial and methodological issues. Firstly: What are the facts? Secondly: Paine used "present time" data; I used interviews about the past. If Paine observed this himself, how can we be certain it was interpreted correctly? If he was told about it, how can we know he was told the truth? If taken to be truth, is it possible to generalize the whole reindeer Sami community? And lastly: How can ethnographic data such as these be controlled by others?
I need also to inquire into my own methods. How can I know my informants told the facts? How can I find out whether they tried to cover a practice that they didn't want to be associated with?
I see several indications that they told me the truth. I have known some of them for more than 20 years, and I don't think they would risk a relation by false speaking – which sooner or later would be discovered. Some of them are known in the village as 'laestadians', a pietistic Christian group, among whom *honesty* is a an important value. One of my informants admitted he took part in reindeer theft during his youth, but they never let the carcass behind. And that was before he became a Christian. This informant was a member of the family that Paine was with during his field work 1960-61. Other informants confirmed his story. They knew whom one could trust, and whom one could not trust, in the case of reindeer theft. They added that *any* taking of other's animals would be called 'theft' whatever one did with the carcass. Some of the informants said they would like to meet professor Paine next time he came to Norway, to discuss the matter. I take all this as indications that they are to be trusted.
My data raises another substantial issue as well: Was the practice that Paine describes, common in other parts of the Sami reindeer land?

Kontroll med eget beiteland på 1960-tallet: "Reintyveri" som kontrollmekanisme?

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I mitt arbeid som dreng hos flyttsamer i Vest-Finnmark fra 1979 og utover i 80-årene ble jeg kjent med en *ærlighetskultur*. Om vinteren holdt man seg til ens eget beiteland. For å unngå sammenblanding, snakket man med andre eiere om hvor flokkene var. Dette var spesielt viktig før og under flyttingene. Kom det rein fra en annen flokk, så passet man på dem, til man kunne få gitt eieren beskjed.
I "*Acta Borealia*" nr. 1-1999 redegjør professor Robert Paine for det han kaller et *beskjedsystem* på 1960-tallet. Hvis andres dyr hadde kommet inn på ens eget beiteland, drepte man dyret og lot skrotten ligge igjen på fjellet, som en beskjed til den andre om at han hadde kommet inn på ens eget beiteland. Man gjorde slik også når man ville hevde krav på nye områder, og slike handlinger spilte "en viktig rolle i å regulere forholdet mellom siidaene". Paine beskriver det som et rettferdig system som medvirket til at alle beiteområder ble brukt. Dette var noe som "karakteriserte 60-årene" og "omfattet alle utøverne i konkurranserelasjoner". Paine går imot å kalle dette 'tyveri', for ved et tyveri prøver man å skjule sine spor, mens her var poenget nettopp å legge igjen en melding eller et signal med "formidling om tillit eller mistillit, om god eller dårlig vilje". Man formidler "sosial avstand og personlig omdømme" (mine oversettelser).
Da jeg leste om en praksis som var så totalt ulik hva jeg selv hadde opplevd, ønsket jeg å undersøke saken nærmere. Jeg kjenner flere flyttsamer over 60 år; de var 20 - 30 år på 1960-tallet. Jeg besluttet å intervjue noen av dem om praksisen med å slakte andres dyr for å hevde rett til beiteland. Sju er fra midtre sone i Vest-Finnmark, én er fra Karasjok. Sju av dem sier at de *ikke* selv drev med noe slikt, og har heller ikke hørt om at andre gjorde det. Og de la til at hvis dette hadde vært vanlig, så hadde de hørt om det. Seks av utøverne fra Vest-Finnmark poengterer at de bare hadde kjennskap til midtre sone. Den sjuende sier at han hadde hørt om det som Paine beskriver fra *vestre* sone, men sier at det ikke var slik i midtre sone. De understreket at det var så mye ledig beiteland i midtre sone på 1960-tallet at det ikke var behov for den slags handling som Paine beskriver.
Når det er motstridende opplysninger om et fenomen, så reiser dette både substansielle og metodiske spørsmål. Først: Hva er sant? Dernest, metodisk: Paine brukte "nåtidsdata", han var tilstede på 1960-tallet, mens jeg bruker intervjuer om fortiden. Paine opplyser ikke om han observerte disse hendelsene selv, eller om han ble det fortalt. Hvis han han observerte det, hvordan kan vi vite at han tolket det riktig? Hvis han ble fortalt det, hvordan kan han vite at han ble fortalt sannheten? Hvilket grunnlag har han for å generalisere til hele reindriftssamfunnet?
Hvordan kan man etterprøve opplysninger gitt av en tidligere forsker? Hvordan kan man sikre seg mot at folk i ettertid ikke snakker usant om fortiden? Kan jeg stole på det mine informanter sier? Eller prøver de å dekke over en praksis som de ikke vil være bekjent av?
Jeg ser flere tegn på at de snakker sant. Noen av dem har jeg kjent i over 20 år, og jeg tror ikke de vil sette vennskapet på spill ved å snakke usant – noe som før eller senere vil bli oppdaget. Noen av dem er kjent i bygda som læstadianere, og i det læstadianske miljøet er *sannhet* en dyd. En av informantene fra dette miljøet erkjente at reintyverier var vanlig i ungdommen, *før* vedkommende ble kristen. Andre utøvere har bekreftet dette. De visste hvem man kunne stole på, og hvem man ikke kunne stole på, når det gjaldt reintyverier. Informanten var for øvrig medlem av siidaen som Robert Paine fikk være sammen med i 1960-61. Flere av informantene sa de gjerne ville treffe Paine neste gang han er i Norge og snakke direkte med ham om saken. Dette skulle også være tegn på at de snakker sant.
Det reiser seg også et substansielt spørsmål i forlengelsen av dette: Kan den praksis som Paine beskriver, ha vært utbredt i andre deler av reindriftsområdene?

Lactation curves and milk storage capacity in reindeer udder

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The milk production was assessed in two groups of captive reindeer. In group 1 does were kept together with the calves for free suckling through the lactation period. In group 2 the calves were sacrified at parturition. In group 1 milk production was measured once a week, whereas does in group 2 were milked twice daily with 12- hours interval. The lactation curves obtained from the two groups correspond to two extremes; group 1 representing a natural lactation while in group 2 the milk production was manipulated by a strict milking regime. The two groups showed different shaped lactation curves. In group 1 the milk production peaked between wk 2-4 post-partum, with a maximum daily production of 1.2 kg at wk 3. The milk production decreased gradually until wk 24 where the calves were weaned. In group 2 the milk production peaked at wk 2 with a daily yield of 0.5 kg. However this peak was less distinct and the decrease in production after peak lactation was slighter than in group 1. The storage capacity in the udder was 0.5 kg. Milk secretion was stabile, and the quantity of milk in the udder was proportional with the time interval since previous milking, until the storage capacity was reached. This result was similar for does with calves, and for does without calves at different phases of the lactation. These experiments demonstrate the importance of a frequent emptying of udder on the cell differentiation- and profilation and hence milk production in the mammary gland. The difference in milk yield in the two groups suggests that commercial milk production in reindeer should be based on a system with partly suckling. To obtain maximum production the milk storage capacity in the udder must be taken into account when determining the time interval calves should be separated from does. Hence milking should be implemented before the udder is full.

Laktasjonskurver og lagringskapasitet for melk i reinsjur

Melkeproduksjonen ble registrert i to simlegrupper. I gruppe 1 gikk simler og kalver sammen og diet fritt gjennom hele laktasjonsperioden. I gruppe 2 ble kalvene avlivet ved kalving. I gruppe 1 ble melkeproduksjonen målt en gang pr uke, mens simlene i gruppe 2 ble melket to ganger daglig med et 12-timers intervall. Laktasjonskurvene til de to gruppene viser melkeproduksjon under to ytterliggående forhold; gruppe 1 representerer en naturlig laktasjon mens i gruppe 2 er melkeproduksjonen manipulert gjennom melkeregimet. Laktasjonskurvene fra de to gruppene var forskjellig. Gruppe 1 nådde topplaktasjon mellom uke 2-4, med en maksimal produksjon på 1,3 kg i uke 3. Melkeproduksjonen avtok deretter gradvis frem til uke 24 hvor kalvene ble avvent. Simlene i gruppe 2 nådde topplaktasjon i uke 2 med en daglig produksjon på 0,5 kg. Laktasjonstoppen var imidlertid mindre markant og nedgangen i produksjon var mer gradvis enn i gruppe 1. Lagringskapasiteten i juret var på omlag 0,5 kg. Sekresjonshastigheten var jevn og innholdet av melk i juret økte proporsjonalt med antall timer siden forrige melking frem til lagringskapasiteten var nådd. Dette gjaldt for simler med kalv og simler uten kalv og til ulike tider av laktasjonen. Forsøkene demonstrerer at en hyppig tømming av juret har en avgjørende betydning for celldiffrensiering- og profilering i melkekjertelen og dermed produksjonen. Forskjellen i avdrått i de to gruppene antyder at kommersiell melkeproduksjon bør baseres på et system med delvis suging av kalv. For å oppnå maksimal melkeproduksjon må jurets lagringskapasitet tas i betraktning når man avgjør hvor lenge simlene skal være atskilt fra kalvene. Melking må iverksettes før juret er fullt.

Traditional knowledge on the use of landscape by the reindeer among Sami in northern Sweden

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The purpose of this paper is to describe the traditional Sami knowledge about how the reindeer use the landscape during May to October and how the reindeer herders use their knowledge in the work with the animals during the snow free period of the year. What is there opinion on how the reindeer use the mosaic of biotopes in their own Sami villages? Do they have any general idea on which type of habitat that is necessary for health and need of reindeer? Today the reindeer herders have less close connection to their animals than before the technical revolution of reindeer herding, and perhaps this knowledge run the risk of getting lost for the next generation.
My study is carried out in two mountain reindeer herding district in northern Sweden. Ten reindeer herders, born 1950 or earlier, were interviewed. They were asked to indicate on a map over their Sámi village the locations of reindeer at different time of the year (with different temperature, wind, rain and snow conditions), especially during the rutting and calving seasons. Also questions were asked if there are differences in behaviour among the reindeer according to age and sex. Important questions are for example: Do the reindeer herders use there knowledge in their practical work with the reindeer? Are their skill based on a good knowledge on the behaviour of reindeer?

Traditionell kunskap om renens nyttjande av landskapet bland samer i norra Sverige

Syftet med denna artikel är att beskriva den traditionella kunskapen bland renskötande samer om hur renen nyttjar landskapet under tiden maj till oktober och hur använder de sin kunskap i arbetet med djuren under den snöfria ärstiden. Hur tror de att renen nyttjar mosaiken av biotoper i deras egen sameby? Har det någon generell idé om vilken typ av habitat som är nödvändig för renens behov och välbefinnande? Idag har de flesta renskötare färre nära relationer till sina djur än före den tekniska revolutionen inom rennäringen, och kanske finns det risk att denna typ av kunskap försvinner i nästa generation.
Min studie genomförs i två fjällsamebyar i norra Sverige. Tio renskötare, födda 1950 eller tidigare, är intervjuade. De har fått visa pä en karta över deras sameby var renarna befinner sig under olika tider under äret (med olika temperatur, vind, regn och snöförhällanden), speciellt under kalvnings- och parningssäsongerna. Även frägor ställdes om det är någon skillnad i beteende hos renen beroende pä älder och kön. Viktiga frägor är t. ex.: Använder renskötarna sina kunskaper i sitt praktiska arbete med renarna? Är deras skicklighet baserad pä en god kunskap om renens beteende?

Beard lichen resources in the planning of multiple objective forestry

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The aim of the present research is to provide knowledge of the beard lichen (*Alectoria* spp., *Bryoria* spp., *Usnea* spp.) resources for the multiple objective forestry planning. As part of the landscape ecological planning the lichen resource data facilitates the spatial and temporal distribution of forestry procedures in a certain area and therefore enables to minimise the disadvantages for the reindeer husbandry caused by forestry practises.

In order to gain information on the historical aspects of the use of winter pastures, the first part of the research concentrates on the transition from winter herding to free ranging reindeer husbandry. It will be examined how this transition have been affected by changes in the natural environment i.e. the climatic factors, forest structure etc. as well as on the reindeer herding practises. The data, which consists of annual reports of reindeer herding districts, of reports of the reindeer pasture commission from the beginning of 20th century and of the interviews of the oldest reindeer herders in eight different reindeer herding districts will be collected during the winter and spring of 2002.

In the second part of the research, the correlation of the beard lichen biomasses on the growth site, forest structure as well as the vegetation will be examined. The inventory of beard lichen biomasses is conducted in the reindeer herding districts of Muonio, Hammastunturi and Alakitka in the summer of 2002. The aim of the biomass inventory is to examine the reliability of the subjective method for estimation of the abundance of beard lichens (classes 0-3) used in the reindeer pasture inventory in the Finnish Forest Inventory (FFI) for calculation of the total biomasses as well as of the biomasses accessible to reindeer. The gained information is used to calculate the beard lichen biomasses in the whole reindeer husbandry area using the data of four pasture inventories of FFI (1974-2004).

The lichen biomass data will be applied to model the correlation of the lichen abundance and stand characteristics. These models provide information of the site requirements of the beard lichens and can be used to predict the impact of the changes in the forest structure on the lichen biomasses. ArcInfo 8.1 program is used for the modelling. The biomass models are then applied to create production functions for the forestry planning programmes, in which case the important winter pastures will automatically be taken notice of in the forest planning processes.

In the last part of the research the impact of the integration of reindeer husbandry and timber production on the regional economics is examined by using MELA2000 - optimisation programme. In the programme the impact of restrictions on the forest use and its economical consequences are calculated.

The research is part of a larger project "Reindeer husbandry and changing environment" (2002-2006) co-ordinated from the Finnish Forest Research Institute, Rovaniemi Research Station. In addition to the research presented above, the prolonged changes in the pastures as well as impact of climatic factors on the reindeer husbandry, concept of sustainability and the adaptability of reindeer husbandry are examined in the project.

Luppovarat monitavoitteisessa metsätaloudensuunnittelussa

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Tutkimuksen tarkoituksena on tuottaa tietoa luppovaroista (*Alectoria* spp., *Bryoria* spp., *Usnea* spp.) monitavoitteisen metsäsuunnittelun tarpeisiin. Alue-ekologisen suunnittelun osana luppovaratiedot helpottavat paliskunnan sisäistä metsäalueiden käsittelyn sekä ajallista että paikallista jakauttamista ja näin on mahdollista minimoida poronhoidolle aiheutuvia haittoja.
Historiallisen näkökulman mukaan saamiseksi selvitetään tutkimuksen ensimmäisessä vaiheessa laajemmasta näkökulmasta siirtymää porojen paimennuksesta vapaaseen laidunnukseen. Työssä tarkastellaan porojen talviseen ravinnonkäyttöön vaikuttaneita sekä luonnonympäristössä mm. säätekijöissä ja metsikkörakenteessa että poronhoitotavoissa tapahtuneita muutoksia. Talven ja kevään 2002 aikana kerätään aineisto, joka koostuu paliskuntien vuosikertomuksista, 1900-luvun alun porolaidunkomission lausunnoista sekä kahdeksan paliskunnan vanhimpien poromiesten haastatteluista.
Tutkimuksen seuraavassa vaiheessa selvitetään luppojen lajikohtaisten biomassojen sekä kokonaisbiomassojen riippuvuutta kasvupaikasta, puuston rakenteesta ja pintakasvillisuudesta. Kesällä 2002 aloitetaan luppojen biomassainventointien maastotyöt Muonion, Hammastunturin ja Alakitkan paliskuntien alueella. Biomassainventoinnin tarkoituksena on selvittää VMI:n (Valtakunnan metsien inventointi) porolaiduninventoinnissa käytetyn subjektiiviseen arvioon perustuvan lupon runsausluokituksen (0-3) luotettavuutta sekä kokonaisbiomassan että poron ulottuvilla olevan biomassan osalta, poronhoitoalueen pohjois- ja keskiosissa, sekä tarkentaa tiettyjen luokkien luotettavuutta eteläisessä osassa. Näin voidaan laskea luppobiomassat koko poronhoitoalueelle neljän porolaiduninventoinnin tulosten perusteella (1974-2004).
Saatuja tuloksia käytetään luppoisuuden ja metsikkötunnusten välisten riippuvuuksien mallintamiseen. Mallit tarjoavat tietoa lupon kasvuympäristövaatimuksista ja niiden avulla voidaan arvioida metsikkörakenteessa tapahtuneiden muutosten vaikutuksia luppojen biomassoihin sekä ennustaa erilaisten metsien käsittelyvaihtoehtojen aiheuttamia muutoksia tulevaisuudessa. Mallintamiseen käytetään ArcInfo 8.1 ohjelmaa. Luppobiomassamalleja käytetään tuotantofunktioiden luomiseen metsätalouden suunnitteluohjelmien osaksi, jolloin porotaloudelle tärkeät talviravintokohteet voidaan tulevat automaattisesti huomioiduksi suunnitteluprosessissa.
Puuntuotannon ja porotalouden integroimisen (erilaiset kiertoajat, käsittelymenetelmät) taloudellisia vaikutuksia tarkastellaan MELA2000-optimointiohjelmalla, jossa voidaan määritellä erilaisten luppobiomassatavoitteiden asettamat rajoitukset metsien käsittelylle.
Tutkimus on osa Metlan Rovaniemen asemalta koordinoitavaa Poronhoito ja muuttuva ympäristö -hanketta (2002-2006), jossa tutkitaan edellisten lisäksi laitumien tilassa tapahtuneita pitkäaikaisia muutoksia sekä ilmastollisten tekijöiden vaikutuksia poronhoitoon, kestävyyden käsitettä ja poronhoidon sopeutumiskykyä.

Finnmarksvidda – changes in lichen cover 1987-2000

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Reindeer herding in northern Scandinavia is associated with the Sami people. Traditionally, the local reindeer herding has been managed in perfect balance with the natural resources available. The migration of herds between coast and inland has provided access to high-quality food throughout the year and has protected the areas from overgrazing. During the past decades, this situation has changed. Today the rangeland ecosystems are exposed to a variety of serious threats. The decline in lichen cover due to reindeer overgrazing and subsequent soil erosion represent one of the main regional ecosystem changes experienced today. This presentation demonstrates the advantage of using remote sensing data in mapping and monitoring the reindeer winter ranges. The research fundamentals of this approach are based on the ability to distinguish lichen-rich communities from other vegetation types, sparsely vegetated areas, and bare soil. This distinction appears in the visible part of the electromagnetic spectrum.

Data layers used in the study include Landsat TM/ETM+ images from the years 1987, 1996 and 2000, digital elevation models, field data, and digital topographic maps of forests, mires, water, and open areas. The satellite images covering the Finnmarksvidda area are used as the main information source for production of vegetation maps reflecting the vegetation status of the time periods selected. The overall operations in the production line are image classification, spectral similarity analysis, integration of ancillary data, and relating the products to a vegetation system valid for the study area. The final task is to create a change-detection map focusing on the decline in lichen-rich areas. In the production scheme, both image processing software and geographical information software are needed.

The decline in lichen cover on Finnmarksvidda is expressed through vegetation maps based on Landsat images from the years selected. The map describing the vegetation conditions in 1987 shows large areas of lichen heaths and woodlands in the winter districts. The total lichen cover here is estimated to 1562,4 km^2. In the autumn districts lichen-rich constitute an area of 491,1 km^2, respectively. In 1996 lichen-rich vegetations are more or less absent in the autumn districts, while in the winter areas the amount is reduced to approximately half the amount during the nine years passed. The map describing the conditions in 2000 shows a further decline in lichen cover. The distortion pattern of the lichen cover shows a decline from north to south. From the overall maps, selected sub-areas are described more detailed. Maps from the Lahppolouppal area, shows that in these northern parts of the winter areas, most of the lichen decline occurred in the period 1987-1996. In the southernmost areas, near the Norwegian-Finnish border, large areas of lichen heaths and woodlands are visible in the maps from both 1987 and 1996. In the year 2000, the lichen formations are more scattered and fragmented. Lichen-rich vegetations are only found in areas protected by dense snow cover during winter. When comparing vegetation statistics from selected sub-areas the decline in lichen cover are expressed more accurately. Vegetation statistics from all the autumn and winter districts are produced in this project.

Even though this project is limited to describe subtle changes in lichen cover on Finnmarksvidda, it also meets the specific need to develop a large-scale monitoring system for range areas in northern Scandinavia. In Norway a monitoring programme for the reindeer ranges was initiated in 1998. Satellite images were selected as the main information source for detection and assessment of environmental conditions and trends. NORUT Information Technology is responsible for preparing, processing and interpreting satellite data within this project. NINA is responsible for the field inventory part of the project.

Finnmarksvidda – endringer i lavdekket 1987-2000

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Reindrifta i nordlige Skandinavia er knyttet til den samiske befolkningen. Tradisjonelt har denne næringa vært drevet i balanse med tilgjengelige naturressurser. Flytting av reinflokkene mellom kyst og innland har sikret gode beiteforhold for reinen gjennom året og hindret overbeiting av enkeltområder. Gjennom de siste tiårene er forholdene innen reindrifta endret betydelig. I dag opplever næringa trusler fra ulike hold. Reduksjonen i lavdekket som et resultat av sterkt beitepress gjennom mange år, er en av flere markerte forandringer ved omgivelsene som utøvere innen reindrifta opplever. Sekundære effekter av sterkt beitepress er i dag synlige som sår og erosjonsflater i terrenget. Denne presentasjonen ønsker å demonstrere mulighetene ved bruk av satellittdata til kartlegging og overvåking av reinens vinterområder. Karakteristisk for disse områdene er lavrike vegetasjonstyper. Det har vist seg at lavrike områder lett detekteres i satellittdata. Dette skjer i den synlige delen av det elektromagnetiske spekteret.
Satellittdata som er brukt i dette arbeidet, omfatter Landsat TM/ETM+ scener fra årene 1987, 1996 og 2000. Basert på dette datasettet er det utarbeidet vegetasjonskart over Finnmarksvidda. Vegetasjonskartene gir en beskrivelse av vegetasjonsstatus på vidda for de gitte årene. I bearbeiding av satellittdata for vegetasjonsformål inngår flere operasjoner. Første del av bearbeidingen omfatter klassifikasjon og spektral analyse av informasjonen i satellittdataene. I andre fase inngår bruk av digital terrengmodell, utvalgte karttema fra topografiske kart (skog, myr, vann, åpne flater) og feltregistreinger for korreksjon og tolkning av datasettet. I siste del relateres sluttproduktet til et klassifikasjonssystem gyldig for området. Basert på produserte vegetasjonskart er det gjort en endringsstudie som fokuserer på reduksjonen i lavdekket på Finnmarksvidda. Satellittdata er i dette arbeidet bearbeidet ved bruk av standard programvare innen billedbehandling. Integrering av tilleggsinformasjon og arealanalyse er gjort ved bruk av GIS-teknologi.
Reduksjonen i lavdekket på Finnmarksvidda er uttrykt gjennom vegetasjonskart fra årene 1987, 1996 og 2000. Kartet fra 1987 viser store areal med lavheier og åpne lavbjørkeskoger i store deler av vinterområdet. På dette tidspunktet er arealet av lavrik vegetasjon beregnet til 1562,4 km^2 for vinterdistriktene. Tilsvarende tall for vår-/høstområdene er 491,1 km^2. Tilsvarende beregninger basert på data fra 1996, viser at lavdekket i vår/høstområdet er mer eller mindre forsvunnet i løpet av ni år. Innen vinterområdet er lavdekket redusert til det halve i denne perioden. Kart fra år 2000 viser en ytterligere reduksjon i lavdekket. En sammenligning av kartene fra de ulike år, viser en forflytning av lavrike områder fra nord mot sør. Kartutsnitt fra ulike delområder, viser utviklingen mer i detalj. I området Lahppolouppal har reduksjonen i lavdekket skjedd i perioden 1987-1996. For områdene i sør, mot grensa til Finland, er store areal med lavrik vegetasjon synlig i kartene fra 1987 og 1996. I år 2000 er lavdekket også her mer fragmentert og oppsplittet. Lavrik vegetasjon finnes kun i forsenkninger beskyttet av et tykkere snødekke om vinteren. Ved å sammenligne arealstatistikk fra ulike delområder kan en få et mer nøyaktig bilde av reduksjonen i lavdekket. Det er i dette prosjektet utarbeidet arealstatistikk for de ulike vår-/høst og vinterdistriktene innen området.
Selv om dette prosjektet kun tar for seg de gradvise endringene i lavdekket som har skjedd på Finnmarksvidda gjennom de siste 15 årene, er dette et bevis på at satellittdata kan gi viktige bidrag til naturovervåking også i større skala. I Norge ble det igangsatt et overvåkingsprogram for reinbeiter i 1998. Satellittdata er valgt som en viktig informasjonskilde for overvåking av lavrike områder. NORUT Informasjonsteknologi er ansvarlig for satellittdata-delen av dette prosjektet. NINA har ansvaret for innsamling og bearbeiding av feltinformasjon.

