Project information

Keywords
Reindeer, climate change, traditional knowledge, pathogens, infectious diseases, Iceland, Norway

Project title
Health and infectious diseases in semi-domesticated reindeer in a changing climate

Year
2017-2019

Project leader
Morten Tryland

Geographical localization of the research project in decimal degrees (max 5 per project, ex. 70,662°N and 23,707°E)
Flokk Røros, Feragen (N62.56, E11.85). Flokk Hattfjelldal, Sjåmoen (N65.84, E13.41), Svarthopen (N65.46, E12.21). Flokk Tana: Seidafjellet (N70.18, E28.32). Iceland: East Iceland, all management zones.

Participants

UiT – Arctic University of Norway, AMB: Morten Tryland (project leader), Eva M. Breines (engineer), Javier Sanchez Romano (PhD student).

Norwegian Veterinary Institute: Tromsø: Torill Mørk (Researcher), Ingebjørg H. Nymo (Researcher), Rebecca Davidson (researcher), Karin E. Holmgren (engineer).

Norwegian Institute for Nature Research, Tromsø (NINA): Hans Tømmervik (Sen. Res.)

Northern Research Institute (Norut/NORCE), Tromsø: Jan Åge Riseth (Researcher)

East Iceland Nature Research Centre (Egilsstadir, Iceland): Kristin Áugústdóttir

(Researcher), Rán Þórarinsdóttir (Researcher), Skarphéðinn G. Þórisson (Researcher)

Selected reindeer herders and pasture regions (NO):

Stig Rune Smuk, Tana (Rákkonjárga), Torstein Appfjell, Hattfjelldal (Jillen-Njaarke) and Inge Danielsen (Riast Hylling).

Flagship
Terrestrial

Funding Source

Amount of funding from the Fram Centre, and any internal institutional and/or external funding (i.e. NRC, EU):

Fram:

2017	2018	2019	Totalt
440 000	430 000	450 000	1 320 000

In addition to the main funding for this project from Fram centre, it has been supported by a Nordic Centre of Excellence in Arctic Research; "Climate-change effects on the epidemiology of infectious diseases and the impacts on Northern societies" (CLINF; project leader Birgitta Evengård, Umeå University, Sweden). CLINF has contributed to the sampling of Norwegian semi-domesticated reindeer (three herds) as well as to sampling of wild reindeer on Iceland, by allocating a total of 120 000 NOK for 2017-2018 for field work in Norway, and 100 000 NOK to support sampling of wild reindeer in Iceland. CLINF has also contributed to working hours for UiT, NINA and Norut. Total support from CLINF is indicated below (as budgeted for UiT, NINA and Norut).

2017	2018	2019	Totalt
210 000	210 000	188 000	608 000

Other funding
In addition, all the institutions involved has contributed with considerable resources regarding field and lab facilities, equipment and working hours, which is not directly visible in the budget.

Summary of Results

Highlights from the project:

1. The exposure of semi-domesticated reindeer (NO) to virus infections in the three herds included, are

similar as in other districts, but an exceptionally high seroprevalence (exposure) to pestivirus was revealed in the Hattfjelldal region.

2. The opportunistic bacterial pathogen *Pasteurella multocida* is present in tonsills in semi-domesticated (NO) and wild (Iceland) reindeer.

4. Most of the parasite burdens of Icelandic reindeer consisted of sheep parasites, with the exception of the specific reindeer abomasal parasites *Ostertagia gruhneri* and its minor morph *Ostertagia arctica*, which were identified in Iceland for the first time.

5. Our literature studies and interviews among reindeer herders in Norway and Sweden show that reindeer herders' traditional knowledge may provide a reservoir of precaution and adaptation possibilities to counteract the threats by CSI.

