IS IT POSSIBLE TO RECONCILE CONSERVATION WITH HUMAN ACTIVITIES & DEVELOPMENT?

one of the greatest challenges for wildlife researchers and managers worldwide

Manuela Panzacchi

Bram Van Moorter, Vegard Gundersen, Olav Strand.. and many others

NINA
Norwegian Institute for Nature Research

Strategies for Sustainable Development & Conservation

of the last remaining populations of

Wild Mountain Reindeer

Manuela Panzacchi

Bram Van Moorter, Vegard Gundersen, Olav Strand, Per Jordhøy et al.

The Research Council of Norway

With funding from
The Research Council of Norway

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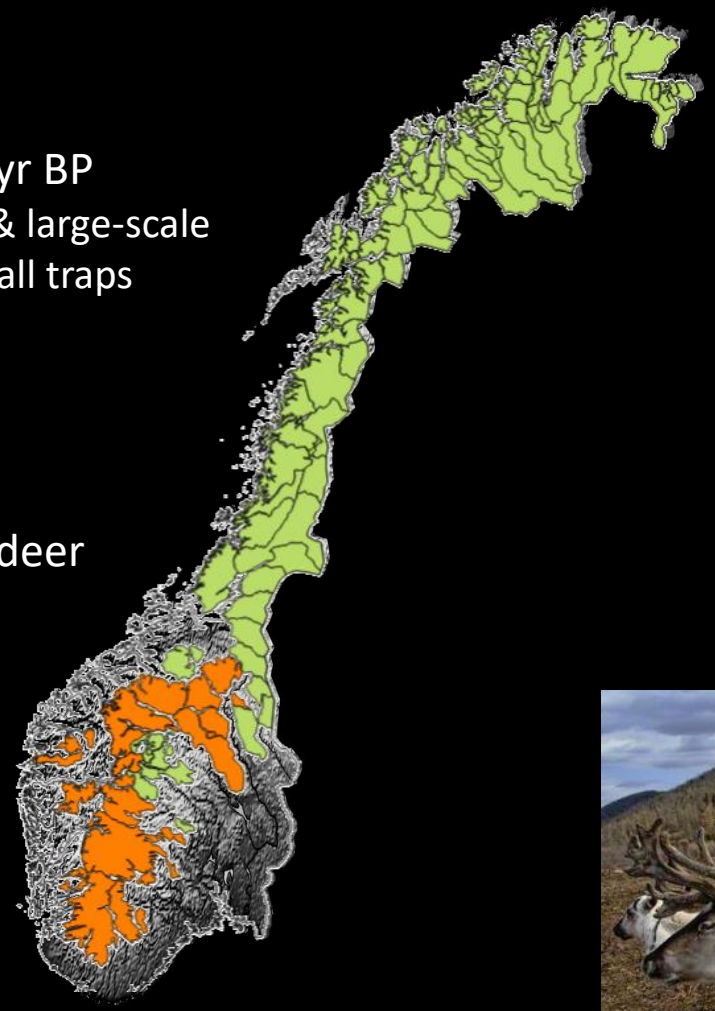
QUICK HISTORY OF REINDEER IN NORWAY

8.000-450 yr BP
Hunting in Corrals & large-scale systems of pitfall traps



Semi-domestic reindeer

Wild reindeer

1900: overharvest

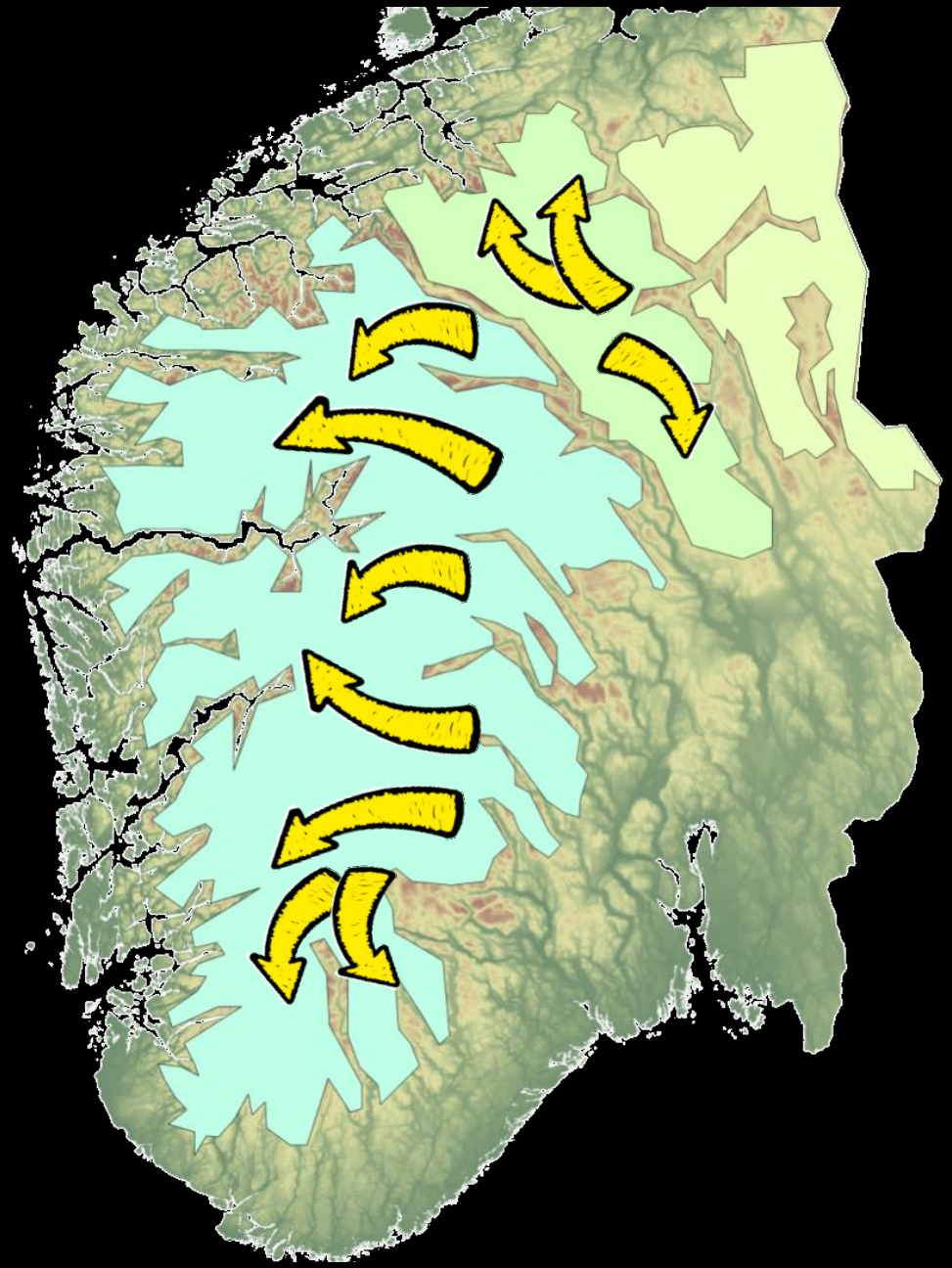
=> protection

O. Strand

12.500 yr BP
Blomvåg – Bergen

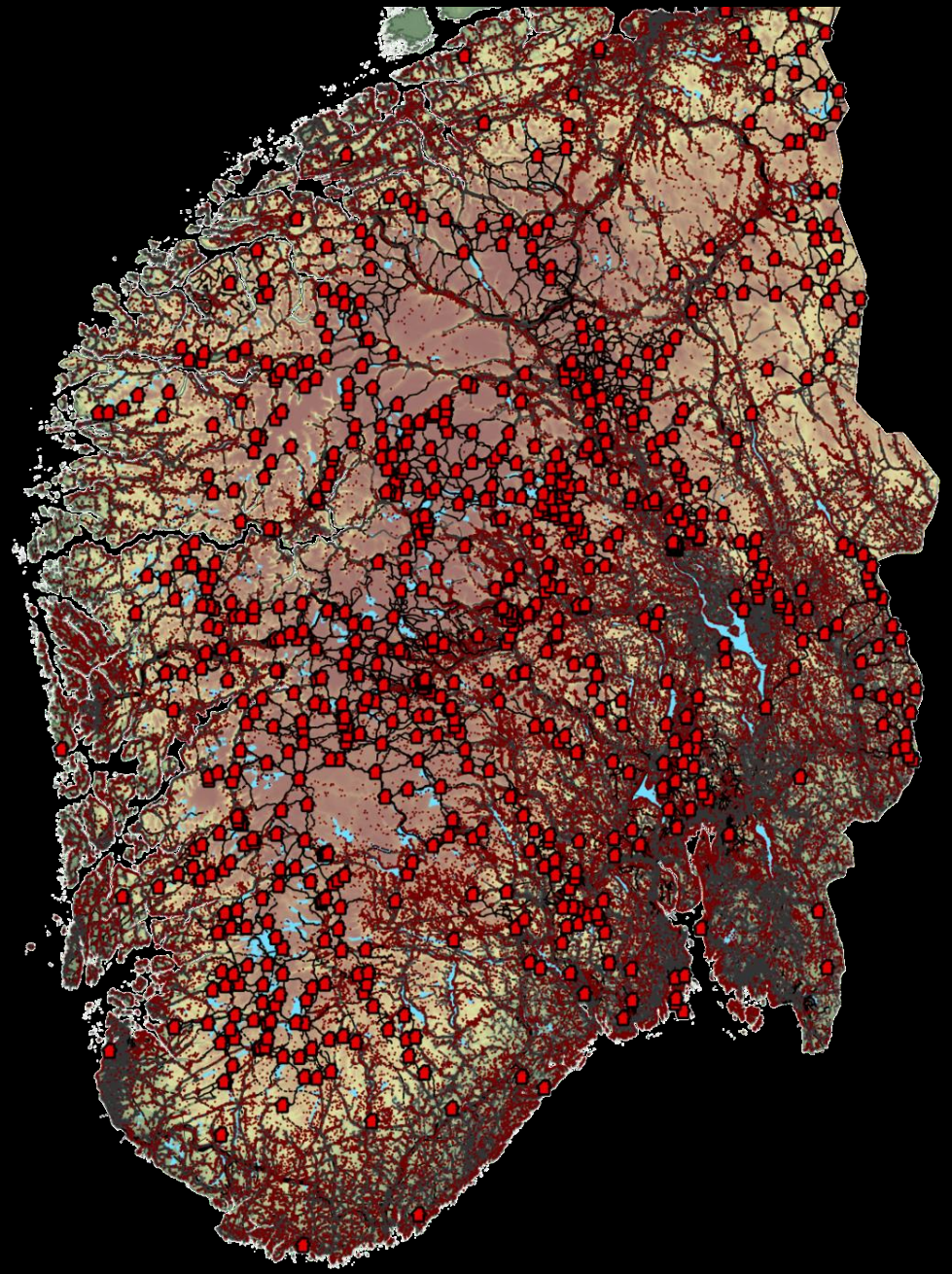
Now: very high cultural, symbolic, economic, conservation value. Conflicts with human development

WILD REINDEER RANGE AND MIGRATION UNTIL CA. 1900



- Few interbreeding populations
- Migrations

LANDSCAPE DEVELOPEMNT SINCE 1900

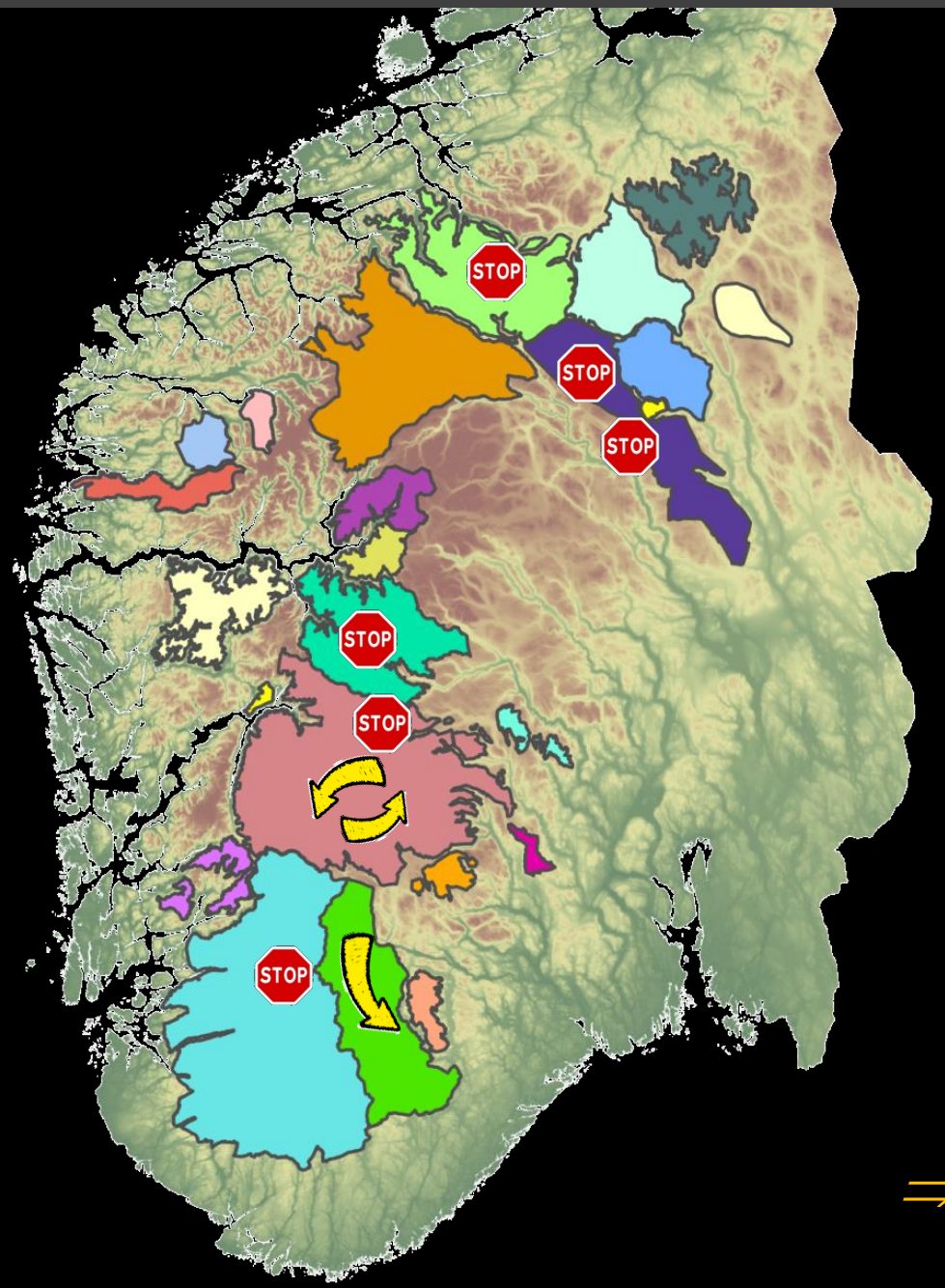


- Major roads
- Railways
- Hydropower stations
- Power lines
- Minor roads
- Tourist cabins
- Private cabins
- Trails
- … snow scooter, skiing, snowkyting, fishing..

HABITAT BECAME RAPIDLY FRAGMENTED

RANGE CA. 1900

NOW



- 23 isolated sub-populations (or more)
- Fragmentation rapidly ongoing
- Few (?) migrations left

Last remaining populations in Europe

⇒ *international responsibility for conservation*

HOW CAN REINDEER & HUMANS COEXIST IN A MULTI-USE LANDSCAPE?

Reindeer are shy..

HOW CAN REINDEER & HUMANS COEXIST IN A MULTI-USE LANDSCAPE?