Paratuberculosis in farmed red deer

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Paratuberculosis is a chronic, progressive enteric disease of ruminants caused by infection with *Mycobacterium avium* subsp. *paratuberculosis*. It is characterised by chronic granulomatous lesions, typically concentrated in the terminal ileum, and often ends as a fatal enteritis. Loss of weight and fertility leads to severe economic loss. Oral infection through faeces of infected animals is the most important infection route (Cocito *et al.*, 1994). Paratuberculosis has been diagnosed in wild ruminants in many European countries, and as become a problem in farmed red deer (*Cervus elaphus*) (Nebbia *et al.*, 2000; Godfroid *et al.*, 2000).The diagnosis of subclinical paratuberculosis is not straightforward (Stabel *et al.*, 1998). Bacterial culture is the most specific evidence of infection, but is time consuming and laborious. Serologic tests often lack both sensitivity and specificity and are hampered by cross-reacting agents. In slaughtered animals, the polymerase chain reaction (PCR) may confirm the presence of the bacteria in tissue. Successful eradication of paratuberculosis depends on removal of carrier animals from the herd, and treatment is rarely indicated.

Paratuberkulose hos oppdrettshjort

Paratuberkulose er en kronisk, progressiv tarmsykdom hos drøvtyggere forårsaket av *Mycobacterium avium* subsp. *paratuberculosis*. Karakteristiske trekk er kronisk granulerte lesjoner hovedsakelig i siste del av ileum, og sykdommen kan ende fatalt. Sykdommen smitter som oftest ved oralt opptak av mycobakterier fra faeces fra infiserte dyr. Reduksjon i vekt og fruktbarhet fører til store økonomiske tap (Cocito *et al.*, 1994). Paratuberkulose har blitt diagnosert hos ville drøvtyggere i mange europeiske land, spesielt hos hjort (*Cervus elaphus*) i oppdrett (Nebbia *et al.*, 2000; Godfroid *et al.*, 2000). Diagnosering av subklinisk paratuberkulose er omfattende (Stabel *et al.*, 1998). Bakteriekultur er det mest spesifikke bevis for infeksjon, men er tids- og arbeidskrevende. Serologiske tester mangler ofte både sensitivitet og spesifisitet og kryssreaksjoner med andre bakterier er problematisk. I forbindelse med slakting er polymerase kjedereaksjon (PCR) en egnet metode for å påvise bakteriene i vevsprøver. Suksess i utryddelsen av paratuberkulose avhenger av uttak av sykdomsbærere i flokken, og behandling av syke dyr blir av den grunn sjelden utført.

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Decision making in reindeer herding

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The aim of this part of my research project is to study how import economical goals is for long time decisions and short time decisions.
Since several reindeer herders use an area of pasture the theories in the field of property rights and common property regimes are interesting. Ostrom, 1993 summarizes for example conditions in decision making that will lead to a long term successful use of a commonly owned resource, some of them are that the participants is a homogenous group when it comes to preferences, and that they have the same values about what the problems are and how to solve them. In decision theory a decision can be seen as process including several events. To summaries a problem in relation to goals and values has to be identified, alternative solutions have to be recognized and a choice based on the facts about the different solutions should be made.
Two questions where asked in a questionnaire that in 1999 was sent to a sample of reindeer herders. The response rate was 63%, and 297 reindeer herders answered both questions (see Table 1).
The preliminary results show that the reindeer herders have the same long term non economical goals. They want to continue with reindeer herding and it is also important for most reindeer herders that there children will continue there business. For most of the reindeer herders the receipts from the slaughter is important for there support. There is no relation between how important the economical goal each year is and the long-term goals of the importance of being a reindeer herder.

Table 1.

	How important is it for you to be a reindeer herder?			
How important is the economical outcome of each years slaughter for you?	I will stop as a reindeerherde if I can find a job with a better income	I can personally not think of stoping as a reindeer herder	I can personally not think of stoping as a reindeer herder and it is important that the next generation continues	Total
The receipts from the slaughter doesn't affect my source of supply				
The receipts from the slaughter gives a little contribution to my supply				
The receipts from the slaughter are important but I also have income from employment				
The combination of receipts from the slaughter, hunting and fishing are important for my supply				
The receipts from the slaughter my determines my supply				
Total				

Beslutsfattande inom rennäringen

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Syftet med denna del av mitt forskningsprojekt är att studera vikten av ekonomiska faktorer för renskötselföretagens långsiktiga och kortsiktiga mål med sitt företagande.
Eftersom renbete är en resurs som brukas gemensamt av flera renskötselföretagere är teorier om hur gemensamt brukade resurser långsiktigt kan utnyttjas intressanta. Oström, 1993 sammanfattar några faktorer som är viktiga för ett hållbart utnyttjande av en gemensam resurs. De är t.ex. att deltagarna är en homogen grupp med avseende på tillgångar, information, och mål. Liksom att deltagarna har samma uppfattning om problemen och hur man kan lösa dem. Inom beslutsteori kan ett beslut ses som en process som består av flera delar. Viktiga delar i beslutsprocessen är mål, problemupptäckt och problemdefinition, analys, val och implementering av lösning.
För att belysa frågeställningen ställdes bl.a. två frågor ställdes till ett urval av renskötselföretagare (se tabell 1.) Svarsprocenten var 63%.
De preliminära resultaten visar att renskötselföretagarna har gemensamma långsiktiga icke-ekonomiska mål med sin verksamhet. Företagarna kan personligen inte tänka sig att sluta som renskötselföretagere. Företagarna ser det också som viktigt att nästa generation fortsätter som renskötare. För de flesta renskötarna är slaktintäkterna viktiga för försörjningen. Det finns inget samband mellan hur viktigt det ekonomiska utfallet av nästa års slakt är och det mera långsiktiga målet att vara renskötare.

Tabell 1.

	Hur viktigt är det för dig att vara renskötare?			
Hur viktigt är det ekonomiska utfallet av varje års slakt för dig?	Jag slutar som renskötare om jag hittar ett arbete med högre inkomst	Jag kan personligen inte tänka mig att sluta som renskötare	Jag kan inte tänka mig att sluta och det är viktigt att nästa generation tar över	Samtliga
Nivån på slaktintäkterna spelar ingen roll för min försörjning				
Slaktintäkterna ger endast ett litet tillskott till min försörjning				
Slaktintäkter viktiga men jag kan kombinera med tjänst				
Kombinationen av renslakt jakt fiske viktig för min försörjning				
Slaktintäkterna är avgörande för min försörjning				
Samtliga				

Examination for occurrence of important enteropathogenic bacteria and parasites (*Cryptosporidium*) in faeces from healthy reindeer calves

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Little is known about the occurrence of bacteria in reindeer husbandry, that have the potential to cause diseases not only in animals but also in humans. The analysis of the faecal shedding of pathogens, which may cause diseases like diarrhoe in humans, is important regarding risks of intensified reindeer herding. Especially calves are susceptible to these pathogens and outbreaks of disease may depend on different factors, such as a lowered immune defence capability. Therefore, and to test and improve the microbiological methodologies for further examinations for the EU project RENMAN (The Challenges of Modernity for Reindeer Mangement) faecal samples from 40 reindeer calves, about 4 weeks of age, of both genders, were collected in summer 2001. Due to difficulties in getting samples from diseased, free-ranging reindeer, and particularily from calves, samples were taken instead from clinically healthy animals kept at a research station. Subsequently, the faecal material was monitored for important enteropathogenic bacteria (*Campylobacter* spp., *Enterococcus* spp., *Escherichia coli*, *Salmonella* spp., *Yersinia* spp.) according to standard procedures. The presence of *E. coli*-virulence genes encoding shigatoxin 1 and 2 (stx 1,2), haemolysin (hly) and intimin (eae) was determined using PCR. An additional examination for enteropathogenic parasites, *Cryptosporidium* spp., was performed using Immunomagnetic Separation (IS). *Enterococcus* ssp. were found in 36 samples (90%) and the prevalence of *E.coli* was 100%. PCR-results revealed that two *E. coli* isolates (5%) carried the eae-gene and four isolates (10%) carried the hly-gene. The genes for stx 1 and stx 2 were not found. *Yersinia enterocolitica* was detected in one case (2,5%). The isolation of *Campylobacter* spp. and *Salmonella* spp. showed no positive results and the IS for *Cryptosporidium* spp. was negative in all cases. Obviously, this is the first report on the isolation of *Enterococcus* spp. and of *Yersinia enterocolitica* in reindeer calves. Even though important enteropathogens such as *Campylobacter*, *Salmonella* or *Cryptosporidium* could not be isolated, the bacteria detected in this study can be considered of a risk of causing diseases as well in animal as in man. Regarding recommendations concerning intensified reindeer herding it is important to know about these risks.

Viktige patogene bakterier i avføring fra 40 reinkalver

For å prøve ut og forbedre mikrobiologiske metoder ble 40 reinkalver fra reinforskningsstasjonen i Kaamanen, Finland, undersøkt etter vanlig standardfremgangsmåte for noen viktige patogene bakterier (resultater i parentes), *Campylobacter* spp. (0%), *Enterococcus* spp. (90%), *Escherichia coli* (100%), *Salmonella* spp. (0%) og *Yersinia* spp. (*Y. enterocolitica* 2,5%). Dessuten ble immunomagnetisk separasjon brukt for å undersøke forekomsten av parasitten *Cryptosporidium* spp. (0%). Videre ble PCR benyttet for å påvise sykdomsfremmende gener som koder for shigatoxin (0%), hemolysin (10%) og intimin (5%) i *E. coli*. Selv om hverken *Salmonella*, *Campylobacter* eller *Cryptosporidium* ble oppdaget i reinmøkka, kan de bakteriene som ble funnet, anses som mulig sykdomsårsak både i dyr og mennesker og bør tas med ved vurdering av intensiv reindrift.

Economic utilization of reindeer

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In the northern Finland reindeer is utilized in many ways. It is a source of highly-priced meat products, one of the key attractions in the northern tourism and an important aspect of the public image of the region.

Lately, the production of reindeer meat has been about two million kilos per year, and the producer price approximately five euros per kilo. The processing of the meat has, as an average, tripled the net revenue. Today, there are about 30 meat processing firms, most of which are small, family owned businesses located in the countryside. About a half of the reindeer meat is retailed in super- and hypermarkets. The value of the meat retail sales has been about 36-37 million euros. The value of slaughter by-products and souvenirs made of reindeer has annually been about at 4-5 millions euros.

The utilization of reindeer in tourism is significant. There are 30-40 reindeer firms with the combined net sales about 17 million euros. The firms organize reindeer rides and -safaris. They organize shows of reindeer and reindeer herding and sell reindeer products.

Finnish Game and Fisheries Research Institute has started a project with the goal to study the economic utilization of reindeer. The project aims at promoting competitiveness of reindeer industry and bringing in knowledge that assists the development of the strategy for reindeer husbandry, decision-making and introducing new innovations and forms of activity.

The project started in December 2001 by publishing the preliminary report. In the report the forms and extent of economic utilization of reindeer are mapped out, reindeer products described and historical development of reindeer husbandry analyzed. During the last years the development aspects of reindeer husbandry have been fast reducing the amount of reindeer owners, increasing of winter feeding of reindeer and mushrooming small-scaled processing industry. In the last five years the amount of reindeer owners have reduced from 7200 to 5700 owners. The supplemental feeding of the animals has become common even in north. Today, the reindeer herding is based on natural pastures only in the most farthest areas.

In this year it is aim to design a research program concerning economic utilization of reindeer for years 2003-2007. The program will be carried out as a co-operative project under co-ordination of the Finnish Game and Fisheries Research Institute. The main themes for research are 1) Reindeer husbandry as a part of society, 2) Production of reindeer meat, 3) Reindeer and tourism, 4) Reindeer products and 5) Subjects that aid research. Research program will be prepared by organizing seminars. Research program of economical utilization of reindeer will be ready in the beginning of the year 2003.

Poron taloudellinen hyödyntäminen

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Pohjois- Suomessa poroa hyödynnetään monella tapaa: lihantuottajana, matkailupalveluissa ja välillisesti osana alueen julkisuuskuvaa. Viime aikoina poronlihan vuosituotanto on ollut noin kaksi miljoonaa kiloa, ja tuottajalle kilosta poronlihaa on maksettu runsaat viisi euroa. Jalostamalla poronlihan arvo lähes kolminkertaistuu. Poronlihaa jalostavia yrityksiä on noin 30, joista valtaosa on pieniä, maaseudulla toimivia perheyrityksiä. Noin puolet poronlihasta kiertää kulutukseen kaupan kautta. Poronomistajien oma käyttö huomioiden poronlihan vähittäismyynnin arvo on 36-37 miljoonaa euroa. Teurastuksen sivutuotteina saatavia käyttötarvikkeita ja matkamuistoja myydään 4-5 miljoonan euron arvosta.
Poron matkailullinen hyödyntäminen on nykyisin varsin mittavaa. Poromatkailua harjoittavia yrityksiä on 30-40, joiden yhteinen liikevaihto on 17 miljoonan euron tasoa. Yritykset järjestävät poroajeluja ja –safareita, esittelevät poroa ja poronhoitoa sekä myyvät porotuotteita. Välittömien vaikutusten ohella poro ja porotalous hyödyttävät Lapin ja Pohjois-Suomen matkailua myös välillisesti, myönteisten mielikuvien kautta.
Riista- ja kalatalouden tutkimuslaitos on käynnistänyt hankkeen, jossa selvitetään tarkemmin poron taloudellista hyödyntämistä. Tutkimus on jäänyt vähäiseksi etenkin porotuotteiden ja niiden kysynnän, poromatkailun sekä porotalouden yhteiskunnallisten ulottuvuuksien osalta. Hankkeen avulla pyritään mm. edistämään porotalouden kilpailukykyä sekä tuottamaan tietoa, joka edesauttaa porotalouden strategista kehittämistä, alaan liittyvää päätöksentekoa sekä uusien innovaatioiden ja toimintamenetelmien kehitystä.
Hanke käynnistyi joulukuussa 2001 valmistuneella esiselvityksellä. Selvityksessä mm. kartoitettiin poron taloudellisen hyödyntämisen muotoja ja laajuutta, kuvattiin porotuotteita ja porotalouden tuotantoketjua sekä analysoitiin porotalouden yleiskehitystä. Viime vuosina porotalouden kehityspiirteitä ovat olleet mm. poronomistajien määrän nopea väheneminen, porojen talviruokinnan lisääntyminen sekä poronlihan pienimuotoisen jalostuksen ja poromatkailun yleistyminen. Poronomistajien määrä on vähentynyt muutamassa vuodessa lähes viidenneksen, noin 5 700 omistajaan. Porojen lisäruokinta alkaa olla yleinen käytäntö jo pohjoisessakin, yksin luonnonlaidunten varassa poronhoito toimii enää kaikkein syrjäisimmillä alueilla.
Kuluvana vuonna laaditaan poron taloudelliseen hyödyntämiseen liittyvä tutkimusohjelma vuosille 2003-2007. Ohjelma toteutetaan Riista- ja kalatalouden tutkimuslaitoksen johdolla yhteistyöhankkeena. Ohjelman tärkeimpiä aihealueita ovat 1) Porotalous osana yhteiskuntaa, 2) Poronlihan tuotanto, 3) Poro & matkailu, 4) Porotuotteet ja 5) Aihetta tukevat tutkimukset. Tutkimusohjelman laadinta toteutetaan seminaarien kautta. Poron hyödyntämisen taloustutkimusohjelma valmistuu vuoden 2003 alussa.

Classification of reindeer pastures: Mapping based on Traditional Ecological Knowledge (TEK) and Remote sensing based pasture mapping

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Traditional ecological knowledge (TEK) is based on indigenous peoples' own locally developed practices of resource use. Several examples in Canada illustrate the utility of applying TEK in the context of scientific research. It provides for a more holistic view by employing local ecological and historical knowledge of a particular area.
Remote sensing has been used in reindeer pasture inventories since 1980s. In these inventories, botanical fieldwork has been incorporated into remote sensing data. Pasture classes have been developed from visible patterns associated with different types of ground cover. Such inventories have provided geographic knowledge about quantity and quality of pastures in Lapland. The data in these studies have usually been derived Landsat TM images with 30 meter resolution.
The aim of the present study is to classify reindeer pastures in the Näkkälä reindeer herding district via systematic comparison of TEK and remote sensing data. These different types of knowledge are to be valued equally in the search for a more complete understanding of the pastures. This will serve to involve local people in the research and scenario development to anticipate and plan for future changes.
Methods used in studying TEK derive primarily from social sciences. They include thematic interviews and participant observation. The main themes are the seasonal exploitation of pastures throughout the year and qualitative classification of pastures. Reindeer herders will also map the areas grazed by their reindeer from their own perspective. Interviewing began in summer 2001 and will continue in winter and spring 2002.
Pasture inventory will be accomplished by using high resolution IKONOS 2 satellite images (4 meter resolution) and botanical ground truthing. Pasture type classification is based on vegetation types and their suitability as either summer or winter pasture. Fieldwork started in summer 2001 and will continue in summer 2002.
Maps based on herders' knowledge will be translated into the GIS program (ARC/INFO). One option will be to compare herders' maps to the remote sensing based maps. One interesting thing to see will be how winter and summer pasture resources differ according to these contrasting methods of mapping. The study aims to provide new knowledge regarding the utility of the latest remote sensing technology for creating high quality maps relevant to contemporary reindeer management. It will also make available new information about the factors that should be taken into account when employing remote sensing for reindeer pasture mapping in particular and pasture mapping in general.

Porolaidunten luokittelu perustuen Perinteiseen ekologiseen tietämykseen (TEK) ja kaukokartoituspohjaiseen laidunluokittamiseen

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Perinteinen ekologinen tietämys (TEK) perustuu alkuperäiskansojen omiin paikallisesti kehittyneisiin resurssien käyttömuotoihin. Useat esimerkit Kanadassa osoittavat TEK:n käyttökelpoisuuden tieteellisen tutkimuksen yhteydessä. Se tuottaa kokonaisvaltaisemman näkemyksen tuomalla mukaan tietyn alueen paikallisen ekologisen ja historiallisen tietämyksen.
Kaukokartoitusta on käytetty porolaidunten inventoinnissa 1980-luvulta lähtien. Siihen on sisällytetty myös kasvitieteellinen laiduntutkimustutkimus. Laiduntyyppiluokitus on kehitetty satelliittikuvissa näkyvistä kasvillisuuskuvioista ja maanpinnan kuvioista. Inventoinnit ovat tuottaneet maantieteellistä tietoa laidunten laadusta ja määrästä Lapissa. Yleensä näissä tutkimuksissa on käytetty Landsat TM aineistoa, jossa on 30 metrin erotuskyky.
Tutkimuksen tarkoituksena on luokitella porolaitumet Näkkälän paliskunnassa ja verrata keskenään poromiesten kartoituksia ja kaukokartoituspohjaisia kartoituksia. Näitä erilaisia tiedon muotoja arvioidaan samalla tavalla, jotta laitumia ymmärrettäisiin paremmin. Paikalliset ihmiset ovat osallisena alueensa tutkimuksessa ja skenaarioiden kehittämisessä.
Metodit, joita käytetään TEK:n tutkimisessa ovat pääosin peräisin yhteiskuntatieteistä. Tässä tutkimuksessa käytetään teemahaastattelua ja osallistuvaa havainnointia. Tutkimuksen pääteemat ovat laidunkierto ja laidunten laadullinen luokittelu. Poromiehet kartoittavat porolaitumet omasta näkökulmastaan. Haastattelut aloitettiin kesällä 2001 ja ne jatkuvat talvella ja keväällä 2002.
Laiduninventoinnissa käytetään uusia IKONOS-2 satelliittikuvia (4 metrin erotuskyky) sekä kasvitieteellisiä maastotöitä. Laiduntyyppiluokitus perustuu kasvillisuustyyppeihin ja niiden sopivuuteen kesä- tai talvilaitumiksi. Kenttätyöt aloitettiin kesällä 2001 ja ne jatkuvat kesällä 2002.
Kartat, jotka perustuvat poromiesten tietoon muunnetaan paikkatieto-ohjelmaan sopivaksi (ARC/INFO). On mielenkiintoista selvittää mm. kuinka paljon talvi- ja kesälaidunvarat mahdollisesti eroavat näiden eri luokitusmenetelmien perusteella. Tutkimuksen tarkoituksena on tuottaa tietoa, miten uusi kaukokartoitustekniikka soveltuu korkealaatuisten laidunkarttojen tuottamiseen ja miten niitä voidaan hyödyntää käytännön porotaloudessa. Poromiesten kartoituksen perusteella tarkastellaan niitä tekijöitä, jotka pitäisi ottaa huomioon käytettäessä kaukokartoitusmenetelmiä laidunkartoituksessa.

