RENEWABLE ENERGY & REINDEER

NEW APPROACHES TO QUANTIFY CUMULATIVE IMPACTS & AID SUSTAINABLE LAND PLANNING

NINA
Norwegian Institute for Nature Research

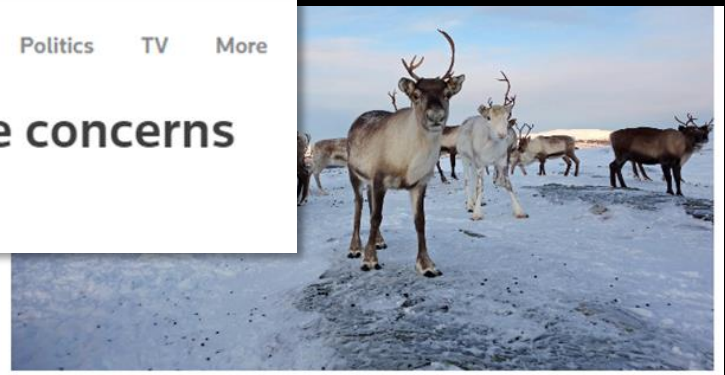
The Research Council of Norway

Manuela Panzacchi, Bram Van Moorter, Ilkka Kivimäki, Marco Særens,
Olav Strand, Audun Stien, Torkild Tveraa, Knut Langeland … & very many others

REUTERS

Business Markets World Politics TV More

Norway to build wind farm despite concerns of reindeer herders



Herding reindeer plays an important role in the Sami culture's income and diet. "I fear the government is taking more and more of our land," says herder Danel Oskal. "I'm afraid that in the future, there will be no more land for the reindeer."

NATIONAL GEOGRAPHIC

Dodging Wind Farms and Bullets in the Arctic

NRK Nyheter Sport Kultur Distrikt Mer

Reinbeitedistrikt går til kamp mot vindmøller

Fosen Vind vil bygge Europas største vindmøllepark i reinbeiteområde. Reinere vil det motsatte, og tirsdag starter en ti-dagers lang sak i skjønnsretten.

WIND More

'Naive wind industry could destroy our way of life'

Pulitzer Center

Reporting Education Reporting Gra

Stories Reporting Fellows Projects Issues E-Books Books

STORY

Wind Turbines or Reindeer—Do We Have to Choose?

November 21, 2017 | *PRI's The World*

THE NORDIC PAGE NORWAY

HOME PANORAMA ECONOMY POLITICS CULTURE TRAVEL EXCLUSIVE MULTIMEDI

Norway's Controversial Wind Turbine Plans and Mining Put Nature and Sami Community at Risk

Business & Human Rights Resource Centre

Norway to build wind farm despite UN calls to suspend project over concerns of impact on indigenous herders' livelihoods

Fosen-samene tapte skjønnsrettssaken om Storheia-utbyggingen

Adresseavisen

NATIONEN

Vindkraft truer villreininteresser

Views and News from Norway

Sami protest windmill project

NORTHERN PEOPLE & HEALTH ARTICLES GENERAL

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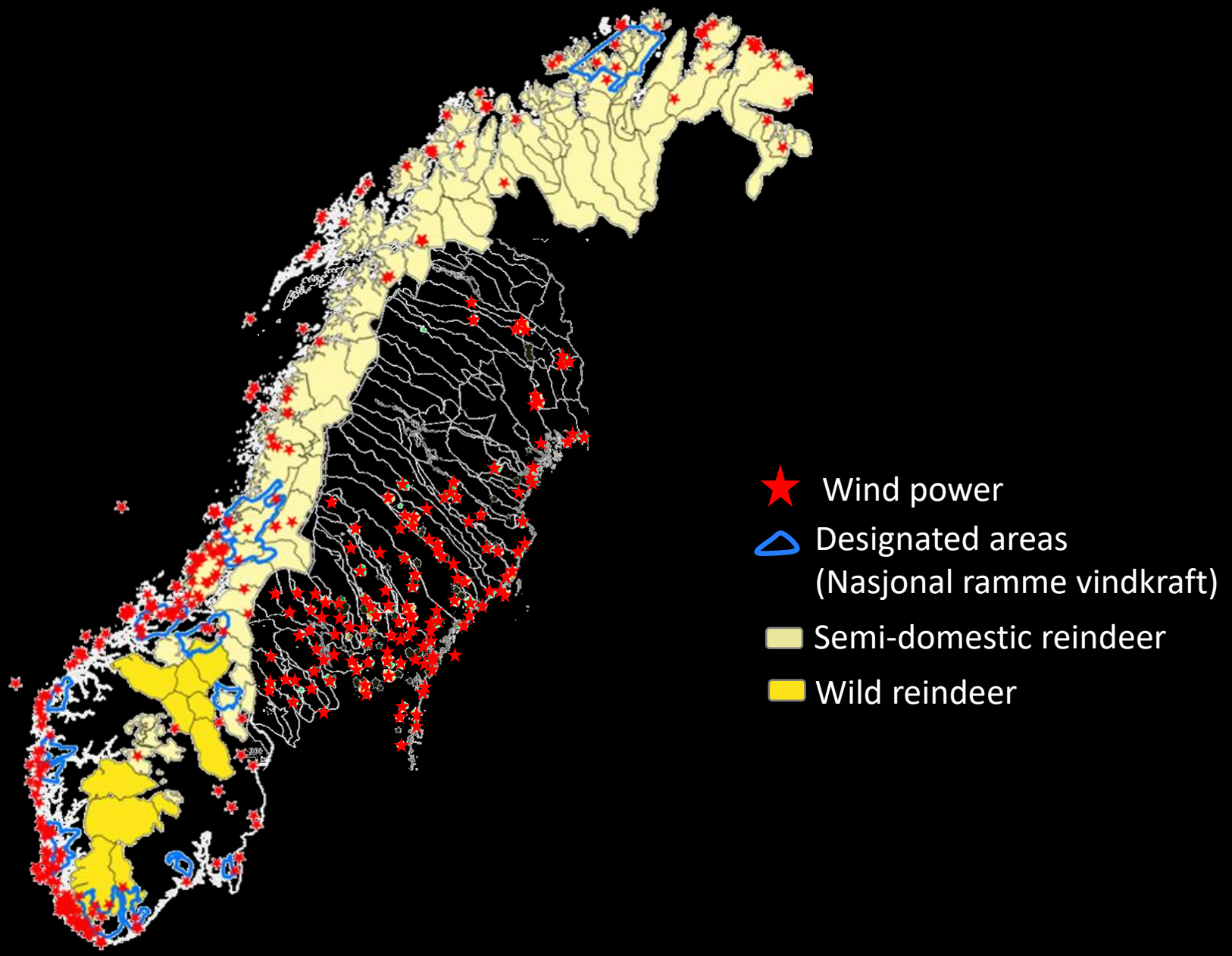
Saami Reindeer Herders Fight Wind Farm Project

Aftenposten A-magasinet Osloby Sport Meninger

What does science say about it?