Option 2: Share space through zonation, sustainable land planning, try to segregate in time

This requires partcipatory processes based upon robust **ECOLOGICAL KNOWLEDGE**:

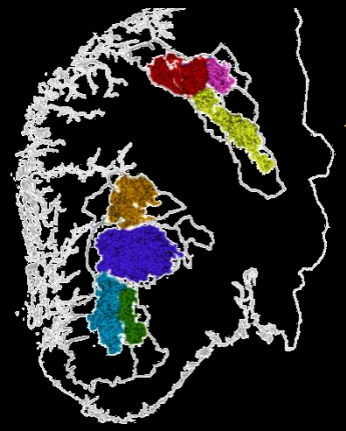
- Single and cumulative impact of infrastructures
- Tolerance thresholds of reindeer to disturbance
- Location of important habitat and movement corridors

PREDICT reindeer behaviour in a scenario approach

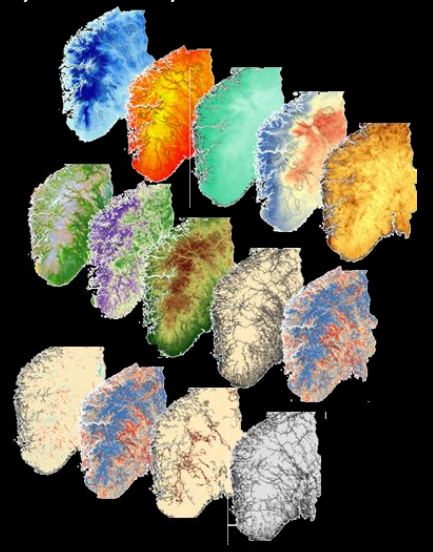
Develop tools to aid sustainable **LAND-PLANNING, ZONATIONS, MITIGATIONS MEASURES..**

HOW WE WORK

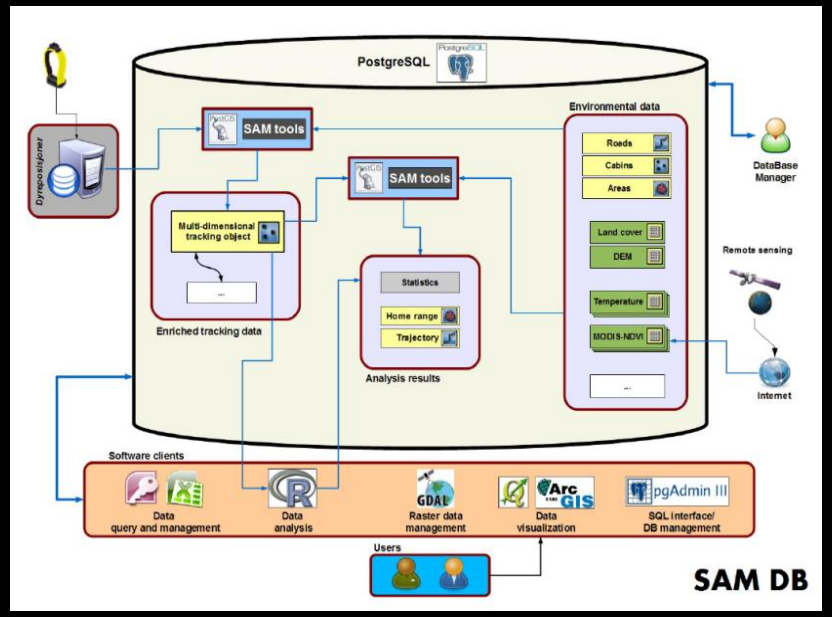
Reindeer movement (GPS) and fitness data



Climate, Habitat, infrastructures..



Spatial database



Cagnacci & Urbano 2015

Output pane

Data Output | Explain | Messages | History

	animals_id integer	acquisition_time timestamp without time zone	longitude double precision	latitude double precision	the_geom geometry	x_utm32 integer	y_utm32 integer	reindeer_areas_id integer	sun_angle double precision	altitude_dem_25 integer	temperature_nve double precision	closest_cabin integer	lc_norut integer
1	43	2008-01-01 00:00:50	8.114352	60.19383	01010000	450891	6673327	3	-52.5105	1187	2547	854	14
2	43	2008-01-01 03:00:44	8.116049	60.195748	01010000	450988	6673540	3	-38.2023	1216	2546	821	14
3	43	2008-01-01 06:00:43	8.123135	60.196081	01010000	451381	6673571	3	-16.3138	1244	2546	1180	17
4	43	2008-01-01 09:00:41	8.12218	60.195436	01010000	451327	6673500	3	1.66246	1223	2546	1150	14
5	43	2008-01-01 12:00:44	8.126824	60.198916	01010000	451590	6673884	3	6.61718	1243	2546	1347	14
6	43	2008-01-01 15:00:41	8.129531	60.201478	01010000	451744	6674168	3	-3.60621	1234	2546	1417	14
7	43	2008-01-01 18:00:25	8.143045	60.20729	01010000	452501	6674805	3	-23.9792	1163	2546	429	17

WHAT HAVE WE LEARNED?

very simplified version: wild reindeer tend to avoid all sources of human disturbance

However, the devil is in the details! Reindeer response to disturbance depends on...

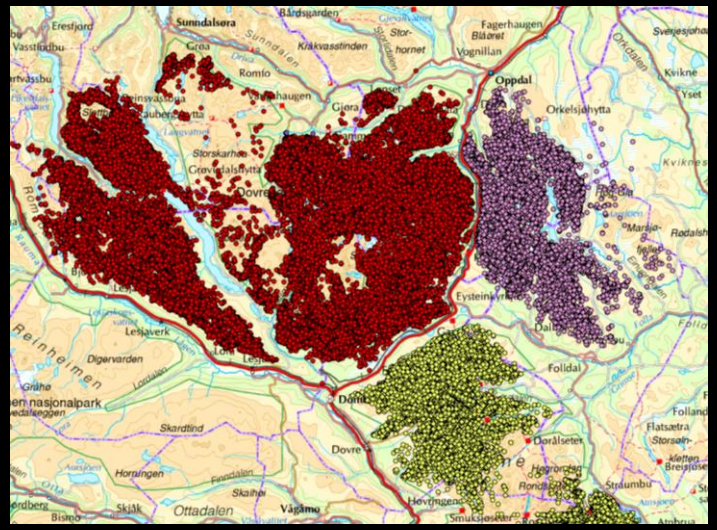
1. TYPE OF DISTURBANCE

ROADS - LARGELY CONSTRAIN REINDEER SPACE USE

⇒ Strongly avoided in all seasons and areas, up to:

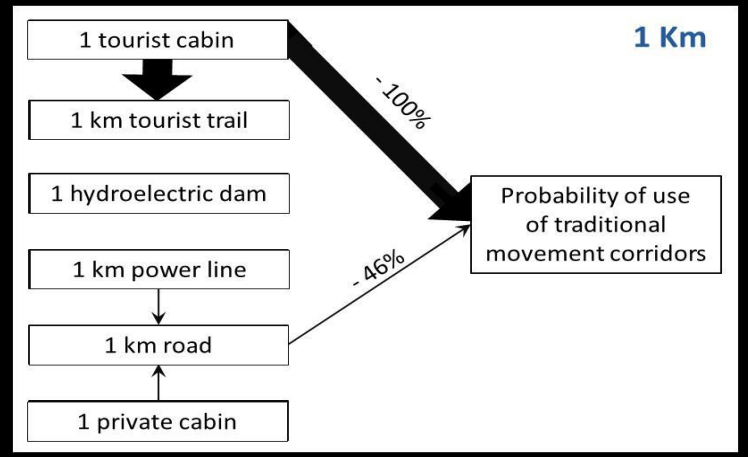
- 10-15 km - public roads
- 1 – 5 km - private roads

⇒ Reduce landscape permeability of 44-100%
⇒ Hamper migration



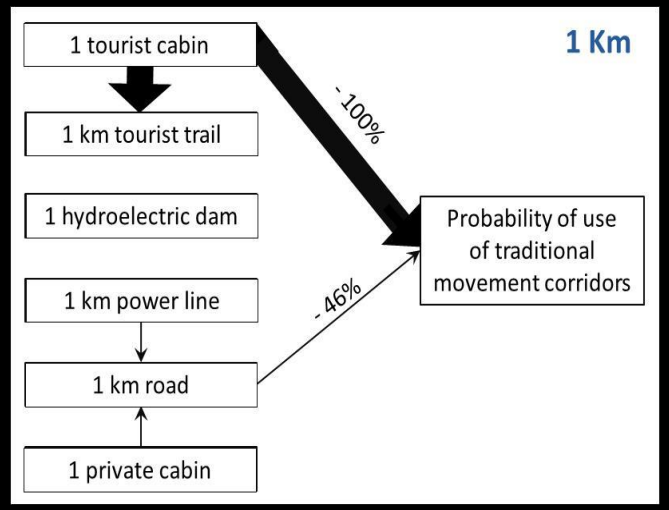
TOURIST CABINS

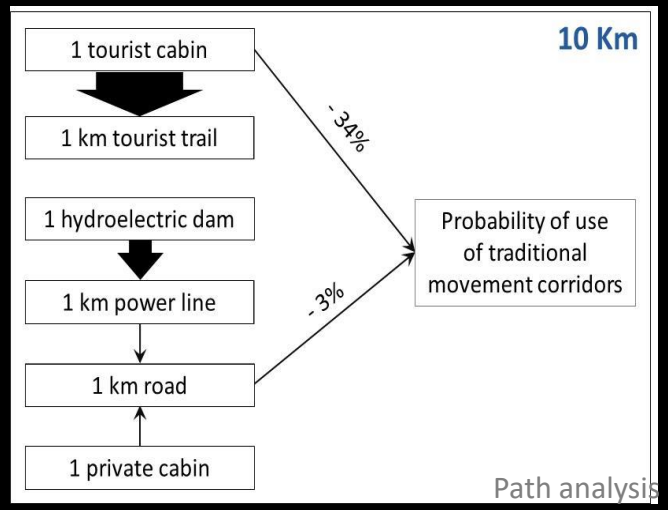
⇒ Strongly avoided, especially in summer
⇒ Can hamper/block migrations



Panzacchi-Van Moorter et al. Ecography, 2015
Panzacchi et al, J anim Ecol 2015
Panzacchi et al Rangifer 2013
Beyer et al J anim Ecol. 2016
Beyer et al J anim Ecol. 2015

DIRECT, INDIRECT, CUMULATIVE EFFECTS





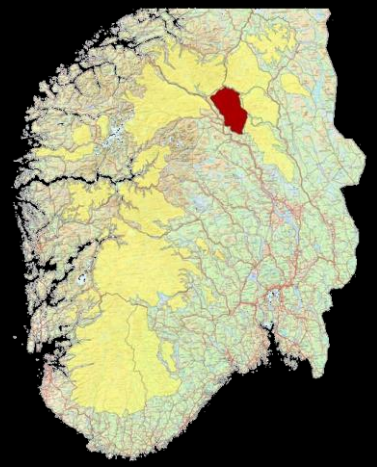
DIRECT EFFECTS: (e.g. 1 km)
- road: -46%
- DNT cabin: -100%

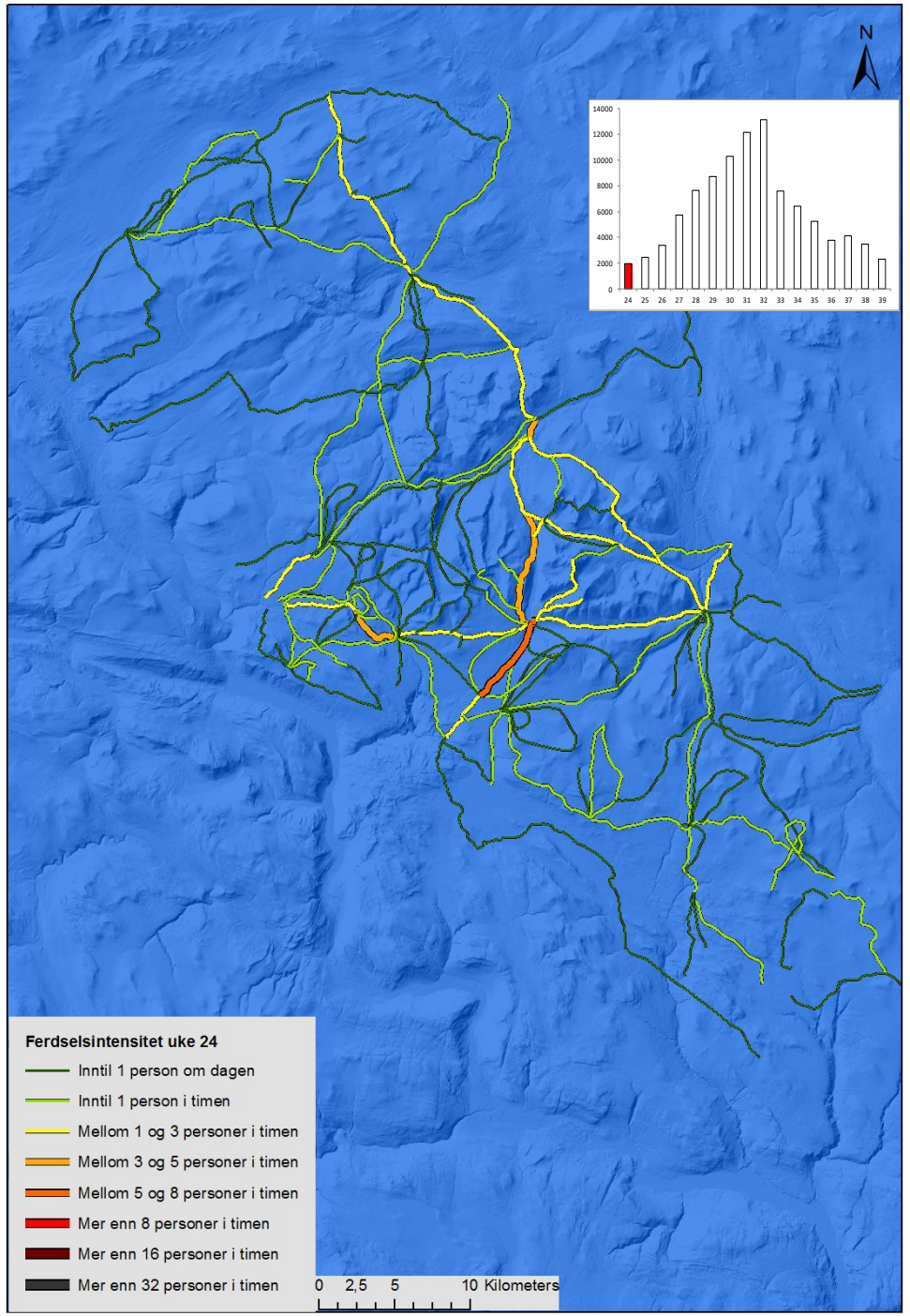
CUMULATIVE (ADDITIVE) EFF. e.g: (e.g. 10 km)
- 1 km road: -3%
- 10 km road: - 25%
- 10 km road + DNT cabin : - 51%

INDIRECT EFFECTS:
- power line
- private cabin
- Reservoir

Panzacchi et al 2013, Land. Ecol.

