

Bioeconomics of reindeer husbandry in Fennoscandia

Arctic Science Summit Week 27.3.2022

Session: Nordic Centres of Excellence in Arctic Research

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ReiGN: Reindeer Husbandry in a Globalizing North

Introduction

- **Reindeer:** keystone species in arctic
- **Reindeer husbandry:** important economic activity in Arctic
- **Reindeer research:** focused mainly on biology/ecology
 - *Need for interdisciplinary approaches*
- **ReiGN:** Reindeer husbandry in a Globalizing North
- **WP5:** Bioeconomics of reindeer husbandry
 - *Interdisciplinary **economic-ecological** approach*



Bioeconomic reindeer husbandry model:

- **Based on discrete time reindeer-lichen model**
- **Age-classes:** 16 female, 12 male
- **Population dynamics:** Winter food limitation → weight, mortality, reproduction
- **Reproduction:** Modified harmonic mean mating function + winter food
- **Diet choice:** Optimal foraging theory
→ Lichen, other cratered food, arboreal lichens, supplementary food
- **Empirical data for the functions and parameters:**
→ Previous research, data from LUKE and Reindeer Herders' Association.
- **Objective function:**
→ Reindeer herding district maximizes the present value of the net revenues



Publications:

- Tahvonen, O, Kumpula, J and Pekkarinen A.-J. 2014. Ecological Modelling 272: 348-361. *Optimal harvesting of an age-structured two sex herbivore-plant system.*
- Pekkarinen, A.-J, Kumpula J. and Tahvonen O. 2015. Ecological Modelling 312: 256-271. *Reindeer management and winter pastures in the presence of supplementary...*
- Pekkarinen, A.-J, Kumpula J. and Tahvonen O. 2017. Ecology and Evolution 7: 8282-8302. *Parameterization and validation of an ungulate-pasture model.*
- Pekkarinen, A.-J. 2018. Dissertationes Forestales 249: 8282-8302. *Ecology and economics of reindeer herding systems.*

Research topics (during ReiGN):

- **Sustainability of reindeer husbandry and winter lichen pastures:**
 1. *Ecology and economics of reindeer herding systems* (Dissertationes Forestales, 2018)
 2. *Parameterization and validation of an ungulate-pasture model* (Ecology and Evolution. 2017)
- **Pasture dynamics, economic incentives and max number of reindeer:**
 3. *What Drives the Number of Semi-domesticated Reindeer?* (Springer Polar Sciences, 2021)
- **Costs of predation:**
 4. *Predation costs and compensations in reindeer husbandry* (Wildlife Biology, 2020)
- **Effects of stochastic winter conditions:**
 5. *Winter condition variability decreases the economic sustainability of reindeer husbandry*
- **Variation within and between and Fennoscandian countries:**
 6. *Bioeconomics of reindeer husbandry in Fennoscandia* (ReiGN Book, Routledge, in Print)
- **Forestry, carbon sequestration and reindeer husbandry:**
 7. *Economics of multifunctional forestry in the Sámi people homeland region of reindeer husbandry in Fennoscandia* (Journal of Environmental Economics and Management, 2021)



This presentation:

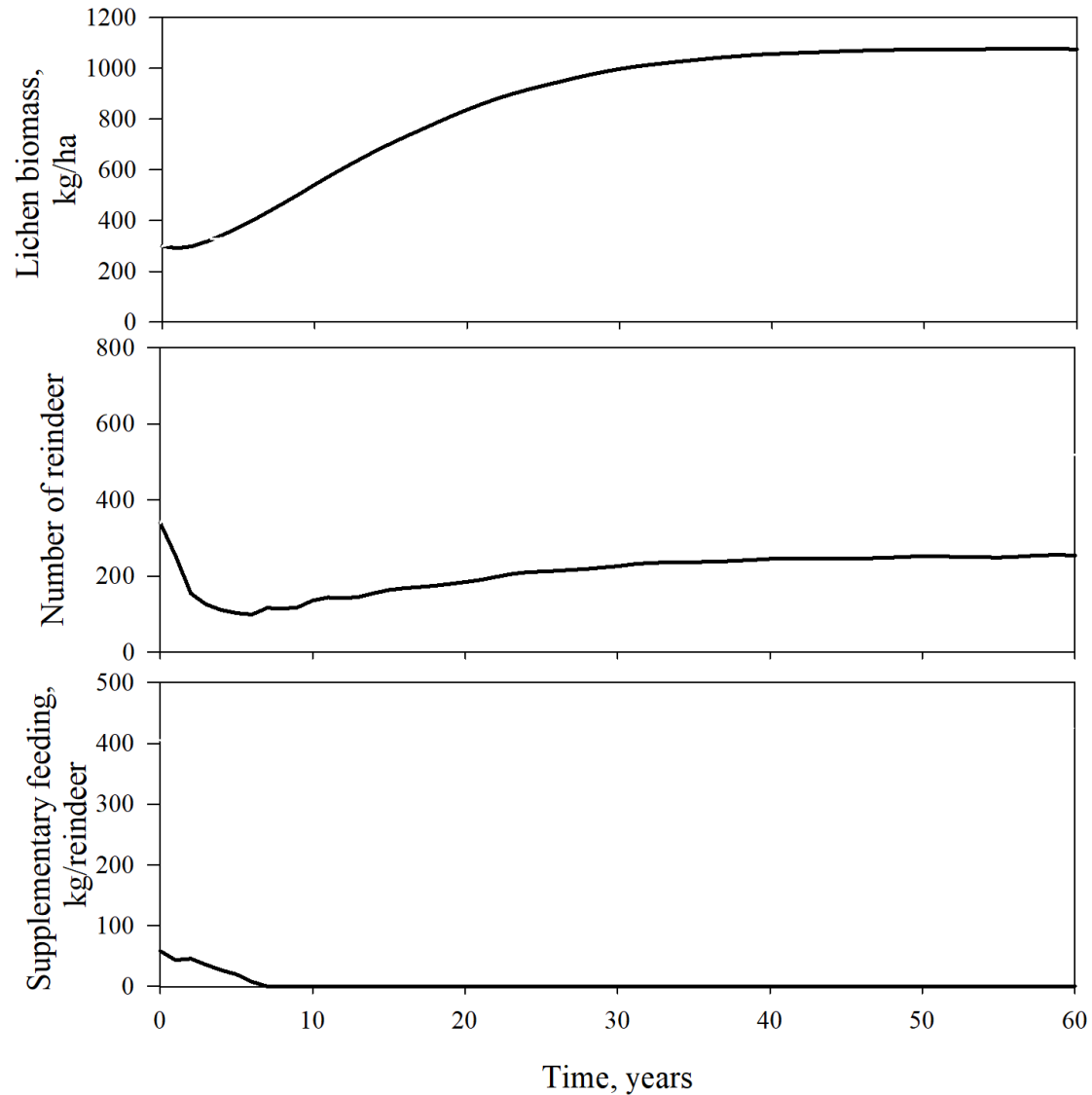
1. Economically optimal lichen biomass, supplementary feeding and overgrazing
2. Drivers in Reindeer Husbandry over Recent Decades



RESULTS



1. Example of economically optimal model solution



Initial state:

- Lichen=300, Reindeer=350

Optimal steady state 1

- Lichen=1070, Reindeer=270

Supplementary feeding:

- During first years

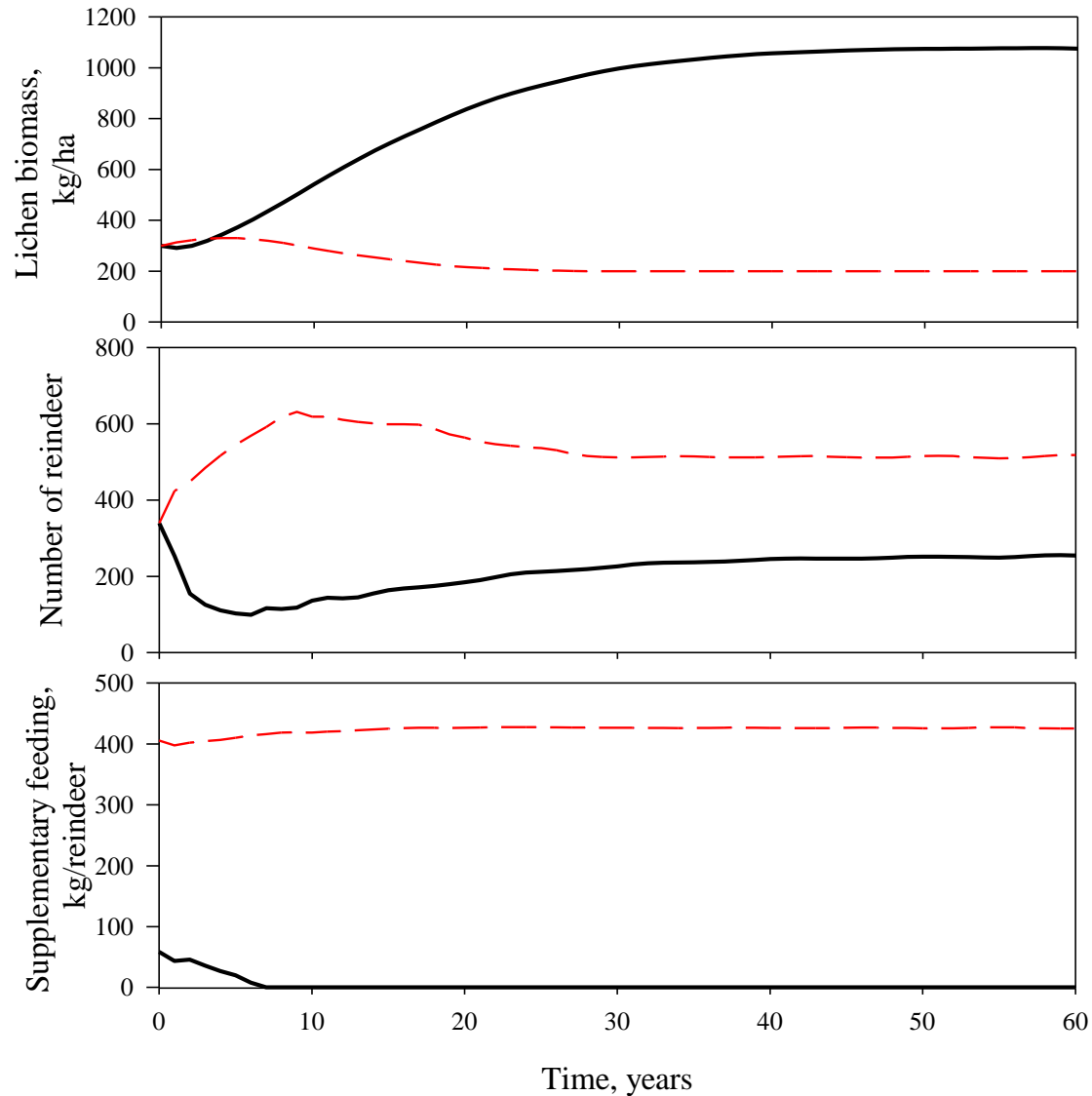
Overgrazing in initial state:

- Maybe?

— Price of supplementary food 0.5€/kg



1. Example of economically optimal model solution



Initial state:

- Lichen=300, Reindeer=350

Optimal steady state 1 and 2

- Lichen=1070, Reindeer=270

- Lichen=200, Reindeer=520

Supplementary feeding:

- During first years

- Also in steady state

Overgrazing in initial state:

- Maybe?

- Maybe not?

— Price of supplementary food 0.5€/kg
- - Price of supplementary food 0.1€/kg



2. Lichen biomass and supplementary feeding in economically optimal steady states

Interest rate	Lichen pastures in old pine forests
1 %	1051
3 %	801
5 %	703

Lichen biomass, kg/ha



2. Lichen biomass and supplementary feeding in economically optimal steady states

Interest rate	Lichen pastures in old pine forests	Lichen pastures in young forests or mountains
1 %	1051	914
3 %	801	688
5 %	703	101*

Lichen biomass, kg/ha

* Supplementary food used as a main energy resource, lichen biomass very low

Factors promoting supplementary feeding and low lichen biomass:

- *High interest rate*
- *Low lichen growth rate*



2. Lichen biomass and supplementary feeding in economically optimal steady states

Interest rate	Lichen pastures in old pine forests	Lichen pastures in young forests or mountains	No pasture rotation system
1 %	1051	914	858
3 %	801	688	151*
5 %	703	101*	101*

Lichen biomass, kg/ha

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2. Lichen biomass and supplementary feeding in economically optimal steady states

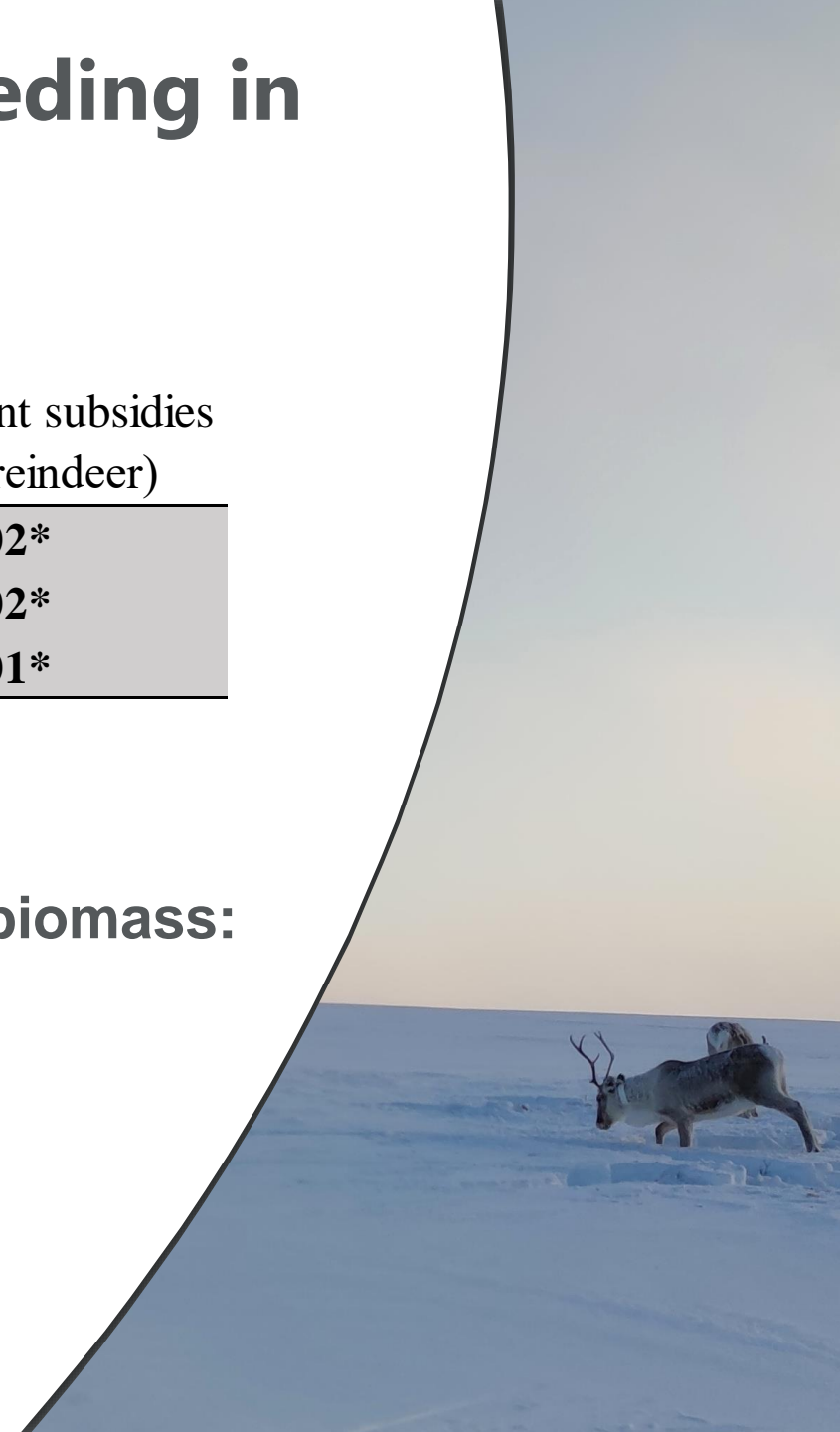
Interest rate	Lichen pastures in old pine forests	Lichen pastures in young forests or mountains	No pasture rotation system	Government subsidies (28.5€/reindeer)
1 %	1051	914	858	102*
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5 %	703	101*	101*	101*

