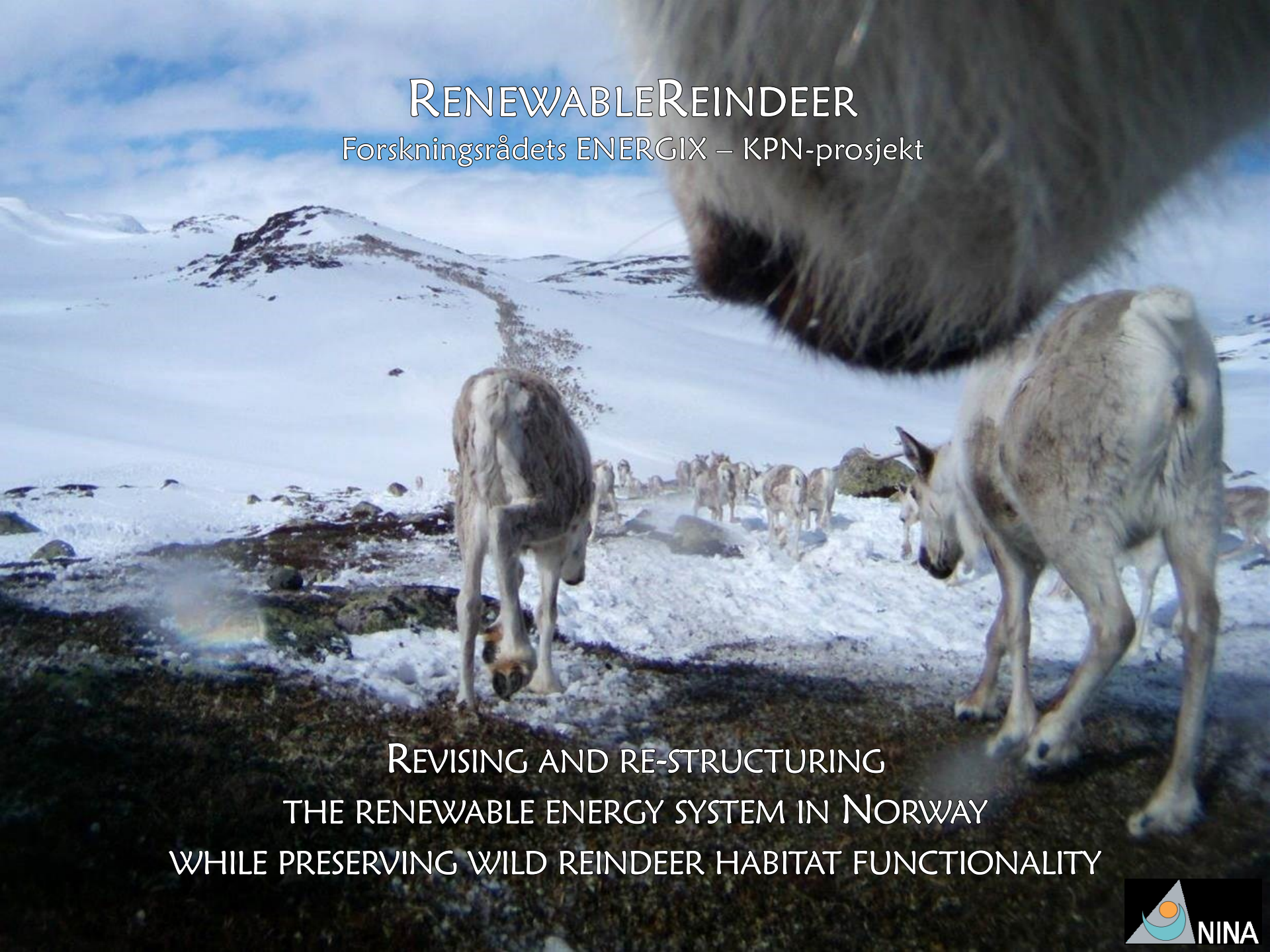

RenewableReindeer

Forskningsrådets ENERGIX – KPN-prosjekt

Revising and re-structuring the renewable energy system in Norway while preserving wild reindeer habitat functionality

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RenewableReindeer

Forskningsrådets ENERGIX – KPN-prosjekt

- ***Prosjektleder:*** Manuela Panzacchi, NINA
- ***Budget:*** 13 800 000 nok
- ***Project duration:*** 4 years, Aug 2015 – 2019
- ***Partners:*** 6 financing partners + 6 scientific partners (+...)
- ***Disciplines***: ecology, mathematics, software development, social sciences

..finne måter å tillate Norge å revidere og utvide fornybare energisystemer - spesielt vannkraft – og samtidig bevare villrein leveområder

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Financing partners

Financing partners	Contact
SIRA KVINA KRAFTSELSKAP	Per Øivind Grimsby
NVE - NORGES VASSDRAGS- OG ENERGIDIREKTORAT	Jan Henning L'Abée Lund
MILJØDIREKTORATET	Kari Bjørneraas – Erik Lund
Villreinprosjektet i Setesdalsheiene v/ Vest-Agder *Consortium of stakeholders*: - National Road Administration (Statens vegvesen) - Railroad Administration (Jernbaneverket) - Tourist Organizations (D.N.T) - Landowners Associations - Steering Board for Setesdal Vesthei villreinområdet - Hydropower industries: • Statkraft • Sira Kvina kraftselskap, • Otteråens Brukseierforening • Agder Energy • Norsk Hydrop Produksjon • Lyse Energi	Kåre Paulsen
Villreinsenter - Villreinrådet	Lena Romtveit