Reindeer health and the presence of reindeer pathogens:

Field work (i.e. sampling) has been conducted in Tana, Hattfjelldal and Røros (semi-domesticated reindeer; 2017 and 2018, 20 animals from each herd, UiT and NVI) and Iceland (wild reindeer; 2017, 2018 and 2019, a total of 295 animals, UiT, NVI, East Iceland Nature Research Centre). Laboratory analyses of 2019 samples are still ongoing.

a) Viruses: Samples from semi-domesticated reindeer in Norway (2017 and 2018) have been investigated for several virus infections, with the following prevalence: Alphaherpesvirus CvHV2 (48 %), Gammaherpesvirus (8 %) and Pestivirus (32 %, but high in the Hattfjelldal region). Analyses for Bluetongue and Schmallenbergvirus were negative. Samples from wild reindeer, Iceland, were seronegative (same pathogen panel as above), with the exception of two seropositive reindeer for Pestivirus (see Omazic et al., 2019).

b) *Pasteurella multocida*: Samples from Norwegian semi-domesticated reindeer revealed the presence of this opportunistic pathogen in swab samples (PCR) and tonsils (cultivation and PCR). From wild reindeer (nose swab samples and tonsils), all samples from 2017-18 were negative for Pasteurella in bacteriological cultivation, but PCR results revealed a prevalence of 10%, indicating Pasteurellosis as a potential disease in reindeer in Iceland, as well as possible contact with and transmission from sheep (to be investigated further). A novel PCR method was designed in an attempt to detect Pasteurella-specific DNA in tonsils (i.e. more sensitive test than cultivation).

c) Parasite studies (Iceland only; Tables 1 and 2, attached)**:** The aim was to identify and quantify parasites and compare with previous screenings on Iceland and in Norway/Fennoscandia. McMaster analysis was performed on 111 fecal samples (2018) (Table 1 and 2). Prevalence and abundance data show low levels of gastrointestinal parasite eggs. Strongylidetype eggs were detected in 1/3 of the samples. Identification of male nematodes from the abomasum revealed hatched Strongylidetype eggs, i.e. no Protostrongylidae larvae (e.g. *Muellerius* or *Elaphostrongylus*) or *Dictyocaulus* larvae, and parasite eggs from *Nematodirus/Nematodirella* and *Trichuris* were not detected. A 5% subsample of the abomasal contents was examined for adult nematodes, in which sheep-associated parasites (*Telodorsagia circumcincta*, *T. trifurcata*) predominated. Also identified reindeer abomasal parasites *Ostertagia gruhneri* and *O. arctica* for the first time in reindeer in Iceland.

Traditional knowledge:

A literature study has been conducted concerning climate, ethnographical literature and reindeer herders` narratives about reindeer diseases from 1700 and up to 1960. Fieldwork and interviews were conducted in Gabna sameby (Sweden-Norway), Mauken/Tromsdalen reinbeitedistrikt and Kanstadfjord og Vestre Hinnøy reinbeitedistrikt.

Master and PhD-students involved in the project

PhD student **Javier Sanchez Romano** (Spain) has worked specifically on a transmissible eye infection among reindeer. He has participated in field work (NO, Iceland) and have conducted laboratory analyses. Javier

defended his PhD thesis successfully in January 2019, and is also involved in publications from this project.

Master student **Emily Magnusson** (UAF, Alaska) was involved in a part of Javier`s PhD project, evaluating antiviral treatment against IKC. She has also been participating in the field work for the Fram project. Emily submitted her thesis in Nov. 2018, followed by a successful exam.

Master student **Selengemurun Dembereldagva** (Mongolia) is conducting parasite studies (Iceland) together with NVI (Rebecca Davidson). Tentative title of her thesis is “Parasites in Icelandic reindeer (2018-2019)”, to be submitted spring 2020 (UiT).

Bachelor student **Christine Nordtun** participated during field work (Iceland) field work and conducted the serological screening for pestivirus. She took her bachelor exam with grade A in December 2018: “Pestivirus in Icelandic reindeer».