Digging work of reindeer in woodland lichen pasture during winter

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In the main part of the winter reindeer has to forage in the snow. Although digging work (cratering) is an essential part of the foraging of reindeer in winter, relatively few studies have been made on it. Our aim was to investigate the technique, speed and amount of digging work and grazing by reindeer in woodland lichen pasture. From the middle of February 2001 until the end of April altogether eight unpregnant reindeer females were kept on freely grazing in the fenced area (20 ha) in the reindeer research station, in Kaamanen. Two third of the fenced area were dry pine forest in which the amount of lichens in the previous autumn was on average 600 kg DM/ha. Digging work, foraging and activity of reindeer were observed and measured on the daytime (from dark to dark) during the two separate periods on February (15 days) and April (19 days). Body mass of reindeer and snow conditions were monitored during the experiment. There were very easy snow conditions in winter 2000-2001. Snow depth on lichen pasture inside the fence was on average 31.1 cm and snow density 159 g/dm^3 on the beginning of February. On the beginning of April, snow depth was 41.8 cm and snow density 239 g/dm^3. During the daytime on February reindeer spent 39.8% digging/grazing, 1.0% browsing, 21.0% lying, 25.9% standing and 12.3% walking/running. On April, they spent 29.8% digging/grazing, 5.2% browsing, 40.3% lying, 15.4% standing and 9.3% walking/running. During the actual grazing period, reindeer foraged (dug and grazed) within a certain repeated rhythm, which total length was on average 30.2 s on February and 35.9 s on April. Within this rhythm on February, reindeer made first on average 6.8 pawings and then used 21,5 s for grazing. On April, reindeer made first on average 9.5 pawings and then used 29.4 s for grazing. The speed of pawing was on average 1.5 pawings/s on February and 1.7 pawings/s on April. During the digging work, reindeer used both of the front foots equally. Size of the grazed area within a single crater was on average 1.51 m^2 on February (snow depth mean in crater 38,3 cm) and 1.40 m^2 on April (snow depth mean in crater 44,3 cm). Size of the grazed area within a single crater (m^2) was dependent on the total foraging time (s) used per crater (R^2=0.51, $y=-0.008x+0.0196x^{0,9}$, n=35, P<0.001). The mean body mass of reindeer was 67.1±2,67 kg on the mid of February and 64,9±2,98 kg on end of April. If the reindeer had foraged in same way during the whole 24 hours as observed on the daytime, reindeer would have dug and grazed ca. 66 m^2/24 h/one reindeer during the observation period on February when the mean weight change of reindeer was actually +50,0 g/24 h/one reindeer. Calculated in the same way, reindeer would have dug and grazed ca. 59 m^2/24 h/one reindeer during the observation period on April when the mean weight change of reindeer was –26,3 g/24 h/one reindeer.

Poron talvinen kaivutyö metsäalueen jäkälälaitumella

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Pääosan talvea poro joutuu hankkimaan ravintonsa lumen alta. Vaikka kaivutyö onkin olennainen osa poron ravinnonhankintaa talvella, sitä on silti tutkittu vielä verrattain vähän. Tarkoituksemme oli tutkia poron kaivutyön ja ravinnonoton tekniikkaa, nopeutta ja määrää metsäalueen jäkälälaitumella talvella. Helmikuun puolestavälistä 2001, huhtikuun loppuun kahdeksaa ei-tiinettä vaadinta pidettiin vapaassa laidunnuksessa aidatulla alueella (20 ha) porotutkimusasemalla Kaamasessa. Kaksi kolmasosaa aidatusta alueesta oli kuivaa mäntykangasta, jossa poronjäkälien määrä oli edellisenä syksynä keskimäärin 600 kg DM/ha. Porojen kaivutyötä, ravinnonottoa ja aktiivisuutta seurattiin ja mitattiin päiväsaikana (pimeästä pimeään) kahtena eri jaksona, helmikuussa (15 päivää) ja huhtikuussa (19 päivää). Porojen painon muutosta ja lumiolosuhteita mitattiin kokeen aikana. Talvella 2000-2001 olivat lumiolosuhteet erittäin helpot. Helmikuun alussa lumen syvyys aitauksen sisässä jäkälälaitumella oli keskimäärin 31,1 cm ja tiheys 239 g/dm^3. Vastaavasti huhtikuun alussa lumen syvyys oli keskimäärin 41,8 cm ja tiheys 239 g/dm^3. Päiväsajasta helmikuussa porot käyttivät 39,8% kaivutyöhön/ruokailuun, 1,0% lupon syöntiin, 21% makaamiseen, 25,9% seisomiseen ja 12,3% kävelyyn/juoksuun. Huhtikuussa porot käyttivät 29,8% kaivutyöhön/ruokailuun, 5,2% lupon syöntiin, 40,3% makaamiseen, 15,4% seisomiseen ja 9,3% kävelyyn/juoksuun. Varsinaisen ravinnonkaivuujakson aikana, porot ottivat ravintoa (kaivoivat ja ruokailivat) tietyssä toistuvassa rytmissä, jonka pituus oli helmikuussa 30,2 sekuntia ja huhtikuussa 35,9 sekuntia. Tämän rytmin aikana porot tekivät helmikuussa ensin keskimäärin 6,8 kuopaisua, minkä jälkeen ruokailivat 21,5 sekuntia. Huhtikuussa porot tekivät ensin keskimäärin 9,5 kuopaisua, minkä jälkeen ruokailivat 29,4 sekuntia. Kuopimisnopeus oli helmikuussa keskimäärin 1,4 kuopaisua/sekunti ja huhtikuussa 1,7 kuopaisua/sekunti. Kaivutyön aikana porot käyttivät kumpaakin etujalkaansa yhtä paljon. Laidunnetun alueen koko yksittäisessä kaivukuopassa oli helmikuussa keskimäärin 1,51 m^2 (lumen syvyys kuopassa keskimäärin 38,3 cm) ja huhtikuussa 1,40 m^2 (lumen syvyys kuopassa keskimäärin 44,3 cm). Laidunnetun alueen koko (m^2) kaivukuopassa oli riippuvainen ravinnonoton kokonaisajasta (sekuntia) kaivukuopalla (R^2=0.51, $y=-0.008x+0.0196x^{0,9}$, n=35, P<0.001). Porojen keskipaino oli helmikuun puolivälissä 67.1±2,67 kg ja huhtikuun loppupuolella 64,9±2,98 kg. Jos porot olisivat hankkineet ravintoa koko vuorokauden niin kuin niiden havaittiin päiväsaikana tekevän, porot olisivat kaivaneet ja laiduntaneet noin 66 m^2/vrk/poro helmikuun tarkkailujaksolla, jolloin porojen paino itse asiassa nousi +50g/vrk/poro. Samalla tavoin laskettuna porot olisivat kaivaneet ja laiduntaneet noin 59 m^2/vrk/poro huhtikuun tarkkailujakson aikana, jolloin porojen painon muutos oli –26,3 g/vrk/poro.

Evidence of different pasture use from satellite images: Cases from Lapland and the Tibetan plateau

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Intensive grazing causes changes to pastures. Difference in grazing intensity is not easy to detect from satellite images. Grazing intensity are more visible in treeless areas. This is the case in Northern Lapland and the Tibetan plateau. Usually ungulates like yaks and reindeer forage mainly the vegetation of the field layer. Ground lichens (*Cladina* sp.) are important winter forage to reindeer. When the percent coverage of lichens is high, lichen pastures are visible in satellite images with whitish shades. In Tibetan plateau grasslands yaks and sheep browse grasses, forbs and sedges. Grazed or ungrazed pastures are possible to detect comparing intensity of near infrared (NIR) reflectance in satellite images. In grazed areas NIR amount is lower and vice versa.
Grazing intensity may become visible if there is some natural (eg. rivers, lakes, mountain ridges) or manmade barrier that divides pastureland. Most common manmade barriers in are fences. Fences can be set up for pasture separation into winter and summer areas or to separate herding communities. Borders between countries are in many cases fenced to prevent humans and animals from crossing.
Our research area on the Tibetan plateau, Dzoge, much of the pastures have been divided between the nomadic families. The fencing of the areas has been intensive since the middle of 1990s. Especially winter and summer pastures have been separated. The increase of the herd size has affected on pasture condition and there are many visible signs of erosion and degradation in satellite images and in the field.
In Finland differences in grazing intensity between herding districts are in most cases not visible. However along the border area between Finland and Norway the difference between grazing intensity is clearly visible in satellite images. The reindeer fence along the border was built in the 1950s. The Finnish side has been both in summer and winter use while the Norwegian pastures are only used in winter. Trampling and overgrazing by reindeer has degraded Finnish lichen pastures.
In the forest area of Finnish Lapland forestry is the main land user that affects pastures. Clear cuts area visible in satellite images tens of years after harvesting timber. Forest management includes also extensive road building to remote areas.

Laidunnuksen intensiteetin arviointi satelliittiaineistosta: esimerkkinä Lappi ja Tiibetin ylänkö

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Laidunnus aiheuttaa muutoksia laitumiin. Laidunnuksen voimakkuutta ei ole helppoa havaita satelliittikuvista. Erot laidunnuksessa näkyvät selvimmin puuttomilla alueilla, kuten Pohjois-Lapissa ja Tiibetin ylängöllä. Laiduntavat sorkkaeläimet syövät lähinnä kenttäkerroksen kasveja. Poronjäkälät (*Cladina* sp.) ovat tärkeä osa porojen talviravintoa. Kun poronjäkälän määrä alueella on korkea voidaan, satelliittikuvasta havaita jäkälälaidun valkoisen sävyisenä. Tiibetin ylängön ruohostoilla jakit ja lampaat laiduntavat pääasiassa heiniä, saroja ja ruohoja. Laidunnutetut ja laiduntamattomat laitumet voi erottaa vertaamalla lähi-infrapunan (NIR) säteilyn heijastumisen voimakkuutta satelliittikuvassa. Laidunnetuilla alueilla lähi-infrapunan määrä on matalampi ja päinvastoin.

Jos alueella on luonnollisia tai ihmisen tekemiä esteitä, jotka jakavat laidunmaan osiin, voidaan vertailla laidunnuttujen ja laiduntamattomien alueiden välisiä eroja sekä pohtia laidunnuksen intensiteetin vaikutusta alueen kasvillisuuteen. Luonnollisia esteitä ovat mm. joet, järvet ja vuorten harjanteet. Aidat ovat yleisempiä ihmisen tekemiä esteitä. Niitä käytetään jaettaessa laitumia talvi- ja kesälaitumiin tai jaettaessa laitumia eri laidunyhteisöjen välillä. Valtioiden väliset raja-aidat estävät sekä ihmisten että eläinten kulun rajan yli.

Tutkimusalueella Tiibetin ylängöllä, Dzoigessa, laitumia on jaettu paimentolaisperheiden kesken. Laidunten aitaaminen yleistyi 1990-luvun puolivälissä. Varsinkin talvi- ja kesälaitumet on erotettu aidoin. Karjan määrän lisääntyminen on vaikuttanut laidunten kuntoon, ja monin paikoin on havaittavissa laidunten kunnon huonontuminen sekä satelliittikuvalla että maastossa.

Paliskuntien välisiä eroja laidunnuksen voimakkuudessa ei ole havaittavissa satelliittikuvilta. Suomen ja Norjan raja-alueella laidunnuksen erot ovat selvästi havaittavissa satelliittikuvilta. Rajaa myötäilevä poroaita rakennettiin 1950-luvulla. Suomen puolella laitumet ovat sekä talvi- että kesäkäytössä, mutta Norjan puolen laitumet ovat ainoastaan talvikäytössä. Tallaaminen ja ylilaidunnus ovat kuluttaneet Suomen puoleisia jäkälämaita.

Metsälapissa metsäteollisuus on suurin porolaitumiin vaikuttava tekijä. Avohakkuut näkyvät satelliittikuvissa vuosikymmeniä. Hakkuut vaikuttavat poronhoitoon vähentämällä lupon määrää. Metsien hakkuisiin liittyy myös voimakas teiden rakentaminen, joka pirstoo erämaita.

Hierarchy evolution and diurnal activities of female reindeer *Rangifer tarandus tarandus* L. in winter time

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Our main aim was to figure out if hierarchy would change in a female group according to dominance relationships throughout three different types of interactions: aggressiveness, theft of crater and positive contacts between individuals (for ex. cares, tolerate proximity). At same time we studied activities and feeding behaviour at crater sites. For instance, we tried to look if there were differences in activities between individuals with different social rank.

8 female reindeer, living on natural food in a 15 ha enclosure in the fence of the Reindeer Research Station (FGFRI) were studied at two different periods (February and April) in winter 2000-2001. Altogether 5 females were also equipped with heart rate system in order to record cardiac rhythm during one week in each observation period.

Activities were collected through 15 minutes focus on each individual. Thus, observed variables were digging a crater, walking, running, standing, laying, browsing. Social dominance was studied by the mean of 30 minutes scanning of the group from 2 to 5 hours per day in order to establish the hierarchy and its evolution between two months. Patterns as aggressiveness and accessibility to crater, leadership in the group, initiation of main activities were considered.

Study on calf production in the Finnish reindeer herding area

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Calf production is an important measure for reindeer husbandry in Finland. From the 1970's calf slaughter developed to a main production strategy, and nowadays over 70% of all slaughtered reindeer are calves. Calf production (calves/100 hinds) varies temporally and spatially. There is also large variation in the mean slaughter weight of calves in different parts of the Finnish reindeer herding area. Stochastic mechanisms such as weather conditions may strongly affect reproduction, survival and weight gain in reindeer stock. However, there are also many other important factors such as annual herd structure, management strategies, condition of pastures, maternal characteristics and qualities of offspring, which should be studied. Also predation needs to be studied in connection with calf production. The aim of this study was to study calf production in nine Finnish reindeer herding districts by assessing pregnancy rates, calf-% during summer and slaughter season, and rates and causes of mortality during 1999-2001.

The study reindeer were marked individually: hinds with numbered plastic collars and calves with plastic ear-tags. In three of the study districts calves were also equipped with mortality indicating radio transmitters fixed in flexible collar. The total number of hinds in the study was 4455 in 1999-2001. Altogether 1255 calves were fitted with mortality transmitters during 1999-2001, and 2 145 were marked with ear-tags. Survival of marked calves was followed using telemetry in the field and recording presence/absence -data at round-ups (both ear-marking and slaughter). Weighing and measurements of study animals were carried out before and at calving in spring, in connection with earmarking during summer and at round-ups during autumn and winter. Slaughter weights of marked calves were collected with assistance of the reindeer herding districts. The pregnancy rates were studied using ultrasound device in eight reindeer herding districts in January 2000.

Pregnancy rate of total 1265 hinds was 92.8% (range by districts 85.2-97.4%). Young hinds (2-3-year old) had lower pregnancy rates (87.0%) compared with older hinds (4-10-years old: 94.1%; >10-years old: 94.6%). The calf-% of studied hinds in the earmarking of the subsequent summer in 2000 was on average 83% (n=1 373 hinds, 7 districts; range by district 61-91%), and 85% (n=803 hinds, 4 districts; range 72-90%) in 2001. The eventual calf production was recorded in conjunction with round-ups, and was on average 76% in the whole studied group of hinds (n=1 315, 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 (2-3-year old) were significantly lower (P<0.001) compared with calves of older hinds. The autumn weights of calves reared by hinds in good body condition during previous autumn were higher compared with calves of hinds in moderate/low body condition (P<0.01). Calves born earlier and with higher birth weight had higher autumn weights compared to calves born later and smaller. The hinds with better body condition were heavier compared to those with lower body condition (P<0.001).

Calf mortality in different study areas varied between 3-22% in 1999-2001. According to the results from telemetry studies in the northern district of Ivalo, the most significant single cause of mortality was predation by golden eagle (41% of all mortality cases among radio-collared calves), while in the southeastern district of Oivanki the biggest mortality factor was brown bear (17% of mortality cases). However, additional 50% of all observed cases of mortality in Oivanki were connected with brown bear, but due to inadequate calf remains were classified unknown. In Ivalo mortality was evenly distributed between June-August, but in Oivanki most of the dead calves were found during first two weeks after radio-collaring in May-June. Calf weight at birth and at earmarking was the only character of radio-collared calves explaining their survival. The summer weight of the calves killed by golden eagles in Ivalo (8.9 kg, S.D.=1.7, n=16) was significantly lower compared with calves that survived (11.7 kg, SD=2.7, n=586; P<0.001). The birth weights of bear-killed calves in Oivanki (6.8 kg, SD=0.6, n=6) were lower than weights of calves that survived (7.3 kg, SD=1.1, n=132), but the group means did not differ significantly (P=0.275). However, when cases with bear scavenging and confirmed bear-kills were combined, the mean birth weight of calves in combined group (6.7 kg, SD=0.9, n=24) differed significantly from calves that survived (P=0.012).

Tutkimus vasatuotosta Suomen poronhoitoalueella

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Vasatuotolla on suuri merkitys tämän päivän porotaloudelle Suomessa. 1970-luvulta lähtien porotaloudessa siirryttiin vasateurastukseen, ja nykyään jo yli 70% kaikista teurasporoista on vasoja. Vasatuotto (vasaa/100 vaadinta) vaihtelee ajallisesti ja alueellisesti. Myös vasojen teuraspainot vaihtelevat suuresti eri puolilla poronhoitoaluetta. Satunnaiset mekanismit kuten sääolosuhteet voivat vaikuttaa voimakkaasti vasatuottoon, selviytymiseen ja vasojen painoihin porokarjassa. On kuitenkin monia tärkeitä seikkoja, joita pitäisi tutkia: porokannan rakenne, poronhoitotavat, laidunten kunto, sekä emän ja vasan ominaisuudet (mm. paino ja kunto). Myös petojen saalistuksen yhteyttä vasatuottoon pitäisi tutkia. Tämän tutkimuksen tavoitteena oli tutkia Suomen poronhoitoalueen yhdeksässä paliskunnassa vaatimien tiinehtyvyyttä, vasaprosenttia kesällä ja erotuksissa, sekä vasakuolleisuuden määrää ja kuolinsyitä vuosina 1999-2001. Tutkittavat porot merkittiin yksilöllisesti: vaatimille laitettiin muovinen numeroitu kaulapanta ja vasoille muovinen korvapiltta. Lisäksi kolmessa paliskunnassa vasoille laitettiin kaulaan myös joustava panta, johon oli kiinnitetty kuoleman ilmaiseva radiolähetin. Kaikkiaan vaatimia tutkittiin 4455 vuosina 1999-2001. Yhteensä 1255 vasaa varustettiin kuolevuusradiolähettimellä vuosina 1999-2001, ja 2145 merkittiin korvapiltalla. Tutkimusvasojen selviytymistä seurattiin maastossa radiovastaanottimin ja teuraserotuksissa kirjattiin vasan läsnäolo/poissaolo. Porot punnittiin ja mitattiin ennen vasomista ja vasomisen aikoihin, vasanmerkinnän yhteydessä kesällä ja poroerotuksissa syksyllä ja talvella. Tutkimusvasojen teuraspainot saatiin paliskunnan teuraskirjoista. Vaatimien tiinehtyminen tutkittiin ultraäänilaitteella kahdeksassa paliskunnassa tammikuussa 2000. Vaatimien (n=1265) tiinehtymisaste oli 92.8% (vaihteluväli paliskunnittain 85.2-97.4%). Nuorilla vaatimilla (2-3-vuotiaat) tiinehtymisaste oli alempi (87.0%) kuin vanhemmilla vaatimilla (4-10-vuotiaat: 94.1%; >10-vuotiaat: 94.6%). Vasaprosentti tutkituilla vaatimilla oli seuraavan kesän (2000) vasanmerkinnän aikana keskimäärin 83% (n=1373 vaadinta, 7 paliskuntaa, vaihteluväli 61-91%), ja 85% vuonna 2001 (n=803 vaadinta, 4 paliskuntaa; vaihteluväli 72-90%). Lopullinen vasaprosentti saatiin erotuksissa. Kaikkien tutkimusvaadinten vasaprosentti oli keskimäärin 76% (n=1315, 8 paliskuntaa; vaihteluväli 49-89%) vuonna 2000 ja 73% (n=634, 4 paliskuntaa; vaihteluväli 57-83%) vuonna 2001. Nuorten vaatimien (2-3-vuotiaiden) vasojen elo- ja teuraspainot olivat merkitsevästi alemmat (P<0.001) kuin vanhempien vaatimien vasojen. Hyväkuntoisilla vaatimilla oli seuraavana syksynä painavampia vasoja kuin huonompikuntoisilla vaatimilla (P<0.01). Aikaisemmin ja painavampina syntyneet vasat painoivat syksyllä enemmän kuin myöhemmin ja keveämpinä syntyneet vasat. Parempikuntoiset vaatimet olivat myös painavampia kuin heikompikuntoiset vaatimet (P<0.001). Vasojen kuolleisuus eri tutkimusalueilla vuosina 1999-2001 vaihteli 3-22% välillä. Radiolähetinseurannan mukaan pohjoisessa Ivalon paliskunnassa merkittävin yksittäinen kuolinsyy oli kotkan saaliiksi joutuminen (41% kuolleena löydetyistä radiolähetinvasoista), kun taas poronhoitoalueen kaakkoisosassa Oivangin paliskunnassa suurin kuolinsyy oli karhu (17% kuolleena löydetyistä radiolähetinvasoista). Lisäksi 50% havaituista radiolähetinvasojen kuolintapauksista Oivangin paliskunnassa yhdistettiin karhuun, mutta vähäisten vasan jäännösten takia kuolinsyy luokiteltiin tuntemattomaksi. Ivalon paliskunnassa kuolleisuus jakaantui tasaisesti kesä-elokuulle, mutta Oivangin paliskunnassa suurin osa kuolleista vasoista löydettiin kahden viikon kuluessa radiolähettimen asentamisesta touko-kesäkuussa. Vasan syntymäpaino ja vasanmerkintäaikainen paino kesällä oli ainoa selviytymistä selittävä tekijä radiolähetinvasoilla. Ivalon paliskunnassa kotkan tappamien vasojen vasanmerkintäpaino oli merkitsevästi alempi (8.9 kg, SD=1.7, n=16) kuin selvinneiden vasojen (11.7 kg, SD=2.7, n=586; P<0.001). Karhun tappamien vasojen syntymäpaino oli Oivangin paliskunnassa alempi (6.8 kg, SD=0.6, n=6) kuin selvinneiden vasojen (7.3 kg, SD=1.1, n=132), mutta ryhmien keskiarvot eivät eronneet merkitsevästi (P=0.275). Kun karhun tappamiksi varmistetut ja karhun syömät vasat yhdistettiin yhdeksi ryhmäksi, saatiin näiden vasojen keskimääräiseksi syntymäpainoksi 6.7 kg (SD=0.9, n=24), joka erosi merkitsevästi selvinneiden vasojen painosta (P=0.012).