Scientific collaborations

Scientific collaborators	Affiliation	WP
Audun Ruud, PhD	SINTEF ENERGI AS, Norway	WP4
Prof. Subhash Lele	University of Alberta, Canada	WP 1
Prof. John Fryxell	University of Guelp, Canada	WP 1, 2
Prof. Marco Saerens	Universite Catholique de Louvain, Belgium	WP2
Ilkka Kivimäli (PhD student)	University of Aalto, Helsinki	WP2
Prof. Ferdinando Villa	Basque Centre for Climate Centre, Bilbao, Spain	WP2
Hawthorne Beyer, PhD	University of Queensland, Australia	WP2
Siri Bøthun Naturforvaltning	Siri Bøthun	WP 3,4,5

Background: Hydropower in Norway

- Hydropower developed ***extensively*** during the last century

- Concessions were granted ***before*** the legislation on Environmental Impact Assessment

- Most concessions are/will be subjected to a ***relicensing process*** ***aimed at increasing focus on sustainability***

- EEA Countries are expected to ***increase their share*** of renewable energy to 20% by 2020

- Norway is asked to contribute to Europe's transition to a renewable energy system by serving as a ***"Green Battery"*** through pumped-storage hydropower

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Background: environmental issues of hydropower

Well-known and well-studied effects of hydropower

on freshwater ecosystems (~ salmon)

Foto © Bengt Finstad/NINA

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Background: environmental issues of hydropower

No studies on terrestrial ecosystems.

Foto: Jarle Lunde/Suldal.no

Are there really no environmental issues for terrestrial ecosystems??

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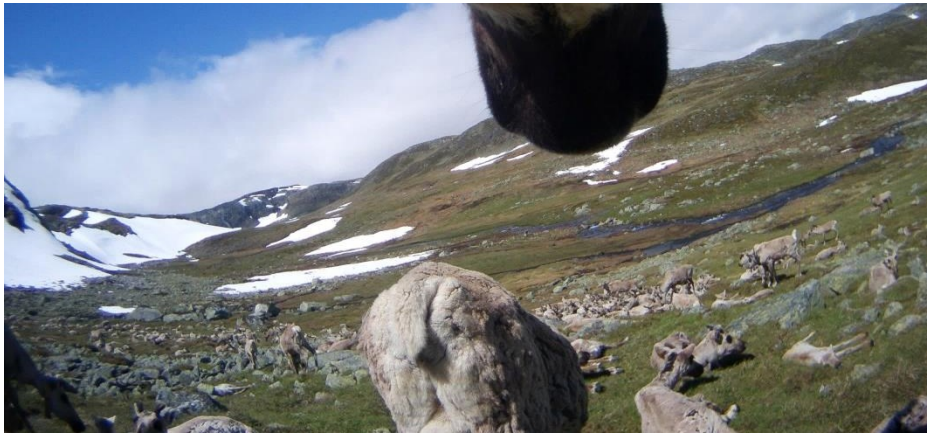
Wild Reindeer migrations - «the Norwegian Serengeti»

- Norway hosts the last remaining populations of wild mountain reindeer
- Large herds, large spatial requirements (capable of the longest terrestrial migrations)

WINTER:

SUMMER



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Ancient reindeer migrations

Pitfall traps (> 8000; 600 – 2000 yrs ago)