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NINA Rapport

Vindkraft og reinsdyr

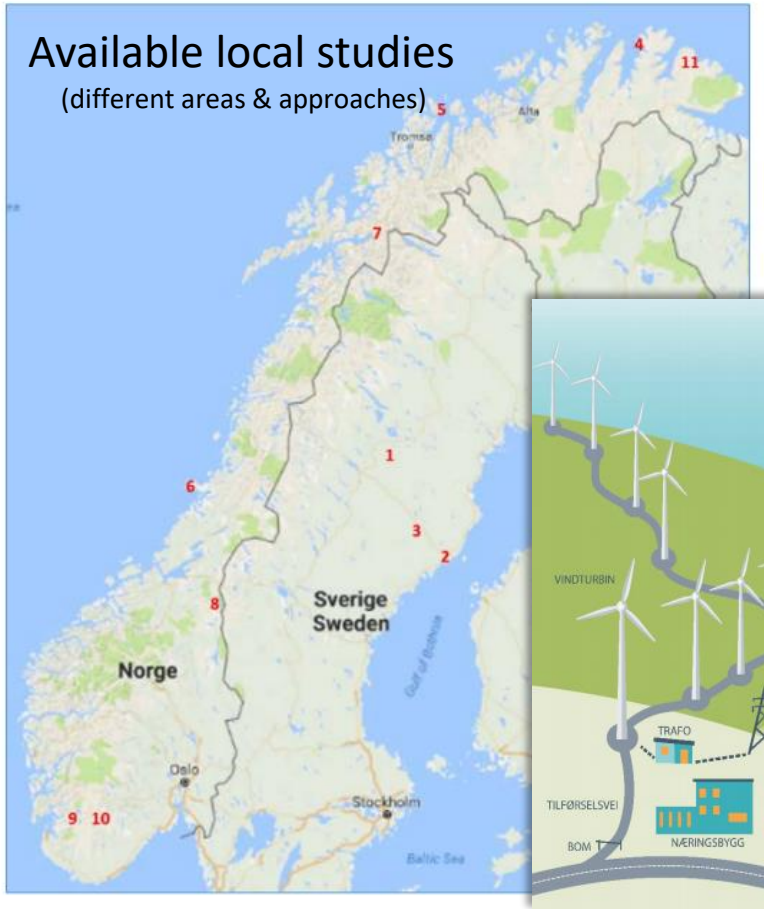
- En kunnskapssyntese

Olav Strand, Jonathan E. Colman, Sindre Eftestøl, Per Sandström, Anna Skarin og Jørn Thomassen

NINA

Available local studies

(different areas & approaches)



***Figur 2**. Geografisk plassering over de enkelte studiene på effekter av vindkraft på tamrein som er gjengitt i denne rapporten. 1. Storliden og Jokkmokksliden, 2. Gabrielsberget, 3. Stor-Rotliden, 4. Kjøllefjord, 5. Fakken, 6. Vikna, 7. Nygårdsfjellet. 8. Essand. 9. Setesdalen vest. 10. Setesdalen aust. 11. Varangerhalvøya Raggovidda. Se også **tabell 1**.*

3.5 Reindriftas erfaringer med vindkraftanlegg

SYNTHESIS OF 11 LOCAL STUDIES (DIFFERENT APPROACHES & SPATIAL-TEMPORAL SCALES)

- **Construction phase**

  Large consensus:
  - Area avoidance, especially during calving
  - Impact on movements / migration

- **Operation phase**

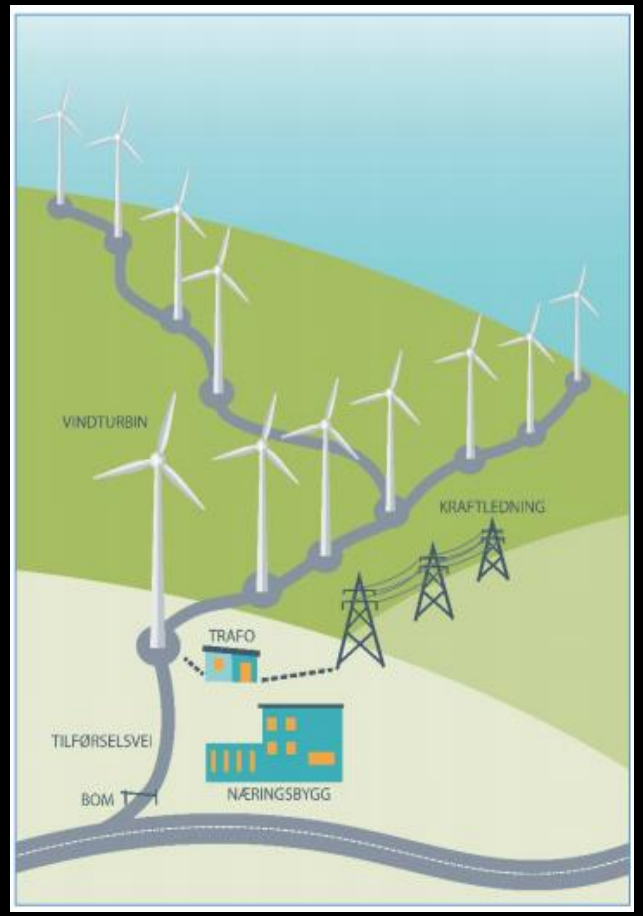
  Range of effects detected:
  - Strong area avoidance, Impact on movements / migration, Reduced feeding time (due to human activity, visual / acoustic impact, ice falling)
  - Only weak effects

- **Roads:**

  Consensus, but effect size vary:
  - Area avoidance, habitat degradation, Can hinder movements / block migrations

- **Powerlines:**

  Range of effects detected:
  - Avoidance – due to disturbance & “Corona effect” (noise and UV light)
  - Weak or no effects detected

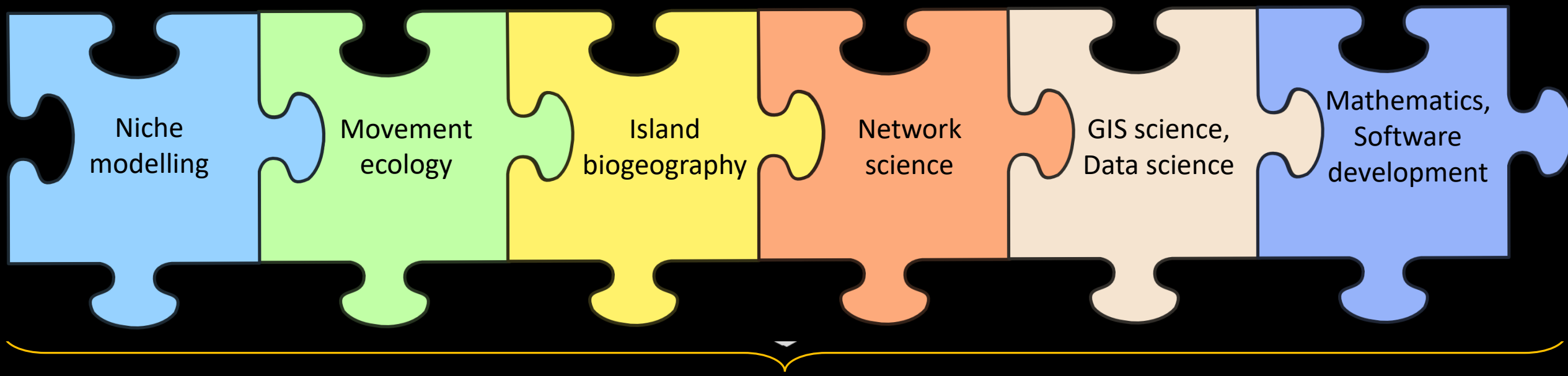


REPORTS' CONCLUSIONS:

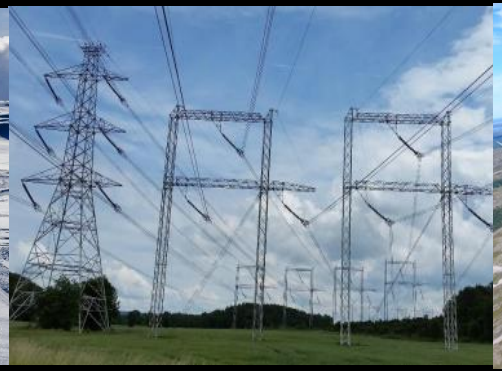
«There is *no doubt* that wind farms and related infrastructure impact reindeer space use, grazing and movements. But the magnitude depends on local conditions - all infrastructures, food availability, population density, climate etc …"

If we want to properly quantify, prevent and/or mitigate damages, it is crucial to assess

CUMULATIVE IMPACTS at LARGE SPATIAL & TEMPORAL SCALES



Cumulative Impacts

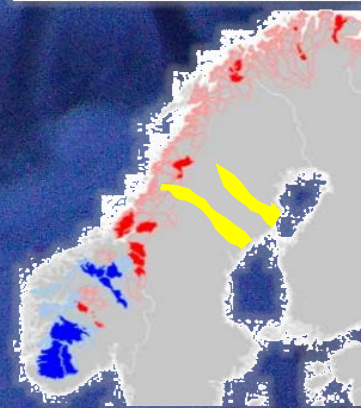




Sustainable Land Planning

- *RENEWABLE REINDEER* (NFR - 2015-20)
- *PROD CHANGE* (NFR - 2017-20)
- *ONE IMPACT* (NFR - 2020-24)