Non-destructive measurements of lichen biomass

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A scientifically-based grazing management strategy is dependent on quantitative data of the status and dynamics of the natural resource that is being used. A critical factor in the management of grazing grounds for reindeer is the amount of ground lichens present on the winter grazing grounds. In order to estimate reindeer lichen biomass, non-destructive measures must be used, i.e. biomass must be calculated from cover and/or lichen thallus height measured in the field. This requires known and verifiable relationships between cover and biomass for the species of interest.
We studied four important food species for reindeer: *Cladina stellaris*, *Cladina arbuscula*, *Cladina rangiferina*, and *Cetraria islandica*. For each species we measured cover and lichen thallus height in 50 x 50 cm quadrats and harvested the lichens for dry weight measurements of biomass. The quadrats were subjectively chosen so that they were as close to monocultures as possible and so that the entire gradient from heavily grazed to thick lichen mats were included. We measured cover through five different methods for each quadrat: visual estimates of cover, presence/absence in a grid of 36 small squares (lichens present, covering at least 50% of the square, or covering 100% of the square), and by contact with 25 points in a point-frame. Lichen thallus height was measured with the pin used in the point-frame, and estimated as a mean of all 25 points, a mean of five points, or by one point. This gives 15 combinations of cover and height to calculate volume which were then compared with biomass through linear regressions.
The explained variance was generally very high in all regressions (usually in the order of 80-90%). No indications of non-linear relationships were found. All measurements of cover, except presence/absence with a 100% cover threshold, gave similarly strong relationships. However, the explained variance decreased rapidly with less good estimates of lichen height, i.e. with fewer points to estimate height. We also regressed the measurements of mean lichen height based on 25 points per quadrat on biomass which gave an equally strong relationship as when volume was regressed on biomass. Relationships for the three *Cladina*-species were generally very similar while the relationship for the *Cetraria*-species was slightly different.
Based on these results we suggest a monitoring method where lichen thallus height is measured in a random or regular sampling scheme over the area of interest. From these measurement, mean thallus height is calculated and lichen biomass is estimated from the linear regressions.

Icke-destruktiva skattningar av lavbiomassa

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En vetenskapligt baserad förvaltningsmodell är beroende av kvantitativa data på status och dynamik hos den resurs som förvaltas. En kritisk faktor i ett betesförvaltningssystem för renar är den mängd marklavar som finns i vinterbetesområdet. För att kunna skatta detta måste man använda icke-destruktiva metoder för att kunna beräkna biomassa från täckning och/eller mått på lavhöjd. Detta kräver att det finns dokumenterade förhållanden mellan täckning och biomass för de arter som man är intresserade av.
Vi studerade fyra viktiga födoarter för ren: *Cladina stellaris* (fönsterlav), *Cladina arbuscula* (gulvit renlav), *Cladina rangiferina* (grå renlav) och *Cetraria islandica* (islandslav). För varje art mätte vi täckning och lavhöjd i 50 x 50 cm rutor, och sedan skördade, torkade och vägde biomassan i dessa rutor. Rutor valdes subjektivt så att de var så nära till monokulturer som vi kunde komma och så att vi täckte in hela gradienten från hårt betade rutor till tjocka lavmattor. Vi mätte täckning enligt fem olika metoder för varje ruta: visuell skattning av täckningsgraden, förekomst i 36 smårutor inom varje ruta (bara förekomst, täckande minst 50% ar smårutan, eller täckande 100% av smårutan), samt genom punktfrekvens (25 punkter). Lavhöjd mättes med pinnen som användes till punktfrekvensen i alla 25 punkter, och skattades sedan som ett medelvärde på alla 25 punkter, ett medelvärde på 5 punkter, eller värdet i mittpunkten. Detta gav 15 olika kombinationer av täckning och höjd som vi beräknade lavvolym på. Denna volym relaterades till biomassa med linjära regressioner.
Förklaringsgraden var generellt hög i alla regressioner (vanligtvis ca 80-90%) och inga indikationer på icke-linjära samband kunde ses. Alla olika skattningar av täckning, förutom förekomst med 100% täckning i smårutorna, gav liknande samband, medan förklaringsgraden sjönk snabbt med sämre skattningar på lavhöjden. Vi gjorde också linjära regressioner på medellavhöjd (skattat med 25 punkter) och biomassa vilket gav ett lika starkt samband som regressionerna med volym och biomassa. Funktionerna för de tre *Cladina*-arterna var generellt väldigt lika medan funktionen för *Cetraria islandica* avvek något från de andra tre.
Baserat på dessa resultat föreslår vi en metod för att skatta biomassa där lavhöjd mäts på ett slumpmässigt eller regelbundet sätt över hela det område man vill undersöka. Medellavhöjd i området beräknas från dessa mätningar och lavbiomassa beräknas med hjälp av de linjära regressionerna.

Modelling spatial interaction and conflicts between reindeer husbandry and other use of natural resources

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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 the 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 adjust them together in a sustainable way. Study area consists of four reindeer management districts in Northern Finland. The aim is to develop a theoretical model for a land use interaction analysis system (LUIAS) to evaluate and valuate the various uses of natural resources in respect to reindeer husbandry. The model will be versatile taking into account possible biological, economical and reindeer management components. 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) will be 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, silviculture and other land use administrations and thus help different human activities to adapt to each other and to the carrying capacity of the area.

Poronhoidon ja muun luonnonkäytön välisiä alueellisia ristiriitoja ja vuorovaikutusta selvittävä tarkastelumalli

Poronhoidossa ja muussa maankäytössä tapahtuneet muutokset ovat vaikuttaneet porotalouteen monella tavalla. Maankäytön tehostuminen on uhkana aluskasvillisuudelle, metsien tilalle ja jopa luonnolle kokonaisuutena. Sisäinen ja ulkoinen kehitys ja paine saavat aikaan porotalouden jatkuvaa muutosta. Tämän vuoksi laidunalueiden tutkiminen on tärkeää, jotta laitumia voitaisiin hyödyntää kestävän kehityksen periaatteiden mukaisesti. Suomen tiedotusvälineissä on viime aikona käyty paljon keskustelua myös eri maankäyttömuotojen välisten vuorovaikutusten ja yhteyksien tutkimisen tärkeydestä. Tämän tutkimuksen keskeisenä tarkoituksena on porotalouden ja muiden maankäyttömuotojen välisten vuorovaikutusten selvittäminen ja niiden sovittaminen yhteen kestävällä tavalla. Tutkimusalue muodostuu neljästä erityisesti poronhoitoa varten tarkoitetun alueen paliskunnasta. Tutkimuksen päämääränä on kehittää luonnon käytön vuorovaikutusta selvittävä tarkastelumalli (Land Use Interaction Analysis System, LUIAS), joka arvioi ja arvottaa erilaisia luonnonvarojen käyttömuotoja suhteessa porotalouteen. Tarkoituksena on monipuolinen malli, joka ottaa huomioon mahdolliset biologiset, taloudelliset ja poronhoidolliset näkökulmat. Mallia laajennetaan tulevaisuudessa myös muiden maankäyttömuotojen analysointiin sopivaksi ja testataan empiirisen tutkimusaineston avulla. Paikkatietojärjestelmä (Geographical Information System, GIS) on keskeisessä asemassa tutkimusaineiston hankinnassa ja käsittelyssä. Projekti tarjoaa käytännön sovelluksena tietoa, jonka avulla voidaan vähentää kilpailua ja ristiriitoja porotalouden, metsätalouden ja muiden maankäyttäjien välillä ja täten auttaa eri toimintojen yhteensovittamista ja alueen luonnon kestävää käyttöä.

Potential effects of climate change on tree-line position in the Swedish mountains

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Future global climate changes has the potential of drastically changing vegetation patterns in the Swedish mountains. This project focuses on potential changes in the position of the alpine tree-line in the Swedish mountains on a 100-year perspective based on regional climate models developed by SWECLIM. We assumed that the position of the tree-line is climate-driven, that mountain birch has the potential to respond rapidly to changes in climate, and that changes in climate will result in a shift in tree-line position. Two climate scenarios were used which both predict changes in the mean monthly temperature during summer in a 44 by 44 km grid. The position of the tree-line, i.e. where continuous mountain birch forest gives way to tree-less heaths, was determined from digital maps and a digital elevation model. We then used a lapse rate of 0.6° per 100 m altitudinal difference to calculate changes in the position of the tree-line. The analysis incorporates the entire mountain chain in Swedish, but for the purpose of this poster we will exemplify with data from Marsfjället, Västerbotten.

Predictions from the climate scenarios for this area varied between 1.9° and 3.5° increase in the mean temperature, which translates into an altitudinal increase of mountain birch forests from 317 to 583 altitudinal meters. This will mean that only 7.5% to 0.4% of tree-less alpine heaths will be left in the area, which constitutes a major change in the alpine ecosystem. Even a much more conservative estimate of a 100 m altitudinal increase will result in loss of more than half of the alpine heath area.

We know that some of our assumptions will not hold, but we have no data with which we can quantify how much the results will diverge from the current ones. For instance, reindeer grazing during the summer may stop, or at least slow down, the upward increase of the mountain birches by consuming saplings, but we do not know how many reindeer are needed or the time-scale of the responses.

To conclude, climate change has a great potential of completely changing our alpine ecosystem with large effects on land use patterns, such as reindeer husbandry and tourism.

Potentiella effekter av klimatförändringar på trädgränsen i de svenska fjällen

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Framtida klimatförändringar kan potentiellt förändra vegetationsmönstren i fjällen på ett drastiskt sätt. Detta projekt fokuserar på potentiella förändringar i trädgränsens läge på ett 100-års perspektiv baserat på klimatdata från SweClim. Vi antog att trädgränsens läge är klimatbestämd, att fjällbjörk har potentialen att svara snabbt på förändringar i klimatet, samt att förändringar i klimatet därmed innebär en förflyttning av trädgränsen. Data på förändringar i sommartemperaturen från två olika klimatscenarier användes (rutstorlek 44 x 44 km). Trädgränsens läge, dvs där kontinuerlig björkskog går över till trädlös hed, bestämdes från digitala kartor och en digital höjdmodell. Vi använde en temperaturgradient på 0.6°/100 m höjdförändring för att överföra temperaturförändringar till förändringar i trädgränsens läge. Analysen täcker hela fjällkedjan men vi kommer att exemplifiera med resultat från Marsfjället, Västerbotten.
Förutsägelser om temperaturförändringar från klimatmodellerna varierade mellan 1.9° och 3.5°, vilket innebär en hödjökning för trädgränsen med 317 till 583 meter. Det kommer att innebära att bara 7.5% till 0.4% av dagens kalfjäll kommer att återstår, vilket måste ses som en kraftig förändring av det alpina ekosystemet. Även en mycket mer konservativ förutsägelse av en 100 m höjdökning av trädgränsen resulterar i en förlust av mer än hälften av kalfjällsarealen inom det undersökta området, vilket kommer att få stora återverkningar på markanvändning, såsom renskötsel och turism.
Vi vet att några av våra antaganden håller inte, men vi har inget data att kvantifiera med hur mycket det avviker. Till exempel så kan man förvänta sig att renbete under sommaren kan stoppa, eller åtminstone försinka, koloniseringen av fjällbjörk på kalfjället, men vi kan inte uppskatta hur stort betestryck som behövs för detta eller under vilken tidsskala detta sker.

Reindeer husbandry: A practical decision-tool for adaptation of herds to rangelands

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In the decision-tool we focus on the adaptation of reindeer herds to available food resources in a district, i.e. to the availability and quality of winter and summer pastures. Previous studies have found that practical management is complicated by the dynamics involved and by a lack of precise information. Furthermore, formal analyses to find optimal herd sizes, to find optimal learning strategies, are both complicated to carry out and difficult to explain to decision-makers. Hence one is faced with an information problem.
Here we present a decision-tool which can capture the essence of earlier normative studies, and be sufficiently simple that it can be used in practice. In short, the decision-tool helps organise time-series information such that it becomes directly useful for decision-making. The derivation of the decision-tool with its equations is not easy to popularise. However, to foster active and correct use, a training simulator goes along with the decision-tool. Hopefully, the simulator will help build the intuition needed without the explicit knowledge of underlying mathematics.
We present case studies from the Nordic countries where the tool has been used. The tool and the simulator will be available for testing at the conference.

Renskötsel: Ett praktiskt beslutsredskap för anpassning av renhjordar till betesmarker

Beslutsredskapet är inriktat på anpassningen av renhjordar till tillgängliga vinter- och sommarbetesresurser inom ett betesområde. Tidigare studier har visat att förvaltningen i praktiken försvåras av den inbyggda dynamiken i systemet och bristen på exakt information. Vidare är formella analyser i syfte att finna optimala hjordstorlekar och optimala lärande strategier svåra att utföra och förklara för beslutsfattare. Detta är i stor utsträckning ett informationsproblem.
Vi presenterar ett beslutsredskap som fångar de viktigaste resultaten från tidigare normativa studier och är tillräckligt enkelt för att kunna användas i praktiken. Beslutsredskapet hjälper användaren att organisera tidsserieinformation så att de kan bli direkt användbart för beslutsfattande. Uppbyggnaden inklusive inbyggda ekvationer är svår att redovisa i populär form. I beslutsredskapet ingår dock en träningssimulator som underlättar inlärning och korrekt användning av det. Förhoppningsvis skall simulatorn kunna skapa den nödvändiga intuitionen utan konkret kännedom om den underliggande matematiken.
Vi presenterar fallstudier från de nordiska länder där redskapet använts. Redskapet och simulatorn kommer att finnas tillgängliga för prövning under konferensen.

Winter pasture resources of wild forest reindeer (*Rangifer tarandusifennicus*) in Salamajärvi area in central Finland

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The wild forest reindeer (*Rangifer tarandus fennicus*) were reintroduced from Kuhmo (today about 2000 individuals) to Salamajärvi area in central Finland 1979 and 1980. The main population from which these reindeer originated, comprising 6000-10 000 individuals, lives in Russian Karelia. The reintroduced wild reindeer were kept in a 15-ha enclosure of Koirasalmi in Kivijärvi until 1984, but their offsprings released into wild since 1981. At present there are about 900 wild forest reindeer in Salamajärvi area in central Finland.

Knowledge about quantity and quality of pastures and also the amount of natural forage resources of wild forest reindeer in the new area are important. This pasture inventory was conducted in Salamajärvi area in 1996. A total of 136 field test sites were evaluated. Pasture condition and amount of forage plants was evaluated on the basis of these test sites. Pasture types and areal extend were mapped using Landsat 5 TM satellite images. The images were classified using supervised classification methods. The land area and the quantity of lichens ranges were calculated using ARC/INFO software. Autumn and winter pasture areas, amount of forage plants and condition of pastures and also the amount of forage resources available per wild reindeer were compared to the previous inventory results in the whole reindeer herding area and especially to the results of the southernmost Halla co-operative.

According to the classification, the lichen-dominated ranges covered 21.3% and arboreal lichen ranges (old and mature conifer forests) 19.2% of whole inventoried area (253 109 ha). The whole bog area was 106 066 ha (41.9% of inventoried area) and deciduous forest area 25 129 ha (9.9%), both of them are important summer pastures for wild forest reindeer. The proportion of bogs in whole Finnish reindeer herding area is on average 34.5% and in Halla co-operative 39.3% (Kumpula *et al.*, 1999). The mean percent cover of lichens was 27,8%, mean height 46.1 mm and calculated biomass 1196.0 kg/ha on lichen pastures. The proportions of different lichen species on lichen cover were: *Cladina rangiferina* 46.2%, *Cladina mitis* 30.9%, *Cladina stellaris* 5.0%, *Cladonia uncialis* 0.7 and *Cladonia* spp. 1.4%. The available amount of arboreal lichens (under 2 meters) was 1.0-1.4 kg/ha in different pine forests and 5.8 kg/ha in spruce forests. The proportions of different grasses and *Deschampsia flexuosa* (hair grass) were 4.7 and 5.9% on lichen pastures. Grass dominated cutting area was 8.8% of inventoried area, and mean amount of *Deschampsia flexuosa* was 792 kg/ha in cutting areas, 162 kg/ha in young pine forests and 422 kg/ha in deciduous forest areas.

The inventory results indicate, that lichen pastures in Salamajärvi area were in good condition especially on very dry pine forests, and especially calculated biomass of lichens was much higher than values in Finnish reindeer herding area and also in Halla co-operative nearby Kuhmo wild forest reindeer area. The mean percent cover of lichens on lichen pastures in whole reindeer herding area was 27.6%, mean height 18,1 mm and calculated biomass only 349.0 kg/ha. In Halla co-operative the respective averages were 34.1%, 35.6 mm and 799.4 kg/ha (Kumpula *et al.*, 1997).

Metsäpeuran (*Rangifer tarandusifennicus*) talviravintovarat Salamajärven alueella Keski-Suomessa

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Villi metsäpeura (*Rangifer tarandus ifennicus*) palautettiin Kuhmosta (kanta nykyään noin 2000 yksilöä) Salamajärven alueelle Keski-Suomeen vuosina 1979 ja 1980. Nämä peurat ovat lähtöisin Venäjän Karjalassa elävästä 6000-10 000 peuran pääpopulaatiosta. Siirrettyjä peuroja pidettiin vuoteen 1984 saakka Kivijärven Koirasalmella 15 ha:n aitauksessa, mutta peurojen jälkeläiset laskettiin luontoon vuodesta 1981 lähtien. Nykyään Salamajärven alueella Keski-Suomessa on noin 900 metsäpeuraa.
Tieto laidunten määrästä ja laadusta sekä myös villin metsäpeuran luonnollista ravintomääristä uudella alueella on tärkeää. Tämä laiduninventointi suoritettiin Salamajärven alueella vuonna 1996. Yhteensä tutkittiin136 koealuetta. Näiden koealueiden avulla arvioitiin laidunten kunto ja ravintokasvien määrä. Laiduntyypit ja niiden alueet kartoitettiin Landsat 5 TM satelliittikuvien avulla. Kuvat luokitettiin ohjattuna luokituksena. Alueiden pinta-alat ja jäkälälaidunten määrä laskettiin käyttäen ARC/INFO -ohjelmistoa. Syksy- ja talvilaidunalueita, ravintokasvien määrää ja laidunten kuntoa sekä myös metsäpeurojen ravintoresursseja verrattiin aikaisempiin koko poronhoitoalueen, ja varsinkin eteläisimmän Hallan paliskunnan tuloksiin.
Luokituksen mukaan jäkäläiset laitumet peittivät 21.3% ja luppolaitumet (vanhat ja varttuneet havupuumetsät) 19.2% inventoidusta kokonaisalasta (253 109 ha). Suota oli yhteensä 106 066 ha (41.9% inventoidusta alueesta) ja lehtipuustoista metsää 25 129 ha (9.9%). Molemmat tyypit ovat tärkeää metsäpeurojen kesälaidunta. Soiden osuus maa-alasta koko Suomen poronhoitoalueella on keskimäärin 34.5% ja Hallan paliskunnassa 39.3% (Kumpula ym., 1999). Jäkälälaitumilla jäkälien keskipeittävyys oli 27.8%, keskikorkeus 46.1 mm ja laskennallinen keskibiomassa 1196.0 kg/ha. Eri jäkälälajien osuudet jäkälien peittävyydestä olivat: *Cladina rangiferina* 46.2%, *Cladina mitis* 30.9%, *Cladina stellaris* 5.0%, *Cladonia uncialis* 0,7% ja *Cladonia* spp. 1.4%. Saatavilla olevan lupon määrä (alle kahden metrin korkeudella) oli 1.0-1.4 kg/ha eri mäntymetsissä ja 5.8 kg/ha kuusikoissa. Eri heinien osuus peittävyydestä jäkälälaitumilla oli 4.7% ja metsälauhan (*Deschampsia iflexuosa*) 5.9%. Heinittyneitä hakkuualueita oli 8.8% inventoidusta alueesta, ja metsälauhan määrä oli keskimäärin 792 kg/ha hakkuualueilla, 162 kg/ha nuorissa mäntymetsissä ja 422 kg/ha lehtipuustoisissa metsissä.
Inventointitulokset osoittavat, että Salamajärven alueella jäkälälaidunten kunto oli hyvä erityisesti karuilla mäntykankailla, ja varsinkin jäkälien laskettu keskibiomassa oli paljon suurempi kuin vastaava Suomen poronhoitoalueella ja myös Hallan paliskunnassa lähellä Kuhmon metsäpeura-aluetta. Jäkälien keskipeittävyys jäkälälaitumilla koko poronhoitoalueella oli 27.6%, keskikorkeus 18.1 mm ja laskennallinen keskibiomassa vain 349.0 kg/ha. Hallan paliskunnassa vastaavat keskiarvot olivat 34.1%, 35.6 mm ja 799.4 kg/ha (Kumpula ym., 1997).

Cervid echinococcosis in Fennoscandia

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Echinococcus granusosus is a cestode parasite species (or a species group) having canid carnivores as definitive hosts and various herbivores as intermediate hosts. The infection is considered harmless and symptom-free in the definitive host, but in the intermediate host, the parasite causes so-called hydatid cysts in lungs or other internal organs. Humans may serve as accidental intermediate hosts following ingestion of parasite eggs originating from definitive host faeces. Even 15 litre hydatid cysts have been reported. Apparently, the dog/sheep cycle strain parasite is the one most dangerous to humans.The "cervid strain", also referred to as *E. granulosus canadensis,* is regarded as circumpolar, but the genetic similarities and differences between North American and Eurasian parasites are still unresolved. In Canada, the parasite appears to be very common in the moose (*Alces alces*), with prevalences from 30% to 60% having been reported. However, based on published reports, cystic echinococcosis is not regarded as a serious public health hazard in Canada.
Echinococcosis has been known in northern Norway for a century, but clinical human cases have been rare. However, in the 1950s, 17 cases were recorded amongst the 1700 people of Kautokeino. In reindeer, infection was common, with 10% prevalence in 2200 reindeer investigated on slaughter. As the parasite clearly had a dog/reindeer cycle, control was based on treating dogs with arecoline and later praziquantel, and improving slaughter hygiene to prevent dogs from being infected. This worked very well, and in 1975/76, the prevalence had decreased to 1.5%, and in 1980/81 to 0.1%. In Sweden, a prevalence of 1.6% was reported in the early 1970s. In the late 1990s a few reindeer were found infected in Sweden.
In Finland, situation was rather similar to that in Sweden, until in the 1990s, meat inspection started to reveal infected reindeer in the easternmost parts of the Finnish reindeer husbandry area. The number of infected animals has varied around 10 of the about 100 000 reindeer slaughtered yearly. No infected dogs have been found in spite of active search. In the wolf, in the other hand, parasites have been demonstrated. In Jona in the western part of Kola Peninsula, local veterinarians told in 1997 that water-filled cysts were frequent in the lungs of slaughtered reindeer. They also told that wolves were common in the area.
In 2001, moose lungs were collected from hunters from different districts in Finland, including Kuusamo, which is in the middle of the area where reindeer cases have been found. Amongst the 50 animals from Kuusamo, one adult moose cow was found infected. The National Food Agency has recently requested a risk assessment of *E. granulosus* in Finland. The assessment will be prepared by an expert group with members from research institutions EELA, METLA (Finnish Forest Researh Institute), the Finnish Game and Fisheries Research Institute and the University of Helsinki. Emphasis will be given to matters such as the safety of wild berries and mushrooms and to the treatment of moose offals, for example.