Published Results/Planned Publications

Published results/planned publication(s) - i.e. international journals, reports, abstracts from conferences/workshops (Send a copy of publications, for the database, to kathryn.donnelly@framsentret.no):

Scientific articles, international journals (directly or indirectly associated with the project):

Sánchez Romano J, Mørk T, Laaksonen S, Ågren E, Nymo IH, Sunde M, Tryland M. 2018. Infectious keratoconjunctivitis in semi-domesticated Eurasian tundra reindeer (*Rangifer tarandus tarandus*): microbiological study of clinically affected and unaffected animals with special reference to cervid herpesvirus 2. BMC Vet Res. 14(1):15. doi: 10.1186/s12917-018-1338-y.

Skre O, Karlsen SR, Riseth JÅ, Wíelgolaski FE. 2018. Consequences of future expansion at the Arctic treeline in northernmost Norway. J Agric Sci Techn B 8(3) DOI: 10.17265/2161-6264/2018.03.006

Omazic A, Aurosell C, Fedorov V, Hagström Å, Kantanen J, Leijon M, Mørk T, Nordtun CS, Nymo IH, Þórisson SG, Reilas T, Rockström U, Sánchez Romano J, Thorarinsdottir R, Tryland M, Johansson Wensman J, Albihn A. 2019. Seroprevalence of pestivirus in Fennoscandian, Russian and Icelandic Eurasian tundra reindeer. Infect Ecol Epidemiol 9:1, 1682223, DOI: 10.1080/20008686.2019.1682223

Omazic A, Bylund H, Boqvist S, Högberg A, Björkman C, Tryland M, Evengård B, Koch A, Berggren C, Malogolovkin A, Kolbasov D, Pavelko N, Thierfelder T, Albihn A. 2019. Identifying Climate-Sensitive Infectious Diseases in Humans and Animals in Northern Regions. Acta Vet Scand 61:53. Doi: https://doi.org/10.1186/s13028-019-0490-0

Sànchez Romano J, Leijon M, Hagström Å, Jinnerot T, Rockström UK, Tryland M. 2019. Chlamydia pecorum Associated with an Outbreak of Infectious Keratoconjunctivitis in Semi-domesticated Reindeer in Sweden. Front Vet Sci 6:14.doi: 10.3389/fvets.2019.00014.

Tryland M, Nymo IH, Sánchez Romano J, Mørk T, Klein J, Rockström U. 2019. Infectious disease outbreak associated with supplementary feeding of semi-domesticated reindeer. Front Vet Sci 6:126. doi: 10.3389/fvets.2019.00126.

Abstract/conferences:

Riseth JÅ, Tømmervik H. 2019. *May Traditional Reindeer Herding Knowledge help in counteracting climate sensitive infections (CSIs)?* Abstract/oral, NAISA Conference 2019, Session 87. Native American and Indigenous Studies Association. 26-29.06.19. Hamilton, New Zealand.

Book chapters with relevance to the project:

Riseth, J. Å., Tømmervik, H., and Forbes, B. 2018. Sustainable and resilient reindeer herding. *In*: Tryland M, Kutz SJ (Eds.), Reindeer and Caribou – Health and Disease. CRC Press, Boca Raton, pp.

Tryland, M., Ravolainen, V., and Pedersen, Å. Ø. 2018. Climate change - potential impacts on pasture resources, health and diseases of reindeer and caribou. *In*: Tryland M, Kutz SJ (Eds.), Reindeer and Caribou – Health and Disease. CRC Press, Boca Raton, pp. 493-514.

Tryland M, Das Neves CG, Klein J, Mørk T, Hautaniemi M, Wensman J. 2018. Viral infections and diseases. *In*: Tryland M, Kutz SJ (Eds.), Reindeer and Caribou – Health and Disease. CRC Press, Boca Raton, pp. 273-303.

Tryland M, Soveri T. 2018. Haematology and blood biochemistry reference values for *Rangifer*. *In*: Tryland M, Kutz SJ (Eds.), Reindeer and Caribou – Health and Disease. CRC Press, Boca Raton, pp. 445-454.