- Focus: cumulative impacts
- Both wild and semi-domestic reindeer
- Norway & Sweden

- *Collaboration with SLU - Vindval*
- *many local projects*



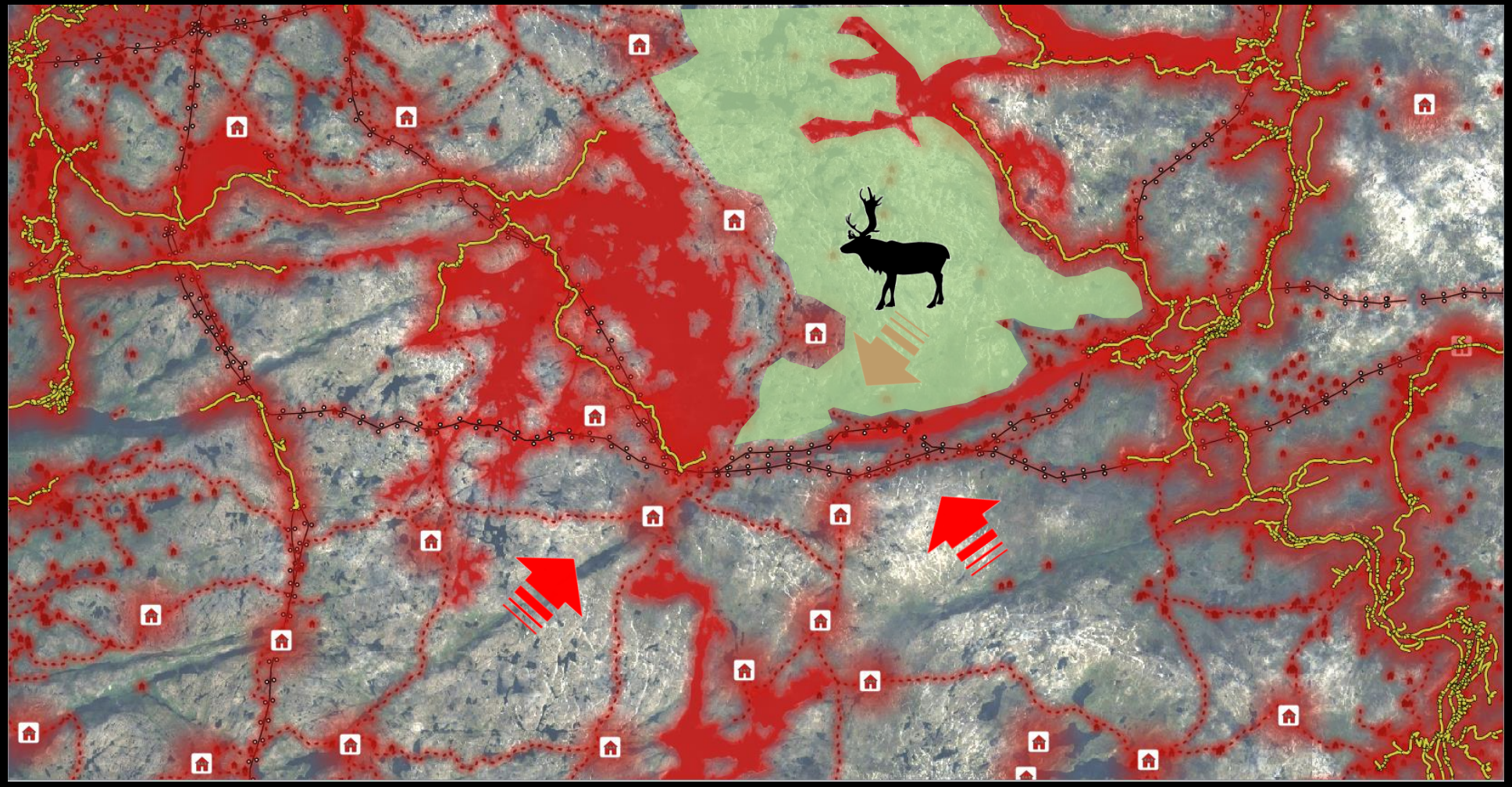
Calculate impact of EACH driver on

HABITAT LOSS

FRAGMENTATION

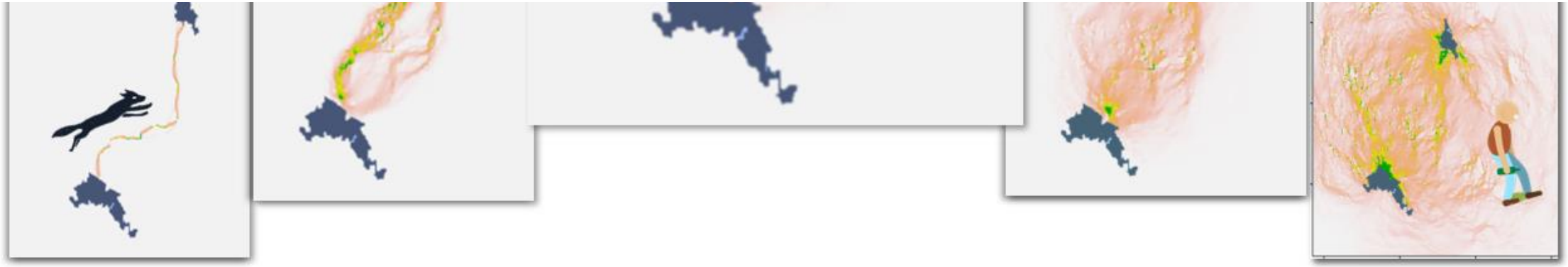
CUMULATIVE IMPACT on **FUNCTIONAL HABITAT**

AID SUSTINABLE LAND PLANNING
Simulate impact of planned infrastructures, mitigations, off-set measures



RANDOMIZED SHORTEST PATH ALGORITHM

$$HF(s) = Q(s) \times \int_{\Omega} Q(t) \times Prox(s,t)\,\mathrm{d}t$$



WORKFLOW

SPECIES	HABITAT	CLIMATE - WEATHER	LAND USE & INFRASTRUCTURES	BIOTIC INTERACTIONS
• Locations	• Vegetation	• T, precipitation	• Road, railway, forestry	• Competition
• Movements	• Topography	• Icing	• Renewable energy	• Predation
• Life history	• Trophic res..	• Extreme events...	• Tourism..	• Parasites..

HABITAT QUALITY / LOSS

Preferred

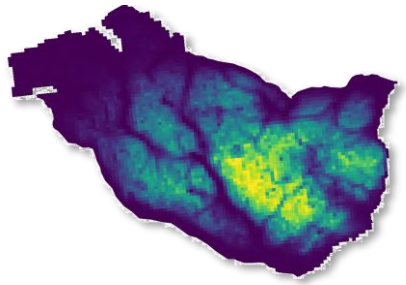
Avoided

HABITAT PERMEABILITY / FRAGMENTATION

Easy to traverse

Barrier

GOOD & WELL CONNECTED HABITAT



FUNCTIONAL HABITAT

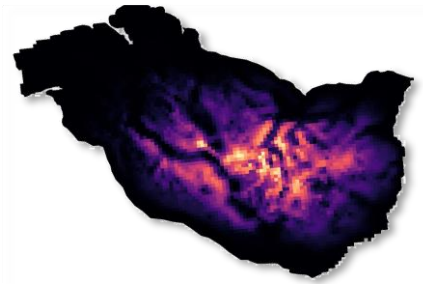
Good & well connected (Green Infrastructures)

Poor quality / connectivity

CORRIDORS

High probability of movement

Little movement



SUSTAINABLE LAND MANAGEMENT

- SCENARIOS: predict impact of planned infrastructures / land use changes / climate changes
- PRIORITY AREAS FOR CONSERVATION / RESTORATION

