Climate change and reindeer herding

a bioeconomic model on the economic implications for Saami reindeer herders in Norway and Sweden

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FutureArcticLives Seminar March 14th

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Overview

We aim to demonstrate the economic implications of different climate change scenarios for reindeer herders in a set of stylized areas.

- Bioeconomic model
- Calibrate with data on past weather and slaughter weights
  - Empirical analysis
- Numerical simulation of model with three climate projection scenarios

Bioeconomic model

How does climate change affect reindeer herding?

climate change → grazing conditions → weight →reproduction →survival

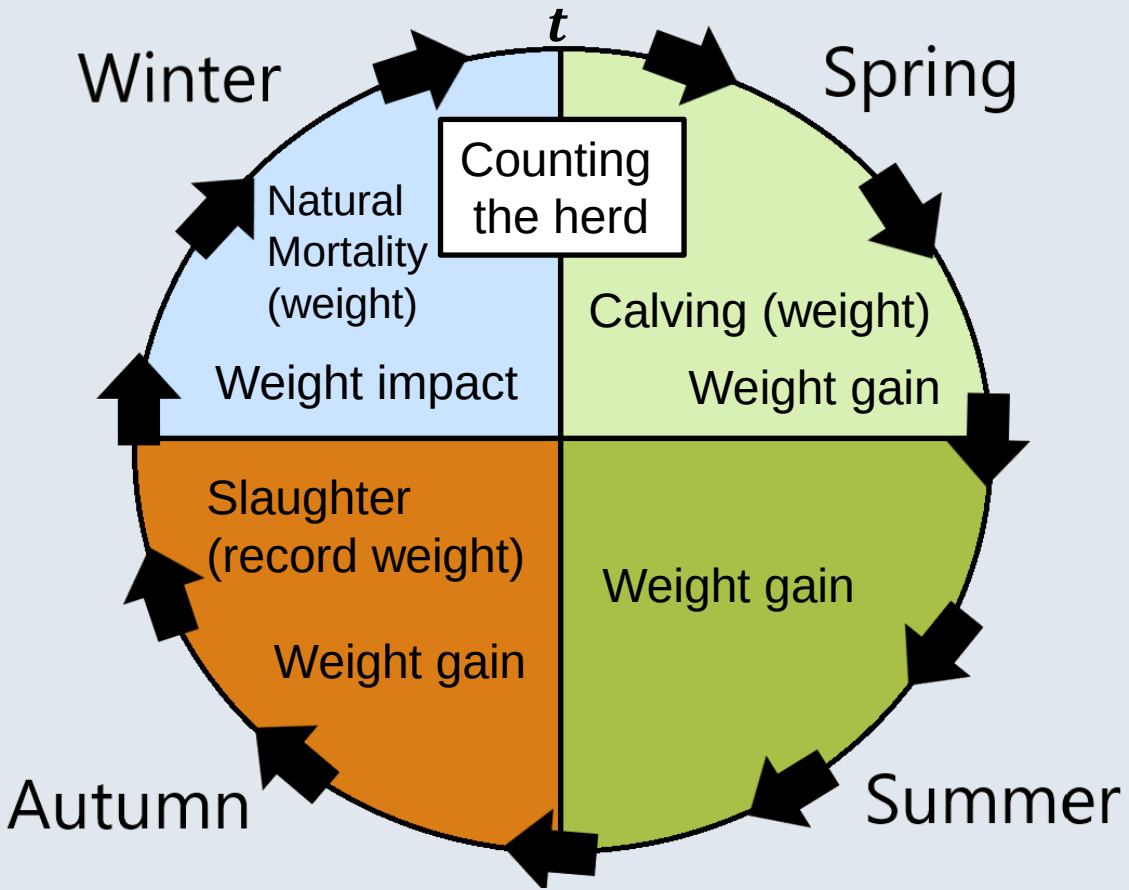
Profits/utility

Bioeconomic model

Events over the year-cycle

Spring/Summer effect: +

Winter effect: -

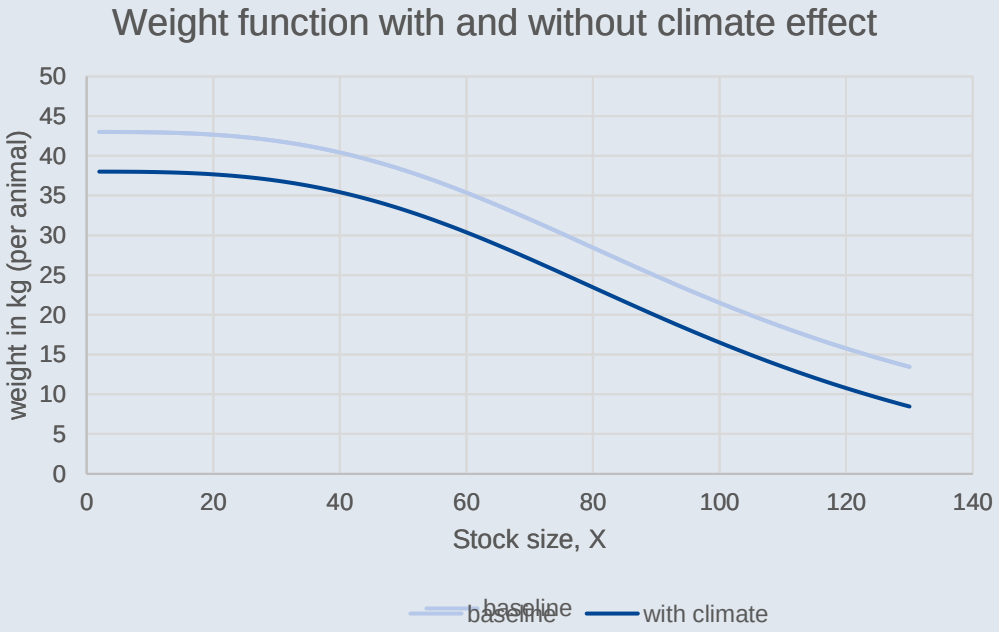


Weight function of adult reindeer

$$w_{i,t} = \frac{\overline{w_i}}{1 + (X_t/K)^{\beta}}$$

$$w_{i,t} = \frac{\bar{w}_i}{1+(X_t/K)^{\beta}} + \boldsymbol{\alpha_{1,i} C_{S,t}} + \boldsymbol{\alpha_{2,i}\, C_{W,t-1}}$$