2. INTENSITY OF DISTURBANCE

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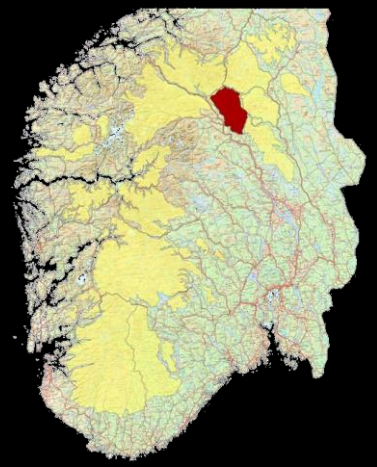

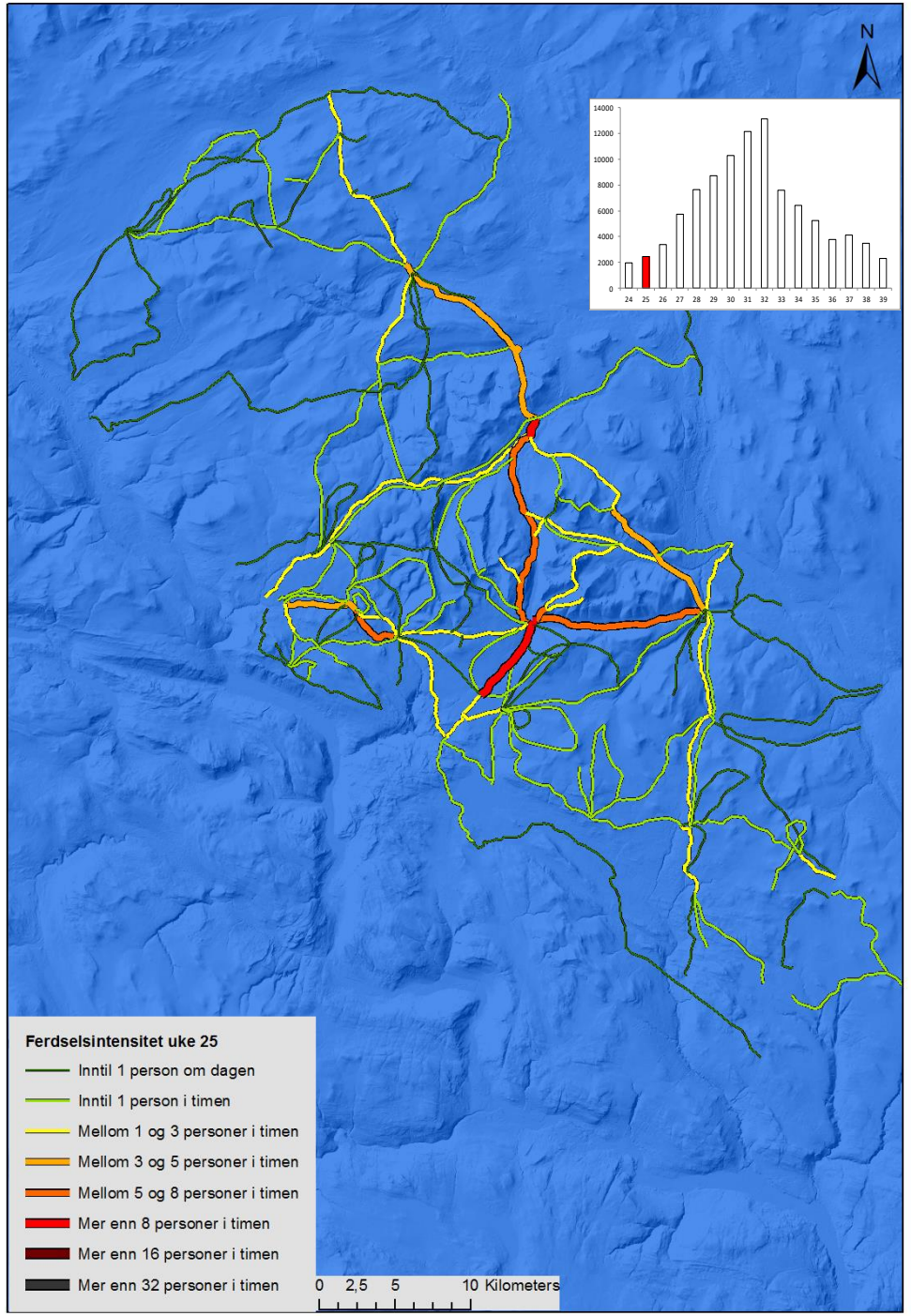
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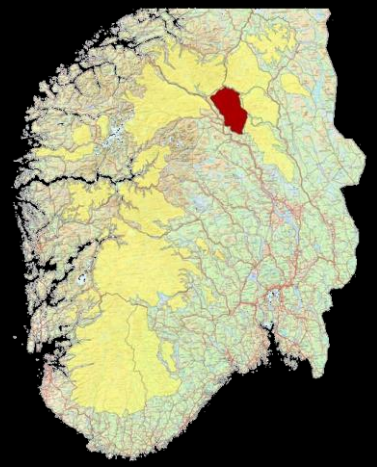

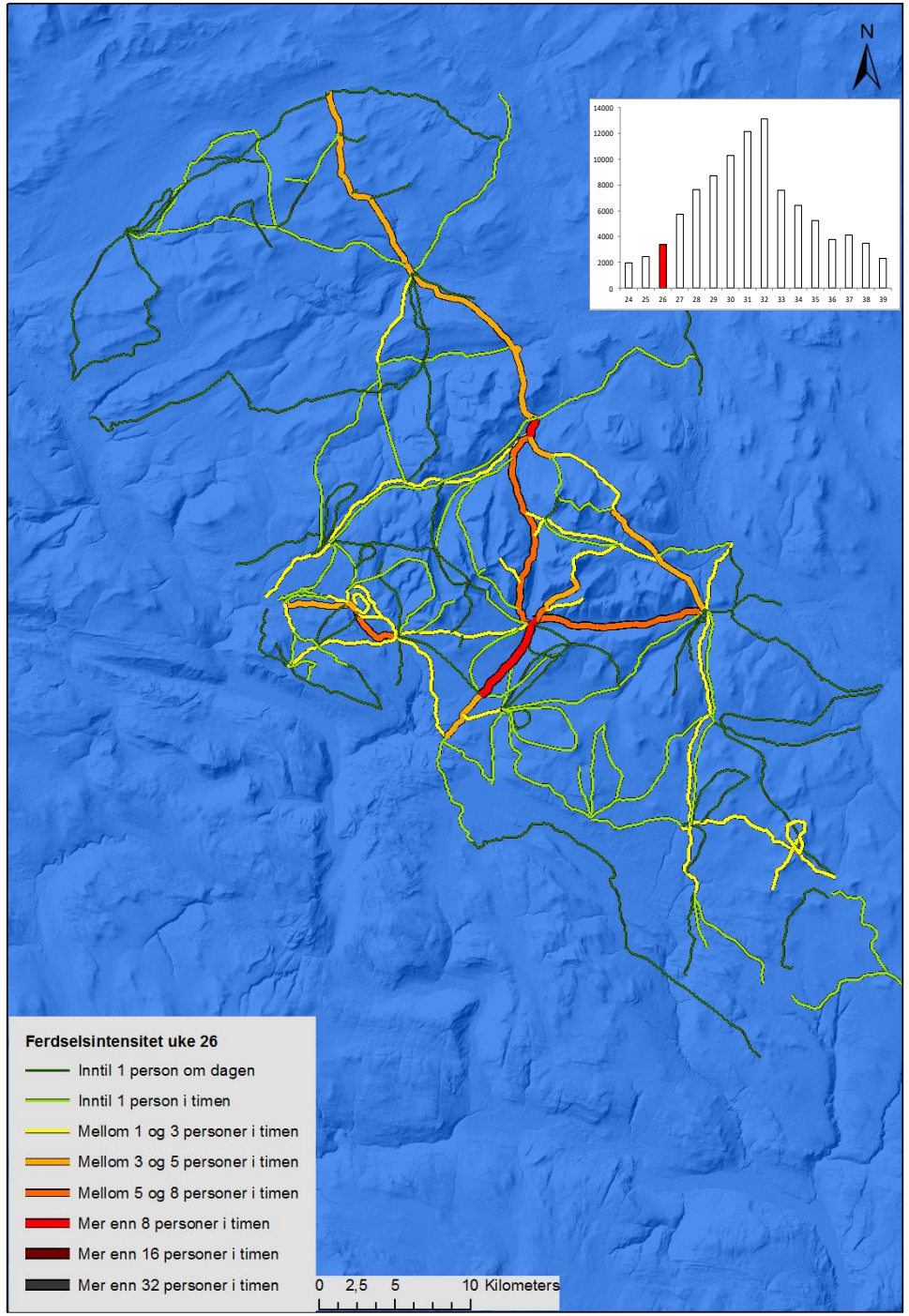
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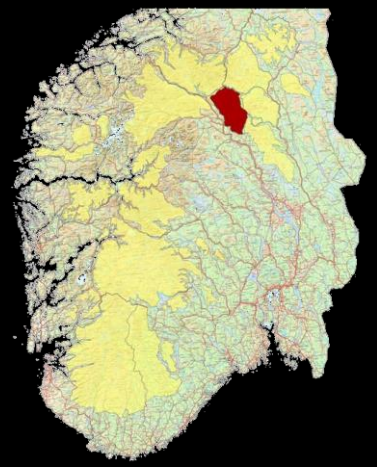

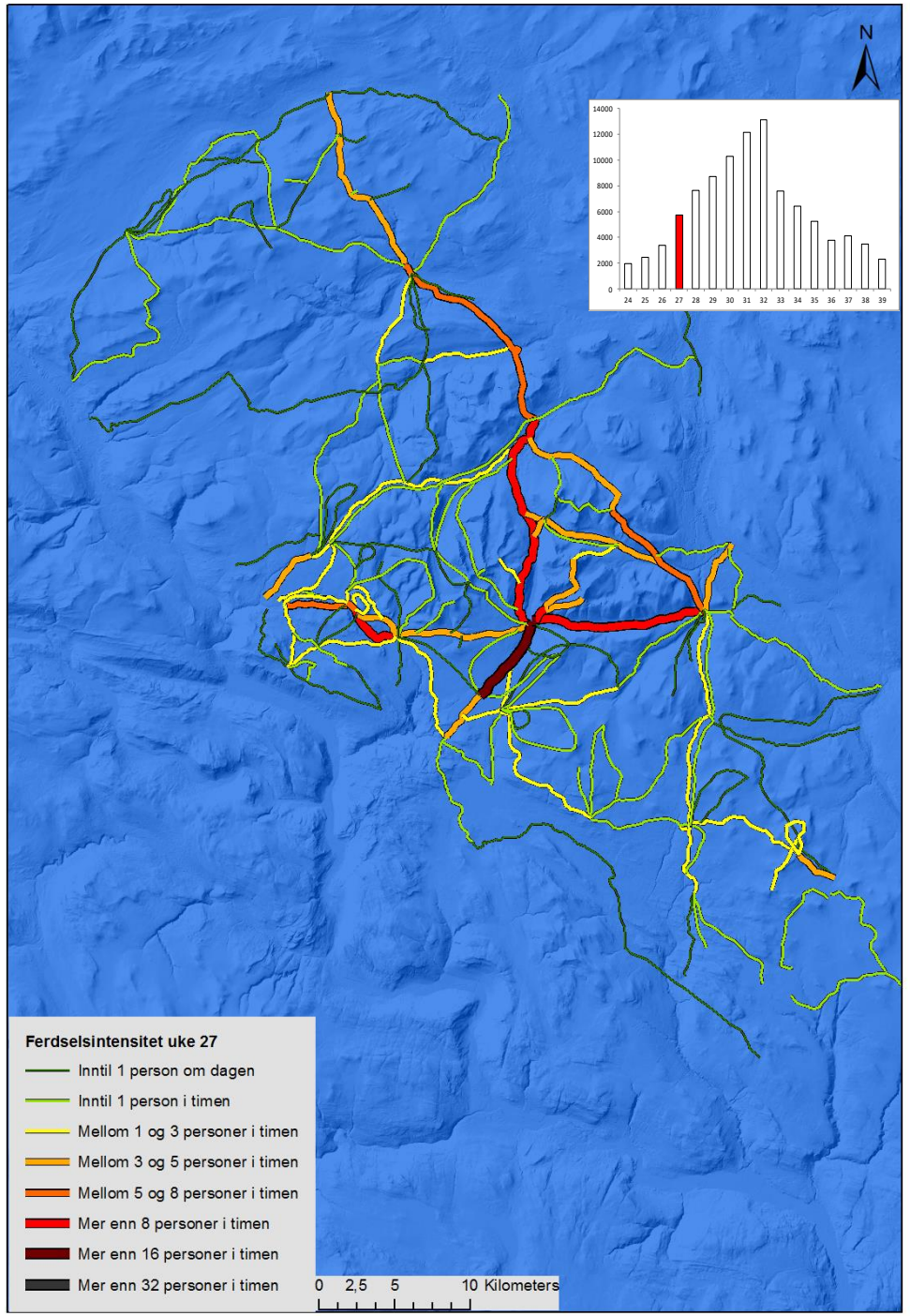
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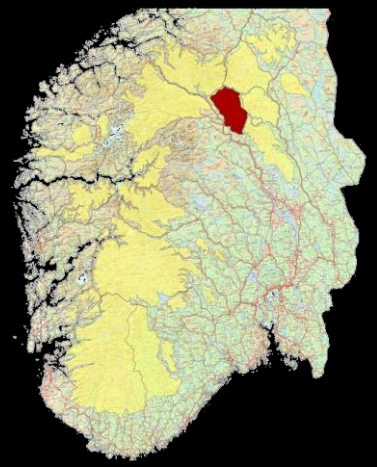

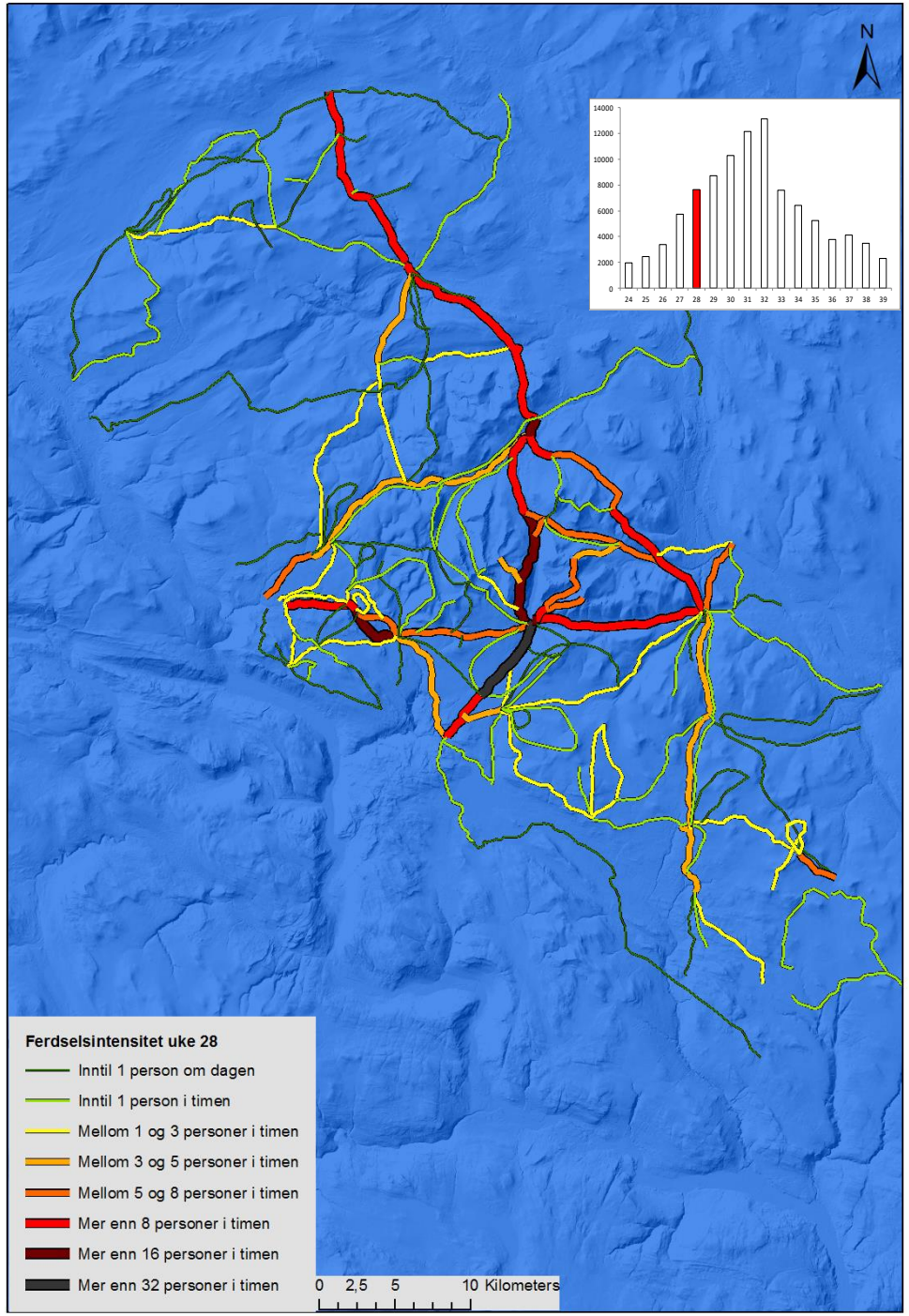
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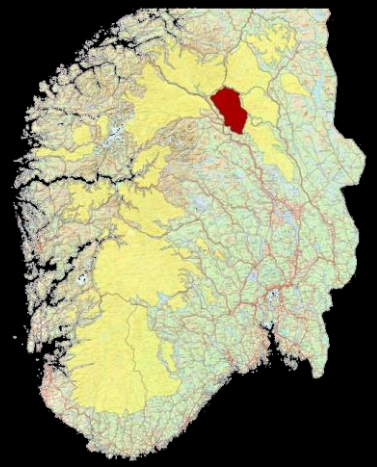