Example on wild reindeer

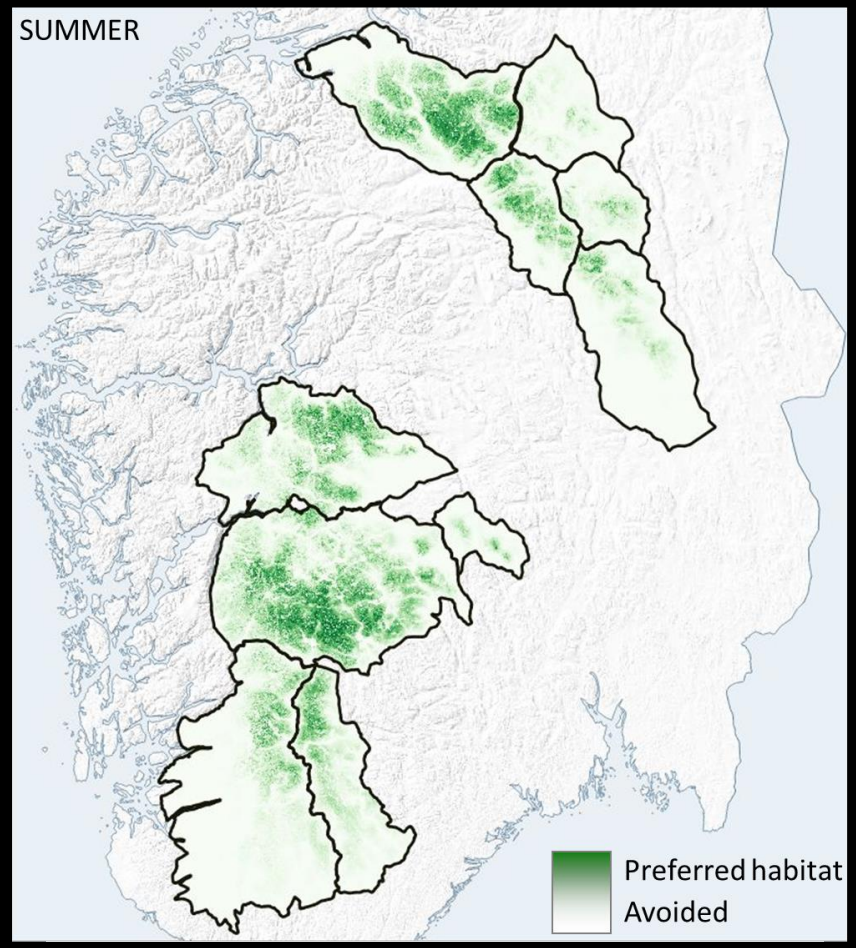
(analyses for semi-domestic reindeer ongoing)

Step 1 – calculate habitat quality & permeability

Habitat quality / loss

Resource Selection Probability Functions

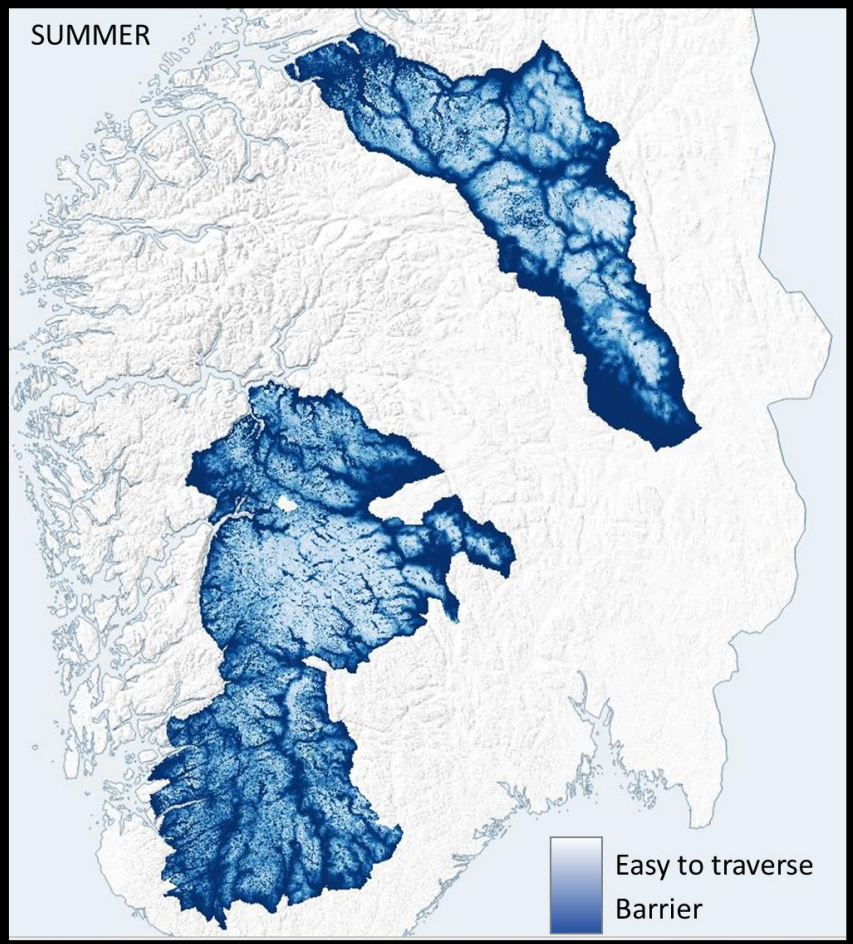
(see Panzacchi v an Moorter et al 2015)



Habitat Permeability / Fragmentation

Step Selection Probability Functions

(Panzacchi et al JAE 2016)