Hirviekinokokki Fennoskandiassa

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Echinococcus granulosus on heisimatolaji (tai lajiryhmä), jolla on pääisäntänä koiraeläin ja väli-isäntinä erilaisia kasvinsyöjäeläimiä. Tartuntaa pidetään pääisännälle harmittomana, mutta väli-isännän keuhkoihin tai muihin elimiin muodostuu rakkuloita, ns.hydatidikystia, joiden on todettu altistavan esimerkiksi hirvet saalistukselle. Ihminen voi satunnaisesti olla väli-isäntänä, ja jopa 15 litran rakkuloita on ihmisistä tavattu. Ilmeisesti koira/lammas-kierron loinen on ihmisille vaarallisin. Hirviekinokokkia, josta käytetään nimiä *E. granulosus canadensis* ja *E. canadensis*, pidetään sirkumpolaarisena alalajina/lajina, mutta amerikkalaisten ja euraasialaisten loisten geneettinen vertailu on vielä kesken. Kanadassa tartunta on hirvissä hyvin yleinen; prevalenssi on eri tutkimuksissa ollut jopa 30-60%. Kuitenkaan ei loista pidetä, ainakaan päätellen sitä koskevien tieteellisten julkaisujen määrästä, kovin vakavana kansanterveydellisenä ongelmana.
Ekinokokkoosi on tunnettu Norjassa viime vuosisadan alusta, mutta ihmisten sairastumiset ovat olleet harvinaisia. Kautokeinon 1700 asukaan joukossa todettiin tosin 17 tapausta 1950-luvulla. Poroissa tartunta oli yleinen, 2200 tutkitusta teurasporosta 10% oli tartunnan kantajia. Koska loisen elämänkierto selvästi kulki koiran ja poron välillä, torjunta perustettiin koirien lääkitsemiseen arekoliinilla ja myöhemmin pratsikvantelilla, samalla kun teurastushygieniaa parannettiin niin, ettei mahdollisesti infektiivisiä jätteitä jäänyt koirien ulottuville. Yksinkertainen ohjelma toimi mainiosti; vuonna 1975/76 prevalenssi oli laskenut ollen enää 1,5% ja edelleen vuonna 1980/81 0,1%. Ruotsissa prevalenssiksi todettiin 1970-luvun alun tutkimuksessa 1,6%. Tartunta hävisi sittemmin, mutta muutama tapaus todettiin 1990-luvun lopulla.
Suomessa tilanne oli samankaltainen kuin Ruotsissa, kunnes 1990-luvulla lihantarkastuksessa alkoi löytyä tartuntoja poronhoitoalueen itäosissa. Tapausten määrä vaihteli vuosittain kymmenen molemmin puolin. Huolimatta tartunta-alueella kerätyistä otoksista koirissa ei tartuntaa ole todettu. Susissa loisia sitävastoin on todettu. Jonassa Kuolan niemimaalla Sallan naapurissa paikalliset eläinlääkärit kertoivat 1997, että poroilla on keuhkoissa yleisesti vesirakkuloita. Susien kerrottiin olevan alueella yleisiä.
Eläinlääkintä- ja elintarviketutkimuslaitos EELA tutki vuonna 2001 noin 240 hirven keuhkot ekinokokkien varalta. Hirven keuhkoja kerättiin Etelä-Suomesta, Oulun läheltä, Kuusamosta ja Lapista. Kuusamo on keskellä aluetta, missä satunnaisia porotartuntoja on löytynyt, muilta tutkimusalueilta ei ole viitteitä ekinokokin esiintymisestä. Kuusamosta oli tutkittavana 50 hirven keuhkot, ja eläimistä yksi osoittautui tartunnan kantajaksi. Muut näytteet Kuusamosta ja muilta alueilta olivat kielteisiä. Elintarvikevirasto on sittemmin pyytänyt hirviekinokokin riskinarviointia suoritettavaksi. Sen tekee ekinokokkiasiantuntijatyöryhmä, jossa on jäseniä EELAsta , METLAsta, RKTL:sta ja Helsingin yliopiston Haartman instituutista. Huomiota kiinnitetään esimerkiksi sienten ja marjojen turvallisuuteen ja hirven teurasjätteiden käsittelyyn.

Characterization of betalactoglobulin from reindeer milk

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Betalactoglobulin (BLG) is the main whey protein in most ruminants. In its native state BLG consists of two identical subunits (162 amino acids) with a molecular mass of 18 kDa. BLG does not appear in human milk and is therefore among the first foreign proteins children are disposed to. Since the immunologic system of young children is in the process of development, bovine BLG may cause allergic reactions that affect up to 2-5% of infants thus making cow's milk allergy (CMA) one of the most significant food allergies. Our aim was to purify BLG from reindeer milk and to characterize its biochemical properties, and later on by using this data to investigate its allergenic potential.

Reindeer milk was obtained from the Reindeer Research Station (Kaamanen, Finland). Milk fat was removed by centrifugation, and caseins and other whey proteins by isoelectric precipitations at pH 4.6 and at pH 2 while BLG remained in the supernatant and was further purified by gel filtration (Superdex-75) and by ion-exchange chromatography (Uno Q-1). Isolated BLG was characterized with 12% SDS-PAGE, native PAGE and isoelectric focusing, and was identified with polyclonal antisera to bovine BLG. The amino-terminal sequence of purified BLG was determined with the ABI 477 A sequensator (University of Turku, Finland). Amino acid analyses were performed at Commonwealth Biotechnologies inc. (Richmond, VA, USA).

BLG isolated from reindeer milk by using isoelectric precipitations, gel filtration, and ion-exchange chromatography was pure and free of other reindeer milk proteins. Estimated BLG concentration in reindeer milk was about two to four g/l while the respective value for bovine milk BLG is about three g/l. The amino acid composition of reindeer milk BLG resembles that of bovine milk BLG. Interesting is that reindeer milk BLG seems to contain only three cysteines, while the bovine BLG contains five cysteines. This may affect the three dimensional structure of reindeer BLG since cysteines play an important role in the formation of the three-dimensional structure of BLG. The sequence homology between reindeer and bovine milk BLG is at the same level as with the other ruminants (some 90%), since only three differing amino acids were found among the 26 N-terminal amino acids of reindeer and bovine BLG investigated in this study.The molecular mass of reindeer milk BLG is about 18 kDa, as estimated by gel filtration, amino acid composition and SDS-PAGE, and is similar to that of bovine milk BLG. The isoelectric point of reindeer milk BLG estimated by isoelectric focusing was about 4.9 and is lower compared to that of bovine BLG. To summarize the molecular masses of both reindeer and bovine BLG are similar, but the isoelectric points differ indicating charge differences between the two proteins. Interesting is also that only one non-glycosylated genetic variant was detected in BLG purified from reindeer milk. Since the antisera to bovine BLG cross-reacted with BLG isolated from reindeer milk, some immunological characteristics of reindeer and bovine milk BLG probably resemble each other. To our knowledge BLG has not been isolated previously from reindeer milk. However, further studies are needed to examine if the structural differences detected in this study affect the allergenic properties of reindeer milk BLG as compared to those of bovine milk BLG.

Poronmaidon betalaktoglobuliinin karakterisointi

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Betalaktoglobuliini (BLG) on lehmänmaidon heraproteiineista määrältään merkittävin. Natiivimuodossaan se koostuu kahdesta proteiiniketjusta (162 aminohappoa), joiden molekyylipaino on 18 kDa. BLG:a ei esiinny äidinmaidossa ja siten se on ensimmäisiä vieraita proteiineja, joille lapsi saattaa altistua. Koska lapsen immunologinen järjestelmä ei ole vielä täysin kehittynyt, BLG aiheuttaa allergisia reaktioita n. 2-5%:lla lapsista. Tarkoituksemme oli puhdistaa BLG:a poronmaidosta ja karakterisoida sen biokemiallisia ominaisuuksia, ja myöhemmin käyttää saatuja tutkimustuloksia tutkittaessa poronmaidon BLG:n allergeenisyyttä.
Poronmaito hankittiin Kaamasen porontutkimusasemalta. Maitorasva poistettiin sentrifugoimalla ja kaseiinit ja muut heraproteiinit isoelektrisillä saostuksilla, BLG:n jäädessä supernatanttiin. BLG:a puhdistettiin edelleen geelisuodatuksella (Superdex-75) ja ioninvaihtokromatografialla (Uno Q-1). Puhdistettua BLG:a karakterisoitiin SDS-PAGE:lla, natiivi-PAGE:lla ja isoelektrisellä fokusoinnilla sekä identifioitiin lehmän natiivia BLG:a vastaan tuotetulla polyklonaalisella vasta-aineella. Puhdistetun BLG:n aminoterminaalinen sekvenssi määritettiin ABI 477 A sekvensaattorilla (Turun yliopisto). Aminohappoanalyysit tehtiin Commonwealth Biotechnologies yhtiössä (Richmond, VA, USA).
Poronmaidosta eristetty BLG oli puhdasta, muita maitoperäisiä proteiineja ei esiintynyt. Arvioitu poronmaidon BLG-konsentraatio oli n. 2-4 g/l, kun taas lehmänmaidon BLG pitoisuus on n. 3g/l. Poron BLG:n aminohappokoostumus muistuttaa lehmän BLG:n aminohappokoostumusta. Mielenkiintoista on, että poron BLG:ssa on vain kolme kysteiiniä, kun taas lehmän BLG:ssa on viisi kysteiiniä. Tämä voi vaikuttaa poron BLG:n kolmiulotteiseen rakenteeseen, koska kysteiini on merkittävä BLG:n kolmiulotteisen rakenteen määräytymisessä. Sekvenssihomologia poron ja lehmän BLG:n välillä on samaa tasoa kuin muillakin märehtijöillä (n. 90%), koska vain kolme erilaista aminohappoa havaittiin ensimmäisten 26:den N-terminaalisen aminohapon joukossa. Poron BLG:n molekyylipaino on 18 kDa arvioituna geelifiltraatiolla, SDS-PAGE:lla ja laskettuna aminohappokoostumuksen perusteella ts. sekä poron että lehmän BLG:t ovat samankokoisia. Poron BLG:n isoelektrinen piste isoelektrisellä fokusoinnilla määritettynä oli n. 4.9, joka on alhaisempi verrattuna lehmän BLG vastaavaan arvoon. Koska molempien BLG:en molekyylipainot ovat samat, johtuu isoelektrisen pisteen erilaisuus poron ja lehmän BLG:en aminohappojen varauseroista. Merkittävää on myös se, että vain yksi ei glykosyloitu BLG variantti detektoitiin poronmaidosta eristetystä BLG:sta. Koska lehmän BLG:a vastaan tuotettu polyklonaalinen vasta-aine reagoi myös poron maidosta eristetyn BLG:n kanssa, lehmän ja poron BLG:n immunologiset ominaisuudet muistuttavat toisiaan. BLG:a ei ole ennen eristetty poronmaidosta. Jatkotutkimuksen tarkoituksena on selvittää, vaikuttavatko havaitut rakenteelliset erot poron BLG:n allergeenisiin ominaisuuksiin.

Life-time patterns in adult female weight, reproduction and offspring weight in semi-domesticated reindeer

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The objective of our investigation was to obtain life-time patterns of female weight, reproduction and offspring weight, and to obtain a comprehensive picture of the relationships between these traits. Our results are aimed for parameterization of age-structured simulation models of herd dynamics. We used data recorded between 1986 and 1997 in the herding community of *Ruvhten Sijte* (formerly *Tännäs Sameby*) in Sweden. The data consisted of 8056 observations of calf weights with mother's age known and 3449 observations of adult female weights. A female reproducing the previous year weighed 3.1 kg (s.e. 0.3) less than non-reproducing females. The regression coefficient of calf autumn weight on female weight the previous winter was 0.26 (s.e.0.02). The average difference in autumn weight between male and female calves was 2.86 kg (s.e. 0.20), but was less for calves with mothers aged 2 to 4 years. The calving percentage for females aged 4 to 10 years was 73%. Calving percentage was calculated as the percentage of females weighed in winter with calf the following summer. We also obtained clear patterns of female weight for ages 1 to 10 years, calving percentage for 2- to 11-year-old females and calf weights for 1- to 15-year-old mothers.

Vajvikt, kalvningsprocent och kalvvikt – Vilka samband finns det mellan dem och hur utvecklas de med vajans ålder?

Syftet med vår studie var att skatta livstidsmönster av vajvvikter, reproduktion och kalvvikter, och att skatta beroenden mellan dessa egenskaper. Vi utnyttjade data insamlat av renskötare i *Ruvhten Sijte* (tidigare *Tännäs Sameby*) mellan åren 1986 och 1997. Materialet bestod av 8056 kalvvikter (höst) och 3449 vajvikter (vinter). En vaja med kalv vägde 3,1 kg mindre ån en vaja utan kalv. Regressionskoefficienten mellan kalvens vikt och vajans vikt var 0,26, dvs en ökning av vajvikten med 10 kg ökar kalvens vikt med 2,6 kg. Skillnaden i vikt mellan han- och hon-kalvar var i genomsnitt 2,86 kg, men skillnaden var något mindre för kalvar med unga mödrar (2 till 4 år). Kalvningsprocenten för vajor i åldrarna 4 till 10 år var 73%. Kalvningsprocenten beräknades som den procent av vajorna vägda på vintern som hade kalv vid kalvmärkningen påföljande sommar. Vi fann även tydliga mönster över hur vajans vikt, kalvningsprocent och kalvvikter utvecklas med vajans ålder. Vi åmnar att utnyttja resultaten till att simulera dynamiken i en renhjords produktion, och därmed kunna studera hur utnyttjandet av märkningssystem och selektion påverkar kalvvikter och kalvningsprocenten.

Fatty acid composition and levels of vitamins E and A in fresh and smoked reindeer meat

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Reindeer husbandry in Scandinavia is a pastoral system for meat production. Natural pasture is the most common feed source for reindeer, but sometimes the animals are fed commercial feed mixtures (pellets) in combination with hay, silage or lichens to reduce radioactive caesium in the meat or to improve carcass grading scores and slaughter weights. In earlier studies of the sensory properties of reindeer meat, where we used a trained expert panel as well as consumer preference tests, we have found that the flavour of reindeer meat was affected by the type of feed the animals had consumed (Wiklund *et al*, 2002). In a pilot-study we also demonstrated how the fatty acid composition in reindeer meat was affected by feeding regimen (Wiklund *et al*., 2001).

A total of 16 reindeer calves (8 males and 8 females, age about 10 months) were included in the study. The animals had been fed a commercial pelleted feed mixture (Renfor Bas, Lantmännen Fori, Holmsund, Sweden) for two months before slaughter. At slaughter (about 45 min *post mortem*) samples were taken from the right hand side *M. semimembranosus* and frozen immediately at –20 °C. The day after slaughter the whole left hand side *M. semimembranosus* was cut out, divided in two pieces and one of the pieces was randomly chosen for warm smoking. Before smoking, a salt solution was injected into the meat and the curing period lasted for 3 days. The meat was then rinsed and dried at 40 °C for about 2 hours, before it was smoked at 80 °C until a core temperature of 65 °C was obtained. When the meat had cooled down, samples were collected and frozen at –20 °C. The samples were transported to SLU, Uppsala and finally frozen at –80 °C until analysis.

The fatty acid composition of the samples was analysed by gas chromatography (GC). The fat was extracted with a solution of hexane and isopropanol (3:2). Before chromatography, the total lipids were separated into neutral lipid and polar lipid classes and then methylated. Vitamin E (α- and γ-tocopherol) and vitamin A (retinol) was measured by HPLC. The meat samples were homogenised with methanol and ascorbic acid. Potassium hydroxide solution was used for saponification and the samples were heated for 20 min at 70 °C. The vitamins were then extracted with hexane. For analysis the solvent was evaporated and the vitamins solubilised in the mobile phase (95% methanol: acetonitrile (1:1) and 5% chloroform).

Polyunsaturated fatty acids (PUFA) are much more prone to oxidation than saturated fatty acids (SFA), which makes all types of meat with high PUFA content much more sensitive to any kind of processing and storage. However, in the present study, the amount of unsaturated fatty acids did not decrease as much as expected in the smoked samples compared with the fresh ones. This could be due to the added ascorbate (vitamin C) during the curing process, as ascorbate acts as an antioxidant. On the other hand, the content of retinol and γ-tocopherol was reduced significantly by the smoking process.

From the present study we can conclude that the smoking process used seemed to be gentle and did not change the nutritional value of the meat as much as we had expected.

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Fettsyrasammansättning och innehåll av vitamin E och A i färskt och rökt renkött

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Renskötseln i Skandinavien är baserad på utnyttjandet av naturliga beten varifrån renen vanligtvis tillgodoser hela sitt näringsbehov. Renen är väl anpassad till ett liv i arktisk miljö med snö under stora delar av året och därför varierar också renens diet märkbart under året. I vissa områden utfodras slaktrenar under vintern dels för att sänka innehållet av radioaktivt cesium i köttet och dels för att förbättra slaktkroppskvaliteten. Vid utfodringen används kommersiellt renfoder (pellets) kombinerat med hö, ensilage eller lav. i tidigare studier har vi genom att utföra smaktester med expertpanel och konsumentundersökningar visat att renköttets smak påverkas av vilken typ av foder renarna konsumerat (Wiklund *et al.*, 2002). I en pilot-studie har vi också demonstrerat hur renköttets fettsyrasammansättning påverkats av utfodring (Wiklund *et al.*, 2001).
Totalt ingick 16 renkalvar (8 handjur och 8 hondjur, ålder ca. 10 mån) i undersökningen. Djuren hade utfodrats med ett kommersiellt pelletterat renfoder (Renfor Bas, Lantmännen Fori, Holmsund, Sverige) under två månader före slakt. Vid slakt (ca. 45 min. *post mortem*) togs prover från höger *M. semimembranosus* (innanlår) som frystes direkt i –20 °C. Dagen efter slakt togs hela vänster *M. semimembranosus* från slaktkroppen, delades i två delar och en av delarna valdes slumpmässigt ut för att varmrökas. Före rökningen injecerades saltlag i köttet och saltningen pågick i 3 dygn. Köttet sköljdes sedan och torkades i ca. 2 tim i 40 °C, innan det varmröktes i 80 °C till en innertemperatur på 65 °C. När köttet svalnat togs prover som frystes i –20 °C. Proverna transporterades frysta till SLU i Uppsala där de förvarades i –80 °C.
Fettsyrasammansättningen i proverna analyserades med gaskromatografi (GC). Fettet extraherades med en lösning innehållande hexan och isopropanol (3:2), separerades i en polär och en neutral fraktion och metylerades innan proverna injecerades i GCn. Analyser av vitamin E (α- och γ-tokoferol) och vitamin A (retinol) gjordes med HPLC. Köttproverna homogeniserades i metanol och askorbinsyra och förtvålades sedan i kaliumhydroxid i 20 min och 70 °C. Vitaminerna extraherades sedan med hexan, lösningsmedlet avdunstades och vitaminerna löstes i ett medium anpassad för HPLC-analys (95% metanol/acetonitril (1:1) och 5% kloroform).
Fleromättade fettsyror är känsligare för oxidation än mättade fettsyror, vilket gör att kött med högt innehåll av fleromättat fett är betydligt ömtåligare vid processing och långtidslagring. Resultaten från denna studie visade dock att innehållet av omättade fettsyror inte minskade efter varmrökning i den omfattning vi hade förväntat oss. Detta kan förklaras med att askorbat (vitamin C) - som är en antioxidant – ingick som en ingrediens i saltlagen som användes före rökningen. Innehållet av vitamin E (γ-tokoferol) och vitamin A (retinol) i köttet minskade signifikant efter varmrökning.
Från denna undersökning kunde vi dra slutsatsen att den använda rökningsprocessen var skonsam och inte förändrade köttets näringsmässiga värde så mycket som vi hade förväntat oss.

Referenser

Wiklund, E., Pickova, J., Sampels, S & Lundström. K. 2001. Fatty acid composition of *M. longissimus lumborum*, ultimate muscle pH values and carcass parameters in reindeer (*Rangifer tarandus tarandus* L) grazed on natural pasture or fed a commercial feed mixture. – *Meat Science* 58: 293-298. **Wiklund, E., Johansson, L., Rødbotten, M. & Malmfors, G. 2002.** Sensory meat quality, ultimate pH values and carcass characteristics in reindeer (*Rangifer tarandus tarandus* L) grazed on natural pasture or fed a commercial feed mixture. (sendt til publisering).

Project "Renbruksplan" in the county of Västerbotten

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This project was initiated by the County Forestry Board of Västerbotten (SVS) and the County Board of Västerbotten (LST) who invited Swedish University of Agricultural Sciences (SLU) to participate. Additional funding was provided through the RESE project for SLU's contribution.
Involved Sami Villages (sw: sameby) throughout the project period were members of Malå and Vilhelmina Norra Sami Villages. The project represents a user oriented effort largely dependent on the work carried out by the sameby-members. Two specific objectives of this project were to develop methods and to produce material which would provide information to:

- Facilitate in consultation between the sameby and other land users, such as the timber industry.
- Facilitate in planning of the operational reindeer management for the sameby.

The goals are achieved by carrying out vegetation classifications, digital mapping, and field inventories.
Education of the participants is a central part of the project. SLU together with Norwegian Institute of Nature Research (NINA) have held both GIS and field-methods courses for the participants. To accomplish the objective of facilitating consultations between different land users, we first developed a protocol to identify and map important key habitat resources in reindeer management. Sameby members who had the most knowledge of each area digitized boundaries for the different categories of key habitat areas with a multispectral satellite image as background. The satellite images proved very helpful in this mapping work despite the users having had no prior experience with viewing satellite images. This effort represents the first attempt to provide a detailed view of specific areas of importance for reindeer husbandry, an effort that has already proven useful in land use consultations. Key habitat areas have been identified throughout both samebys and field work is completed for the wintering grounds. Field workers included personnel from Malå Sameby and Vilhelmina Norra Sameby as well as SVS.
We produced manuals for standardizing identification of key habitat areas and fieldwork. Work has also began to produce a RenGIS, which is a custom made and user friendly GIS to facilitate efficient use of a completed Renbruksplan.

Projekt Renbruksplan i två samebyar i Västerbotten

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Projektet präglas av ett användarstyrt arbetssätt, där resultatet i stor utsträckning kommer att vara beroende av samebyarnas insatser. Syftet är att genom kartläggning, vegetationsklassningar, fältinventering samt utveckling av ett användarvänligt och anpassat RenGIS förbättra:

- **Underlaget för operativ renskötsel** (information om beteskvalitet och tillgång, områdets tillgänglighet, årstidsanpassning m.m.)
- **Underlaget för samrådsdiskussioner med andra markanvändare** (från skogsbruket).