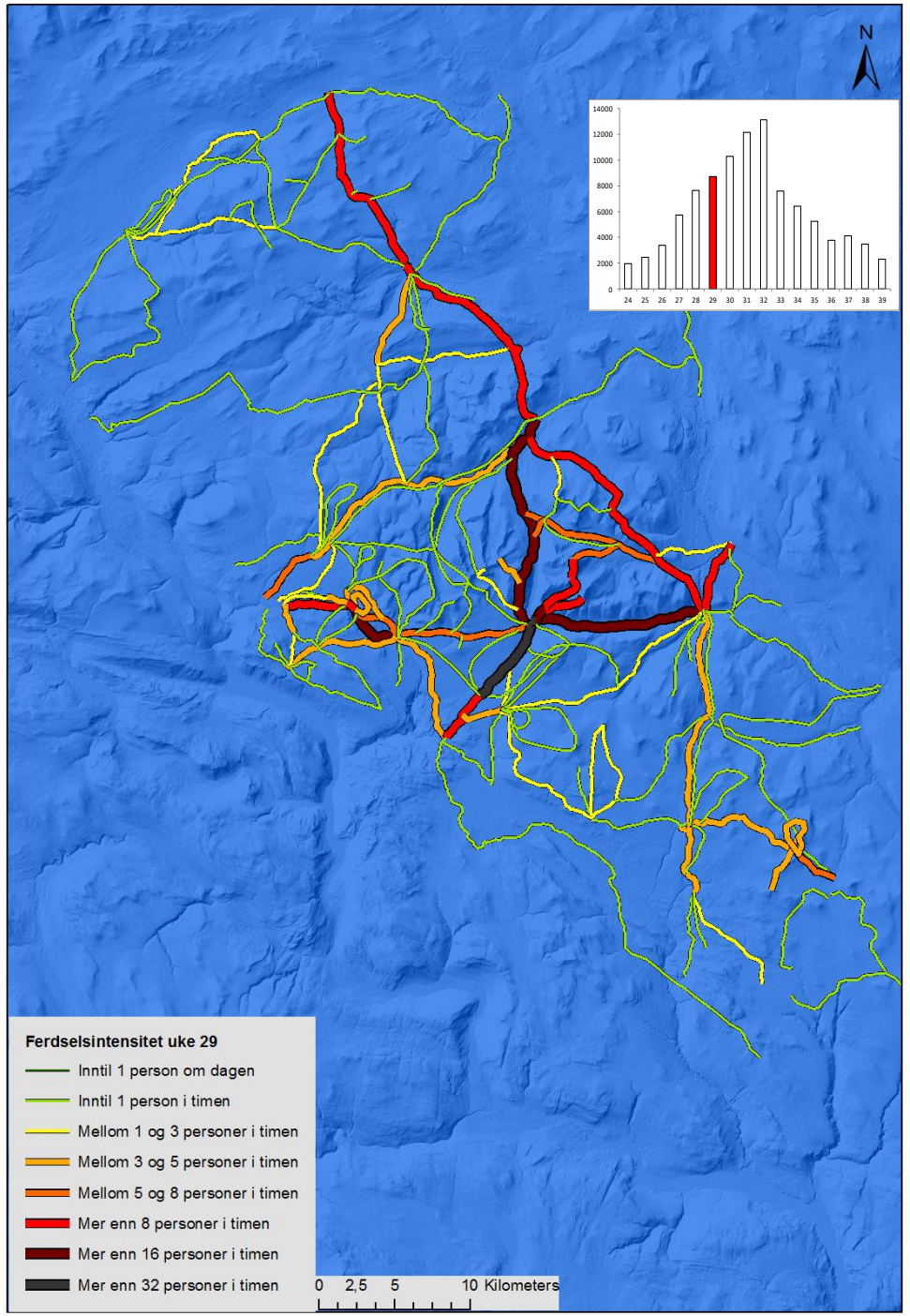
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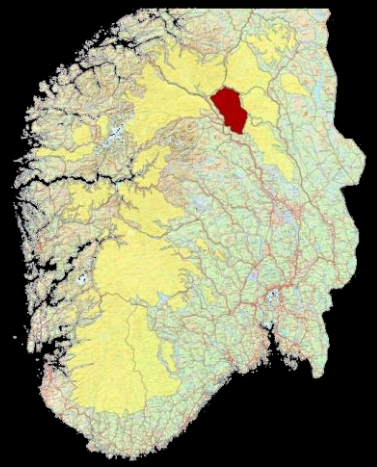

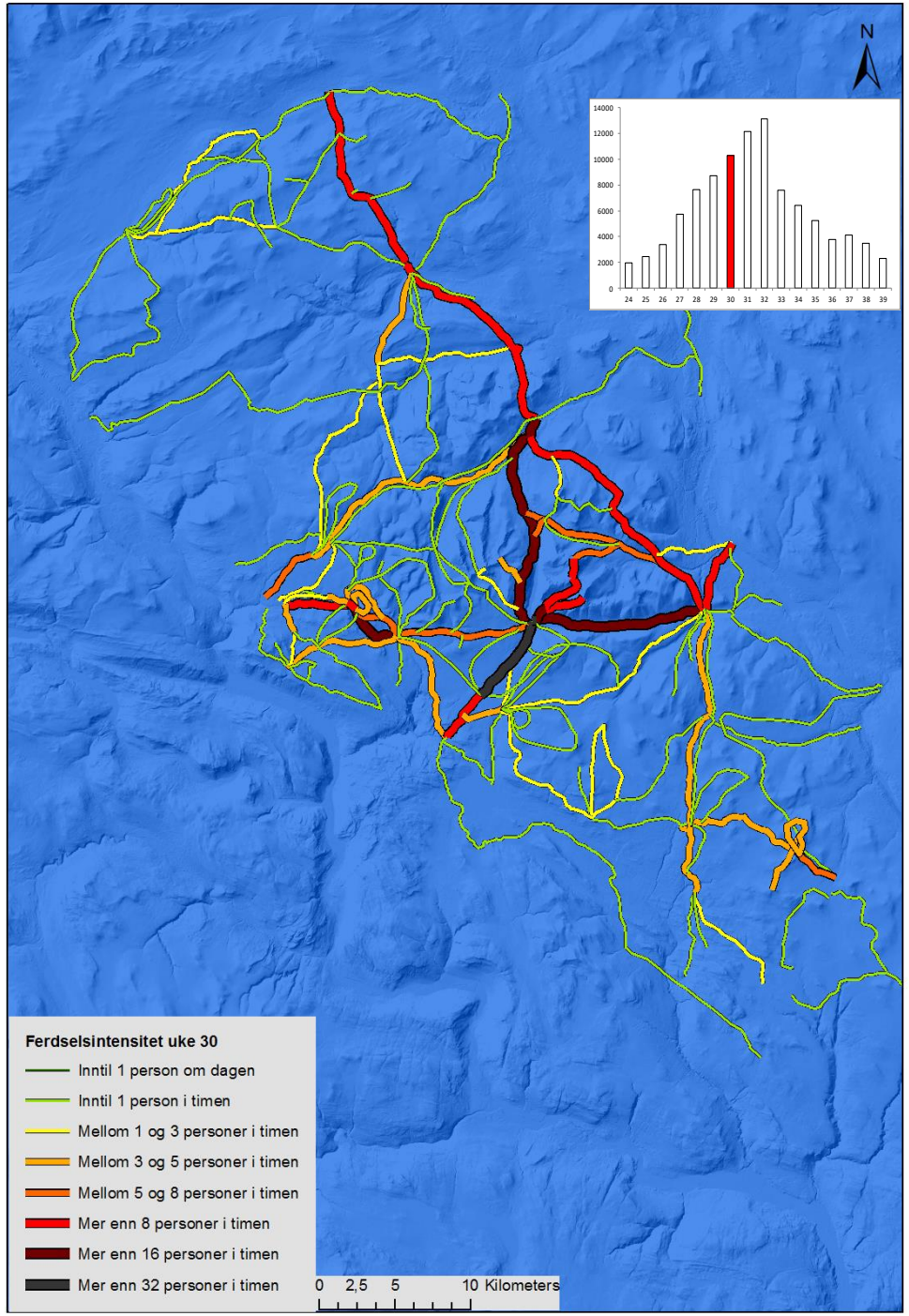
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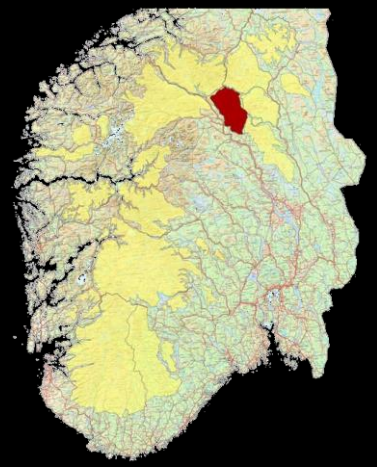

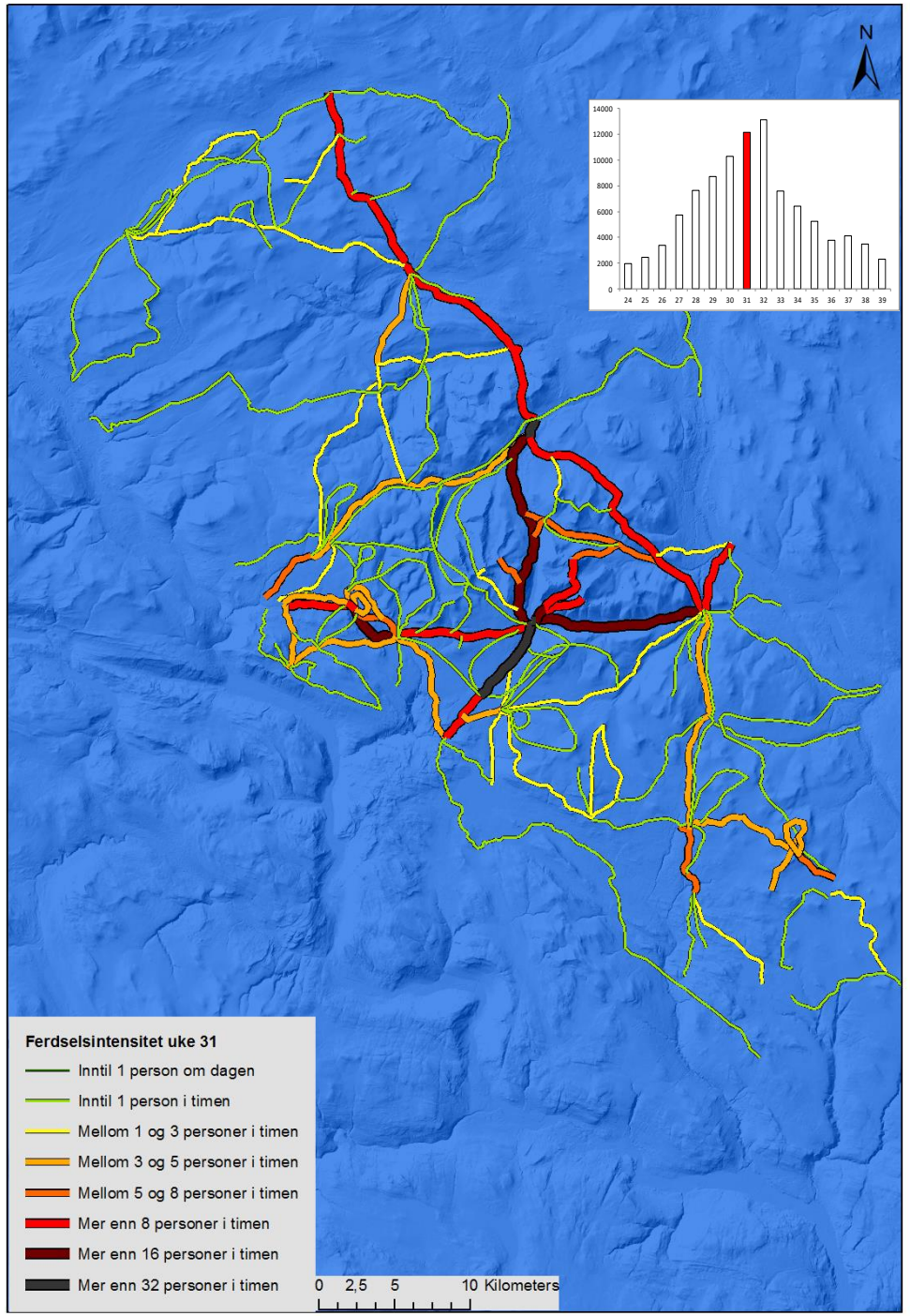
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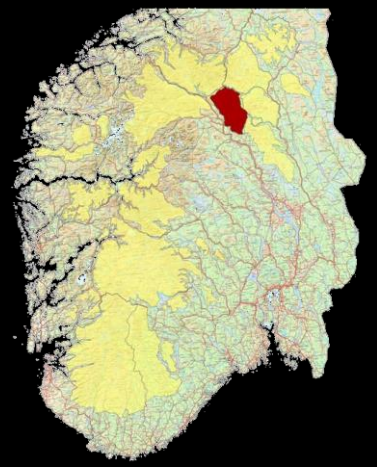