$$i = f, m.$$



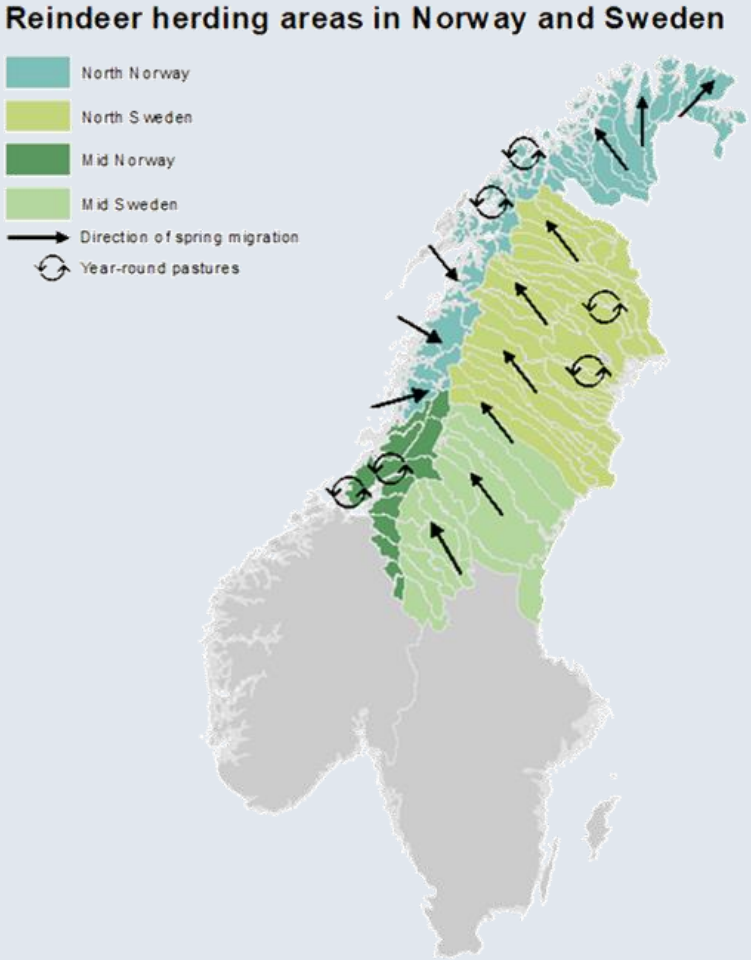
Data

Empirical analysis

- Norwegian district level data on slaughter weights, average for Sweden (1984 – 2020)
- Reanalysis data of historic weather (1984-2014) (CMIP6 multi model ensemble)

Numerical illustration

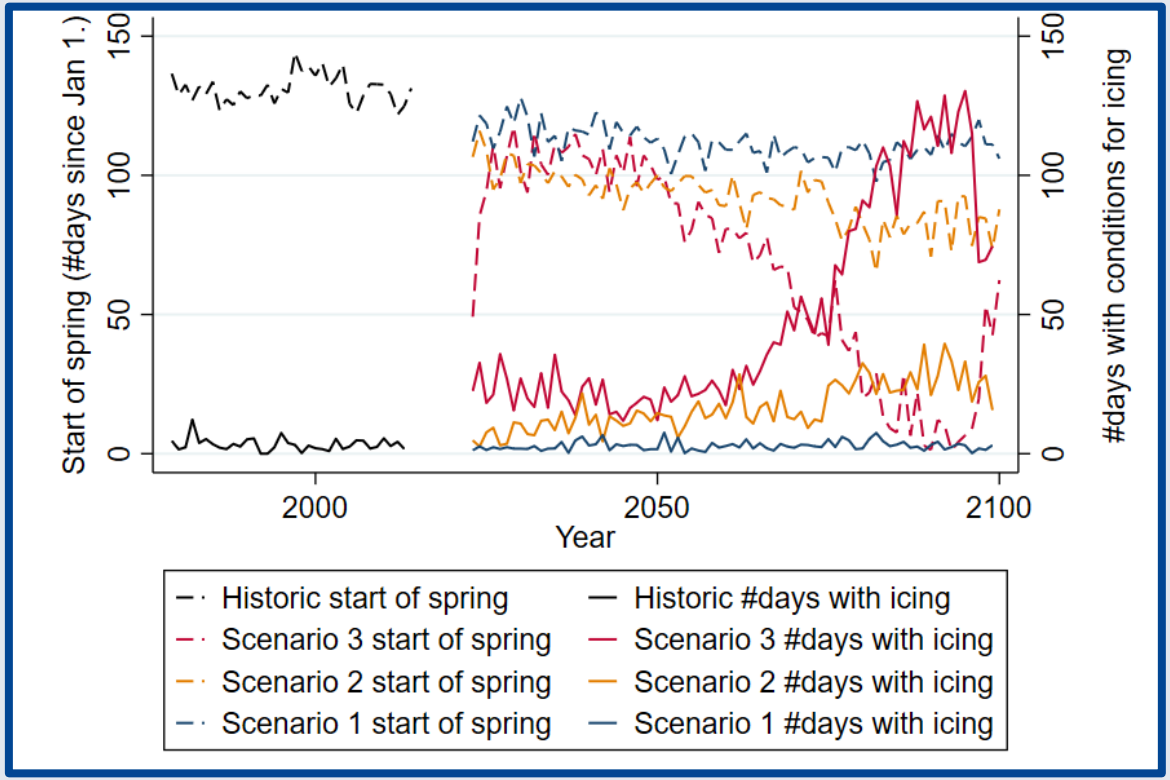
- Future climate projection data for three scenarios (1.5°C target, intermediate, business-as-usual)
  - Four simulation areas



Data

Historic weather observations

- On average, onset of spring was May 10th (130 days after Jan 1st) (min 100, max 205)
- There were, on average, 4.7 days with conditions for icing. (min 0, max 24)



Empirical analysis

$$w_{i,t} = \frac{\bar{w}_i}{1+(X_t/K)^{\beta}} + \alpha_{1,i} C_{S,t} + \alpha_{2,i}\, C_{W,t-1}$$