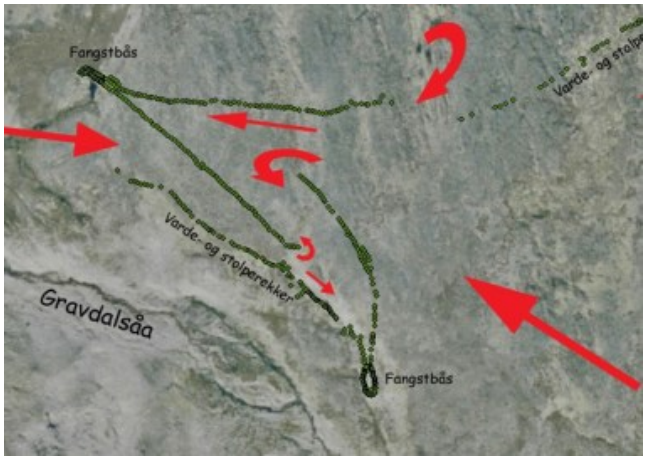

Photo: Per Hjordhøy

Hunting blinds

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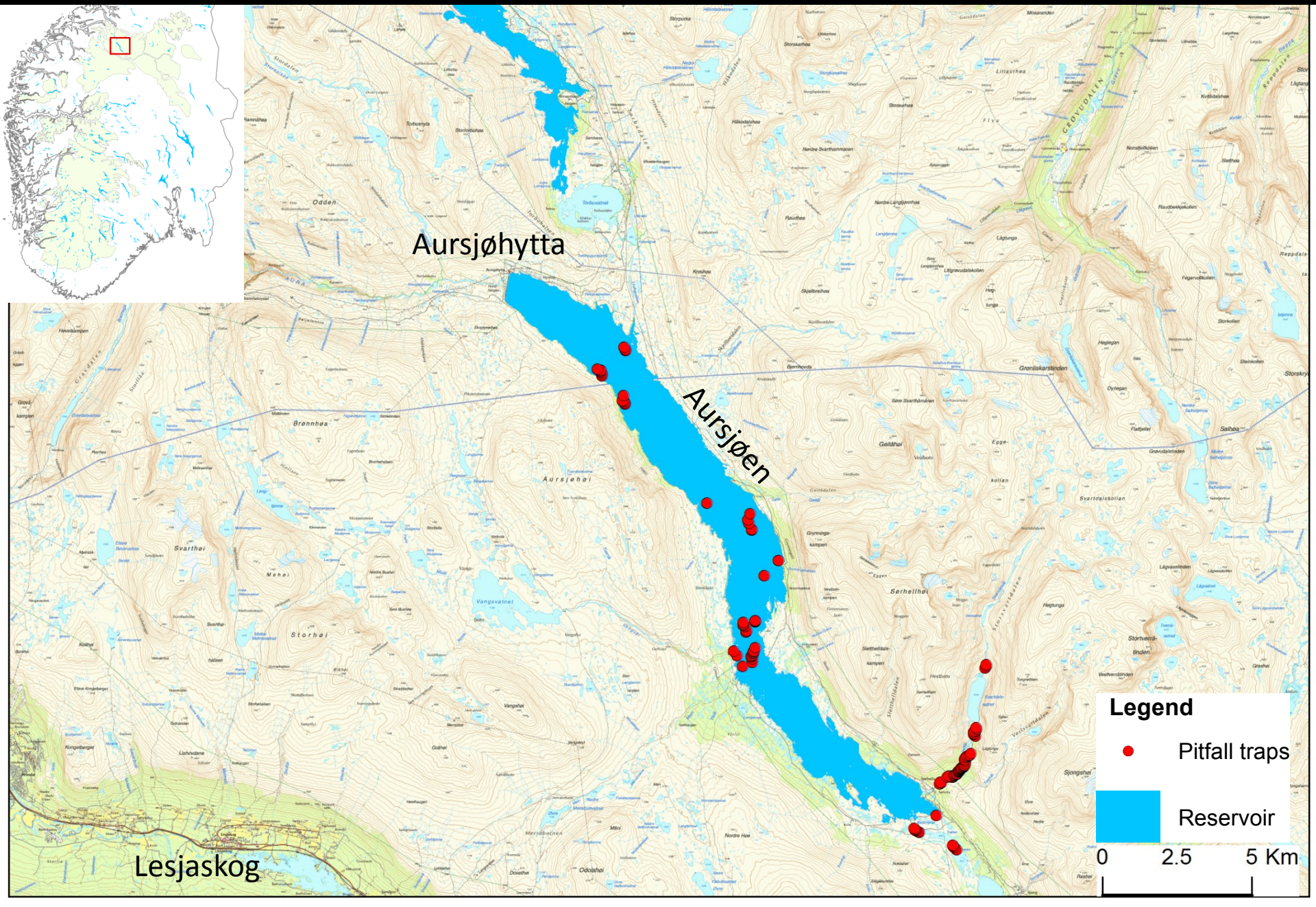
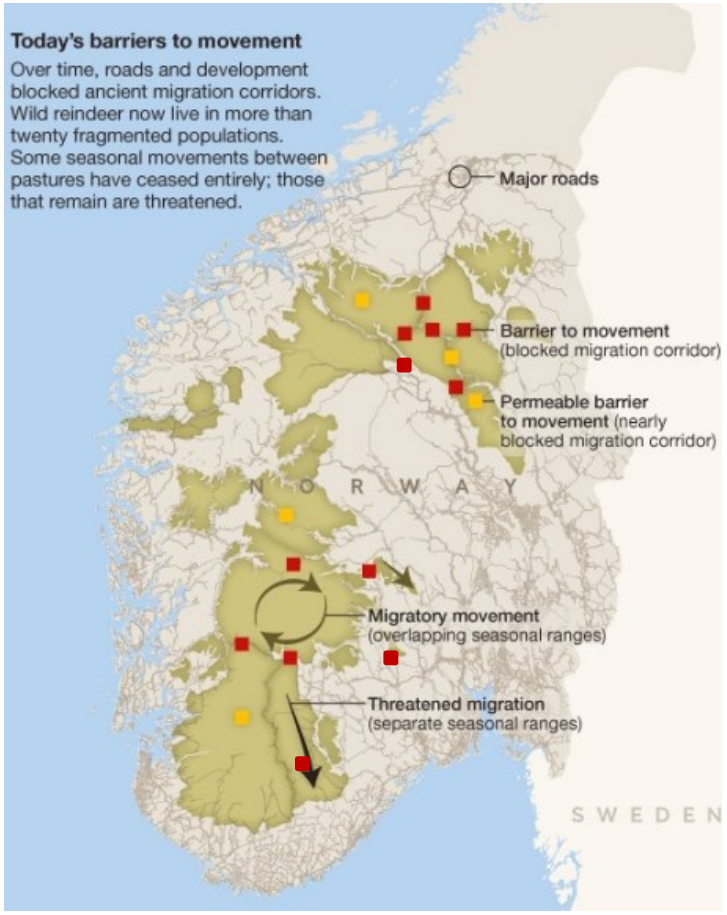
Pitfall traps, Aursjøen, Snøhetta



Ancient vs. Present range & migrations

Before industrialization:
few panmictic, migratory populations

2015: 26 isolated pop. Few (?) migrations left



MAIN ISSUE: FRAGMENTATION (rapidly increasing)

Still, Norway has ca. 30.000 deer. So, does it matter? Is long-term viability granted for all sub-populations?
Well... it depends…

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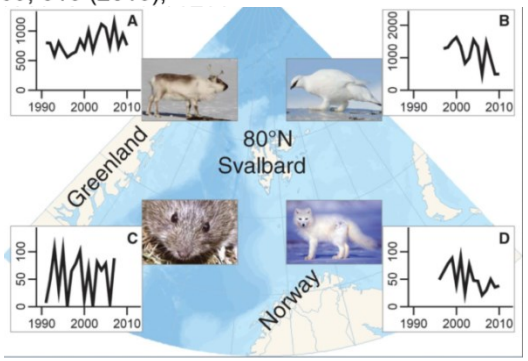
Fragmentation: does it matter?