Reports:

Riseth, J.Å. & Tømmervik, H. 2017. Klimautfordringer og arealforvalting for reindrifta i Norge. Kunnskapsstatus og forslag til tiltak – eksempler fra Troms.. Tromsø: Norut Rapport 6/2017, (ISBN 978-82-7492-352-2) 62 s.

Kjørstad, M.A. Bøthun, S., Gundersen, V., Holand, Ø., Madslien, K., Mysterud, A., Nerhoel, I., Punsvik, T., Røed, K., Strand, O., Tveraa, T., Tømmervik, H., Ytrehus, B., Veiberg, V. 2017. Miljøkvalitetsnorm for villrein. Forslag fra en ekspertgruppe. Trondheim: Norsk instituttt for naturforskning 2017 (ISBN 978-82-426-3131-2) 193 s. NINA rapport (1400).

Manuscripts in preparation:

Riseth, Jan Åge, Hans Tømmervik (in progress). *"May Traditional Reindeer Herding Knowledge help in counteracting climate sensitive infections (CSIs)?"* (In Prep).

Tømmervik, Hans, Jan Åge Riseth, Morten Tryland. *"Sámi reindeer utilization forms and adaptation between disease outbreaks and climate change. A historical analysis"* (In Prep).

Risvoll, Camilla, Grete Haavelsrud, Tømmervik, Hans, Riseth, Jan Åge. "Multiple stressors meeting traditional knowledge: Current barriers in reindeer herding adaptations" (In Prep).

Tryland M, Sánchez Romano J, Nymo ICH, Mørk T, Thorarinsdottir R, Breines EM, Li H, Skarphéðinn G. Þórisson. A screening for virus infections among wild Eurasian tundra reindeer (*Rangifer tarandus tarandus*) in Iceland, 2017-2019.

Tryland M, Sánchez Romano J, Nymo ICH, Mørk T, Breines EM, Kjenstad OC, Li H. A screening for virus infections in eight different herds of semi-domesticated Eurasian tundra reindeer (*Rangifer tarandus tarandus*) in Norway, 2013-2015.

Communicated Results

1. Communicated results and their channels (i.e. workshops, press, users):

Tryland M. Health aspects of supplementary feeding. Workshop on supplementary feeding (NORDFORSK-Centre of Excellence), Kiruna, Sweden, February 22-23, 2018.

Tryland M. Virus infections in reindeer – a comparison between Norway and Iceland. Research seminar – Graduate School for Veterinary Medicine and Animal Sciences, Uppsala September 24, 2018.

Riseth, J.Å. & Tømmervik, H. 2018. May Traditional Reindeer Herding Knowledge help in counteracting climate sensitive infections (CSIs)? 4th International Indigenous Social Work Conference; 2017-06-11 - 2017-06-14. Reindeer health – CLINF (delprosjekt-nr. 362256).

Riseth, J.Å. & Tømmervik, H. 2018. May Traditional Reindeer Herding Knowledge help in counteracting climate sensitive infections (CSIs)? Arctic Frontiers-Connecting the Arctic; 2018-01-21 - 2018-01-26. Reindeer health – CLINF (delprosjekt-nr. 362256).

Tømmervik, H. & Riseth, J.Å. 2018 Social aspects on reindeer disease problems – The contribution of traditional knowledge in counteracting climate sensitive infections. Aspects on Reindeer Herding and on their Important Infectious Diseases, 2018-09-24 - 2018-09-24, SLU, Uppsala. Reindeer health – CLINF (delprosjekt-nr. 362256).

Tryland M. Reindeer parasites and infectious diseases – a brief comparison between Norway and Iceland. East Iceland Nature Research Centre, Egilsstaðir, Iceland. October 24, 2019.

Tryland M. Reindeer parasites and infectious diseases – a brief comparison between Norway and Iceland. Institute for Experimental Pathology, University of Iceland, Keldur, Reykjavík, Iceland. October 30, 2019.