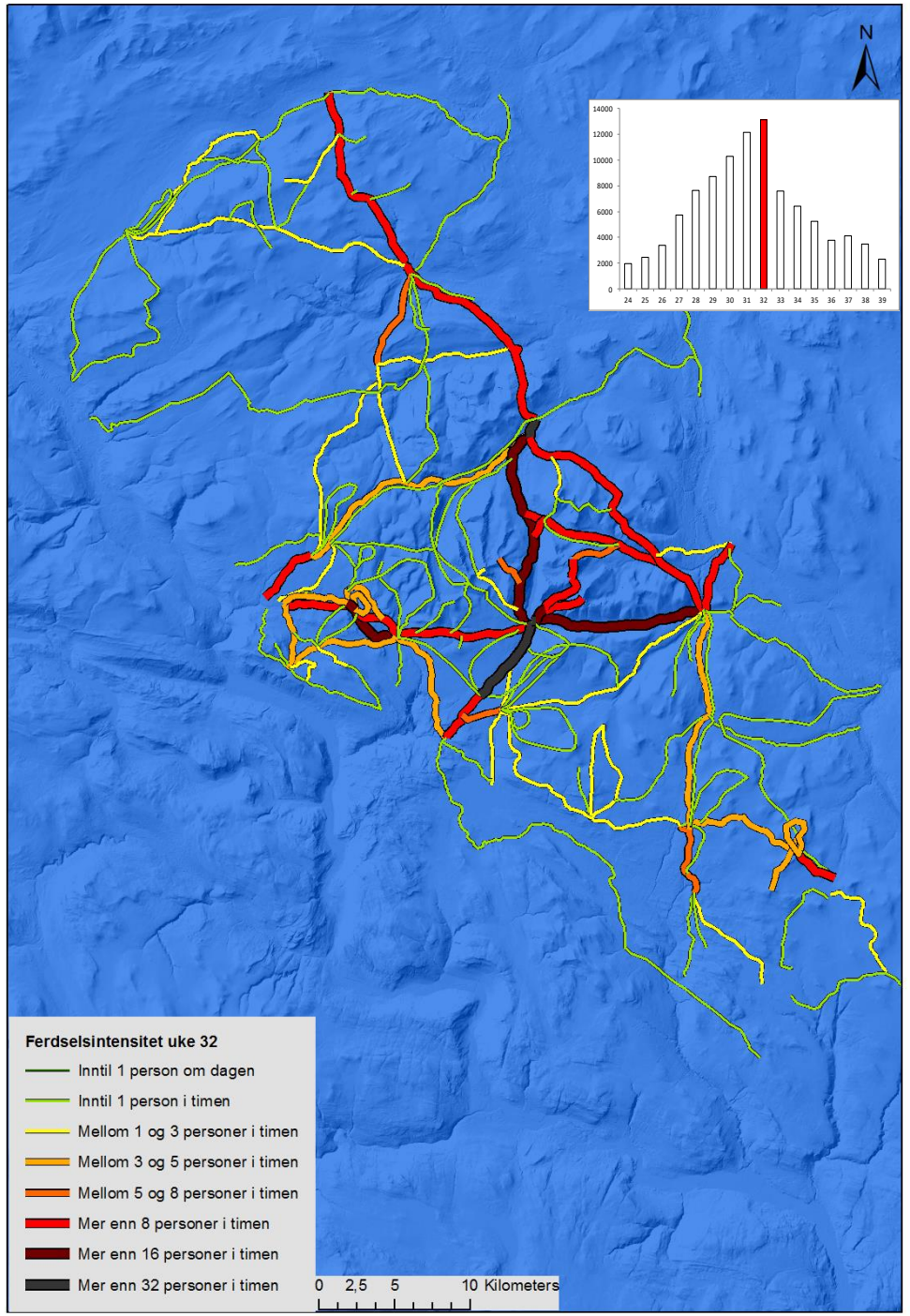
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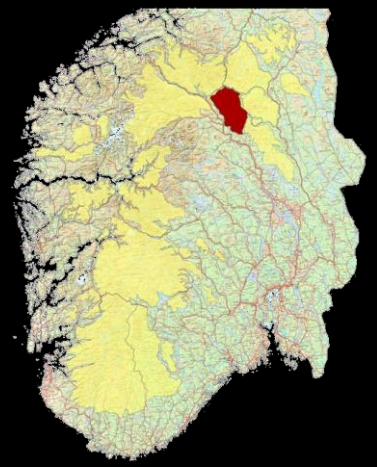

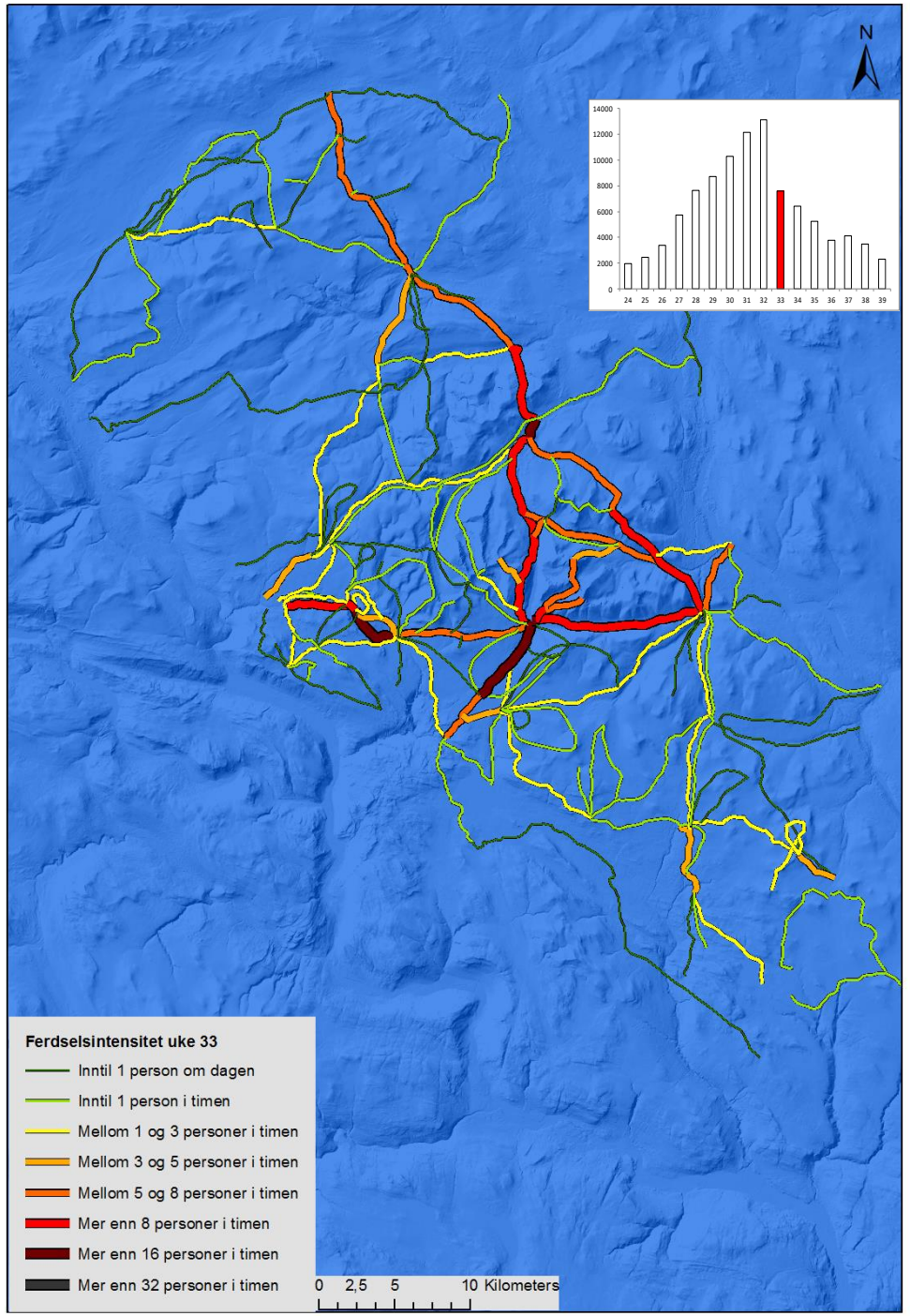
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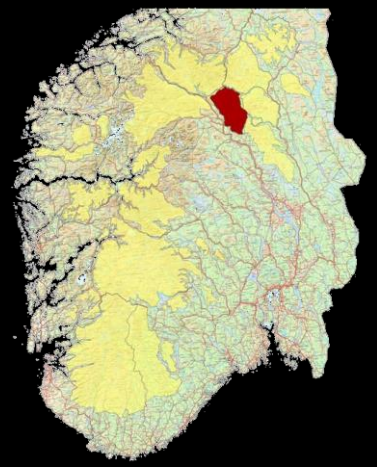

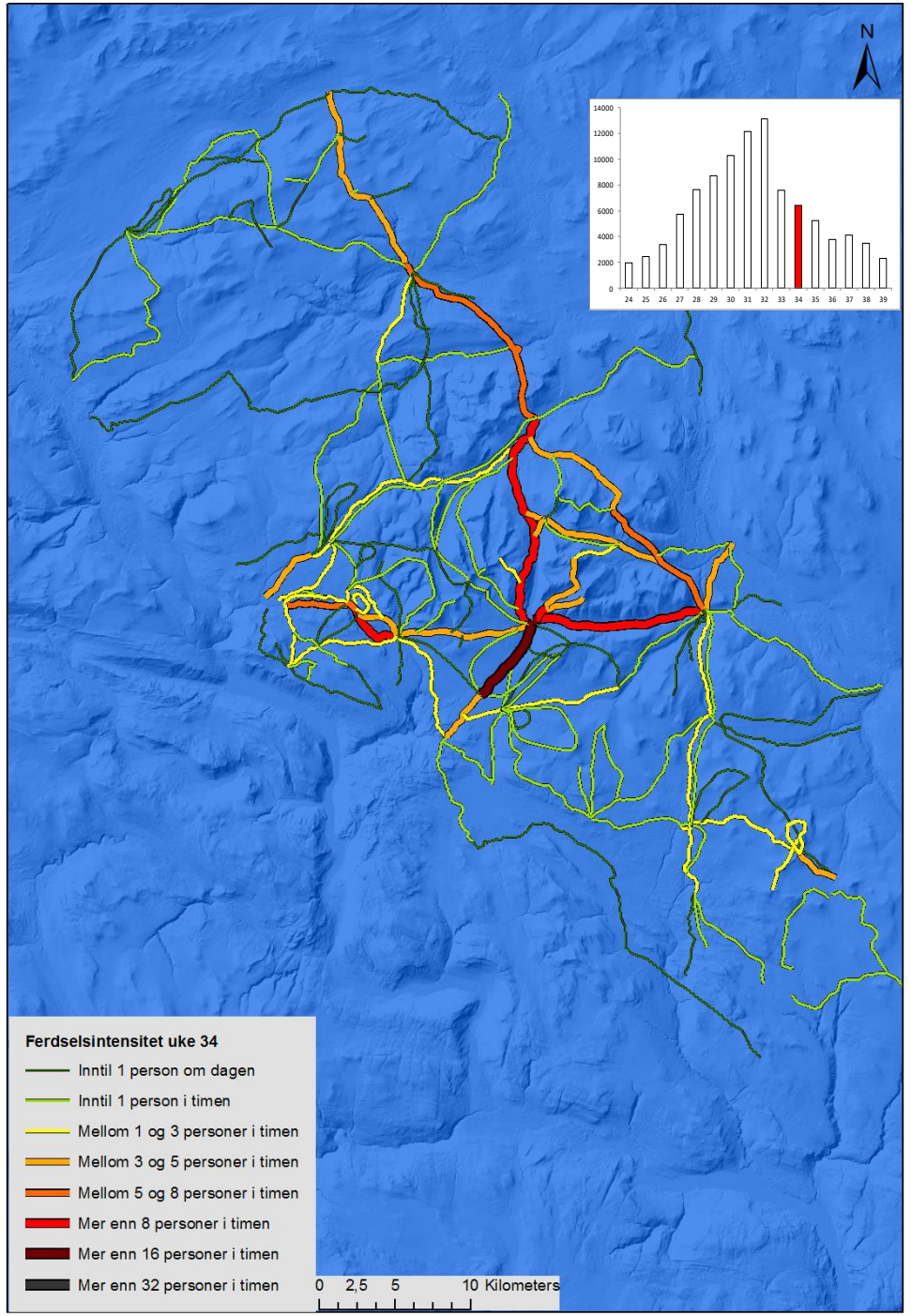
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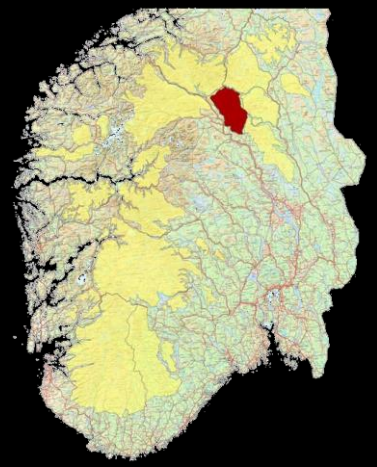