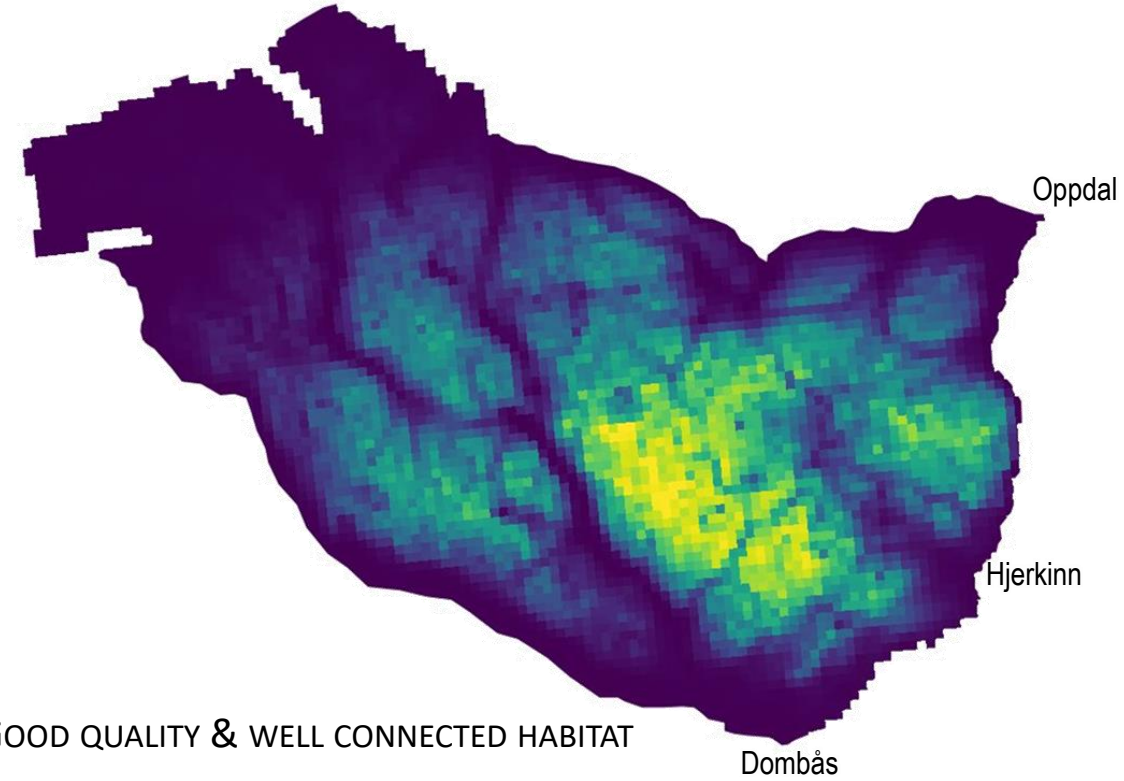


Step 2 – calculate connectivity

Habitat prEference

Habitat permeability

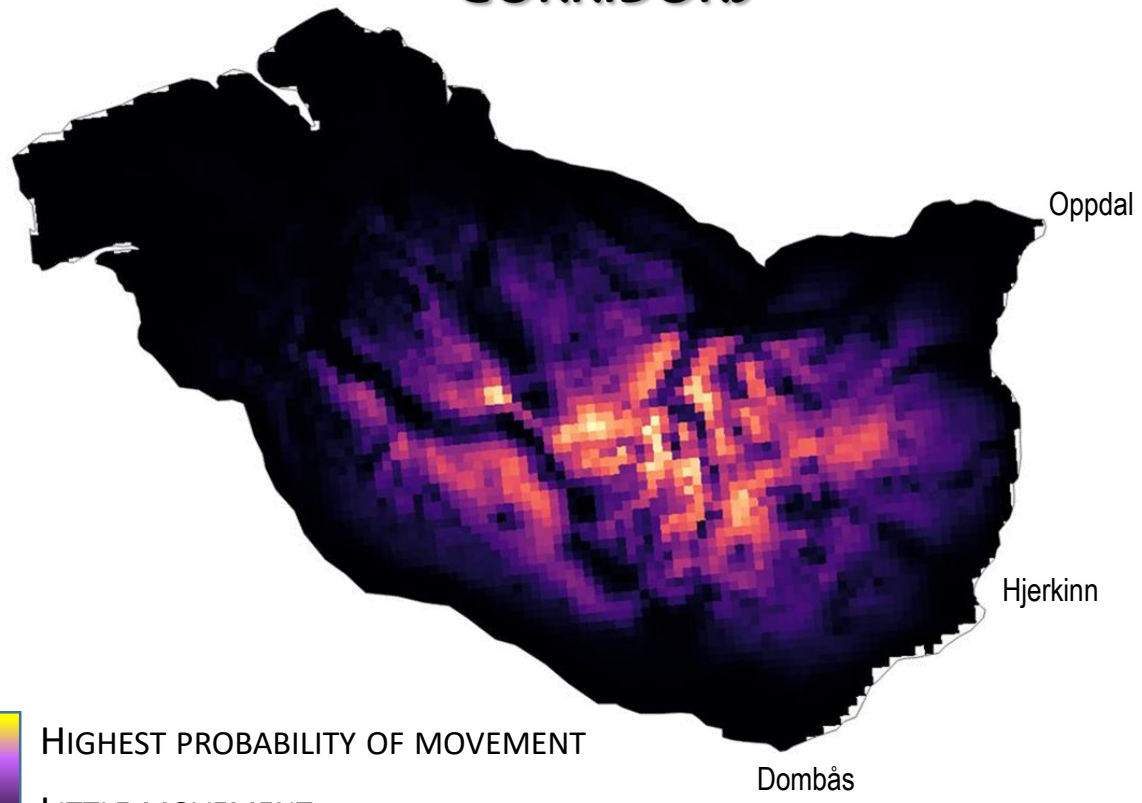
Functional Habitat



Good quality & well connected habitat

Poor quality / connectivity

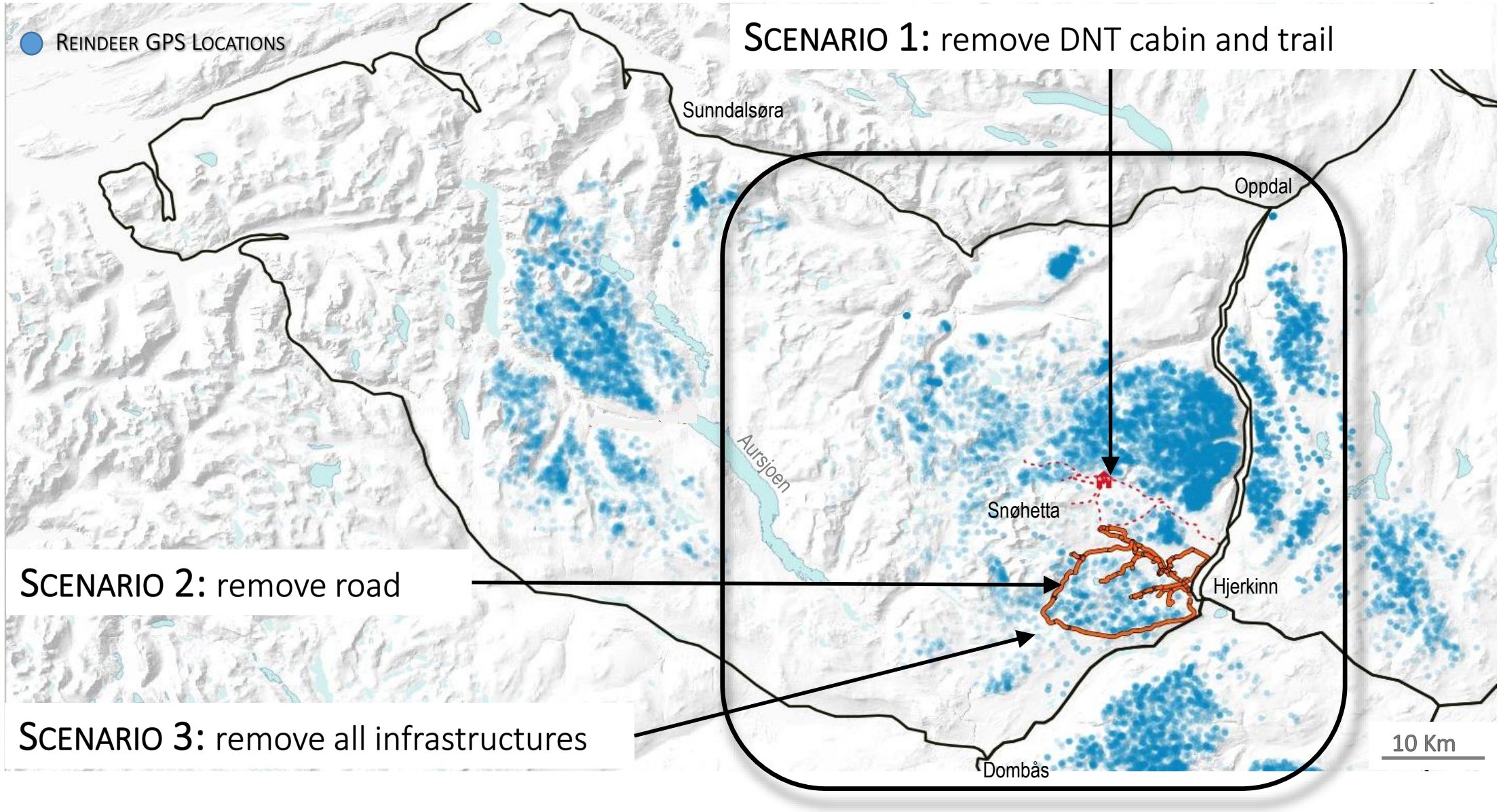
Corridors