Tryland M, Thorisson S, Thorarinsdottir R. Article: Fra Avjovarre til Vopnafjördur: 35 tamrein fra Finnmark er blitt til nesten 7000 islandske villrein. Forskning.no (October 27, 2019). https://forskersonen.no/dyreverden-meninger-populaervitenskap/fra-avjovarre-til-vopnafjrdur-35-tamrein-fra-finnmark-er-blitt-til-nesten-7000-islandske-villrein/1583097

Tryland M. Interview with Iceland television news, about reindeer health and diseases in Iceland., Sunday October 29, 2019.

Tryland M, Thorisson S, Thorarinsdottir R. Article: Fra Avjovarre til Vopnafjördur: 35 tamrein fra Finnmark er blitt til nesten 7000 islandske villrein. Villreinen.no (November 20, 2019).

Interdisciplinary Cooperation

This project has several interdisciplinary elements, such as veterinary medicine, ecology and social science. In addition to screening for diseases and disease pathogens (parasites, bacteria and viruses; UiT, NVI) we also investigated traditional knowledge and how this is transmitted between reindeer herders (NINA, Norut/NORCE). Further, the work in Iceland has been conducted in cooperation with the biologists and ecologists at East Iceland Nature Research Centre. The link to CLINF (Nordic countries, Russia) also has strong interdisciplinary aspects, and the samples generated from this project are made available to CLINF, addressing how reindeer diseases may impact Northern societies (see Omazic et al., 2019). Through the field work (Norway) we also have had direct contact with the involved reindeer herders. Whereas veterinary medicine is science based, traditional knowledge is often not, but rather based on experience, culture and traditions. The complexity of the issues involved in the project require interdisciplinary perspectives, but also makes cooperation more demanding.

Budget in accordance to results

The support from Fram Centre was essential in order to conduct field work in Norway and to be able to follow Icelandic wild reindeer population over three years (2017-2019). In 2017, we managed to sample only 40 animals, increasing to 115 in 2018 and 140 in 2019. Since analyses of the 2017 samples indicated limited exposure to known reindeer pathogens in Fennoscandia, it was crucial to increase sample size, also introducing

an interesting variable (sample year). With the current animal numbers/years, we may present our results in a robust manner, restricting bias due to low numbers and one year only. The Fram Centre funding has been sufficient to cover the analytical costs at Norwegian Veterinary Institute and UiT, which was not included in the CLINF funding. With the funding through CLINF, the support from Fram Centre was sufficient to completing the project. The Fram Centre Funding also secured a broader communication of results and a discussion in wider contexts. The money allocated via Fram has in general been used as budgeted, although smaller adjustments have been necessary.

Could results from the project be subject for any commercial utilization

No

Conclusions

Many research projects aim at tracking potential effects of climate change, which is hardly possible in the time frames usually provided (e.g. 2-4 years). As for the presence and prevalence of reindeer pathogens (NO, Iceland) and parasites (Iceland), this project has contributed to the establishment of a reference point, which is necessary to address changes over time (e.g. climate change). Further, it has created interesting results regarding the parasite fauna in reindeer in Iceland, being mostly related to sheep, but also identified two reindeer parasites not previously detected in Iceland. This has to be seen in the light of the export of 35 reindeer from Norway to Iceland (1787), now comprising a population of 7 000, which represents a major genetical bottleneck as well as an ecological challenge for the pathogens, which might be interesting to follow in future studies. Further, the high prevalence of pestivirus (NO) may indicate that these infections, as in cattle, may have impact on reindeer reproduction and fitness, which should be investigated further.

This project has contributed with a novel PCR method for the specific detection of DNA specific for the bacterial opportunistic pathogen *Pasteurella multocida*.

Traditional knowledge and reindeer handling techniques are still practiced, but are challenged

by efforts to adapt to climate change, such as supplementary feeding and extra moving and handling of animals. This knowledge is a reservoir of understanding for the ability to finetune adaptation measures to limit their adverse effects.