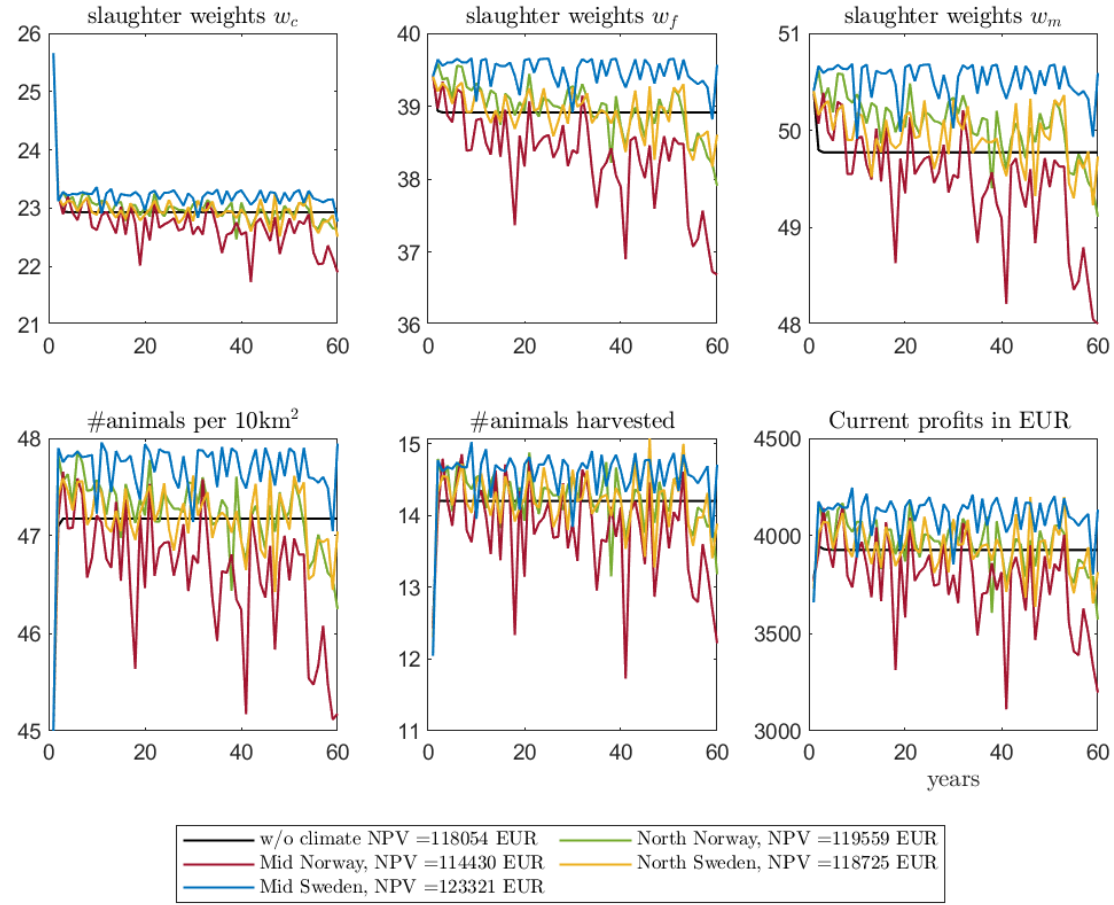
- If spring starts one day earlier than average (May 10th) slaughter weights of adult females increase by 28.7g (0.09 %)
- One more day with icing, than average, decreases slaughter weights by 67 g (0.22 %)

- There is a limit to how much reindeer can consume and grow
- An onset of spring earlier than average is related to slaughter weights that are 600 g higher than the mean, whereas a late onset of spring is related to a decrease in slaughter weights by 800 g.