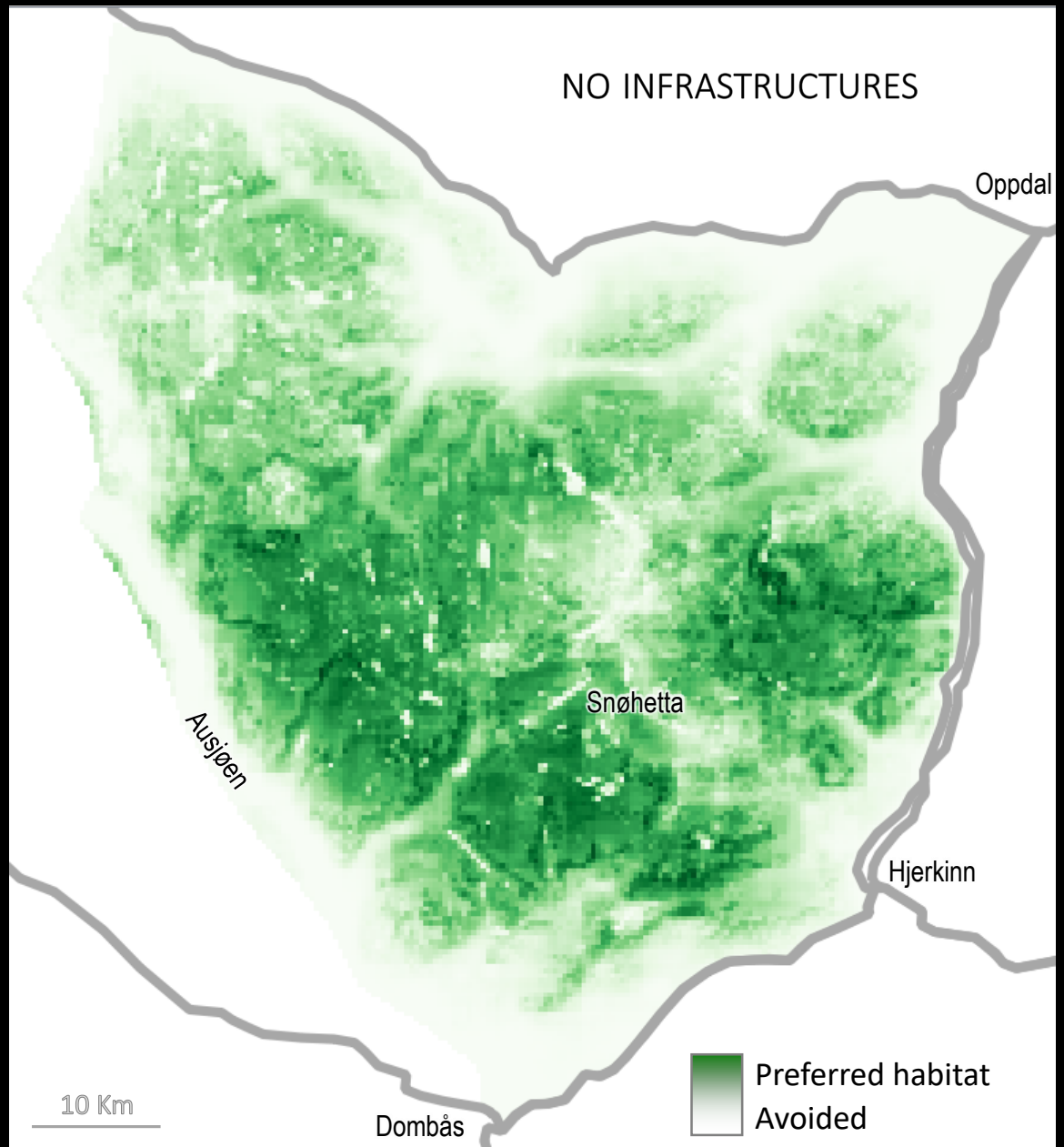
Highest probability of movement

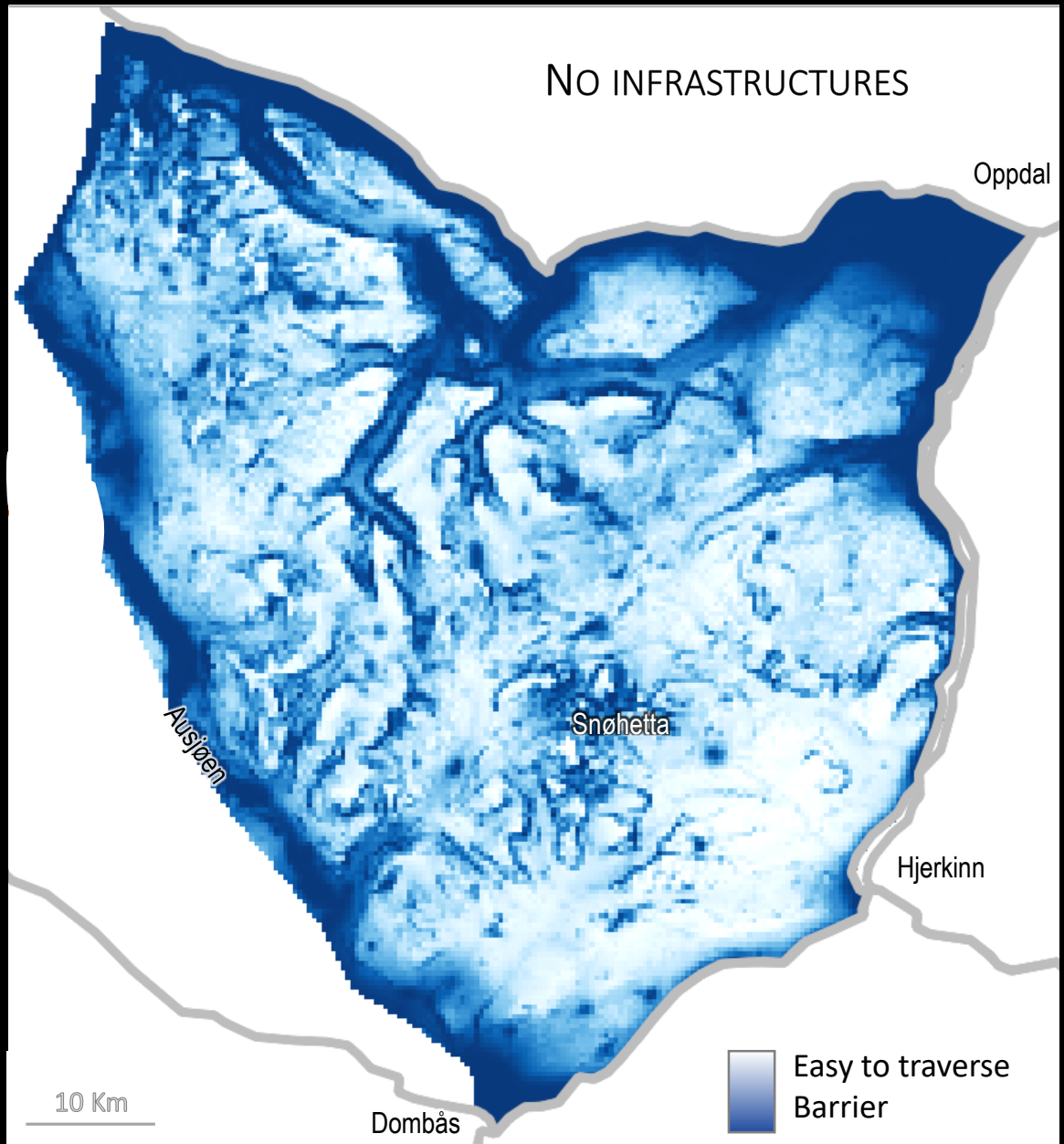
Little movement

STEP 3: SIMULATE THE EFFICACY OF MITIGATION MEASURES



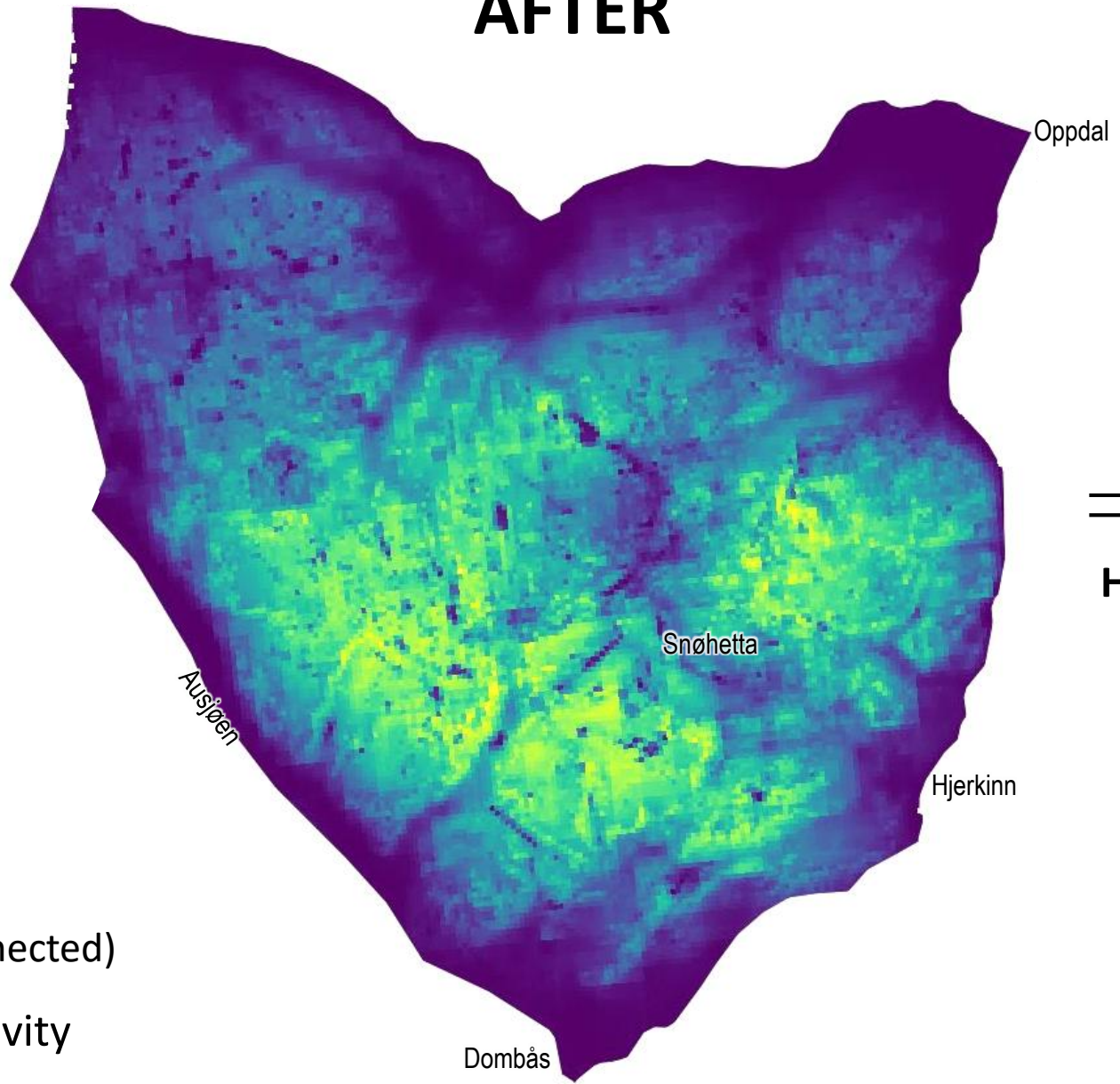
SCENARIO 3: REMOVE ALL INFRASTRUCTURES





SCENARIO 3: HABITAT FUNCTIONALITY

AFTER



Functional habitat