Populations confined to smaller & “seasonally wrong” ranges:

⇒ Decreased carrying capacity (pop. must be kept at low densities to avoid overgrazing)

⇒ Increased vulnerability to stochastic events

Climate Events Synchronize the Dynamics of a Resident Vertebrate Community in the High Arctic
Brage B. Hansen *et al.*
Science **339**, 313 (2013);



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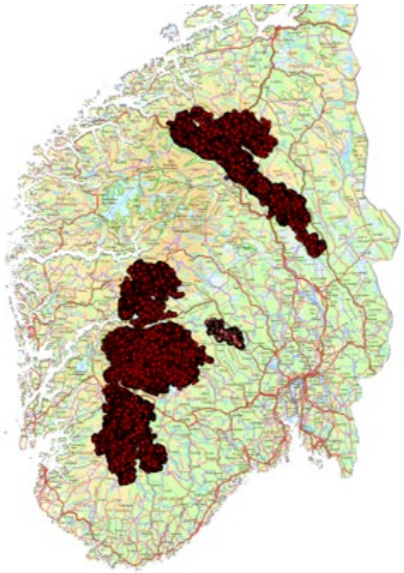
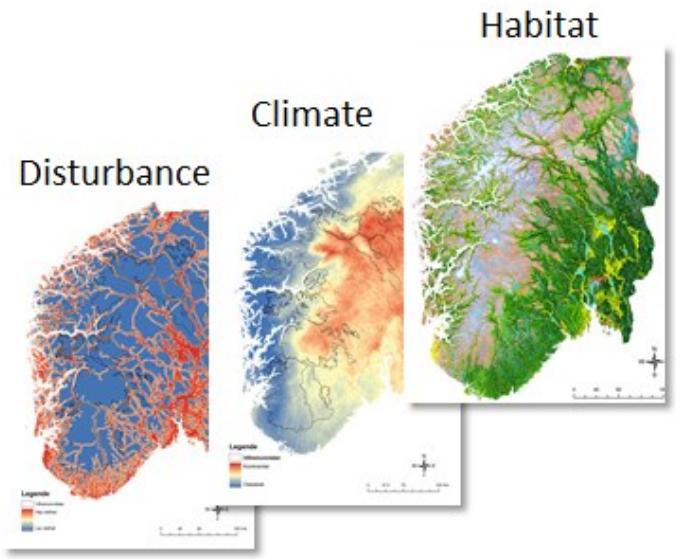
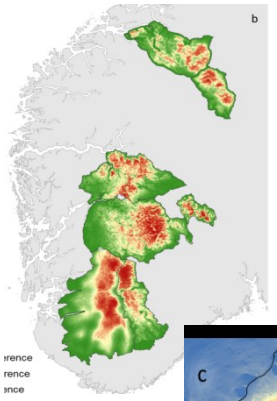
Our work on Reindeer & Infrastructures



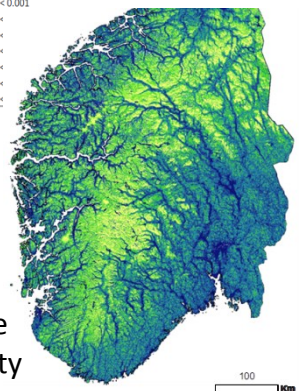
Massive GPS study:
> 270 GPS-monitored deer
from 10 populations since 2001



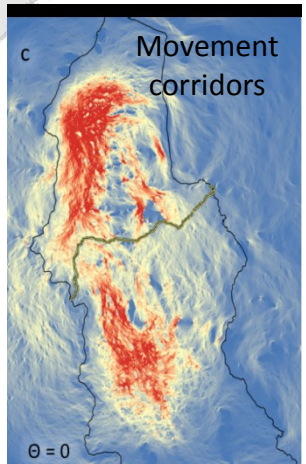
Area	Variables	coef	se(coef)	z	Pr(>|z|)
Norway	poly(pca1, 2)1	341.955	20.507	16.675	< 0.001
	poly(pca1, 2)2	-297.059	16.850	-17.630	< 0.001
	poly(pca2, 2)1	-889.623	39.347	-22.609	< 0.001
	poly(pca2, 2)2	-494.932	24.107	-20.531	< 0.001
	poly(pca3, 2)1	-126.648	14.798	-8.558	< 0.001
	poly(pca3, 2)2	-118.996	14.257	-8.347	< 0.001
	poly(pca4, 2)1	4.090	11.998	0.341	0.733
	poly(pca4, 2)2	24.017	9.647	2.490	0.013
	CabinsPublic_10K	-0.157	0.023	-6.843	< 0.001
	PowerLines_res15K	-0.305	0.025	-11.990	< 0.001
	CabinsPrivate_15K	-0.226	0.035	-6.456	< 0.001
	RoadsPrivate_res1K	-0.781	0.074	-10.544	< 0.001
	RoadsPublic_15K	-0.684	0.058	-11.726	< 0.001
	SkiTrails_res3K	0.089	0.017	5.420	< 0.001
	NORUT_Mountain12	1.500	0.165	9.081	< 0.001
	NORUT_Mountain13	3.057	0.155	19.745	< 0.001
	NORUT_Mountain14	2.637	0.150	17.543	< 0.001
	NORUT_Mountain15	2.871	0.169	17.026	< 0.001
	NORUT_Mountain16	2.674	0.151	17.677	< 0.001
	NORUT_Mountain17	2.483	0.146	16.981	< 0.001
	NORUT_Mountain18	1.986	0.167	11.909	<
	NORUT_Mountain19	2.501	0.155	16.106	<
	NORUT_Mountain20	1.813	0.156	11.588	<
	NORUT_Bog	1.184	0.199	5.934	<
	NORUT_Water	1.114	0.181	6.169	<
	NORUT_Other	-11.727	1.E+03	-0.011	<



Habitat requirements



Landscape permeability



Our work on Reindeer & Infrastructures

Ecography 38: 001–011, 2015
doi: 10.1111/ecog.01075

Subject Editor: Jorge Soberon. Editor-in-Chief: Miguel Araújo. Accepted 10 October 2014

Searching for the fundamental niche using individual-based habitat selection modelling across populations

Manuela Panzacchi*, Bram Van Moorter*, Olav Strand, Leif Egil Loe and Egil Reimers