Results

Scenario 2

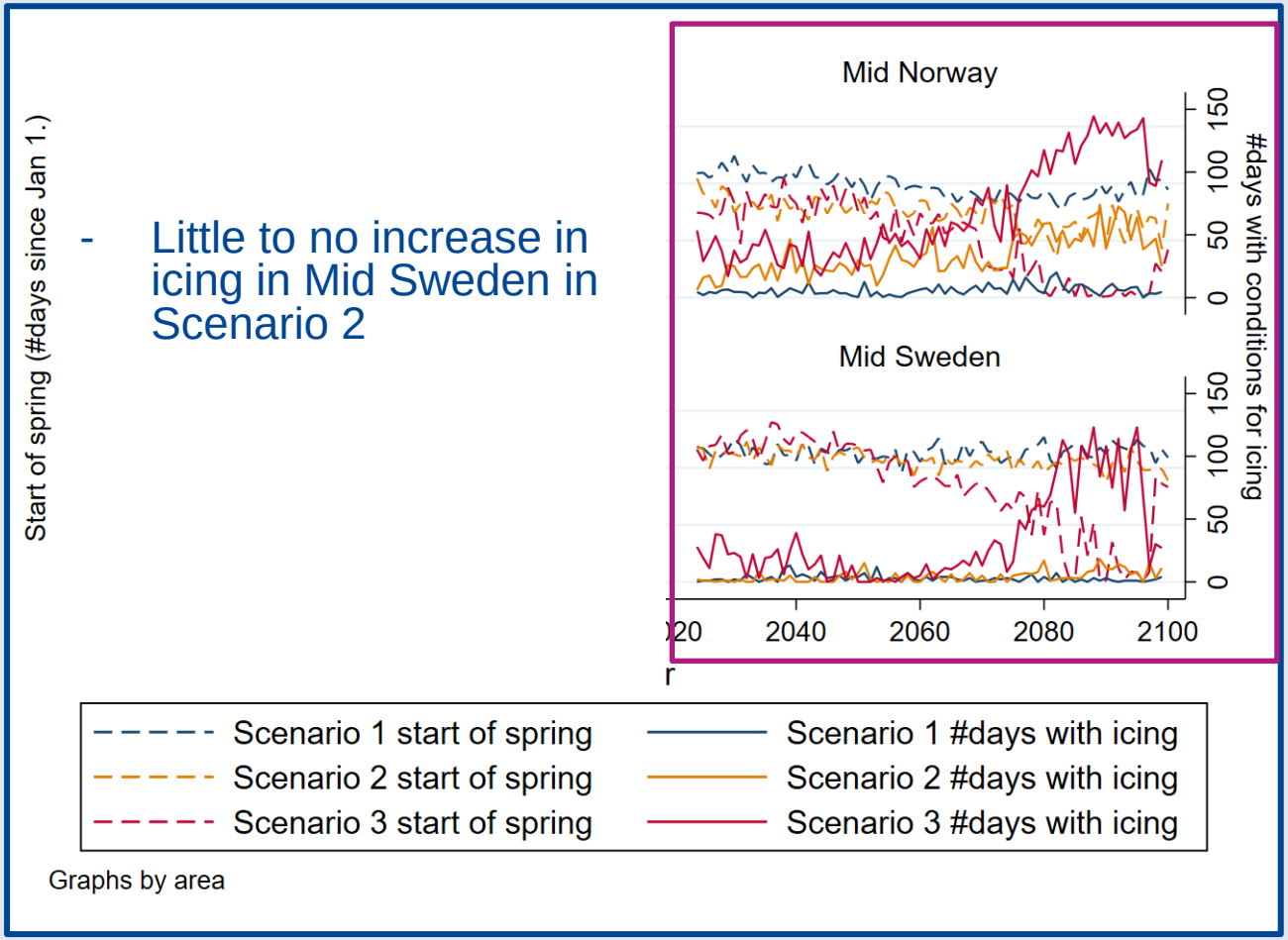
- Greater variation makes the future more unpredictable → Shock slaughter weights
- Negative weather shocks → Negative shock to current value profits
- Ambiguous adjustment strategy
- Mid Norway vs. Mid Sweden