(good quality & well connected)

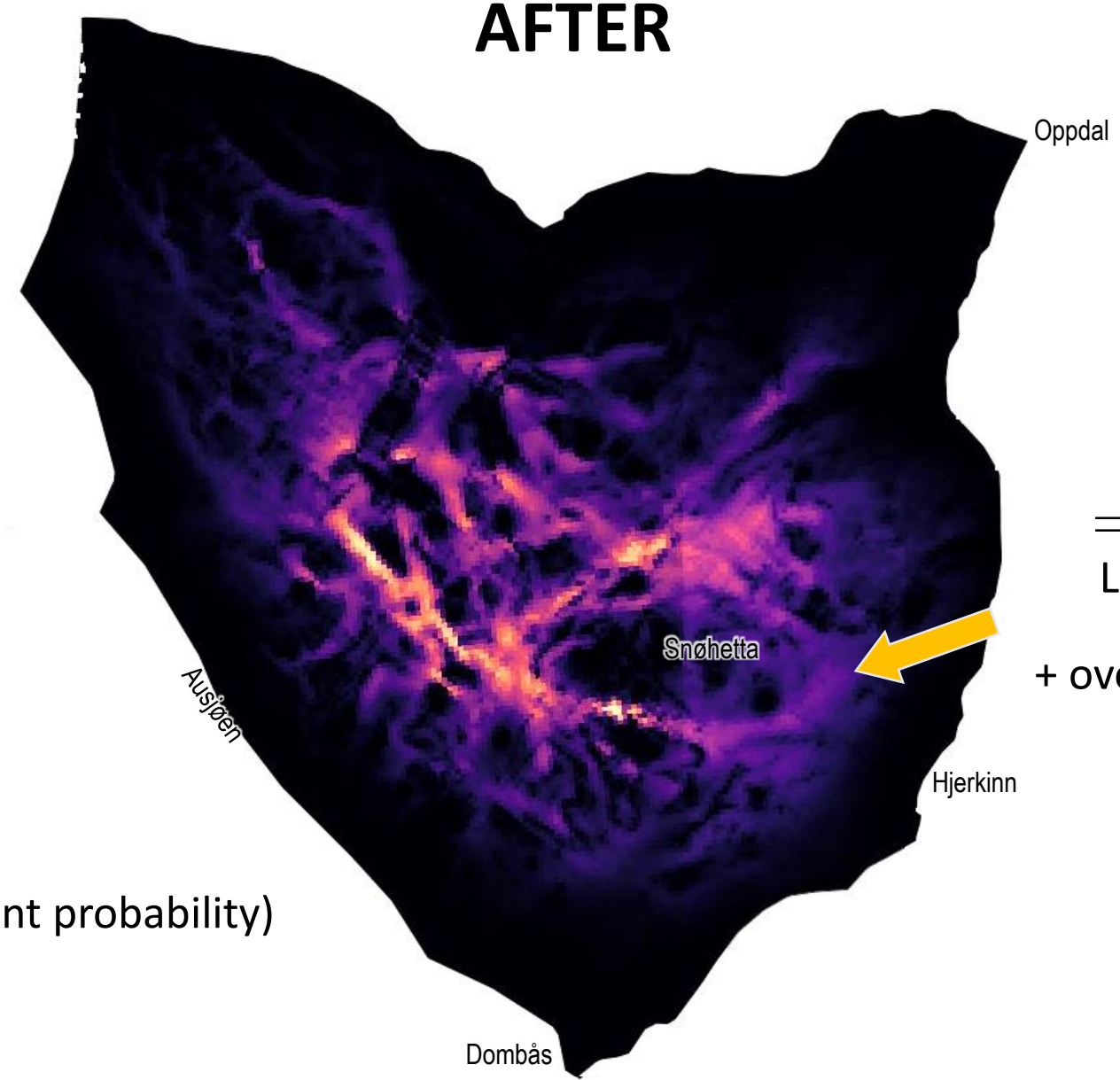
Poor quality / connectivity

⇒ 19 % INCREASE

HABITAT FUNCTIONALITY

Scenario 3: Movement Flow

AFTER



⇒ RE-ESTABLISHMENT OF LOST MOVEMENT CORRIDOR

+ overall increase in connectivity in the entire area

Corridor (high movement probability)