Arbetet med Renbruksplan har genomförts i form av en fullskalestudie under två år 2000-2001 inom två samebyar, Vilhelmina Norra och Malå Samebyar i Västerbotten. Under år 2002 kommer arbetet att intensifieras med ytterligare fältarbete samt analyser och systemutveckling. Därefter avslutas projektet och slutrapporteras till Jordbruksverket.
Under år 2000 utarbetades vissa grundläggande metoder och begrepp för att skapa en Renbruksplan. Olika bearbetningar av satellitscener utfördes som utgjorde underlag för både **beteslandsindelning** och **renbetestaxering**. Fältarbetet under det första året koncentrerades på att utforma metodik för beskrivning och inventering av renbetestyper. Arbetet med **omvärldsfaktorer** fortsatte genom att skapa olika skikt som kan ingå i en framtida databas.
Under år 2001 har en fördjupning ägt rum inom de olika ämnesblocken, företrädesvis i form av kartering och inventering av betesland. Med satellitbild som bildbakgrund har samebyarna digitaliserat betesland baserat på en indelning i fem olika klasser, där nyckelområdena utgör den mest värdefulla områdestypen ur betessynpunkt. Inom nyckelområden har fältkontroller utförts på alla förvinter- och vinterbetesmarker avseende renbetestyp, träd- och marklavsförekomst. Nyckelområdenas avgränsning har kontrollerats och justerats utifrån den på rummet digitaliserade informationen. Preliminära resultat har tagits fram över hur stor del av samebyarnas vinterbetesland som utgör lavrik barrskog.
En sammanställning av GIS-skikt har påbörjats avseende olika omvärldsfaktorers påverkan på rennäringen. De faktorer som främst lyfts fram är skogsbruk, jordbruk, samhällsutbyggnad, jakt, rovdjur, klimatförhållanden och natur- och kulturhänsyn.

Stor vikt har lagts vid att ta fram manualer för beteslandsindelning och renbetestaxering. Blanketter för fältarbetet och databaser för de olika ämnesblocken har producerats. Arbetet med att skapa ett användarvänligt datorstöd för samebyarna – ett RenGIS – har påbörjats. I allt arbete styr vi nomenklatur och lagringsstruktur m m till att vara densamma som i renskötselns databas ”Ren 2000” som togs fram av svensk-norska renbeteskommissionen år 1997-2001.
Finansieringen sker huvudsakligen med medel från Statens Jordbruksverk (SJV) men även med medel från övriga ingående aktörer. SLU medfinansierar t ex med stöd från Stiftelsen för miljöstrategisk forskning (MISTRA) inom det tvärvetenskapliga forskningsprogrammet ”Remote Sensing for the Environment” (RESE).

The influence of weather on reindeer habitat choice on the landscape level

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Habitat use of reindeer (*Rangifer tarandus*) is assumed to depend on several factors, e.g. the time of the year, the availability of forage, harassment by insects, humans and predators. Hence, habitat choice is controlled by factors at different spatial and temporal scales. Here we report attempts to measure the influence of weather on the reindeer habitat choice in Idre and Mittådalen reindeer herding districts. We predicted that reindeer would occupy slopes with the same aspect as the direction of the wind in order to find relief from insects and heat. During eight days in the middle of June 2001, direct observations of reindeer were done above the timberline in the two areas. The probabilities of finding reindeer on the different aspects depending on weather were estimated by nominal logistic regressions. There was higher probability for the reindeer to be on the southern slopes (P=0.25 in Idre and P=0.80 in Mittådalen) than on the northern slopes (P=0.05 resp. P=0.015) if the wind was northern and strong (>5 m/s). This was opposite of what we expected. An explanation might be that this early in the summer forage was better on the southern slopes than on the northern slopes. The temperature was also low when the wind was strong so there was less need to find relief from the insects or from the heat. The wind could also have been strong enough to keep all the slopes insect-free. When the wind was light (<5 m/s) and temperature higher the southern and the eastern slopes were preferred almost independent of the wind direction, although there seemed to be a preference for higher altitudes.

Vädrets inverkan på renens habitatval på landskapsnivå

Habitatval hos renar (*Rangifer tarandus*) anses bero på många saker, t.ex. tiden på året, betestillgång, störningar från insekter, människor och predatorer. Med andra ord kontrolleras habitatvalet av många faktorer i olika rumsliga och tidsberoende skalor. Här redovisas ett försök att mäta vädrets inverkan på renarnas habitatval på kalfjället i Idre och Mittådalens samebyar. Eftersom renarna ofta söker sig till områden där de blir mindre störda av insekter och kan få svalka sommartid förväntade vi oss att finna renarna på sluttningar som låg i vindriktningen. Under åtta dagar i mitten av juni 2001 samlade vi in data genom att observera renar från luften. För att uppskatta sannolikheterna för att finna renar på sluttningar beroende på väderleken användes nominala logistiska regressioner. Det var högre sannolikhet att finna renarna på de sydliga sluttningarna (P=0.25 i Idre och P=0.80 i Mittådalen) än på de nordliga sluttningarna (P=0.05 resp. P=0.015) när vinden var stark (>5 m/s) nordlig. Detta var tvärtemot vad vi förväntat oss. En förklaring kan vara att så här tidigt på sommaren var betestillgången bättre på de sydliga än på de nordliga sluttningarna. Temperaturen var låg när vinden var stark vilket också gjorde att behovet av att undvika störningar från insekter och att finna svalka var mindre. När vinden var svag (<5 m/s) och temperaturen högre föredrog renarna de ostliga och sydliga sluttningarna nästan oberoende av vilken vind det var, och det tycktes även finnas en preferens för högre höjder.

Reindeer Summer Pastures and Ultraviolet (UV) Radiation: A Research Proposal

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The aim of the proposed research is to investigate the effects of UV-radiation on chemical composition, palatability and digestibility of summer pasture plants of reindeer. The studies are planned to be conducted in natural peatland ecosystems with (I) enhanced UV-B radiation, provided by UV-B lamps (Sodankylä, Finnish Meteorological Institute, FUVIRC sites) and (II) with UV-filtration experiments with the same plant species in reindeer pastures in the Lappi Reindeer Herding Co-operative in Eastern Finnish Lapland (RENMAN experimental sites). A pilot study was conducted in 2001 in the Lappi co-operative where plant species and sampling schedule were determined and proportional species composition from ambient control sites was calculated. Plant species included *Betula nana, Eriophorum vaginatum, E. angustifolium, Menyanthes trifoliata, Rubus chamaemorus* and *Carex* sp. Total concentration of soluble phenolics will be determined from the plant samples. In addition, nitrogen, soluble carbohydrate, fiber fractions, some major macro minerals and trace elements will be determined. The digestibility of plants will be analysed in rumen fluid *in vitro*. The determinations will be conducted during the following years on samples collected during the early, mid and late growing seasons. Palatability studies will be conducted with captive reindeer via cafeteria feeding experiments. The results will be compared with the results of the summer pastures in the related RENMAN project and UV-exposures in the FUVIRC project. The results will provide information about the effects of ambient and enhanced UV radiation on summer pastures of reindeer and can be used to evaluate their consequences on reindeer management. Funding for the proposed research is applied both from national and international sources.

Key words: UV-radiation, reindeer, ecosystem, summer pastures, defence compounds, digestibility, palatability.

Abbreviations:
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/).

Poron kesälaitumet ja ultravioletti (UV) -säteily: tutkimus-suunnitelma

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Tutkimushankkeen tavoitteena on selvittää UV-säteilyn vaikutuksia poron kesälaidunkasvien kemialliseen koostumukseen, maittavuuteen ja sulavuuteen. Tutkimukset tehdään luonnon suoekosysteemeissä, joissa tutkitaan (I) kohotetun UV-säteilyn vaikutusta UV-B-lamppukokeiden avulla (Sodankylä, Ilmatieteen laitos, FUVIRC-koealue) sekä (II) luontaisen UV-säteilyn vaikutusta suodatuskokeiden avulla porolaidunalueella Lapin paliskunnassa Itä-Lapissa (RENMAN koealat). Kesällä 2001 tehtiin alustava koe Lapin paliskunnassa, jossa valittiin kasvilajit ja otettiin alkutilanteen näytteet, sekä kartoitettiin kasvipeitteen peruskoostumusta kymmenellä koealalla. Tutkittavat kasvilajit ovat vaivaiskoivu (*Betula nana),* tupasvilla (*Eriophorum vaginatum),* luhtavilla (*E. angustifolium),* raate *(Menyanthes trifoliata),* hilla (*Rubus chamaemorus)* ja sarat (*Carex spp).* Kasvinäytteistä määritetään liukoisten fenolien kokonaispitoisuudet, typpi, liukoiset hiilihydraatit ja kuitupitoisuudet sekä eräitä kivennäis- ja hivenaineita. Ravintokasvien sulavuuskokeet tehdään pötsinesteessä *in vitro.* Määritykset tehdään seuraavina vuosina kasvukauden alussa, keskellä ja lopussa. Maittavuuskokeet tehdään tarhaporoilla ns. cafeteria-ruokintakokeina. Tutkimustuloksia verrataan poron kesälaitumia käsittelevän RENMAN-hankkeen ja UV-altistusta käsittelevän FUVIRC-hankkeen tuloksiin. Tulosten perusteella voidaan arvioida luontaisen ja kohotetun UV-säteilyn vaikutuksia poron kesälaitumiin ja porotalouteen. Hankkeeseen haetaan rahoitusta sekä kansallisista että kansainvälisistä lähteistä.

Avainsanat: UV-säteily, poro, ekosysteemi, kesälaitumet, puolustusaineet, sulavuus, maittavuus.

Lyhenteet:
FUVIRC: Finnish Ultraviolet International Research Center; Suomen kansanvälinen ultraviolettitutkimuskeskus (http://thule.oulu.fi/fuvirc/).
RENMAN: The Challenges of Modernity for Reindeer Management: Integration and Sustainable Development in Europe's Subarctic and Boreal Regions; Nykypäivän haasteet poronhoidossa: yhteistyö ja kestävä kehitys Euroopan pohjoisilla alueilla (http://www.urova.fi/home/renman/).

Virus infections among semi-domesticated reindeer in Finnmark, Norway

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As a part of a research project, 48 reindeer carcasses were collected from four different herds in Finnmark. Necropsy showed that most animals (88%) died of emaciation. No indications of virus infections as the primary cause of death were found, although lesions in the oral and abomasal mucosa could be consistent with herpes or bovine virus diarrhoea virus (BVDV) infections. No indications of contagious ecthyma were found. **Parapoxvirus:** 279 tissue samples were analysed for the presence of parapoxvirus DNA by a PCR (B2L-gene, orf virus strain NZ-2)(Inoshima *et al.*, 2000; Tryland *et al.*, 2001). In samples from 6 individuals PCR products with size equal to parapoxvirus (574 base pairs) were detected, and DNA sequencing of a 354 base pairs showed 99% homology with orf virus from sheep. Parapoxvirus causes the disease contagious ecthyma which was diagnosed in reindeer in Troms and Nordland Counties in 1999 and 2000, respectively (Tryland *et al.*, 2001). The outbreak in Nordland was severe and killed 7 reindeer and caused economical loss for the herder. These results show that parapoxvirus is present in reindeer herds in Finnmark without obvious clinical symptoms being reported. It is still unknown whether sheep and goats serve as the source of infection for reindeer (identical virus) or whether a specific reindeer parapoxvirus circulates. Contagious ecthyma was for the first time diagnosed in reindeer in Finland in 1992-93 (Oksanen *et al.*, 1994), and has since caused annually outbreaks. **Herpesvirus:** Blood/tissue fluids were analysed by a virus neutralisation test (VN; Stuen *et al.*, 1993). Antibodies against herpes virus (RanHV-1) were found in 4 of 41 animals (10%), all being newborn calves. These findings are consistent with previous investigations (Stuen *et al.*, 1993). Herpes virus antibodies have previously been detected in reindeer in Sweden and Finland. Herpes infections are life-long and may be reactivated under certain circumstances such as restricted food availability and stress and may cause mucosal lesions and abortions. **Bovine virus diarrhoea virus (BVDV):** Antibodies against the pestivirus BVDV (VN; Stuen et al., 1993) were detected in 14 of 39 individuals (36%), of which 3 were adults, 3 were I ½ year old, 5 were yearlings and 3 were some days old. The prevalence corresponds with previous investigations (Stuen *et al.*, 1993). It is still unknown whether this is identical with the bovine virus (BVDV). In cattle, most BVDV infections is subclinical. Calves may be borne weak with viremia. If reinfected, such calves may develop mucosal disease, which is characterised by acute illness, ulcerations in the intestinal mucosa, dehydration, and death. A high death rate of new born calves and mucosal lesions may be caused by these infections, but further investigations are needed on this issue. Since feeding of reindeer is increasing, which may cause stress and facilitate spread of infectious agents, contagious ecthyma, BVD, and herpes virus infections may have increased importance in the coming years.

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Virusinfeksjoner hos rein i Finnmark

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Som en del av forskningsprosjektet "Tap og dødelighet hos rein i Finnmark" ble 48 reinkadavre (hovedsakelig selvdøde) samlet inn fra fire driftsenheter i Finnmark. Obduksjon viste at den viktigste dødsårsaken var avmagring (88%). Ingen dyr hadde lesjoner som indikerte virusinfeksjoner som primær dødsårsak, men enkelte sår i munnslimhinne og løpe kunne være forenlig med infeksjoner med reinsdyr herpesvirus eller bovin virusdiarrévirus (BVDV). Lesjoner karakteristisk for munnskurv ble ikke påvist. **Parapoxvirus:** 279 vevsprøver ble undersøkt for forekomst av parapoxvirus-DNA ved hjelp av PCR (B2L-genet til orf virus stamme NZ-2) (Inoshima *et al.*, 2000; Tryland *et al.*, 2001). I prøver fra 6 dyr ble det oppformert DNA-fragmenter forenlig med parapoxvirus i størrelse (574 basepar). Sekvensering av DNA fra ett av disse PCR-produktene viste en sekvens på 354 basepar som hadde 99% samsvar med et parapoxvirus fra sau (orf). Sjukdommen smittsom munnskurv ble påvist hos rein i Troms og Nordland i henholdsvis 1999 og 2000 (Tryland *et al.*, 2001). I Nordland tok infeksjonen livet av 7 dyr og påførte eieren betydelige tap. Funn av parapoxvirus DNA hos rein i Finnmark viser at viruset er tilstede til tross for at kliniske symptomer ikke har vært rapportert hos rein. Munnskurv forekommer imidlertid hos sau og geit på mellom 1000 og 1500 gårdsbruk årlig, men om småfe er smittekilden til rein (identisk virus), eller om reinen har en egen type munnskurv-virus, er ennå ikke klarlagt. Munnskurv forekommer nå jevnlig hos rein i Finland etter at sjukdommen ble påvist vinteren 1992-93 da flere hundre dyr døde (Oksanen *et al.*, 1994). **Herpesvirus:** Blod/vevsvæske ble undersøkt ved hjelp av en virusnøytralisasjonstest (NT) (Stuen *et al.*, 1993). Antistoffer mot rein herpesvirus (RanHV-1) ble funnet i 4 av 41 dyr (10%). Alle var spekalver, hvorav 3 var selvdøde (lav vekt) og én drept av gaupe. Antistoff-funnene og prevalens er i tråd med tidligere undersøkelser (Stuen *et al.*, 1993). Herpesvirus-antistoffer er også påvist hos rein i Sverige og Finland uten at det er knyttet direkte til sjukdomsutbrudd. Herpesvirus gir en livslang infeksjon som i perioder kan være uten symptomer, men som kan reaktiveres under spesielle forhold som dårlig ernæringstilstand og stress og føre til slimhinnesår og aborter. **Bovin virusdiare virus (BVDV):** Antistoffer mot pestiviruset BVDV (NT; Stuen *et al.*, 1993) ble funnet hos 14 av 39 dyr (36%), hvorav 3 var voksne, 3 var 1½ år, 5 var fjorårskalver og 3 var spedkalver. Funnene samsvarer med tidligere funn (Stuen *et al.*, 1993). Det er derfor klart at pestivirus forekommer hos rein i Finnmark, men om dette er identisk med viruset hos storfe og hvilken helsemessig betydning viruset har vet man lite om. Den alvorligste formen for BVD virusinfeksjon hos storfe oppstår som fosterinfeksjon, hvorpå kalven fødes med virusinfeksjonen og har nedsatte livsfunksjoner. Etter en eventuell re-infeksjon kan sjukdommen mucosal disease utvikles, med akutt sjukdom, sår i slimhinna i tarmkanalen, dehydrering og død. Høy kalvedødelighet og sår i slimhinner kan muligens tilskrives herpes og BVDV infeksjoner, men videre undersøkelser er nødvendige for å avklare dette.

Gjennom en utvikling med økt fôring av rein som ofte bidrar til økt smittepress og stress, kan virusinfeksjoner som munnskurv, herpes og BVD bli viktige i reindrifta i tiden som kommer.

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Changes in the start and length of the growing season in Fennoscandia in the period 1982-1999 and the implications for the reindeer husbandry

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The GIMMS NDVI dataset extracted from weather satellite data and field observation data (phenological data) were used to investigate regional climatic change impact on the length of the growing season in Fennoscandia, Denmark and Kola Peninsula. In general, results show a pattern according to vegetation zones (mostly north-south direction) and vegetation belts (altitude), and partly according to vegetation sections (mostly east-west direction in Fennoscandia). The results show that the spring is delayed in the alpine belts and the northern boreal zone. The strongest delay occurred in the most continental section of the northern boreal zone. In the entire boreonemoral and nemoral zone, which occupy the southern part of Fennoscandia, the spring starts considerably earlier. In the most oceanic section, the coastline of Western and Northern Norway, the spring also starts earlier. At the same time the autumn is delayed in the whole area except in the most continental section of northern Fennoscandia (Finnmarksvidda and northern parts of Lapland län in Finland). This also means that the growing season is prolonged for the whole area, except the northern continental section. The implications for the reindeer husbandry if these trends continue - could be that the reindeer can be moved/migrated to the winter pasture areas later in the autumn or in the beginning of winter. In the coastal part of northern Norway also spring migrations could start earlier - which means that the winter pasture resources could be spared.

Endringer i start og lengde av vekstsesongen i Norden i perioden 1982-1999 og hva det innebærer for reindriften

Værsatellittdata (GIMMS NDVI) og felt data (fenologiske data*) ble brukt for å studere regionale effekter som følge av klimaendringer på lengden av vekstsesongen i Norden og på Kolahalvøya. Resultatene fra dette prosjektet viser et mønster som har stor sammenheng om hvor vi er (nord eller syd, på kysten eller innlandet samt i lavklandet eller på fjellet). Våre resultater viser at våren er forsinket i fjellet og i den nordlige skogssonen, mens våren kommer tidligere i den sydlige og vestlige delen av Norden. Høsten er også forsinket i det meste av Norden unntatt deler av Lapland län i Finland og deler av Finnmarksvidda, noe som igjen betyr at vekstsesongen også er forlenget i mesteparten av Norden.
Hva betyr dette for reindriften hvis disse trendene fortsetter? En konsekvens kan være at reinen kan flyttes til vinterbeitene senere på høsten/forvinteren, samt at vårflyttingen til sommerbeitene på kysten av Finnmark/N-Troms kan starte tidligere. Dette vil igjen si at man sparer på vinterbeiteressursene i disse områdene.

*Definisjon fenologi: Undersøkelser av årlige tilbakevendende fenomener i naturen som for eksempel "løvsprett, "løvfall", isløsning etc.

Impacts of reindeer grazing on soil properties on Finnmarksvidda, northern Norway

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Numerous investigations have documented changes in vegetation due to reindeer grazing in Finnmark County, Northern Norway, during the last 30 years. Soil properties are known to play an essential role for plant growth and thus ecosystem productivity. However, rather few investigations are done on the impact of reindeer grazing on soil properties. The aim of this investigation was to identify possible changes in physical and chemical soil properties due to reindeer grazing. At four different locations on Finnmarksvidda 3 sample sites were selected subjectively according to lichen and plant cover at each of the locations: A) good lichen and plant cover; B) reduced lichen cover, but moderate plant cover; C) lichen and plant cover almost absent. It was supposed that differences in lichen and plant cover were due to differences in grazing intensity. Vegetations types investigated were lichen rich mountain birch forest, and lichen heath. At each sample site one soil profile was excavated, thoroughly described and sampled for physical and chemical analysis from the different soil horizons. Physical parameters studied were soil density, soil porosity, water and air content at different suctions, plant available water and texture. Chemical parameters measured were pH, soil organic carbon (org-C), Kjeldahl-N, Cation Exchance Capacity (CEC), base saturation, and plant available P, Ca, Mg, K. The results showed that the mineral soil at all sites consisted of loamy sand/sandy loam with about 1-3% clay. On sample sites with good lichen and plant cover, the thickness of the organic layer did not exceed 6 cm. Plant roots were mainly found in or directly below the organic layer, but could also be numerous in mineral B-horizons until the depth of 20 cm. The thickness of the organic-O horizons decreased with decreasing lichen and plant cover, while soil pH of organic-O horizons and mineral A-horizons increased with decreasing soil organic matter. Rather little changes in the soil physical properties of the mineral soil were found. A strong correlation was found between soil org-C and CEC for all sites and horizons. Furthermore, organic-O horizons had generally the highest amounts of plant available P, Ca, Mg, K. Assuming that differences in lichen and plant cover are related to differences in grazing intensities, results indicate, that reindeer grazing can considerably reduce amounts of soil organic matter and thus also of potential plant nutrients. At the investigated sites on Finnmarksvidda, soil organic matter is regarded as one of the most essential key factors for soil fertility, and thus ecosystem sustainability and productivity.

Innvirkning av reinsdyrbeiting på jordegenskaper på Finnmarksvidda

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I løpet av de siste 30 år er det i flere undersøkelser dokumentert at reinsdyrbeiting påvirker vegetasjonen på Finnmarksvidda. Det er kjent at jordegenskapene har avgjørende innvirkning på planteveksten og følgelig på produktiviteten i hele økosystemet. Likevel er det gjennomført få undersøkelser på hvordan reinsdyrbeiting påvirker jordegenskaper og hvordan endringene i disse påvirker veksten. Målet med denne undersøkelsen var å dokumentere eventuelle endringer i fysiske og kjemiske jordegenskaper som følge av beite og tråkk fra rein. På fire lokaliteter på Finnmarksvidda ble det valgt ut 3 prøvesteder etter en subjektiv vurdering av tilstanden for lav og planter: A) godt lav- og plantedekk; B) redusert lavdekke, men moderat dekning av planter; C) lav og andre planter nesten helt borte. Det ble antatt at forskjellene i lav og annen plantebestand var forårsaket av ulik beiteintensitet. De undersøkte vegetasjonstypene var lavrik fjellbjørkeskog og lav-lynghei. På hvert prøvetakingssted ble jordmonnet beskrevet og prøvetatt sjiktvis for fysiske og kjemiske jordanalyser. Fysiske parametere det ble analysert for var jordtetthet, porevolum, vann- og luftinnhold ved forskjellige sug, plantetilgjengelig vann og tekstur. Kjemiske parametere det ble analysert for var pH, organisk karbon (org-C), Kjeldahl-N, kationbyttekapasitet (CEC), basemetning og plantetilgjengelig P, Ca, Mg og K. Resultatene viste at mineraljorda besto av siltig mellomsand med 1-3% leir. På prøvesteder med god lavvegetasjon var det organiske laget cirka 6 cm. Planterøtter var i hovedsak lokalisert til det organiske toppsjiktet, men en god del røtter var også i de øverste 20 cm av mineraljorda. Tykkelsen på det organiske toppsjiktet avtok med avtakende tykkelse på lav- og plantedekke. Bare små forandringer i jordfysiske egenskaper ble funnet mellom de ulike prøvesteder. Det ble imidlertid funnet en sterk korrelasjon mellom org-C i jorda og CEC for alle prøvesteder og sjikt. Videre hadde det organiske toppsjiktet høyest innhold av plantetilgjengelig P, Ca, Mg og K. Ved å gå ut fra at forskjellene i lav og annen vegetasjon er et resultat av ulik beiteintensitet, tilsier resultatene at reinsdyrbeitingen kan føre til en betydelig reduksjon av det organiske materialet og dermed også av plantenæringsstoffer. På de undersøkte lokalitetene på Finnmarksvidda må mengden organisk materiale i jorda betraktes som en av nøkkelfaktorene for jordfruktbarhet og dermed også økosystemets bæreevne og produktivitet.