Results

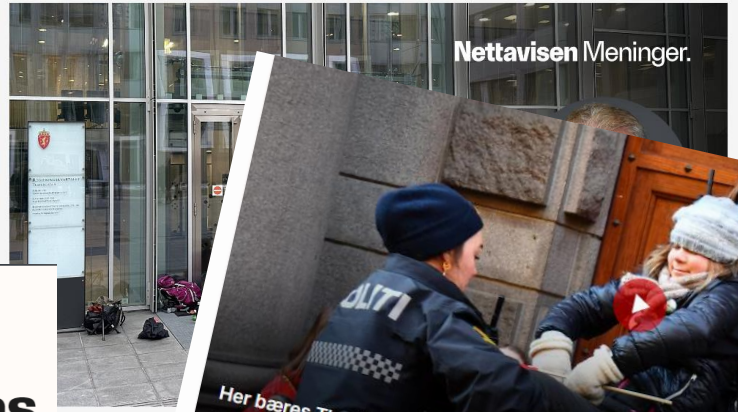
Weather projections

- Little to no increase in icing in Mid Sweden in Scenario 2



Samenes krav om å fjerne vindturbiner koster tre millioner kroner per reinsdyr

ANNONSE



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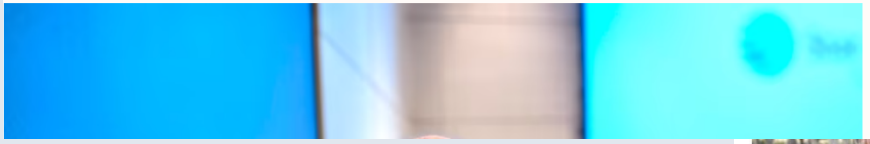
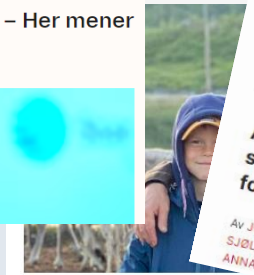
Vindkraft i Norge

Statkraft-sjef om Fosen-vindkraft: Tror riving kan unngås

Demonstranter i Oslo krever at to omstridte vindkraftverk på Fosen skal rives, men Statkraft-sjef Christian Rynning-Tønnesen tror det kan unngås. – Her mener jeg det må kunne være løsninger.



TTIGHETER: Samer
lir seks milliarder kr



STOLT BESTEFAR: Leif Arne Jåma er stolt be
reinsdyrene kan snart bli historie.
FOTO: TOR DANIEL JÅMA

Fosen-aksjonen i Oslo: Politiet har fjernet demonstranter

Aksjonen mot vindkraft på Fosen ble onsdag trappet opp, men klokken 09 startet politiet å bære bort aksjonister. Blant dem svenske Greta Thunberg, som forteller til VG at hun ikke har planer om å gi seg ennå.

Av JOSTEIN MATRE, OLE LØKKEVIK, ANNE MARTE BANG FOSSBERG, STELLA BUGGE, SILJE ENGHAUG , OLIVER BELLINDER, ESPEN SJØLINGSTAD HOEN (FOTO), TORE KRISTIANSEN (FOTO), GISLE ODDSTAD (FOTO), NAINA HELÉN JÅMA (FOTO), KLAUDIA LECH (FOTO), ANNA JULIE NYTRØEN BERGESEN og JULIE TRAN