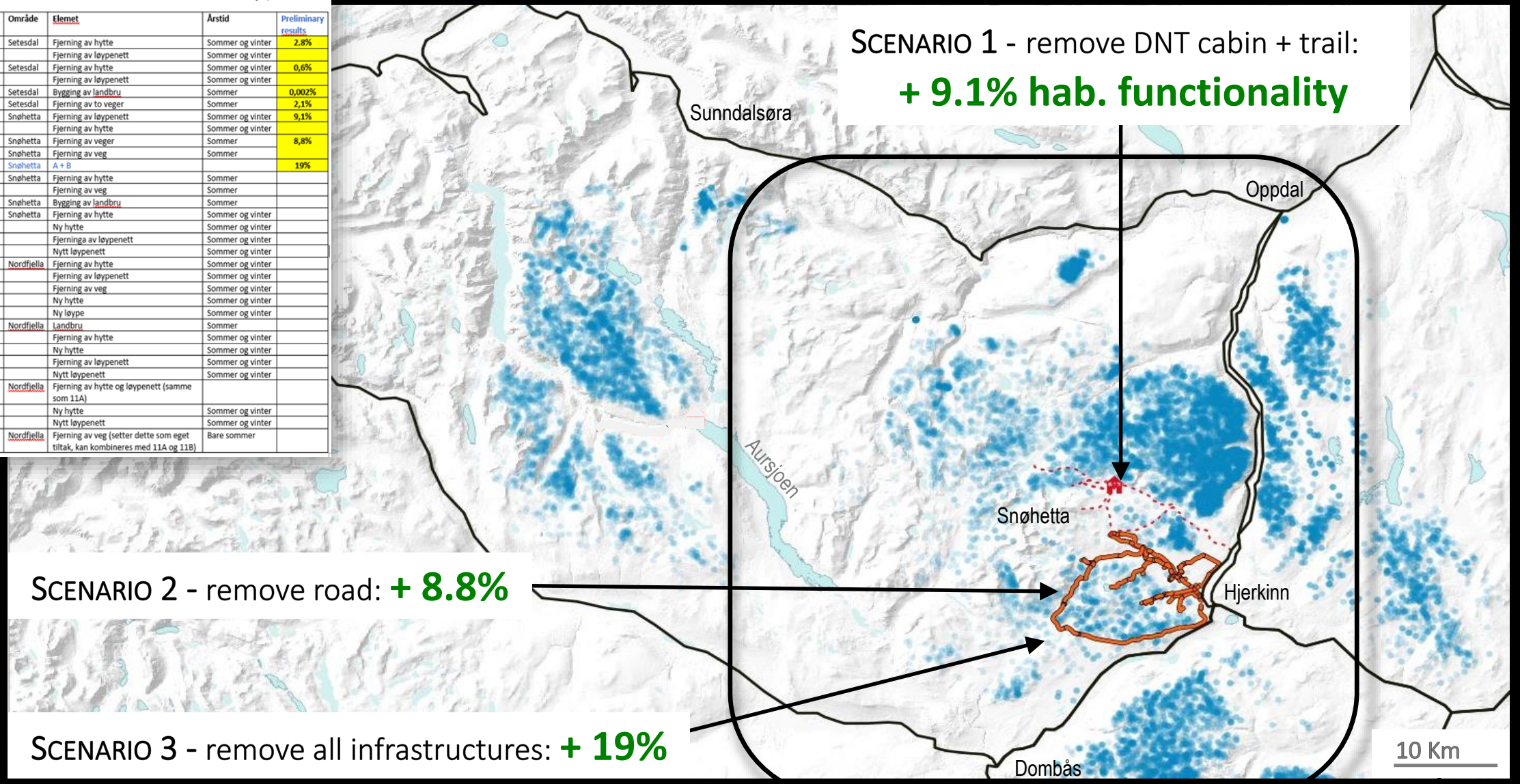
Little movement flow

Cumulative Impacts on Functional Habitat

EXAMPLE OF RESULTS - SNØHETTA

List of mitigation to test (several areas in Norway)

Tiltak	Område	Elemet	Årstid	Preliminary results
1 Brokke suleskard	Setesdal	Fjerning av hytte	Sommer og vinter	2.8%
		Fjerning av løypenett	Sommer og vinter	
2Blåsjø	Setesdal	Fjerning av hytte	Sommer og vinter	0,6%
		Fjerning av løypenett	Sommer og vinter	
3 Svartevassmagasinet	Setesdal	Bygging av landbru	Sommer	0,002%
4 Store Urar	Setesdal	Fjerning av to veger	Sommer	2,1%
5 A Snøhetta	Snøhetta	Fjerning av løypenett	Sommer og vinter	9,1%
		Fjerning av hytte	Sommer og vinter	
5B Snøhetta	Snøhetta	Fjerning av veger	Sommer	8,8%
5C Snøhetta	Snøhetta	Fjerning av veg	Sommer	
5D Snøhetta	Snøhetta	A + B		19%
6 Aursjøen	Snøhetta	Fjerning av hytte	Sommer	
		Fjerning av veg	Sommer	
7 Gåsbu	Snøhetta	Bygging av landbru	Sommer	
8 Reinsvatnet	Snøhetta	Fjerning av hytte	Sommer og vinter	
		Ny hytte	Sommer og vinter	
		Fjerninga av løypenett	Sommer og vinter	
		Nytt løypenett	Sommer og vinter	
9 Geitryggen	Nordfjella	Fjerning av hytte	Sommer og vinter	
		Fjerning av løypenett	Sommer og vinter	
		Fjerning av veg	Sommer og vinter	
		Ny hytte	Sommer og vinter	
		Ny løype	Sommer og vinter	
10 Kvevatnet	Nordfjella	Landbru	Sommer	
11 A Nyhellervatnet		Fjerning av hytte	Sommer og vinter	
		Ny hytte	Sommer og vinter	
		Fjerning av løypenett	Sommer og vinter	
		Nytt løypenett	Sommer og vinter	
11B Nyhellervatnet	Nordfjella	Fjerning av hytte og løypenett (samme som 11A)		
		Ny hytte	Sommer og vinter	
		Nytt løypenett	Sommer og vinter	
11C Nyhellervatnet	Nordfjella	Fjerning av veg (setter dette som eget tiltak, kan kombineres med 11A og 11B)	Bare sommer	

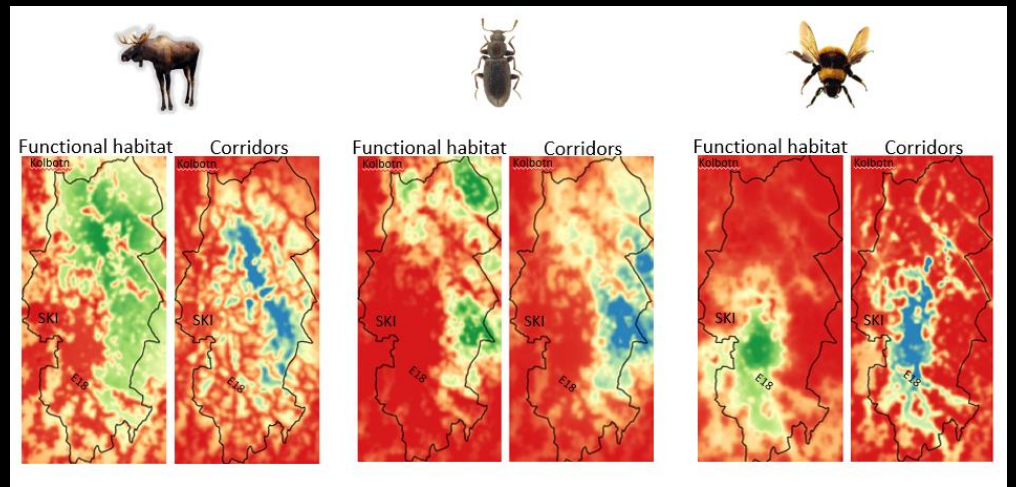


CONCLUSIONS: ASSESSING CUMULATIVE IMPACTS IS CRUCIAL

THIS APPROACH WILL BE USED IN UPSTARTING REINDEER PROJECTS TO TEST IMPACT OF:

- National Development Strategies / planned infrastructures:
- Changes in human activities (e.g. increased tourism / traffic)
- Climate changes
- Mitigation measures / offset measures

THIS APPROACH CAN BE USED TO SUPPORT SUSTAINABLE LAND PLANING FOR ALL MUNICIPALITIES IN NORWAY



Thank you

Thanks to countless collaborators, stakeholders, fieldworkers, volunteers, students, funding sources.

https://www.nina.no/Renewable-Reindeer