Ultrasonography in pregnancy diagnosis and measurements of fetal growth of reindeer

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The pregnancy of 13 multiparous reindeer was followed by ultrasonography 1 Oct 1997-24 Feb 1998. Stag was introduced to the females 1 Oct 1997, and it was allowed to freely mate with them. The ultrasonography was performed once a week until 29 Oct 1997, after which it was done three times a week until 7 Jan 1998. After that the examinations continued once a week until 24 Feb 1998. The scanning was performed transrectally by using a 5 MHz linear tranducer, which was used until 31 Dec 1997. After that the uterus descended down to the abdominal cavity, and the fetus was difficult to locate for measurements by transrectal scanning. From 1 Jan 1998 onwards a 3 MHz sector transducer was used for scanning. The transducer was placed against the abdominal wall on the cranial side of the mammary glands. Each scanning was recorded with a VCR connected to the ultrasonography device. The fetal measurements were taken first from frozen images, and checked afterwards from the recordings.
The pregnancy diagnosis made by ultrasonography was afterwards compared to pregnancy diagnosis obtained from the analyses of serum PAG and P4. Following measurements were recorded during the scanning: 1) Uterine horn diameter, 2) Fetal membranes, 3) Crown-rump length, 4) Trunk width and depth, 5) The first observation of fetal heartbeat.
A positive pregnancy diagnosis was made when liquid, and possibly the fetus, was seen in the uterus. Pregnancy was diagnosed between weeks 3-6 of gestation, earliest on day 18. The accuracy of the diagnosis was 25 % at week 4 of gestation, 58 % at week 5 of the gestation and 100 % at week 6 of the gestation. PAG detected the pregnancy at an average (±SD) on day 25±3 of gestation (range between days 18 and 28 of gestation).
The uterine horn diameter was detectable from week 3 of gestation, right after fluid was observed in the uterus. Uterine horn diameter was measured until week 9 of gestation, after which folding of the uterine horn prevented it. The fetal heartbeat was first detected between days 25-42 of gestation. Fetal membranes could be measured from week 5 of gestation. The trunk diameter could be measured from week 4 of gestation and the trunk depth could be measured from week 5 of gestation. Both measures were detectable until the end of the study (between weeks 15-20 of gestation).
Crown-rump length could be measured from week 3 onwards when the fetuses became detectable on the screen. On week 5 of gestation the crown-rump length was an average 0.9 cm (±0.35) and the trunk diameter was 0.6 cm (±0.36). The crown-rump length was measured with the linear transducer until week 10-13 of gestation (5.9 ±1.83 - 9.6 ±2.35 cm), after which the fetuses were either too big for the screen or the uterus had descended to the abdominal cavity and the measurements were continued with the sector probe. Deviation of the fetal measurements was, however, much greater with the sector probe than with the linear probe because focusing of the sector probe was more difficult.
The results show that pregnancy diagnosis by ultrasonography is reliable for pregnancy diagnosis in early pregnancy.

Porojen tiineyden toteaminen ja sikiön kasvun mittaus ultraäänen avulla

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Kolmentoista porovaatimen tiineyttä seurattiin ultraäänen avulla 1.10.1997-24.2.1998. Vaadinten aitaukseen laitettiin hirvas 1.10.1997 antaen sen vapaasti astua vaatimia. Vaatimille tehtiin ultraäänitutkimus kerran viikossa 29.10.1997 saakka, mistä alkaen tutkimus tehtiin kolmesti viikossa 7.1.1998 saakka. 24.2.1998 saakka tutkimus tehtiin kerran viikossa.
Ultraäänitutkimus tehtiin peräsuolen kautta 5 MHz lineaarianturilla, jota käytettiin 31.12.1997 saakka. Kohdun kasvaessa se painui vatsaontelon pohjaa kohti jolloin sikiö oli vaikea paikantaa lineaarianturilla. 1.1.1998 alkaen ultraäänitutkimus tehtiin 3 MHz sektorianturilla, joka asetettiin tutkimuksessa nisien etupuolelta löytyvälle karvattomalle ihoalueelle. Ultraäänitutkimukset nauhoitettiin videonauhurilla, joka oli yhdistetty ultraäänilaitteeseen. Sikiömittaukset tehtiin ultraäänitutkimuksen aikana pysäytyskuvista ja varmistettiin jälkeenpäin videonauhoituksista.
Ultraäänellä tehtyä tiineysdiagnoosia verrattiin jälkeenpäin seerumin P4- ja PAG-hormonien avulla tehtyihin tiineysdiagnooseihin. Ultraäänitutkimuksissa selvitettiin 1) kohdun sarven läpimitta, 2) sikiökalvot, 3) pää-laki –mitta, 4) rintakehän leveys ja syvyys, 5) sikiön sydämen sykkeen ilmaantumisajankohta.
Tiineysdiagnoosi tulkittiin positiiviseksi jos kohdun sisällä havaittiin nestettä ja mahdollisesti myös sikiö. Diagnoosi voitiin tehdä 3-6 tiineysviikolla, aikaisintaan 18 päivän kuluttua ovulaatiosta. Tiineysdiagnoosin tarkkuus oli 4.tiineysviikolla 25%, 5.tiineysviikolla 58%, ja 6.tiineysviikolla 100%. Seerumin PAG:n avulla positiivinen tiineysdiagnoosi tehtiin keskimäärin (±SD) 25±3 päivän kuluttua ovulaatiosta (vaihteluväli 18-28 päivää ovulaatiosta).
Kohdun sarven läpimitta voitiin mitata 3.tiineysviikosta alkaen, heti kun kohdun sisällä havaittiin nestettä ultraäänitutkimuksessa. Sitä mitattiin 9.tiineysviikolle saakka, minkä jälkeen kohdun seinämän poimuuntuminen haittasi mittausta. Sikiön sydämen syke havaittiin ensimmäisen kerran 25-42 päivän kuluttua ovulaatiosta. Sikiökalvojen kasvamista kyettiin mittaamaan 5.tiineysviikolta alkaen. Rintakehän leveyttä voitiin mitata 4.tiineysviikolta alkaen ja rintakehän syvyyttä 5.tiineysviikolta alkaen. Sekä rintakehän leveyttä että sen syvyyttä voitiin seurata tutkimuksen loppuun saakka, eli tiineysviikoille 15-20.
Pää-laki –mittaa voitiin mitata 3.tiineysviikolta alkaen, eli heti kun sikiö voitiin havaita ultraäänitutkimuksessa. Tiineysviikolla 5 pää-laki –mitta oli keskimäärin 0.9 cm (±0.35) ja rintakehän leveys keskimäärin 0.6 cm (±0.36). Pää-laki –mittaa seurattiin lineaarianturilla tiineysviikolle 10-13 (5.9 ± 1.83-9.6 ± 2.35 cm). Tällöin sikiöt olivat joko liian suuria sopiakseen ultraäänilaitteen näyttöön mittaamista varten, tai kohtu oli sikiön kasvamisen vuoksi laskeutunut niin syvälle vatsaonteloon, että mittausta ei voitu enää tehdä. Mittauksia jatkettiin sektorianturilla. Sikiön mittojen hajonta oli kuitenkin paljon suurempi kuvattaessa sektorianturilla kuin lineaarianturilla, johtuen sektorianturin vaikeammasta kohdistettavuudesta lineaarianturiin verrattuna.
Tulokset osoittavat, että ultraäänitutkimus on luotettava porojen tiineysdiagnostiikassa jo tiineyden alkuvaiheessa.

Infrastructure as barriers to wild reindeer migration

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We studied lichen biomass on either side of infrastructure possibly perceived as barriers to wild reindeer (*Rangifer tarandus tarandus*) in south central Norway as an indicator of use and grazing pressure. Only areas 2-5 km from infrastructure within comparable habitat were studied. Within two reindeer winter ranges, lichen biomass was 530% and 280% higher, respectively, in the regions cut off by two parallel power lines and an adjacent winter-closed road compared to biomass on the other side of the power lines. In a third region, lichen biomass did not vary significantly between areas 2-5 km north and south of a single winter-closed road without any adjacent power line. The data correlate with satellite imagery of lichen cover in the area. Our findings indicate that wild reindeer relatively freely crosses closed roads in winter, whereas two parallel power lines and a winter-closed road in combination are perceived as a barrier and lead to very different grazing pressures on either side of the barrier. In Snøhetta, hydropower development and the two parallel power lines have led to a near stop in migration between the eastern and western parts of the region, and the reindeer of the region are today managed as two separate herds. In Nord-Ottadalen, groups of reindeer have sporadically been observed underneath and crossing the power lines. These crossings have, however, been too infrequent and short-termed to be reflected in lichen biomass. Fragmentation of wild reindeer ranges in Norway has resulted in a substantial reduction in available ranges and traditional migration routes between important seasonal ranges, with an overall reduction in carrying capacity as the result. The current population of around 35 000 wild reindeer, half of the population 35 years ago, is now considered maximum with the limitations in available ranges due to industrial and recreational development.

Infrastruktur som barrierer for villreintrekk

Vi undersøkte om kraftledninger kan oppfattes som barrierer for villrein (*Rangifer tarandus tarandus*) ved å kartlegge lavslitasjen på hver side av kraftledninger i tre villreinområder. Kun områder innen sammenliknbart habitat mellom 2 og 5 km fra kraftledningene ble sammenliknet. I to av villrein-områdene var lavmengden henholdsvis 530% og 280% høyere på den ene siden av to parallelle kraftledninger og en vinterstengt vei sammenliknet med lavmengden på den andre siden. I et tredje villreinområde fant vi ikke forskjeller i lavmengde nord og sør for en vinterstengt vei uten kraftlinjer. Resultatene samsvarer med satellittkart over lavdekket i området. Funnene tyder på at villrein krysser vinterstengte veier uten kraftledninger relativt fritt, men at to parallelle kraftlinjer i kombinasjon med vinterstengt vei oppfattes som en barriere for villreintrekk. Dette vil føre til svært forskjellig beitetrykk på hver side av barrieren. I Snøhetta villreinområde har vannkraftutbygging og to parallelle kraftlinjer nesten stoppet trekket mellom østre og vestre deler av området, og reinen i Snøhetta forvaltes i dag som to separate flokker. I Nord-Ottadalen villreinområde har man observert at enkelte grupper med rein har stått under og krysset to parallelle kraftlinjer, men kryssingene har vært for kortvarige og sporadiske til å føre til endringer i lavmengde. Fragmentering av norske villreinområder har ført til en betydelig reduksjon i tilgjengelige beiter og trekk mellom sesongbeiter, noe som totalt sett har ført til en reduksjon i beitekapasiteten. Dette medfører at dagens villreinpopulasjon på rundt 35 000 dyr, halvparten så stor som populasjonen for 35 år siden, anses som maksimal ut fra dagens beitetilgjengelighet.

Spatial interactions between reindeer husbandry and other forms of land use

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The questions concerning the use of natural resources have become more complex and extensive during last decades. The research of natural resources has often focused on certain and narrow themes but the sustainable use of resources insists on a holistic approach and attention to the interactions of the different forms of the resource use. The objective of this study is to research from the spatial and socioeconomic point of view the interactions and the dynamics between different forms of land use. The study focuses on the reindeer husbandry in Northern Finland, especially in four reindeer herding co-operatives. Progression of the interactions is studied from the 1950s up to the present. The aim of the research is to study questions like how the reindeer husbandry interacts with the other forms of land use, what kind of conflicts exist among the different land user groups, how the land use interactions and patterns have changed during the fifty-year period and what kind of land use planning is required to reach more sustainable use of natural resources. The study is a part of the LUIAS (*Land Use Interaction Analysis System*) –project. The project aims to analyse the interactions between reindeer husbandry and other use of natural resources and to adjust them together in a sustainable way.

Poronhoidon ja muiden maankäyttömuotojen alueellinen vuorovaikutus

Luonnonvarojen käyttöön liittyvät kysymykset ovat viime vuosikymmeninä monimutkaistuneet ja laaja-alaistuneet. Luonnonvaroja on perinteisesti tarkasteltu niistä saatavien aineellisten ja aineettomien hyötyjen kannalta, mutta niiden kestävä käyttö ja sen suunnittelu vaatii myös eri käyttömuotojen välisten vuorovaikutussuhteiden huomioimista ja tarkastelua. Tämän tutkimuksen tavoitteena on selvittää eri maankäyttömuotojen välisiä vuorovaikutussuhteita ja dynamiikkaa luonnonvarojen käytön kannalta alueellisesta ja sosioekonomisesta näkökulmasta. Ajallista ulottuvuutta tutkimukseen tuo vuorovaikutussuhteiden rakentumisen seuraaminen 1950-luvulta nykypäivään. Tutkimuksessa käytetään esimerkkinä porotaloutta Suomen Lapissa ja lähemmässä tarkastelussa on neljä Pohjois-Lapissa sijaitsevaa paliskuntaa. Tutkimuksessa tarkastellaan mm. seuraavia kysymyksiä: miten porotalous kytkeytyy muuhun maankäyttöön, miten eri maankäyttäjät näkevät ja kokevat maankäyttömuotojen vaikutukset suhteessa poronhoitoon ja miten poronhoito vaikuttaa muihin maankäyttömuotoihin, mitkä tekijät aiheuttavat ristiriitakokemuksia eri maankäyttömuotojen välillä, miten maankäytön vuorovaikutussuhteet ovat muuttuneet viimeisen 50 vuoden aikana ja kuinka maankäyttöä tulisi suunnitella ja ohjata, jotta se olisi nykyistä kestävämmällä pohjalla. Tutkimus on osa LUIAS (*Land Use Interaction Analysis System*) – hanketta, jossa tavoitteena on tarkastella poronhoidon ja muiden luonnonkäyttömuotojen välillä olevia alueellisia ristiriitoja ja vuorovaikutusta niin biologisesta kuin alueellisesta ja sosioekonomisesta näkökulmasta.

Plant biomass and flowering in relation to weather in reindeer summer pastures

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In order to address the importance of weather for the productivity of the summer pastures of reindeer (*Rangifer tarandus*), we have carried out biomass estimation over four years in grasslands in North-Norway. Plots were analysed in the beginning of August, which is assumed to be after peak season, in 1998 to 2001. Half of the plots analyzed in each of three locations, were protected from reindeer grazing by small exclosures. The total biomass data was analysed and related to precipitation and temperature data from the closest weather station. There was an increase in flowering biomass in 1999 in comparison to 1998, 2000 and 2001, while there was approximately 20% more biomass in the plots in 1998 than the following three years. This high in total biomass coincided with 1998 being the year with the highest mean July temperature. From 1999 to 2001, the mean July temperature decreased. During these years there was no significant change in total biomass. There was no effect of the exclosure treatment, indicating that plants in grasslands compensate for the grazing. Our results suggest that July temperatures have a major influence on the total biomass production in the present season, and on the total flowering in the following season in grasslands of northern boreal, coastal regions.

Plantebiomasse og blomstring i relasjon til været i reinens sommerbeiter

For å undersøke viktigheten av været for produktiviteten i reinens (*Rangifer tarandus*) sommerbeiter har vi har utført estimering av biomasse over fire år i gressmarker i Nord-Norge. Fastruter ble analysert i årene 1998 til 2001. Analysene ble utført i begynnelsen av august, som er et tidspunkt som er antatt å være etter maksimum av sesongen. Halvparten av rutene som ble analysert i hver av de tre områdene var beskytta fra reinsdyr ved hjelp av små bur. De totale biomasse dataene ble analysert og relatert til nedbør og temperaturdata fra nærmeste værstasjon. Det var en økning i blomstrende biomasse i 1999 sammenliknet med 1998, 2000 og 2001, mens det var ca. 20% mer biomasse i rutene i 1998 enn de tre påfølgende årene. Denne økningen i biomasse sammenfalt med at 1998 var året med høyest gjennomsnittlig juli temperatur. Fra 1999 til 2001 sank den gjennomsnittlige juli temperaturen. I disse tre årene var det ingen signifikant endring i den totale biomassen. Det var ingen effekt av burbehandling, noe som indikerer at planter i gressmarker kompenserer for beitet. Våre resultater antyder at juli temperaturer har en stor innflytelse på den totale biomasseproduksjonen i nåværende sesong, og på den totale blomstringen i påfølgende sesong i gressmarker i nordboreale kystregioner.

Time integrated digestibility of grass silage and lichens in reindeer rumen fluid

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The organic matter digestibility (OMD) of two qualities of grass silage (silage I and II) and a sample of mixed lichens (*Cladina* spp.) was measured *in vitro* in rumen fluid from six reindeer. The reindeer had been fed three different diets (80% lichens and 20% silage or 20% lichens and 80% of either of the two silages) prior to rumen fluid collection. The three feed samples were digested 8, 24, 48 and 72 hours in each rumen fluid. The results were compared to *in vivo* apparent OMD of the three feeds, measured in ten live reindeer by comparing organic matter (OM) intake and OM excretion with *faeces*. The results on the amount of OM digested *in vitro* at different times were very similar in all rumen fluids. The results fitted well to a sigmoid response function. R^2 was 0.993, 0.978 and 0.917 for silage I, silage II and lichens, respectively. Digestion of the two silages seemed to be completed after 72 hours, when 84-89% of the OM was digested. Lichens were digested to 71-80% after 72 hours and the curve indicated that lichens need more time for complete digestion. The results on *in vivo* digestibility for the two silages, 75,7±1.0% (least square means ± standard error) for silage I and 74.9±1.1% for silage II, were in good accordance with adjusted average *in vitro* OMD at 72 hours (using a formula calibrated for cattle), 76.9% for silage I and 76.2% for silage II. The *in vivo* digestibility for lichens, 73.9±1.0% was considerably higher than the corresponding adjusted *in vitro* OMD, 65.1%.

Tidsintegrerad smältbarhet av ensilage och lav i vomvätska från ren

Smältbarhet av organiska substans (OMD) i två kvaliteter av ensilage (ensilage I och II) och ett prov av blandad lav (*Cladina* spp.) mättes *in vitro* i vomvätska från sex renar. Renarna hade utfodrats med tre olika dieter (80% lav och 20% ensilage eller 20% lav och 80% av endera av de två ensilagen) före uttag av vomvätska. De tre foderproven digererades 8, 24, 48 och 72 timmar i varje vomvätska. Resultaten jämfördes med skenbar *in vivo* OMD, som hade uppmätts för de tre fodren i tio levande renar genom jämförelse mellan intag av organisk substans (OM) och utsöndring av OM i *faeces*. Resultaten för mängd digererad OM *in vivo* vid olika tidpunkter var mycket lika för de olika vomvätskorna. Resultaten stämde väl med en sigmoid responsfunktion. R^2 var 0.993, 0.978 och 0.917 för ensilage I, ensilage II respektive lav. Digestionen av de två ensilagen föreföll avslutad efter 72 timmar då 84-89% av OM hade digererats. Laven hade digererats till 71-80% efter 72 timmar och kurvan indikerade att lav behöver mer tid för fullständig digestion. Resultaten för smältbarhet *in vivo* för de två ensilagen, 75,7±1.0% (least square means ± standard error) för ensilage I och 74.9±1.1% för ensilage II, stämde väl med justerad (med en formel kalibrerad för nötkreatur) genomsnittlig *in vitro* OMD vid 72 timmar, 76.9% för ensilage I och 76.2% för ensilage II. *In vivo* smältbarheten för lav, 73.9±1.0% var betydligt högre än motsvarande justerade *in vitro* OMD, 65.1%.

Phenotypic variation among reindeer calf cohorts is affected by density and weather

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We analysed variability of live weight and antler length in early summer among reindeer calves in relation to weather (winter, spring and early summer), sex and density. The data set included more than 5500 calves of both sexes for the period 1979 – 1986 in Østre Namdal, Norway. Body weight of males and females were positively correlated to antler length, suggesting that antler length could be a good measure of calf condition. Body weight and antler length varied significantly among cohorts and between sexes, with interaction between cohort and sex. Consistently, males were heavier (~ 2.5 kg ± SE 0.21) and had longer antler (~3.8 cm ± SE 0.23) than females. Body weight and antler length of male calves were, just as variable between cohorts as were those of female calves. The most parsimonious models, for antler length included density, winter snowfall, spring day degree, May-June precipitation and temperature; while all but May-June temperatures were included in the model for body weight. Unlike winter snowfall, May to June temperature and precipitation that negatively affected phenotypic traits, spring day-degrees were positively correlated with antler length and body weight. That snowfall the winter cohorts were *in utero* was kept in models for both body weight and antler length confirms a cohort effect mediated through the mother, most likely as a combined effect of increased energetic expenditure due to movement in deep snow and reduced food availability. Spring day-degree, May-June precipitation and temperature may influence forage availability and quality in the area while increased density may enhance intra-specific competition and limits food available at the individual level within cohorts.

Tetthet og klima påvirker kroppsvekt og gevirlengde blant årsklasser av kalv

Vi studerte variasjon i kroppsvekt og gevirlengde (målt i juli) hos kalver, sett i sammenheng med klima (vinter, vår og tidlig sommer), kjønn og dyretetthet. Datasettet omfattet ca. 5500 kalver i perioden 1979- 1986 i Østre Namdal reinbeitedistrikt, Nord-Trøndelag. Kroppsvekt var positivt korrelert med gevirlengde hos begge kjønn. Kroppsvekt og gevirlengde varierte signifikant mellom årsklasser og kjønn, og med samspillet mellom årsklasse og kjønn. Hannkalvene var tyngre (~ 2.5 kg ± SE 0.21) og hadde lengre gevir (~3.8 cm ± SE 0.23) enn hunnkalvene. Variasjon i kroppsvekt og gevirlengde mellom årsklasser var lik for begge kjønn. Variasjonen i gevirlengde ble forklart ved tetthet, vinternedbør som snø, døgngrader i april og mai, og nedbørsmengde og temperatur i mai og juni. De samme variablene, unntatt temperatur i mai og juni, forklarte variasjonen i kroppsvekt av kalv. I motsetning til vinternedbør som snø, og nedbørsmengde og temperatur i mai og juni som påvirket fenotypiske trekk negativt, var døgngrader om våren positivt korrelert med gevirlengde og kroppsvekt. At vinternedbør som snø slår ut, tyder på at kalvens fosterutvikling blir negativt påvirket av redusert tilgjengelighet av fôrressursene gjennom økte kostander til graving og forflytning og redusert fôrinntak. Døgngrader i april og mai og temperatur og nedbør i mai og juni påvirker plantenes fenologiske utvikling og biomasseproduksjon, mens økt tetthet bidrar til sterkere innen-art konkurranse om fôrressursene.