Journal of Animal Ecology

Journal of Animal Ecology
British Ecological Society
Journal of Animal Ecology 2014
doi: 10.1111/1365-2656.12275

SPECIAL FEATURE: STUCK IN MOTION? RECONNECTING QUESTIONS AND TOOLS IN MOVEMENT ECOLOGY

'You shall not pass!': quantifying barrier permeability and proximity avoidance by animals

Hawthorne L. Beyer[1]*, Eliezer Gurarie[2,3], Luca Börger[4], Manuela Panzacchi[5], Mathieu Basille[6], Ivar Herfindal[7], Bram Van Moorter[5], Subhash R. Lele[8] and Jason Matthiopoulos[9]

Predicting the *continuum* between corridors and barriers to animal movements using Step Selection Functions and Randomized Shortest Paths

Manuela Panzacchi[a*], Bram Van Moorter[a], Olav Strand[a], Marco Saerens[b], Ilkka Kivimäki[b], Colleen Cassady St. Clair[c], Ivar Herfindal[d], Luigi Boitani [e]

Landscape Ecol
DOI 10.1007/s10980-012-9793-5

RESEARCH ARTICLE

Learning from the past to predict the future: using archaeological findings and GPS data to quantify reindeer sensitivity to anthropogenic disturbance in Norway

Manuela Panzacchi · Bram Van Moorter · Per Jordhøy · Olav Strand

A road in the middle of one of the last wild reindeer migration routes in Norway: crossing behaviour and threats to conservation

Manuela Panzacchi[1], Bram Van Moorter[1] & Olav Strand[1]

Rangifer, 33, Special Issue No. 21, 2013: 15–26

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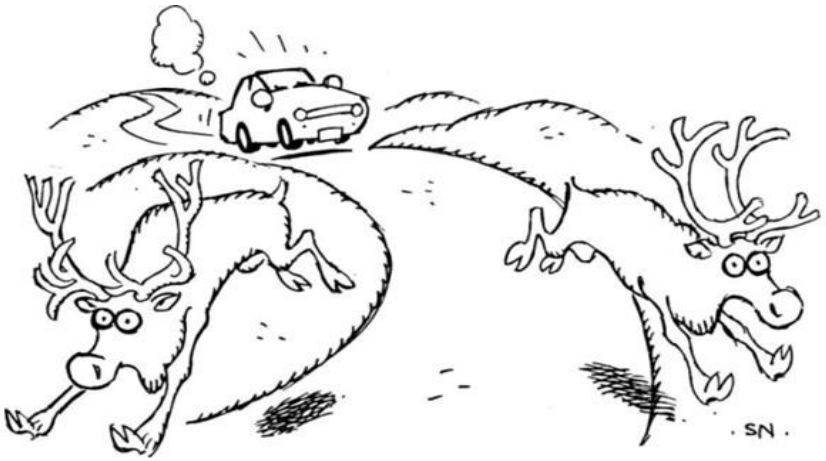
Lesson n. 1: wild reindeer tend to avoid infrastructures







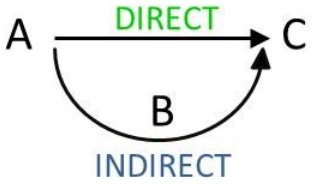






Lesson n 2: Direct, Indirect & Cumulative Effects

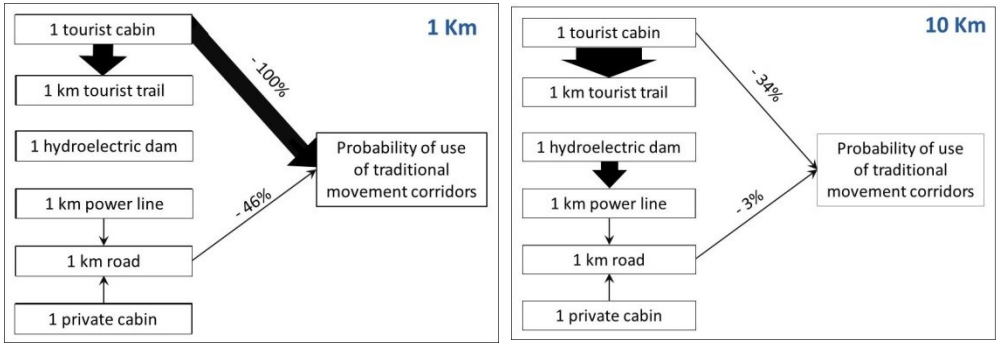
Infrastructures are spatially correlated, and reindeer respond to the *network* of infrastructures



Direct effects:
- roads
- tourist cabins (DNT)

Cumulative effects:
(e.g. 10 km)
- 1 km road: -3%
- 10 km roads: - 25%
- 10 km road + 1 DNT cabin : - 51%

Indirect effects:
- power lines
- private cabins
- hydroelectric dams



Panzacchi et al 2013, Land. Ecol.