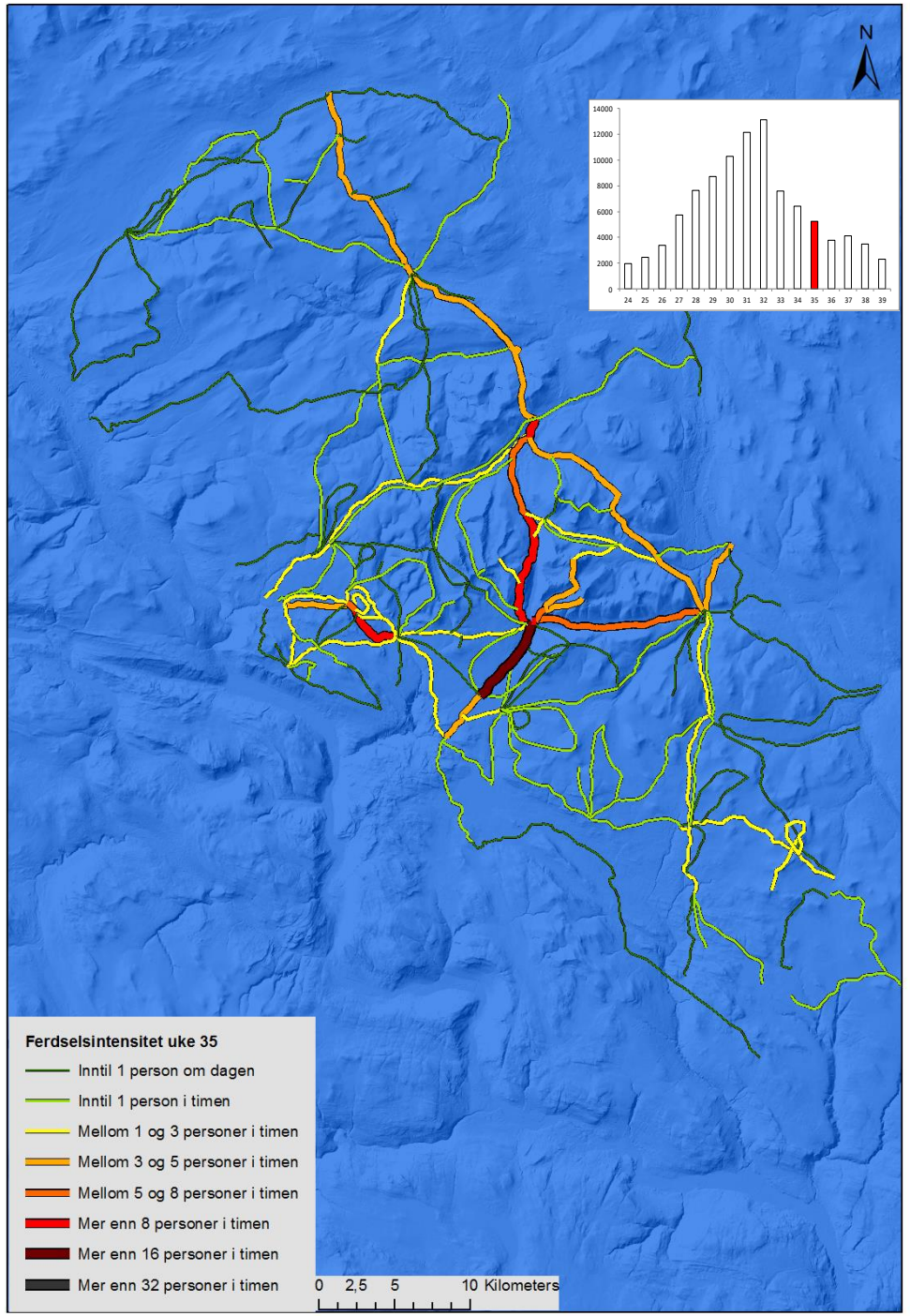
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Ferdselsintensitet uke 35
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Mer enn 32 personer i timen
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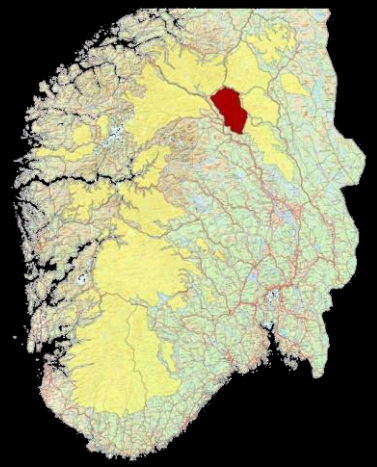
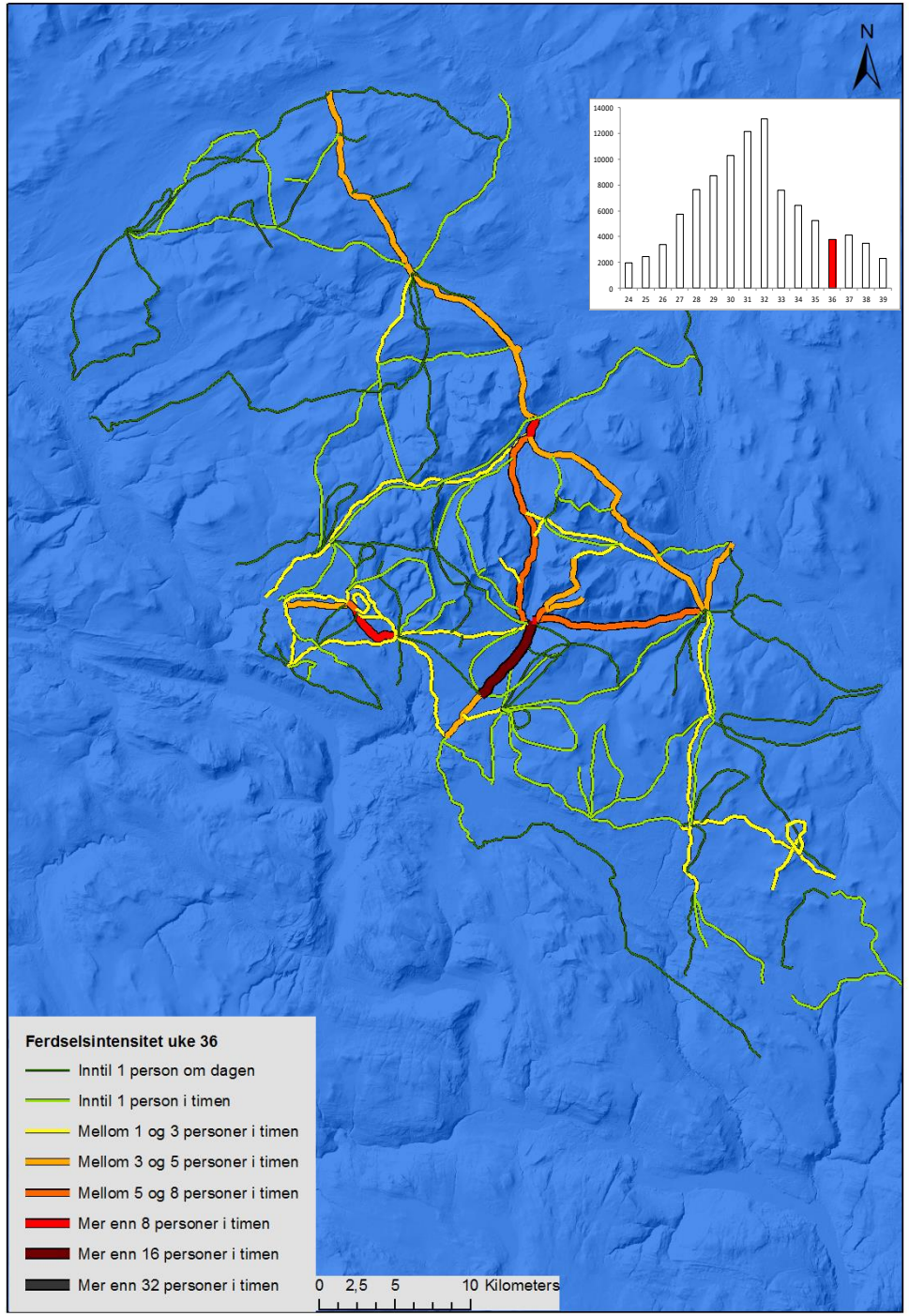
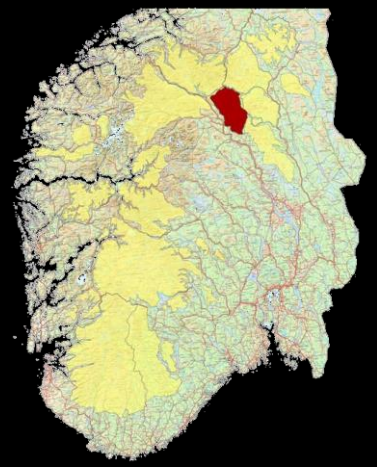
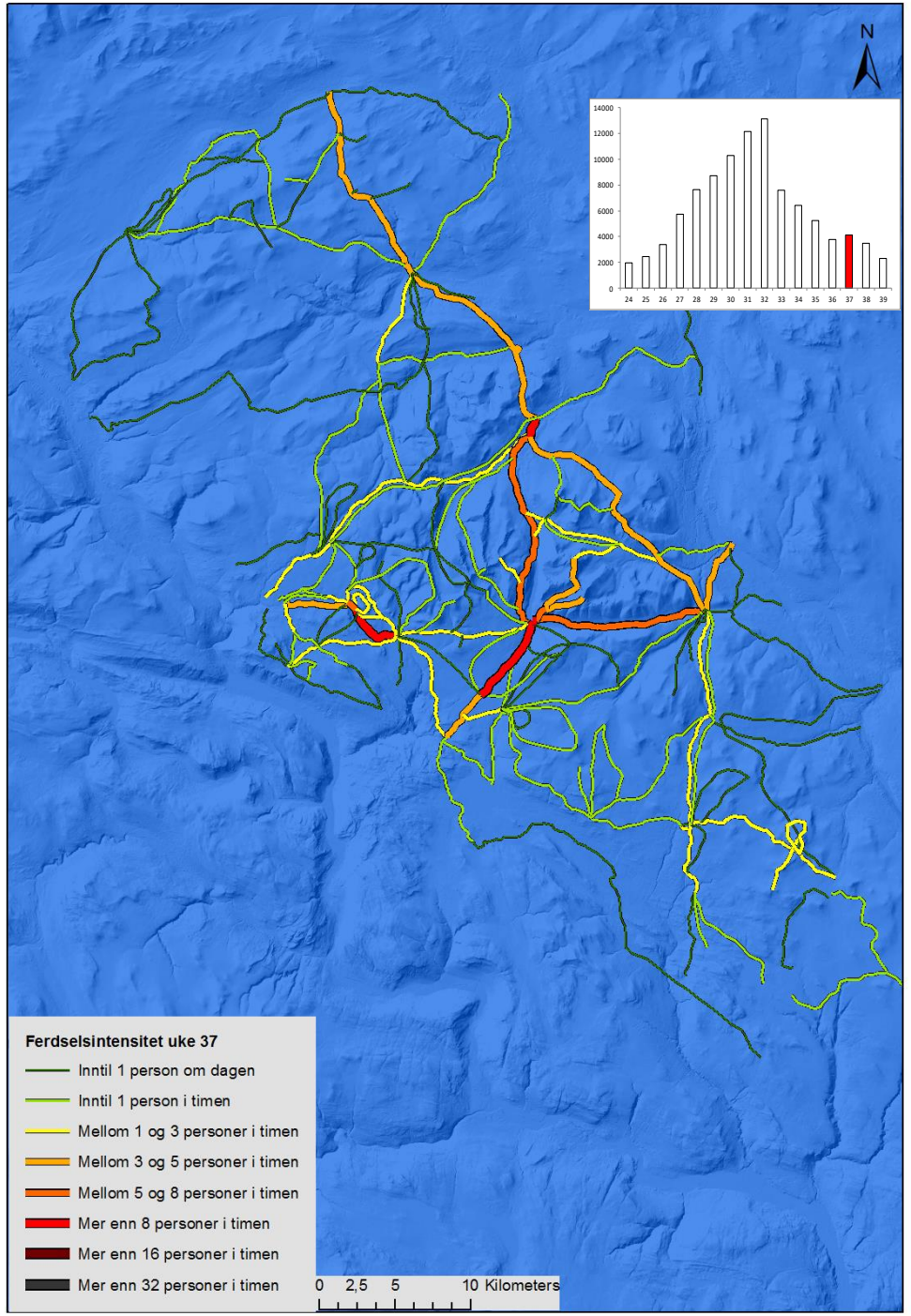



N
14000
12000
10000
8000
6000
4000
2000
0
24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39
Ferdselsintensitet uke 36
Inntil 1 person om dagen
Inntil 1 person i timen
Mellom 1 og 3 personer i timen
Mellom 3 og 5 personer i timen
Mellom 5 og 8 personer i timen
Mer enn 8 personer i timen
Mer enn 16 personer i timen
Mer enn 32 personer i timen
0 2,5 5 10 Kilometers

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Ferdselsintensitet uke 37
Inntil 1 person om dagen
Inntil 1 person i timen
Mellom 1 og 3 personer i timen
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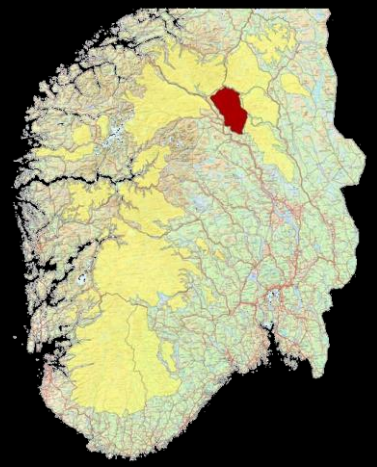

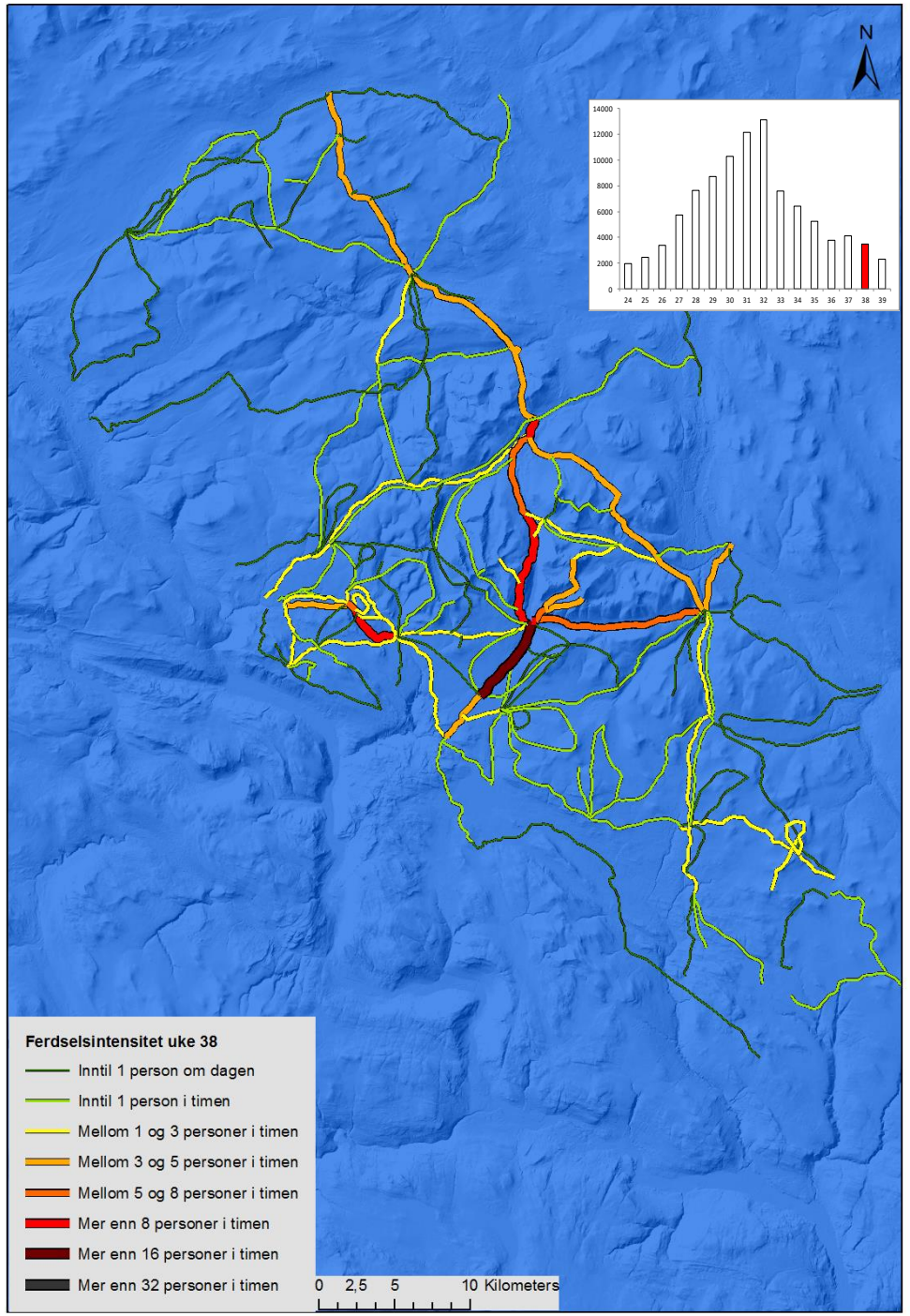
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Ferdselsintensitet uke 38
Inntil 1 person om dagen
Inntil 1 person i timen
Mellom 1 og 3 personer i timen
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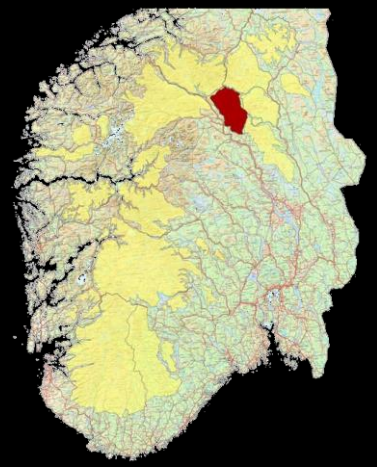
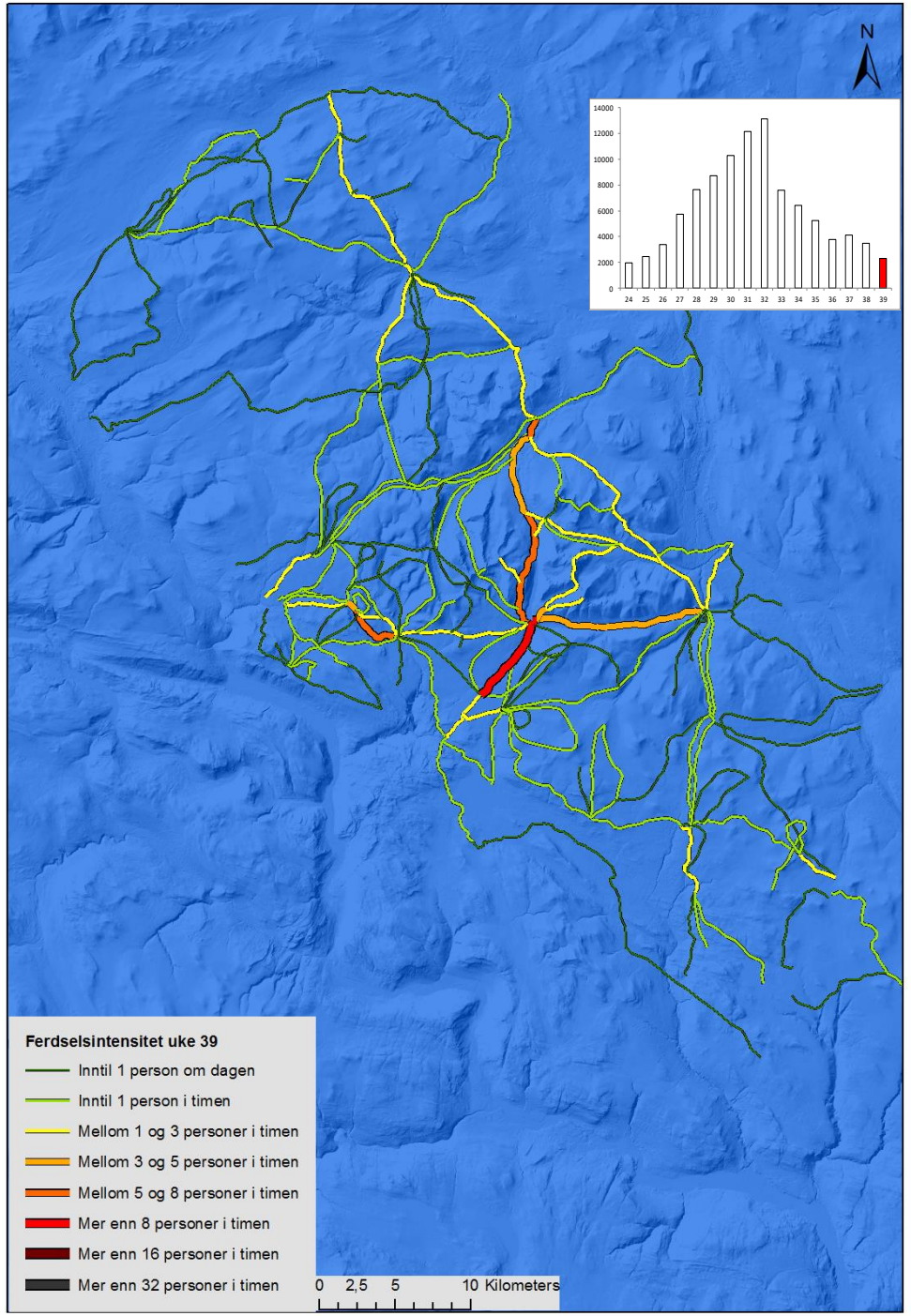
Mer enn 16 personer i timen
Mer enn 32 personer i timen
0 2,5 5 10 Kilometers