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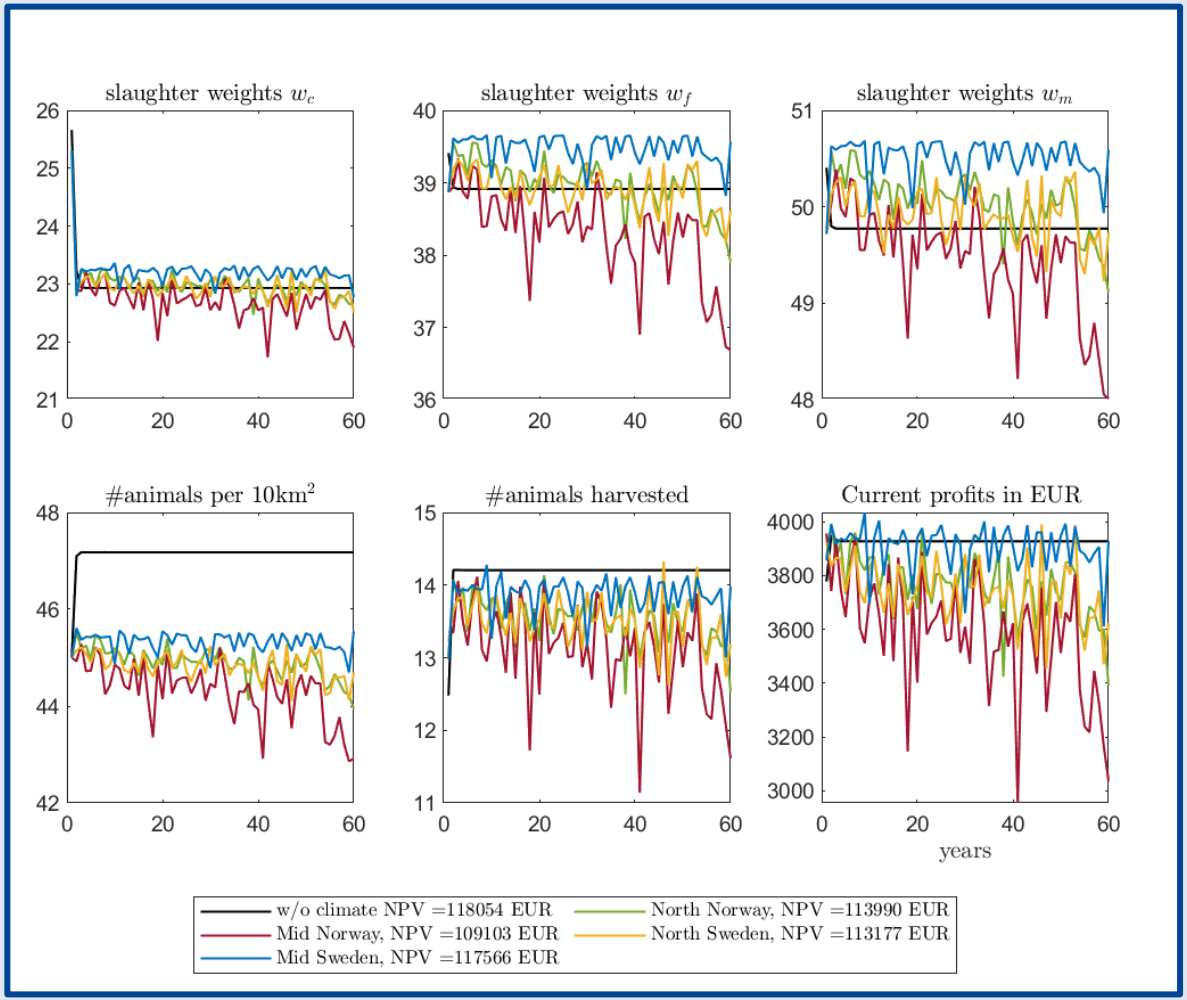
5% Reduction in carrying capacity

Tømmervik et al. (2022) calculated the range area loss related to the windfarm in Storheia and Roan in Trøndelag. The direct loss amounted to 5 % and indirect loss up to 25 %



Reduction in carrying capacity

% change in NPV

	Scenario	Baseline carrying capacity	5 % reduction in carrying capacity	25 % reduction in carrying capacity
North Norway	1	4.04	-0.82	-20.61
	2	1,27	-3.44	-22.71
	3	-3.77	-8.25	-26.49
Mid Norway	1	3.59	-1.27	-20.96
	2	-3.07	-7.58	-25.96
	3	-10.27	-14.41	-31.37
North Sweden	1	3.31	-1.52	-21.18
	2	0.57	-4.13	-23.23
	3	-6.35	-10.65	-28.41
Mid Sweden	1	4.09	-0.75	-20.59
	2	4.46	-0.41	-20.29
	3	-2.81	-7.32	-25.78

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Concluding remarks

- Earlier spring and reduced icing can generate improvements in Scenario 1 and 2
  - Except Mid Norway which will experience a greater increase in icing events
- All areas experience a net loss in Scenario 3
- Adjustment strategies are ambiguous, but generally weights decrease and it is optimal to harvest less as we move through the scenarios
- Policies that lead to land loss and may be required to reach Scenario 1 or 2 may be more detrimental than the climate impact.

Questions and discussion