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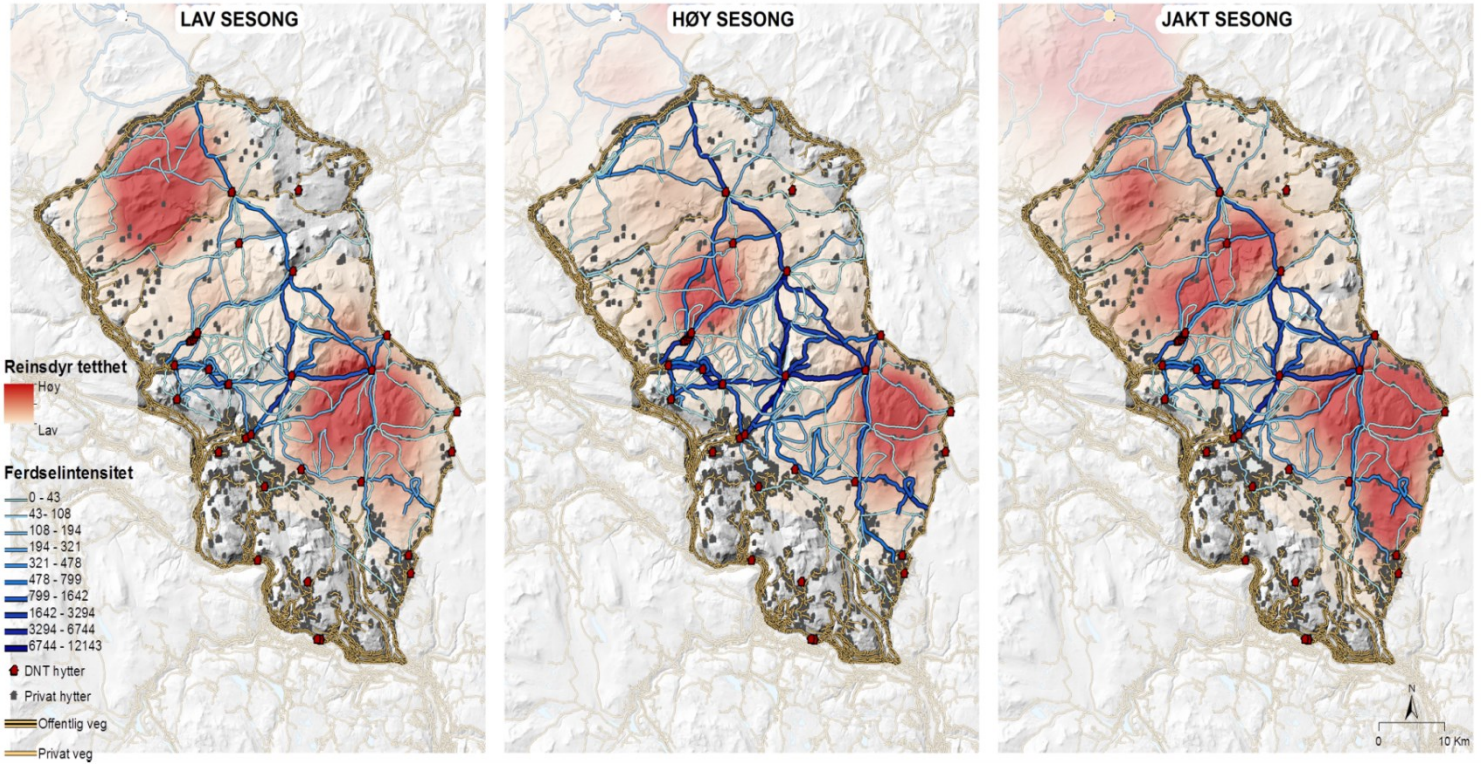
Lesson n 3: response depends on the *intensity* of disturbance

Rondane north



People counters

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Impact of hydropower on wild reindeer *(& possibility of mitigation)*

Construction of reservoirs $\Rightarrow$ area flooding $\Rightarrow$ habitat loss, temporary (?) barriers

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Impact of hydropower on wild reindeer *(& possibility of mitigation)*

Unsafe ice, steep banks, strong current ⇒ barriers, habitat fragmentation

We estimated that in spring the probability of reindeer walking on a reservoir is only 2% (barriers), while it is 24% higher for natural lakes

Panzacchi et al, Journal Animal Ecology 2015

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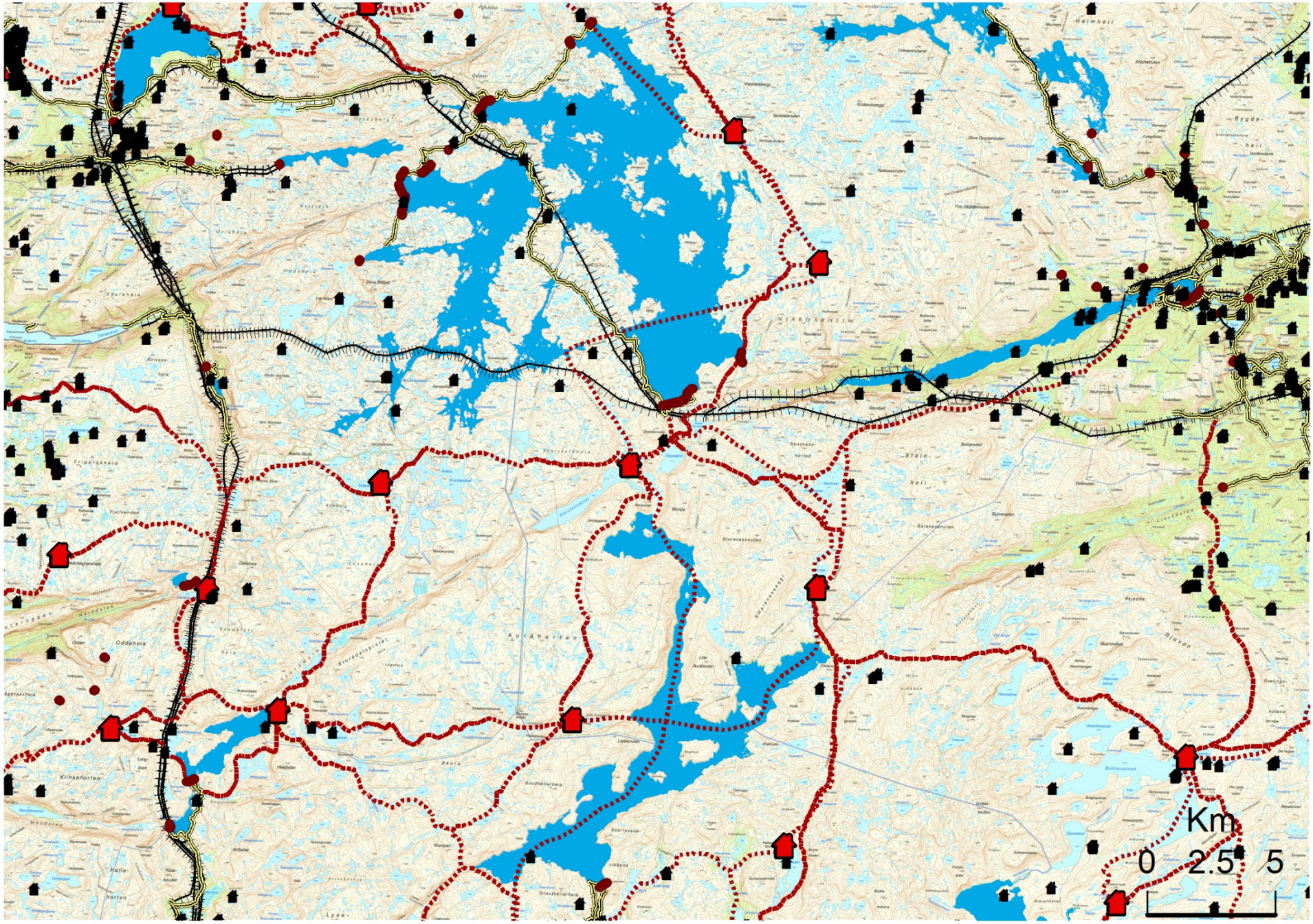
Impact of hydropower on wild reindeer *(& possibility of mitigation)*