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24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39
Ferdselsintensitet uke 39
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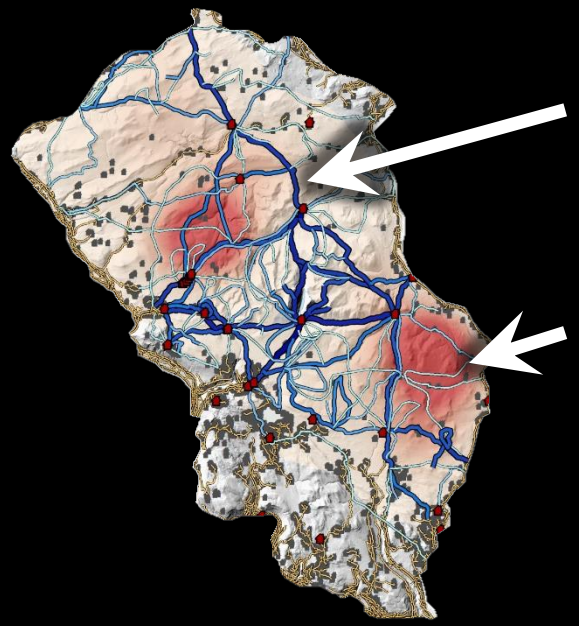
Mellom 5 og 8 personer i timen
Mer enn 8 personer i timen
Mer enn 16 personer i timen
Mer enn 32 personer i timen
0 2,5 5 10 Kilometers

IMPACT OF TOURISM ON REINDEER SPACE USE DEPENDS ON:

- **TOURIST VOLUME:**



> *ca.* 100 people/day*
NON-TRAVERSABLE BARRIER

< *ca.* 2 people/day: acceptable

- **.. IN INTERACTION WITH LANDSCAPE STRUCTURE:**

  If “refuge areas” are available, reindeer use them and avoid tourist areas

- **..AND TYPE OF HUMAN DISTURBANCE:**

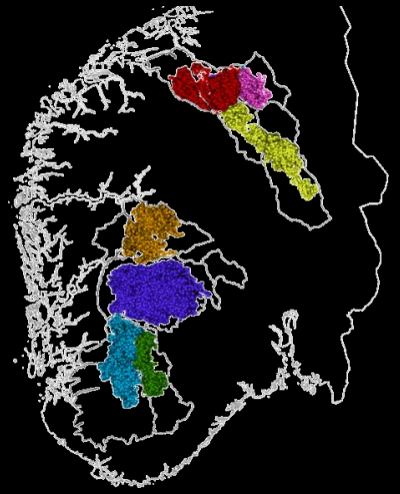
  - Hickers vs. hunters
  - Ongoing studies on the effect of different typologies of hikers, i.e. wilderness seeker vs. comfort seekers

Panzacchi et al in prep

3. LOCATION OF DISTURBANCE WITH RESPECT TO THE MOST IMPORTANT AREAS FOR CONSERVATION

QUANTIFYING SUITABLE HABITAT / HABITAT LOSS

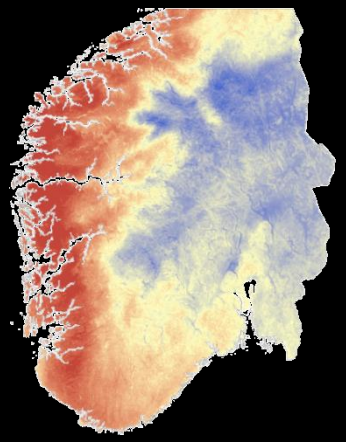
GPS data



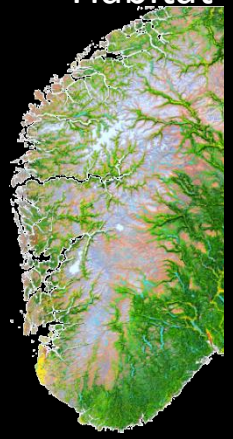
Compare habitat used
to habitat available
at each location

RSPF
Resource Selection Probability Functions

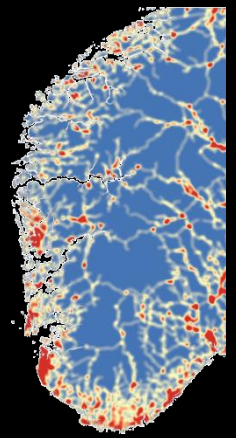
Climate

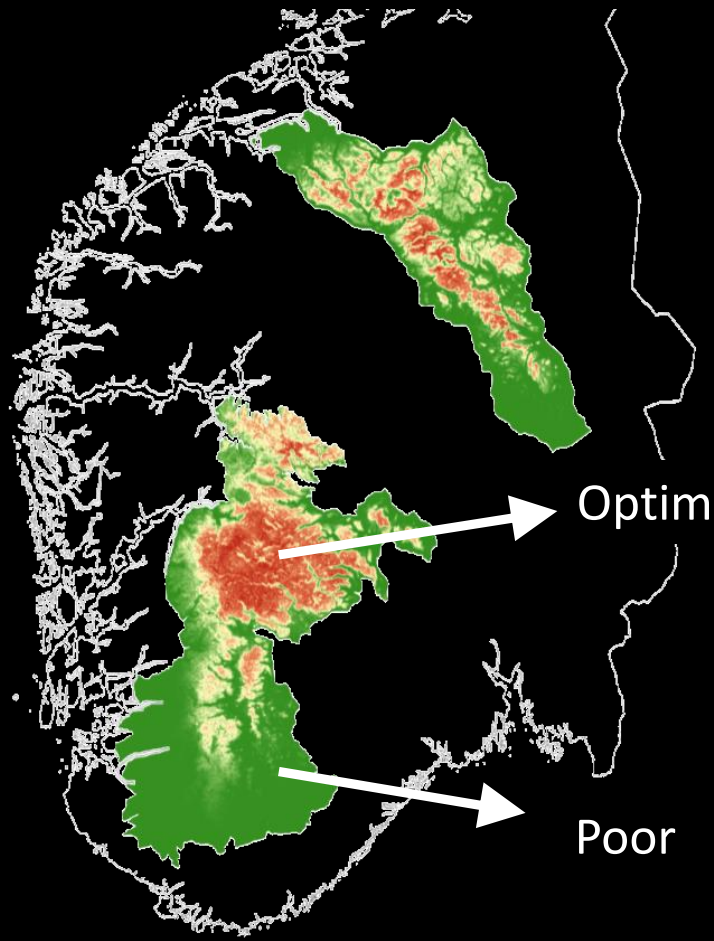


Habitat



Disturbance





Optimal

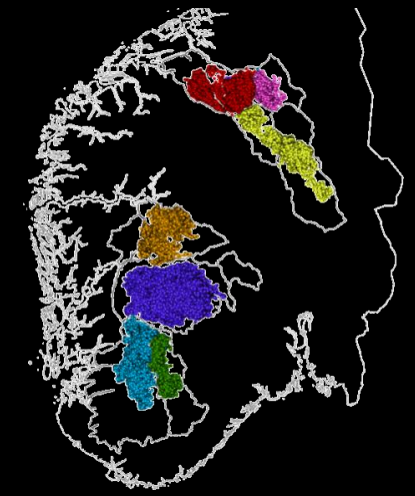
Poor

Variables	coef	se(coef)	z	p
Step length (corrected)	-1.142e-03	1.171e-05	-97.500	***
(Max slope)^2	-1.165e-03	3.559e-05	-32.732	***
Max trail density	-1.538e-01	2.338e-02	-6.581	***
Max road density	-5.324e-01	1.006e-01	-5.295	***
Solar radiation	3.978e-01	1.051e-02	37.832	***
LC: bog	-5.510e-01	1.570e-01	-3.509	***
LC: mountain not edible veg.	1.516e-01	6.908e-02	2.195	*
LC: mountain edible veg.	5.996e-01	6.096e-02	9.835	***
LC: non dammed lakes	1.431e+00	1.268e-01	11.288	***
LC: dammed lakes	-3.936e+00	4.645e-01	-8.473	***
Road crossing	-3.099e-01	1.264e-01	-2.451	*

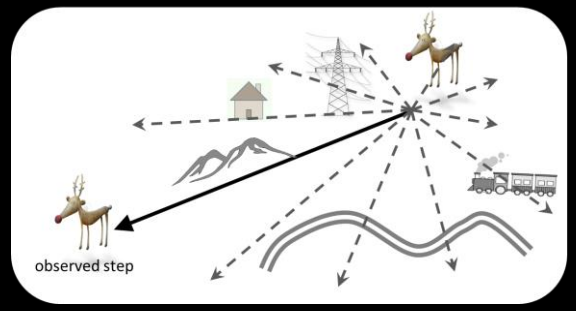
Panzacchi et al 2015, Ecography

QUANTIFYING LANDSCAPE PERMEABILITY TO MOVEMENTS

GPS data

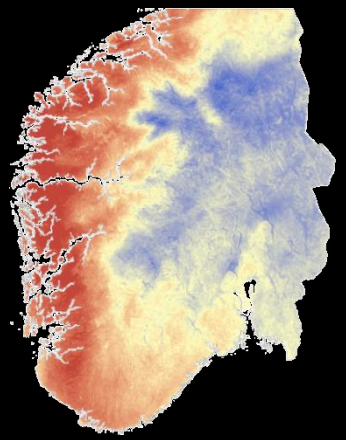


Calculate the probability of traversing each landscape feature with a “step”

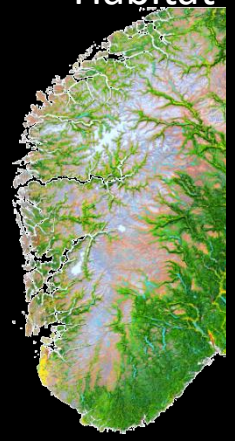


SSPF
Step Selection Probability Functions

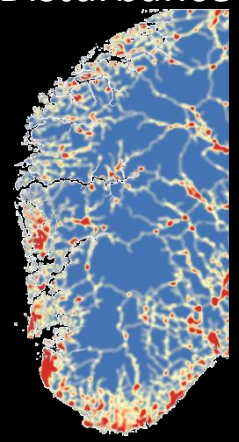
Climate

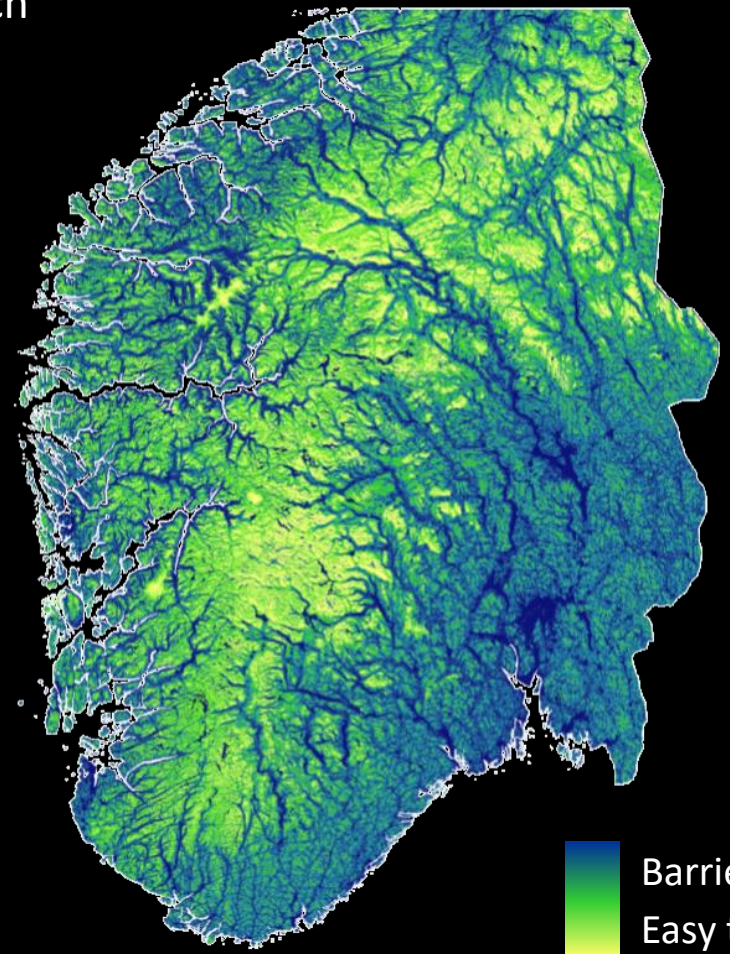


Habitat



Disturbance





Barrier *TO STEP*
Easy to traverse

Variables	coef	se(coef)	z	p
Step length (corrected)	-1.142e-03	1.171e-05	-97.500	***
(Max slope)^2	-1.165e-03	3.559e-05	-32.732	***
Max trail density	-1.538e-01	2.338e-02	-6.581	***
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Road crossing	-3.099e-01	1.264e-01	-2.451	*