Effect of "owners" selection strategies on autumn calf weight in reindeer (*Rangifer tarandus*)

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In view of the socio-cultural and economical importance of reindeer herding, emphasis should be put on appropriate herd structure and selection strategies that maximize marketable products, such as meat (the primary marketable product nowadays). Empirical observations reveal that within a herd, some owners seems to have better productivity in term of calf body weight than others. We hypothesized that there may be an owner effect in reindeer herding, i.e. some owner may be applying particular selection strategies that might be beneficial. We investigated this in three reindeer grazing districts in South Norway, using mixed linear models. We found that autumn dresses weight of calves varied significantly with year and "owner" within herd in all three districts. Consistently some particular owners within a herd had significantly higher average autumn dressed weight of their calves than others. We attributed this difference to "individual selection strategies", meaning that some owners may follow more accurately the calf and weight-based recommended strategy. In addition, they may make superior choices based on "Traditional Ecological Knowledge" when selecting animals to be kept in their stock.

Utvalg av avlsdyr påvirker vektene på reinsdyrkalver (*Rangifer tarandus*) hos individuelle reineiere

Dagens reindrift er i hovedsak basert på kjøttprodukjon. En bør derfor legge vekt på å finne fram til flokkstrukturer som gir et optimalt utbytte i form av salgbare produkter. Empiri tyder på at enkelte reineiere - også innen samme driftegruppe – har bedre kalvevekter enn andre. Vår hypotese er at det er en "eier-effekt" i reindrifta, det vil si at noen eiere på grunn av "bedre" seleksjonsstrategier i utvalg av avlsdyr oppnår bedre driftsresultater. Vi undersøkte dette i tre reindriftsdistrikter i Sør-Norge, og analyserte data med *mixed linear models*. Vi fant at kalveslaktevektene var signifikant påvirket av år og eier i alle tre distriktene. Noen eiere hadde gjennomgående høyere kalvevekter enn andre innen samme driftegruppe, og vi argumenterer for at dette er på grunn av individuelle seleksjonsstrategier: Noen eiere kan være flinkere til å følge den anbefalte kalvevektbaserte strategien, og i tillegg gjøre egne, velfunderte valg, basert på "tradisjonell økologisk kunnskap".

Sensory quality of meat from reindeer bulls, cows and calves

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An increasing number of reindeer calves are being slaughtered in Sweden (62.4% of the total reindeer slaughter 2000/2001 (National Board of Agriculture, 2001)). Therefore, it is important to investigate and compare their carcass quality with that of adult animals. Earlier studies within the project have demonstrated a clear seasonal variation in reindeer carcass quality (Wiklund *et al.*, 2000) as well as describing the composition of light (< 20 kg) and heavy (> 20 kg) reindeer calf carcasses (Wiklund & Hansson, 2001).

A total of 44 reindeer (8 bulls, 7 cows, 15 female calves and 14 male calves) were included in the study to compare the sensory quality of meat from reindeer of various ages and sex. All reindeer were slaughtered at a commercial slaughter plant, Arctic Deli AB, Harads, Sweden. At slaughter the animals were stunned with a captive bolt. The carcasses were selected over the whole slaughter season i.e. from September to March to represent the normal time of slaughter for various animal categories and the seasonal variation in quality. At 2 days post mortem, *M. longissimus* from the left side were excised, vacuum packaged and frozen at –20 ºC. 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 meat (ISO 6564, 1985; ISO 8586-1, 1993). All assessments were done in a sensory laboratory with separate booths equipped with the PSA program (PSA System/3.2.07) and under normal white light (ISO 8589, 1988). The following attributes were selected and unanimously agreed upon during panel training; odour, fibre coarseness, tenderness, juiciness, reindeer flavour, liver flavour, fat flavour and bitter flavour.

The meat from reindeer bulls and cows had a more coarse fibre structure, more fat flavour and was less tender compared with meat from the calves. The bull meat had significantly higher values for liver flavour, reindeer flavour, fat flavour and a stronger odour compared with all other animal categories. When comparing the calves, there was a tendency for the females to produce meat with a less bitter flavour.

From this study it was concluded that there was a significant difference in the eating quality of reindeer meat from reindeer bulls, cows and calves. However, the slaughter strategy used today with an increasing number of slaughtered calves and in many reindeer herding districts also a decreasing number of slaughtered bulls, might therefore contribute to an overall improved reindeer meat quality. In the present study we also observed a variation in odour- and flavour attributes in meat from calves. It is of interest to further study the sensory properties in meat from reindeer calves.

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Sensorisk kvalitet i renkött från sarvar, vajor och kalvar

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Kalvar utgör en ökande andel av den svenska renslakten idag (62,4% av den totala slakten slaktsäsongen 2000/01 (Statens Jordbruksverk, 2001)). Därför är det viktigt att beskriva och jämföra kalvarnas slaktkroppsegenskaper med vuxna djurs. I tidigare undersökningar inom projektet har vi visat att det fanns en klar säsongsvariation i slaktkroppskvalitet hos renar (Wiklund *et al.*, 2000) och också beskrivit sammansättningen hos lättare (<20 kg) och tyngre (>20 kg) kalvslaktkroppar (Wiklund & Hansson, 2001).
I denna undersökning studerades köttets sensoriska kvalitet. I försöket ingick 44 renar (8 sarvar, 7 vajor, 15 honkalvar och 14 hankalvar). Alla renar slaktades på slakteriet i Harads, Sverige (Arctic Deli AB). Vid slakt bedövades renarna med bultpistol före avblödningen. Slaktkropparna som ingick i undersökningen valdes ut under hela slaktsäsongen (från september till mars) för att på bästa sätt beskriva säsongsvariationen och samtidigt slakta respektive djurkategori vid normal tidpunkt på året. Två dagar efter slakt styckades slaktkropparna och *M. longissimus* (ytterfilén) från vänster sida vakuumpackades och frystes (-20 °C). Proverna transporterades frysta till Institutionen för hushållsvetenskap, Uppsala Universitet. Köttet tillagades i en konventionell ugn (150° C) till en innertemperatur på 68 °C. En beskrivande test utfördes av en utvald och tränad smakpanel, alla deltagare i panelen hade tidigare erfarenheter av att bedöma köttprover (ISO 6564, 1985; ISO 8586-1, 1993). Bedömningen utfördes under normalt vitt ljus i ett laboratorium utrustat för sensorisk analys med separata bås och PSA-program (PSA System/3.2.07) för varje deltagare (ISO 8589, 1988). Följande egenskaper bedömdes efter att ha valts ut under träning med panelen: lukt, fibergrovlek, mörhet, saftighet, rensmak, leversmak, fettsmak och bitter smak.
Både sarvar och vajor hade grövre fiberstruktur i köttet, mer fettsmak och mindre mört kött än kalvarna. Sarvköttet skiljde sig signifikant från de andra grupperna, det hade högre värden för egenskaperna leversmak, rensmak, luktintensitet och fettsmak. Inom kalvgruppen hade honkalvarna en tendens till mindre bitter smak i köttet jämfört med hankalvarna.
Från denna undersökning kunde vi dra slutsatsen att det var signifikanta skillnader i ätkvalitet i renkött från vuxna djur och kalvar. Den slaktstrategi som nu tillämpas med en ökande andel kalvslakt och i många samebyar också en minskande andel sarvslakt, kan därför påverka den genomsnittliga renköttskvaliteten positivt. I denna undersökning observerade vi också variationer, framförallt i lukt- och smakegenskaper, i köttet från han- och honkalvar. Det är därför av intresse att fortsätta studierna av ätkvaliteten i kött från renkalvar.

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Reindeer grazing adapted to coming clearcuts

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In the north of Sweden reindeer herding and forestry share the same land. This sometimes leads to a conflict of interests. Ground lichen is an essential source of reindeer forage during the winter. A lot of ground lichen is destroyed as a result of common forestry measure clear-cutting, both by machinery at the actual clear-cutting and later on by site preparation. The remaining lichen is partially covered by logging residue and therefore not accessible to reindeer. All this, in combination with the fact that open areas, more than forests, are exposed to severe snow conditions, makes clear-cut areas unsuitable as reindeer pastures for a number of years.
The effect of intensified reindeer grazing the years prior to clear-cutting is analysed in two steps. Firstly the effect was analysed without regard to the spatial dimension, and secondly with regard to the size and localisation of the forest treatment units.
The modelling period in the first analysis is eleven years. At the start, year one, all of the forest is 100 years of age. One tenth of the total area is clear-cut annually, during the years four to eight. In total half of the area is cut during the eleven-year period.
Under these conditions two strategies are studied: (1) The reindeer herders do not know about the forestry harvesting plans, thus the reindeer foraging will be evenly distributed all over the area. (2) The reindeer herders know about the forestry harvesting plans and the reindeer are directed to areas going to be clear-cut within three years. The foraging pressure in areas soon to be harvested was thus assumed 67% higher during three years than it would have been in the same area using the strategy 1.
By increasing reindeer foraging by 67% for three years prior to clear-cutting, and consequently reducing reindeer foraging in other areas, the total lichen-stock will be 20% higher on the eleventh year and the accessible lichen-stock (the part not covered by logging residue) became almost 40% higher. The main reason for this is that by using more of the lichen-stock prior to clear-cutting less lichen is left to destruction by clear-cutting.
In this model the lichen-stock was 1000 kg/ha at year one. In the used lichen growth model (Moxnes et al., 1998), maximum growth of lichen occurred at a lichen-stock of approximately 2450 kg/ha. This suggests advantages of saving lichen at some locations: as the lichen-stock increases, so will lichen production.
A sensitivity analysis was done for lichen growth, minimum edible lichen-stock, coverage of lichen by logging residue, decomposition of logging residue, how much of the lichen - covered by logging residue - that dies after clear-cutting, and how much of the lichen that dies due to site preparation.
In a second step of this study the theoretically possible improvement in ground lichens for grazing will be analysed with spatial aspects concerning size and localisation of the treatment units considered. In reality ground lichen for grazing occurs in stands of varying size and mixed with land without any ground lichen or unsuitable for grazing depending on other land classes, younger stands, or recently thinned stands. Planned reindeer grazing can not be done in small and isolated stands.

Renbete anpassat till kommande slutavverkningar

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I de norra delarna av Sverige bedrivs skogsbruk och rennäring på samma marker. Detta kan i många fall leda till intressekonflikter. Marklavar är en viktig del av renarnas vinterfoder. Mycket marklav förstörs vid slutavverkning, både av avverkningsmaskinerna och senare vid markberedningen. Den återstående laven täcks delvis av avverkningsrester och är därför inte tillgänglig för renbete. Detta, i kombination med det faktum att öppna områden är mer exponerade för väder och vind än sluten skog, gör slutavverkade områden olämpliga som renbetesmarker i ett antal år efter avverkningen.
Effekten av intensifierad renbetning åren före slutavverkning analyseras i två steg. I steg ett antas att betet kan genomföras oberoende av slutavverkningsobjektens storlek och rumsliga fördelning. I steg två beaktas även de rumsliga aspekterna.
Modellperioden för den första analysen är elva år. I utgångsläget är all skog 100 år gammal. En tiondel av arealen slutavverkas årligen åren fyra till och med åtta. Totalt avverkas halva arealen under elvaårsperioden.
Under dessa förhållanden studeras två olika strategier: (1) Renägarna känner inte till skogsbrukets avverkningsplaner och renarna betar jämnt spridda över arealen. (2) Renägarna känner till skogsbrukets avverkningsplaner och styr renarna till områden som ska avverkas inom tre år. Betestrycket inom dessa områden antogs därför vara 67% högre under de tre sista åren före avverkning än det skulle ha varit om strategi nr 1 använts.
Genom att öka betestrycket med 67% i tre år före slutavverkningen och följaktligen minska betestrycket i andra områden, blev det totala lavförrådet 20% högre år elva. Det tillgängliga lavförrådet (d v s den del av lavförrådet som inte täcks av avverkningsrester) blev då att bli nästan 40% högre. Genom större avbetning av lavförrådet före avverkning, återstår mindre lav som kan förstöras utan att komma renarna till del.
I denna studie var lavförrådet 1000 kg/ha vid modellperiodens början. I den använda lavtillväxtmodell (Moxnes m. fl., 1998) infaller den maximala lavtillväxten vid ett lavförråd av ungefär 2450 kg/ha. Att spara lav innebär i detta fall den positiva effekten, att när lavförrådet ökar, ökar även lavproduktionen.
Känslighetsanalys görs av lavtillväxt, minsta betningsbara lavmängd, marktäckningsprocent av avverkningsrester, avverkningsresters nedbrytningshastighet, andel ristäckt lav som dör efter avverkning, samt andel lav som försvinner vid markberedningen
I en fortsättning av studien analyseras om den teoretiskt möjliga ökningen av marklav för renbete också kan tillgodogöras om rumsliga aspekter beaktas. I verkligheten förekommer betningsbar marklav i bestånd av varierande storlek och utspridd i områden utan marklav eller med yngre eller nyligen gallrad skog. Planerad renskötsel kan inte genomföras i små isolerade bestånd.

The Swedish Mountain-MISTRA programme – interdisciplinary research around resource use conflicts

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The Mountain-Mistra research programme assembles research on resource-based conflicts in the northern mountains and the nearby surroundings. The target area are the mountain municipalities in the north. They cover about 50% of Sweden north of lat. 60ºN. The aim is to create scientifically based strategies for sustainable multiple use of natural resources, and to develop methods and tools for their implementation, as well as actively participate in the solving of problems concerning conflicting resource use. The programme is highly interdisciplinary and includes research in both natural and social sciences. In total about 45 scientists are involved in the programme.

The first full scale phase of the programme during 2000 – 2002 includes research within seven programme fields, which interact with each other through bridging projects:

1. "Humans and Nature in the Mountain Region", applying social science perspectives to planning, management and policy options
2. "Sustainable reindeer husbandry", dealing with management problems within the range-reindeer-predator system as well as business economic questions (see further below)
3. "Multiple use of Mountain Region forests", focusing on the compound production of a wide range of the material, immaterial and environmental values in the forest
4. "Management of wildlife in the Mountain Region", emphasizing strategies for sustainable harvest of small game resources for subsistence and recreational hunting
5. "Management of fish in the Mountain Region", addressing genetic and population dynamic issues in developing sustainable subsidiary and recreational fishing policies
6. "Nature, community and tourism in the Mountain Region", aiming at development of environmentally sensitive and sustainable tourism in the mountains
7. "Biodiversity as a resource", specifically studying biodiversity and nature preservation issues related to consumptive and non-consumptive use of resources

The main question within "Sustainable reindeer husbandry" is development of strategies and tools for adaptive management of reindeer grazing ranges within individual reindeer herding districts. Several individual projects are reported as separate contributions at the conference. One specific project concerns traditional knowledge about grazing and use of the landscape in reindeer husbandry. An important issue within the Mountain-Mistra context is productivity and psycho-social aspects of the co-existence of reindeer husbandry and large predators. One project is devoted to resource use and business economic optimizations of reindeer husbandry firms and reindeer herding districts in competition with other resource users.
The planned second phase of the programme will focus on syntheses, solution strategies and communications with user groups, management authorities, municipality bodies etc. within problem areas, where resource conflicts between users are pronounced.

FjällMistra-programmet – tvärvetenskap om resurskonflikter

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FjällMistra-programmet omfattar forskning kring naturresursbaserade konflikter mellan olika resursanvändare i fjällområdet. Målområdet är Sveriges fjällkomuner, som täcker ca hälften av landytan norr om sextionde breddgraden. Målen är dels att utveckla vetenskapligt baserade strategier för att nå ett uthålligt och mångbruksinriktat nyttjande av naturresurser i fjällregionen med beaktande av ekologiska, ekonomiska och sociala aspekter och att ta fram verktyg och metoder för att realisera dessa. I samband med detta skall forskarna delta aktivt i lösandet av konflikter i fjällregionen. Programmet är flerdisciplinärt och till betydande del tvärvetenskapligt. Sammanlagt medverkar ca 45 forskare i programmet.

Programmets första fas i full skala under åren 2000 – 2002 omfattar sju programområden, som forskningsmässigt samverkar via gemensamma projekt:

1. ”Människa och natur i fjällregionen”, som belyser olika dimensioner av hushållnings- och policybeslut utifrån samhällsvetenskapliga perspektiv
2. ”Uthållig rennäring”, som behandlar förvaltningsproblem rörande bete-ren-rovdjur samt företagsekonomiska frågor i konstellationen företag-sameby (se vidare nedan)
3. ”Mångbruk av skog” med inriktning på optimala avvägningar mellan skogens olika produktionsrelaterade, miljömässiga och sociala funktioner
4. ”Förvaltning av viltresurser”, som är syftar till utveckling av uthålliga beskattningsstrategier för småvilt för lokal försörjning och rekreation via jakt
5. ”Förvaltning av fiskresurser” med inriktning på skötselplaner för sjöar och vattendrag, som nyttjas kommersiellt eller för husbehovs- eller rekreationsfiske
6. ”Natur, samhälle och turism”, som är inriktat på frågor kring utveckling av miljövänlig och ekonomiskt hållbar turism i fjällregionen.
7. ”Biodiversitet som resurs”, som särskilt studerar biodiversitetsaspekter och skydd av naturvärden i relation till olika resursanvändningar i fjällen

Inom programområdet ”Uthållig rennäring” är förvaltningen av renbetet den största frågan. Forskningen syftar till utveckling av strategier och redskap för adaptiv förvaltning av betesresurser inom samebyar. Flera delarbeten redovisas som separata bidrag vid konferensen. I ett av delprogrammets projekt studeras traditionell kunskap om bete och landskapets användning. Ett i FjällMistra-sammanhanget viktigt projekt berör produktivitetseffekter och psyko-sociala konsekvenser av samexistens mellan rennäring och rovdjur. Ett annat projekt syftar till utveckling av planeringsinstrument för optimering av resursanvändning och ekonomi i renskötselföretag och samebyar internt och i konkurrens med andra resursanvändare.
Programmets planerade andra fas kommer att fokusera på synteser, lösningsstrategier och kommunikation med användargrupper, förvaltande myndigheter, kommunala organ och intresseorganisationer inom problemområden med utpräglade resurskonflikter mellan olika användarintressen.

Prevalence of *Sarcocystis* in reindeer calves

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Six different species of *Sarcocystis*, two-host protozoan parasites, have previously been identified in striated muscle of the intermediate host reindeer (*Rangifer tarandus* L.). When reindeer are heavily infested, the parasite may cause macroscopic changes in the muscle tissue, resulting in rejection of the slaughtered carcass. Multiple muscle tissue samples were collected in November during ordinary reindeer calf slaughter. The calves were all approximately six months old, were all from the same Sami village and had since birth been free-range grazing in the Vindelfjällen mountain area in Västerbotten county in Sweden. Transversal cross-section of a small muscle from the front leg, the muscle of Thiernesse (M. extensor indicis) was examined in light microscope. Sarcosporidial parasites were observed in 39% of the sampled animals (n=93). Preliminarily, at least three different *Sarcocystis* species, varying in size and wall thickness, were observed in the studied material. Previous reports based on meat inspection in Norway have shown a prevalence of 4%, with a higher occurrence in older adult animals. One Norwegian report shows prevalence in four herds varying between 10 and 40%, and a Russian study reports sarcocysts in 77% of examined reindeer from the Taimyr Peninsula. No studies have reported the prevalence in Sweden or in calves (animals up to one year of age). In the present study, further light microscopy and ultrastructural studies are needed to identify the different species correctly. Also, examination of known sarcocysts predilection sites (e.g. diaphragma, intercostal muscles, and esophagus) are needed, as the limited muscle area examined in this report probably does not reveal all infected animals. However, the already high prevalence of sarcocysts indicates that the grazing grounds are heavily infected with oocysts from droppings of fox or dogs, the definite hosts for some of the *Sarcocystis* species found in reindeer.

Prevalens av *Sarcocystis* hos halvårsgamla renkalvar

Sex olika arter av *Sarcocystis*, en protozoparasit, har tidigare identifierats i tvärstrimmig muskulatur hos ren (*Rangifer tarandus* L.). En kraftig infestation av dessa parasiter ses som vitaktiga förändringar i köttet och orsakar kassationer vid slakt. Under ordinarie slakt av renkalv i november månad samlades olika muskelbiopsier för en muskelstudie. Kalvarna var halvårsgamla, kom från samma sameby och hade gått på sommarbete i Vindelfjällen i Västerbottens län. Med ljusmikroskop undersöktes ett snitt per djur, en hel tvärsnittad liten muskel från ett framben, Thiernesse muskel (M. extensor indicis). Sarcosporidecystor noterades i 39% av djuren (n=93). Preliminärt observerades minst tre olika arter av *Sarcocystis*, baserat på cystastorlek och cystaväggens tjocklek. Tidigare publicerade artiklar rörande prevalensen av sarcosporidios hos ren har huvudsakligen baserats på norsk köttbesiktningsstatistik från sjuttiotalet, medan redovisning av motsvarande uppgifter i Sverige saknas. Uppgifter om prevalensen sarcosporidios hos renkalv (djur under ett års ålder) har vad vi vet inte tidigare publicerats. Vid okulär köttbesiktning redovisas från Norge en sarcosporidiosprevalens på ca 4%, med en högre förekomst hos äldre renar. I en norsk slaktundersökning av fyra renhjordar varierade prevalensen mellan 10 och 40%. En rysk studie visade att 77% av undersökta renar från Taimyr hade sarcosporidier. I föreliggande studie krävs ytterligare ljus- och elektronmikroskopiska undersökningar för att identifiera de olika *Sarcocystis*arterna. Den funna prevalensen kan misstänkas vara mindre än den verkliga prevalensen p.g.a. den mycket begränsade muskelyta som undersökts. Vidare undersökning av andra muskelgrupper, de som är predilektionsplatser för sarcosporidier, t.ex. mellangärde, interkostalmuskulatur och foderstrupe, behövs. Slutsatsen är dock att betet som de undersökta kalvarna gått på är kraftigt infekterat med smittsamma oocystor som härrör sig från avföringen från slutvärdarna till en del av renens *Sarcocystis*arter, rävar och hundar.