Surrounding roads, tourist cabins, private cabins, power lines, ski tracks, hiking trails..
⇒ hab. loss & fragmentation

Infrastructure network - Setesdal Ryfylke: Bjåsjø



The *RenewableReindeer* project

Objectives

- Predict the impact of the network of hydropower plants and coexisting infrastructures on wild reindeer
- Assist the process of identifying concrete, cost-efficient, socially accepted mitigation options for increasing sustainability of the renewable-energy system in Norway under different land-development scenarios

RenewableReindeer: Ecological & Societal Challenges

Ecological & technical goals

- Identify areas of higher/lower importance for reindeer
- Develop robust models to predict response to specific infrastructures / mitigation measures / development plans
- Develop tools to guide Environmental Impact Assessment / sustainable land planning

Socio-political & economic goals:

- Develop strategies to reconcile contrasting socio-economic interests
- Evaluate the appropriateness of regulatory framework / governance for implementing mitigation measures
- Solve scale issues: discrepancy between large-scale, holistic approach needed for reindeer conservation, and the narrow-focus of the relicensing process

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Work Packages

WP 1 - Manuela Panzacchi, NINA
Habitat suitability and fragmentation

WP 2 - Bram Van Moorter, NINA
Predictive tools for Corridors & Habitat Functionality

Develop models and simulation tools to quantify impact of hydropower and to predict the effect of suggested mitigation options

WP 3 – Olav Strand, NINA
User Involvement and new arenas for dialogue
(3 areas: Setesdal Ryfylke, Nordfjella, Snøhetta)

Closely assists model development and suggests mitigation options to be tested in WP2, and provide a platform for WP4

WP 4 – Audun Ruud, SINTEF
Science-policy interface – the regulatory challenge

Review and suggests improvements in regulatory & multi-governance framework

WP 5 – Manuela Panzacchi, NINA
Dissemination, guidance and support for EIA

Wrap-up everything and make it available and useful for society

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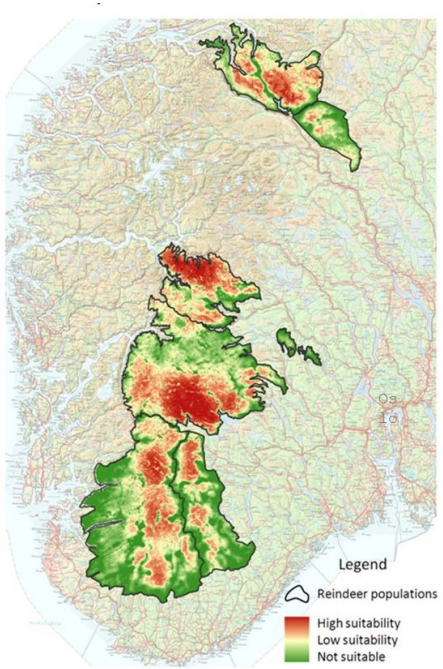
WP 1-2: "ECOLOGY"

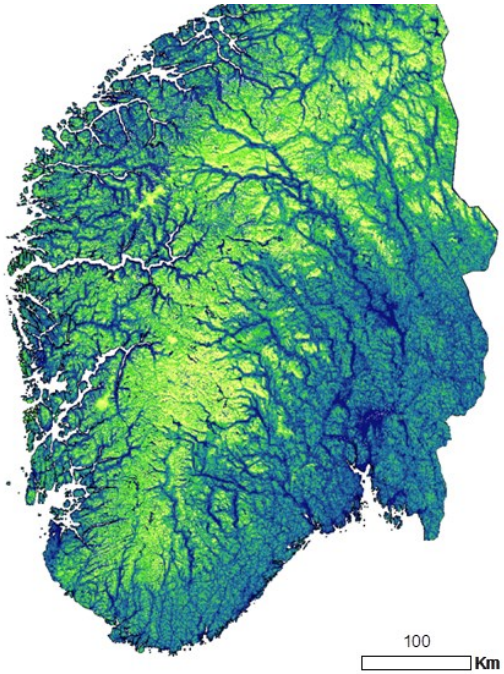
1. Model ***habitat suitability***, ***barriers and corridors*** to movements
2. Develop a novel ***Habitat Functionality*** metric synthesizing the cumulative effects of infrastructures in terms of *habitat loss* and *habitat fragmentation*