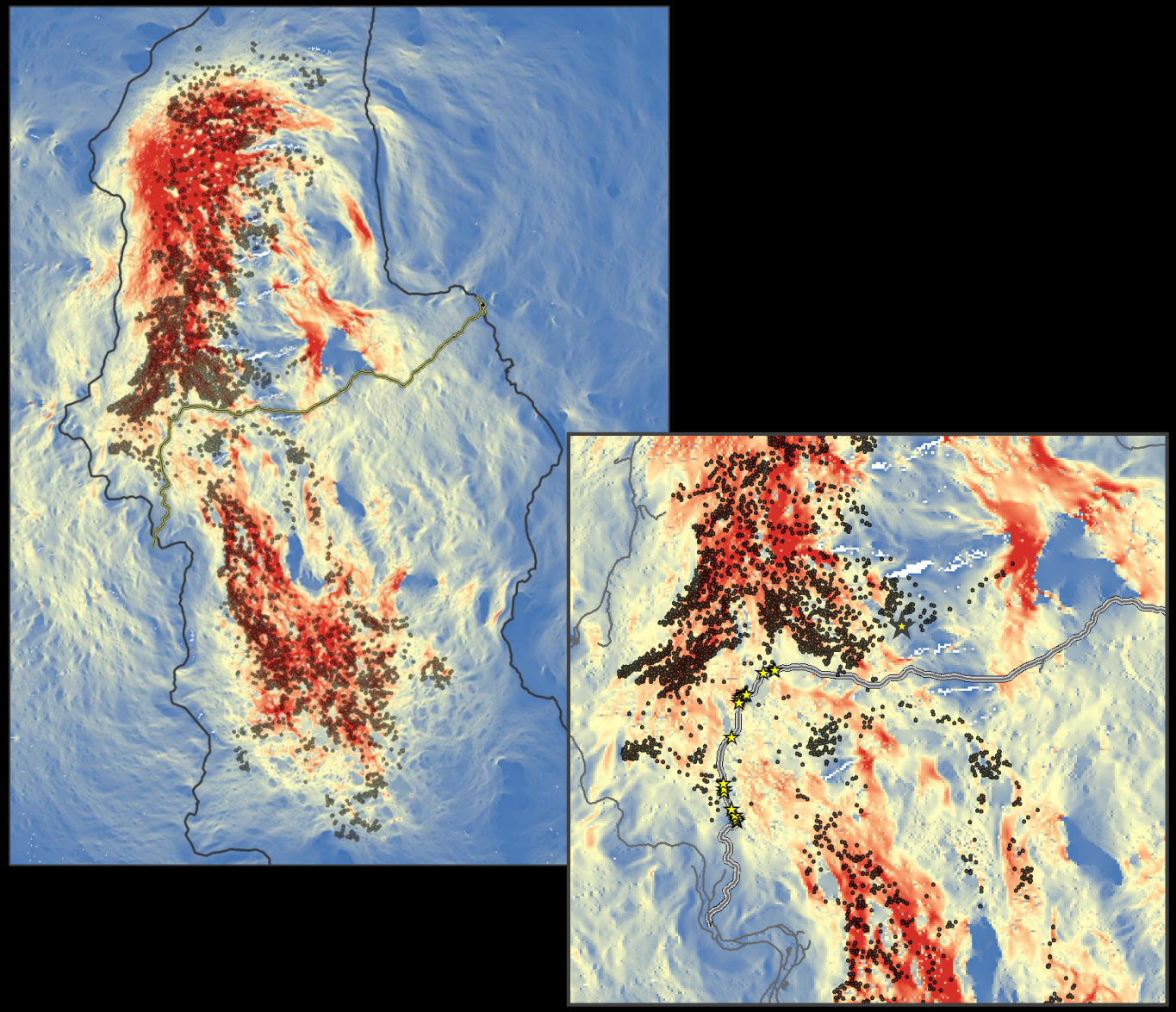
Panzacchi et al 2016, J Anim Ecol

IDENTIFY MOVEMENT / MIGRATION CORRIDORS

Highest probability of movement: **CORRIDOR**

0 *P movement*: **BARRIER**

GPS locations



Randomized Shortest Path Algorithm

Panzacchi et al, J. Anim. Ecol. 2015

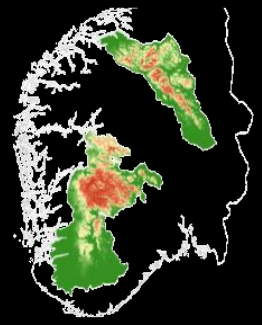
HOW CAN ALL PREVIOUS RESULTS BE USED CONCRETELY FOR ZONATION & SUSTAINABLE LAND PLANNING?

Landscapes are complex, human activities and infrastructure are often correlated in space and in time, and, together, produce cumulative impacts on species

ZONATION, LAND PLANNING AND MANAGEMENT NEED A SYNTHESIS OF ALL RESULTS

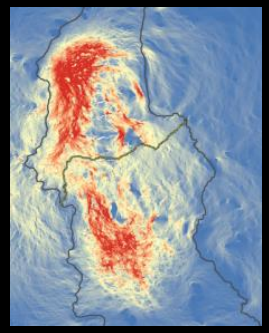
Effect of different types of disturbance

Where is optimal habitat



Where are movement barriers

Where are migration corridors



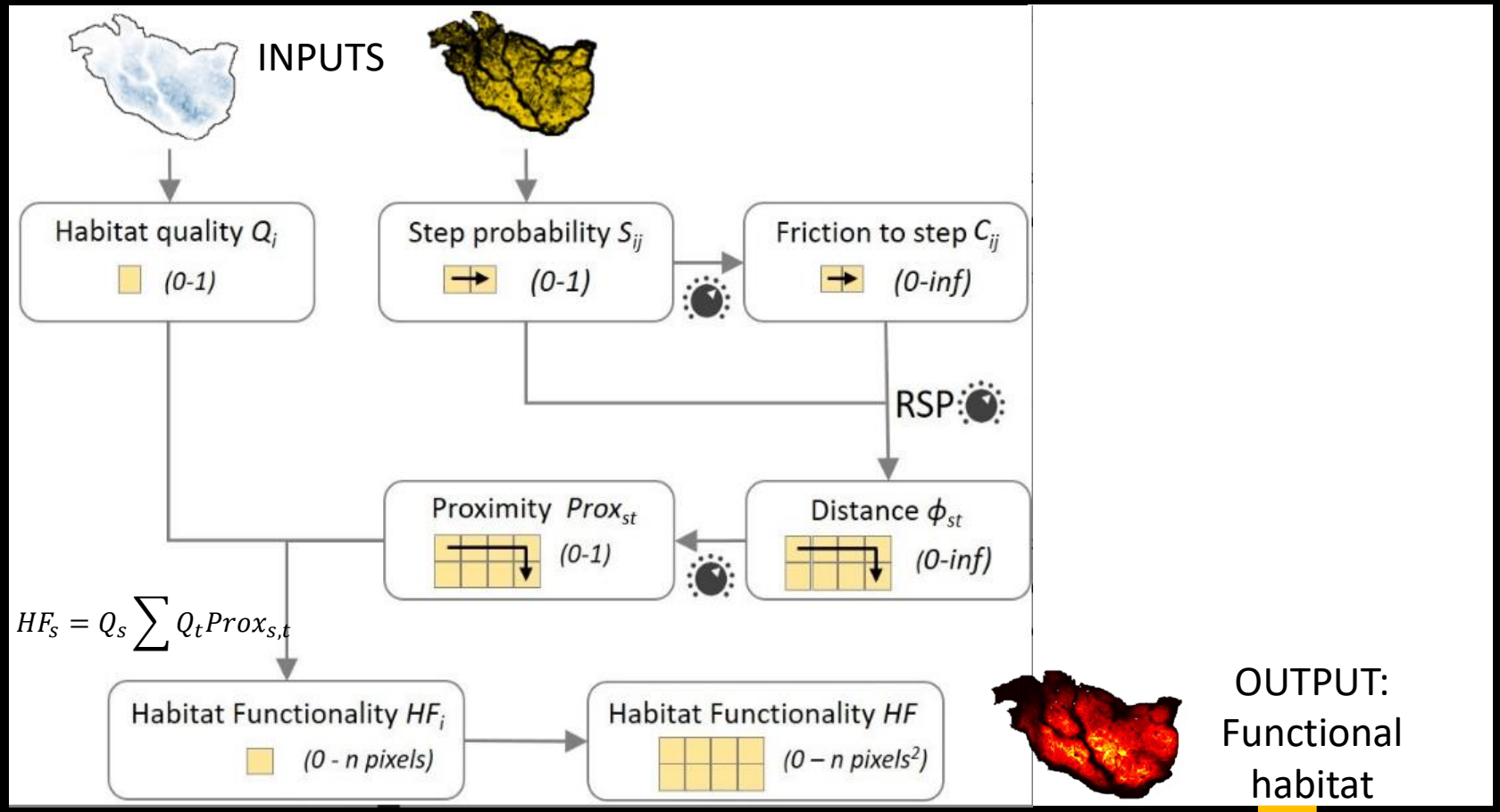
- *Which areas are most important for conservation, and for restoration?*

Need a synthetic index integrating all previous results

A metric identifying habitat that is simultaneously of good quality and well connected

“HABITAT FUNCTIONALITY METRIC”

HABITAT FUNCTIONALITY - WORKFLOW



OUTPUT: Functional habitat

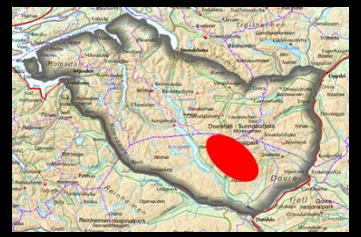
We can make compare the cumulative impact of changes in habitat quality or connectivity, in a scenario approach

Van Moorter et al. manuscript

DEMONSTRATION: SCENARIO OF LAND DEVELOPMENT

Scenario 1: increased road traffic

Scenario 2: build a tourist area

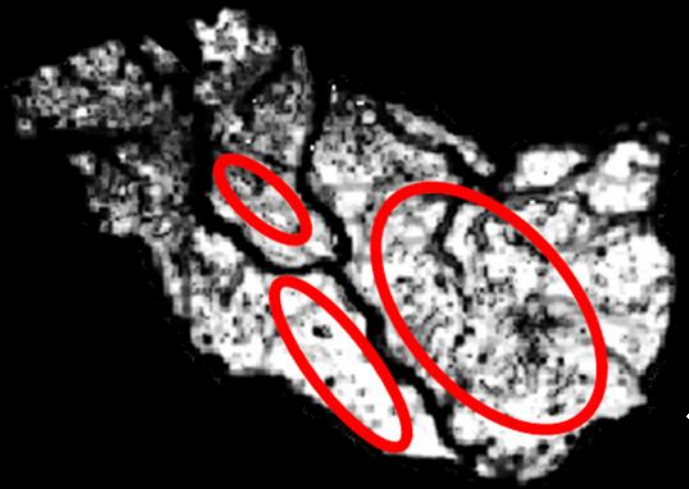


Which scenario of land development would have the smallest impact on reindeer?

DEMONSTRATION: SCENARIO 1

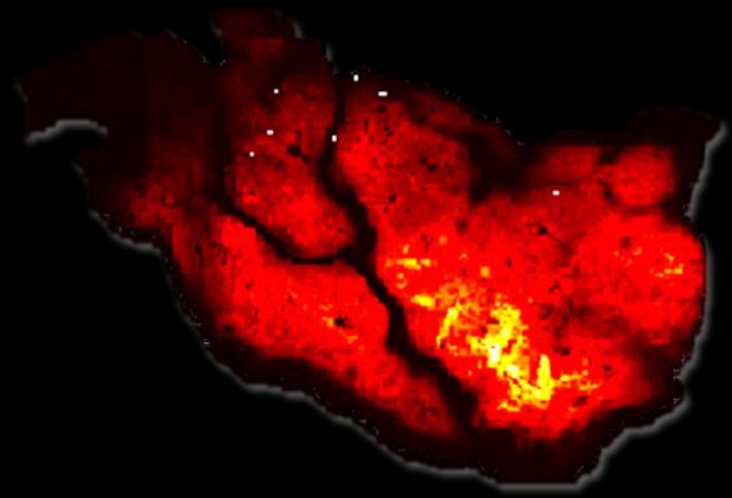
Scenario 1: increased road traffic

↓Habitat Permeability



-15%

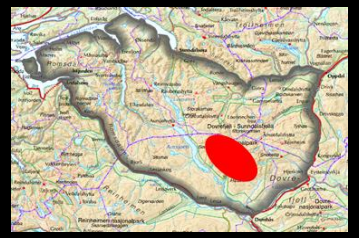
Habitat Functionality



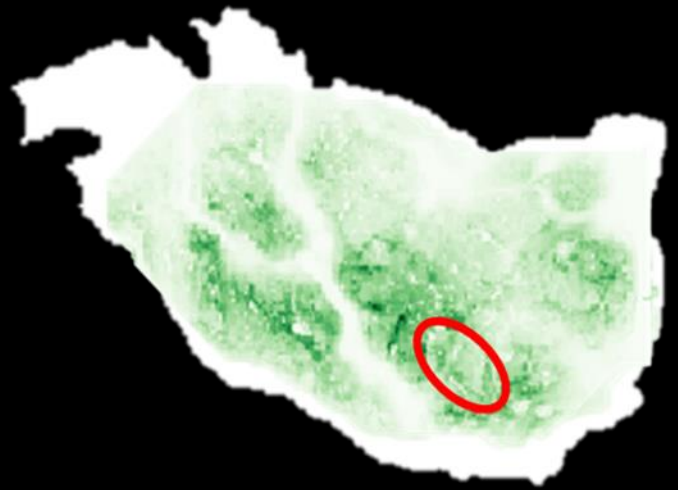
Van Moorter et al. manuscript

DEMONSTRATION: SCENARIO 2

Scenario 2: build a tourist area

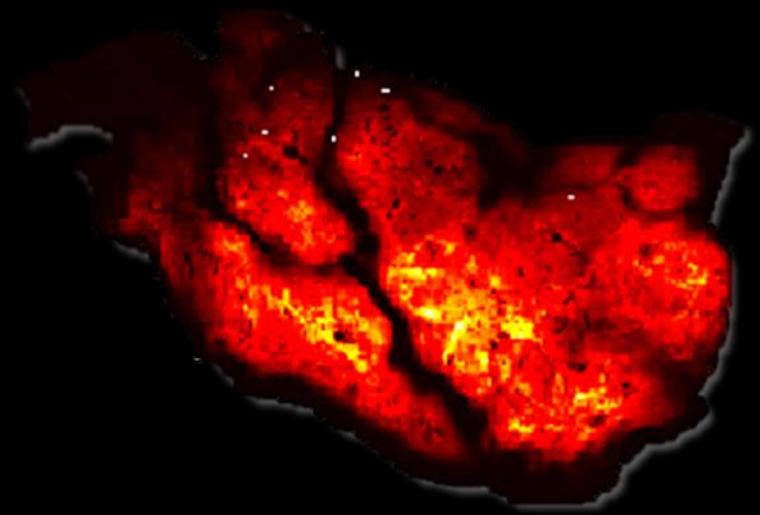


↓Habitat Quality



-10%

Habitat Functionality



Van Moorter et al. manuscript

CONCLUSION

Is it possible to reconcile wild reindeer conservation with human development ?

- To some degree. Crucial to identify tolerance thresholds and limits

- Spatially explicit analyses, using synthetic indices are needed to understand where, how and why to suggest:
  - Areas for conservation
  - Areas for restoration / mitigation
  - Sustainable area use / development

- Ecology is one piece of the puzzle. The next challenge is to investigate how to integrate e.g. societal demands, governance practices, legal aspects etc into **Adaptive Management Strategies**

THANKS!

NINA
Norwegian Institute for Nature Research