Habitat Functionality Metric

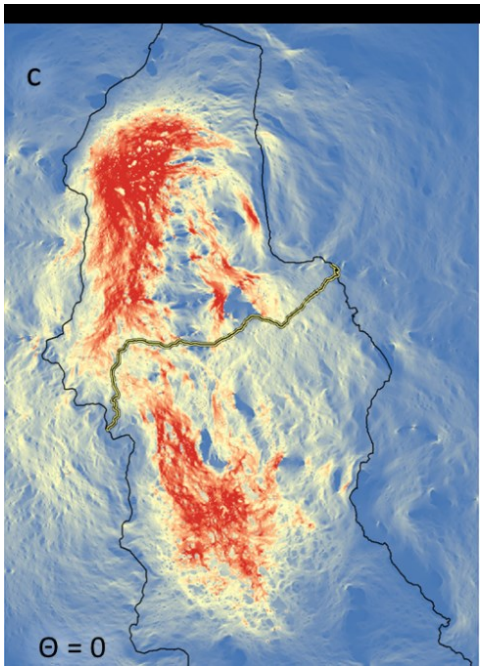
Habitat preference



Permeability to movements



Movement corridors



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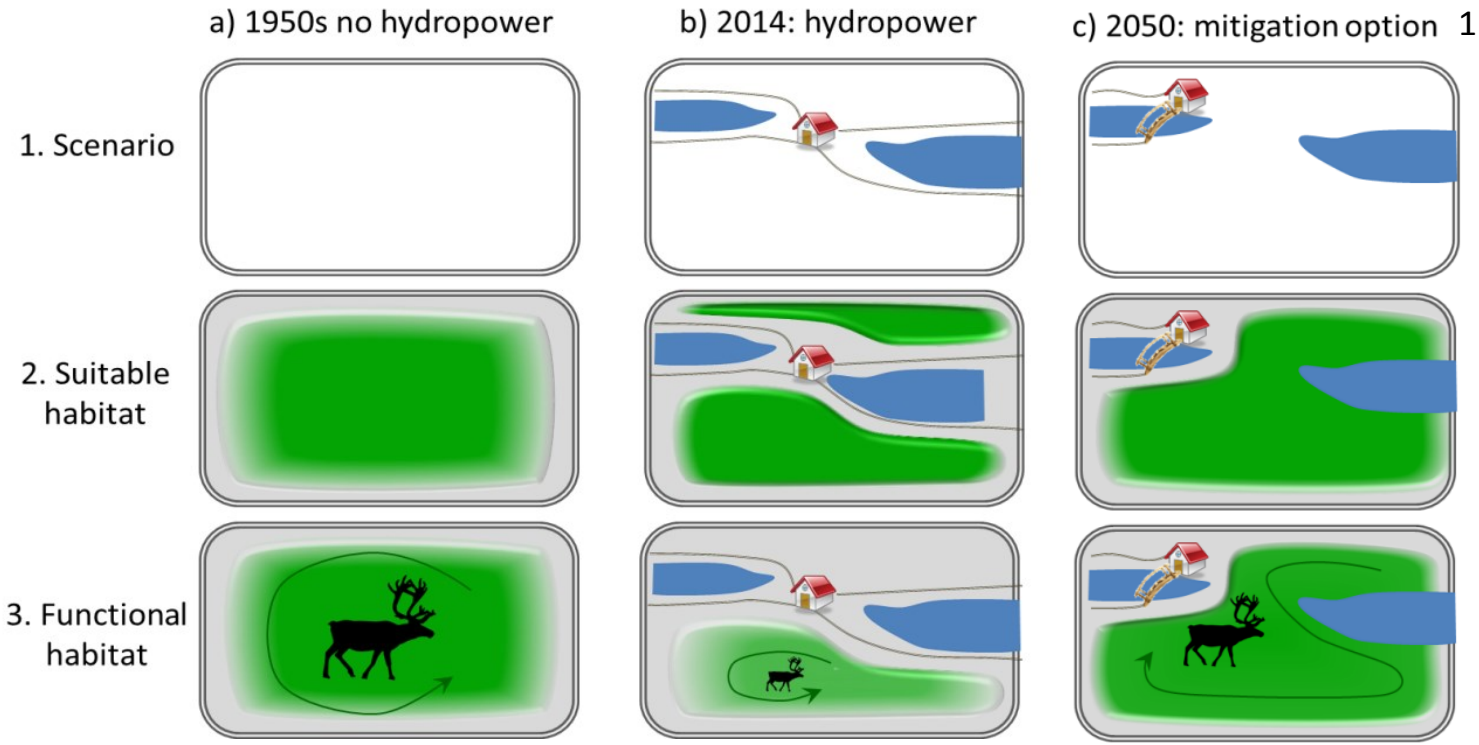
WP 1-2: "ECOLOGY"

1. Model ***habitat suitability***, ***barriers and corridors*** to movements
2. Develop a novel ***Habitat Functionality*** metric synthesizing the cumulative effects of infrastructures in terms of *habitat loss* and *habitat fragmentation*
3. Develop a ***simulation platform*** to predict the effects of mitigation/ land development on Hab. Function.
4. ***Rank mitigation options*** based on their sustainability (scenario approach)



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WP 3-4-5: "SOCIETY"

- Study areas: Setesday Ryfylke, Nordfjella, Snøhetta
- Create ***arenas for dialogue*** to maximize relevance of the models (*Companion Modelling Approach*), secure public engagement, promote social learning
- ***Scoping processes*** to facilitate dialogue, minimize conflict potential, and suggest a set of realistic mitigation options

- Make an ***inventory of laws and regulations*** influencing multilevel governance and suggest possibilities for improvements
- Outreach: training courses, seminars, handbooks, recommendations, and a *Support Centre for reindeer-oriented impact assessment*

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Project start:
14th Arctic Ungulate Conference, Røros 2015
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