Lichen biomass, kg/ha

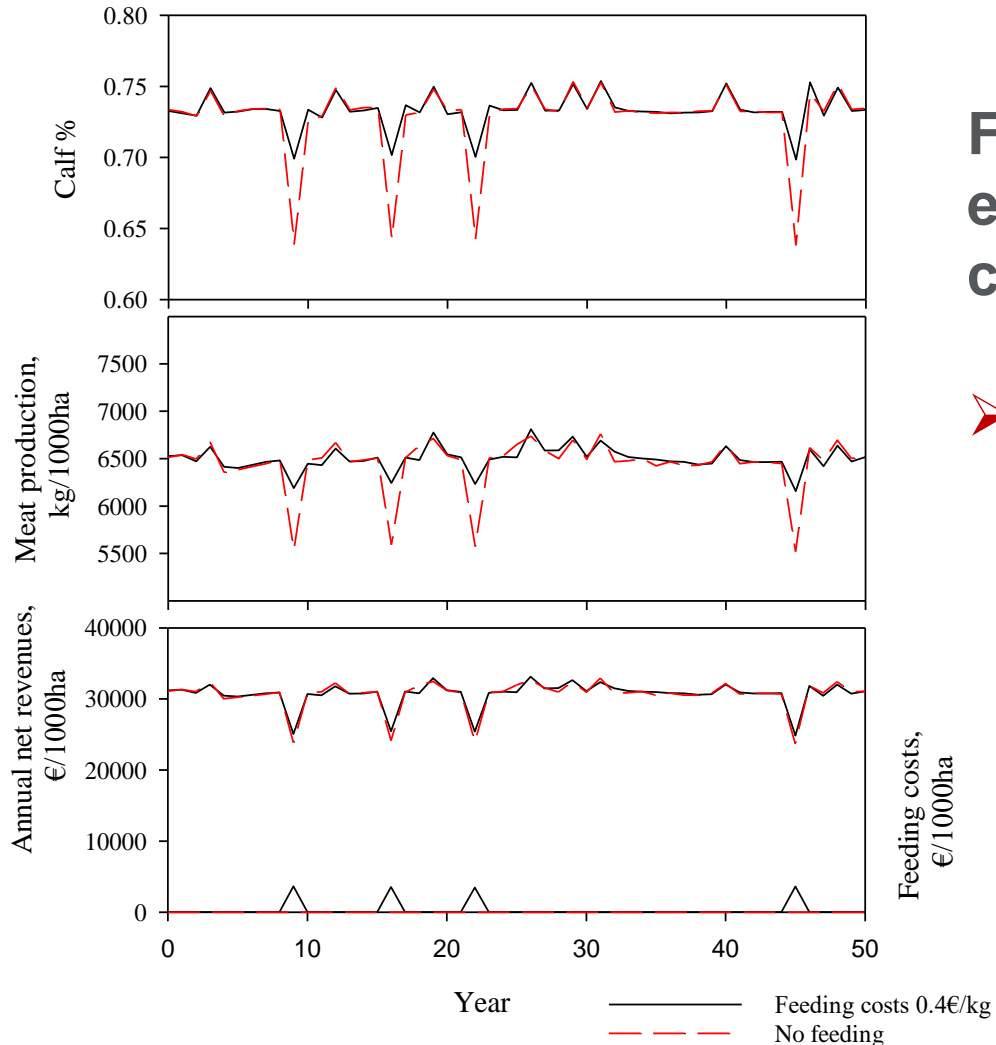
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Factors promoting supplementary feeding and low lichen biomass:

- *High interest rate*
- *Low lichen growth rate*
- *No pasture rotation system*
- *Government subsidies*



3. Supplementary feeding during difficult winters



Feeding during difficult winters ensures higher meat production and calf % than without feeding:

- However, due to high feeding costs, net revenues remain low.



4. Drivers in Reindeer Husbandry over Recent Decades

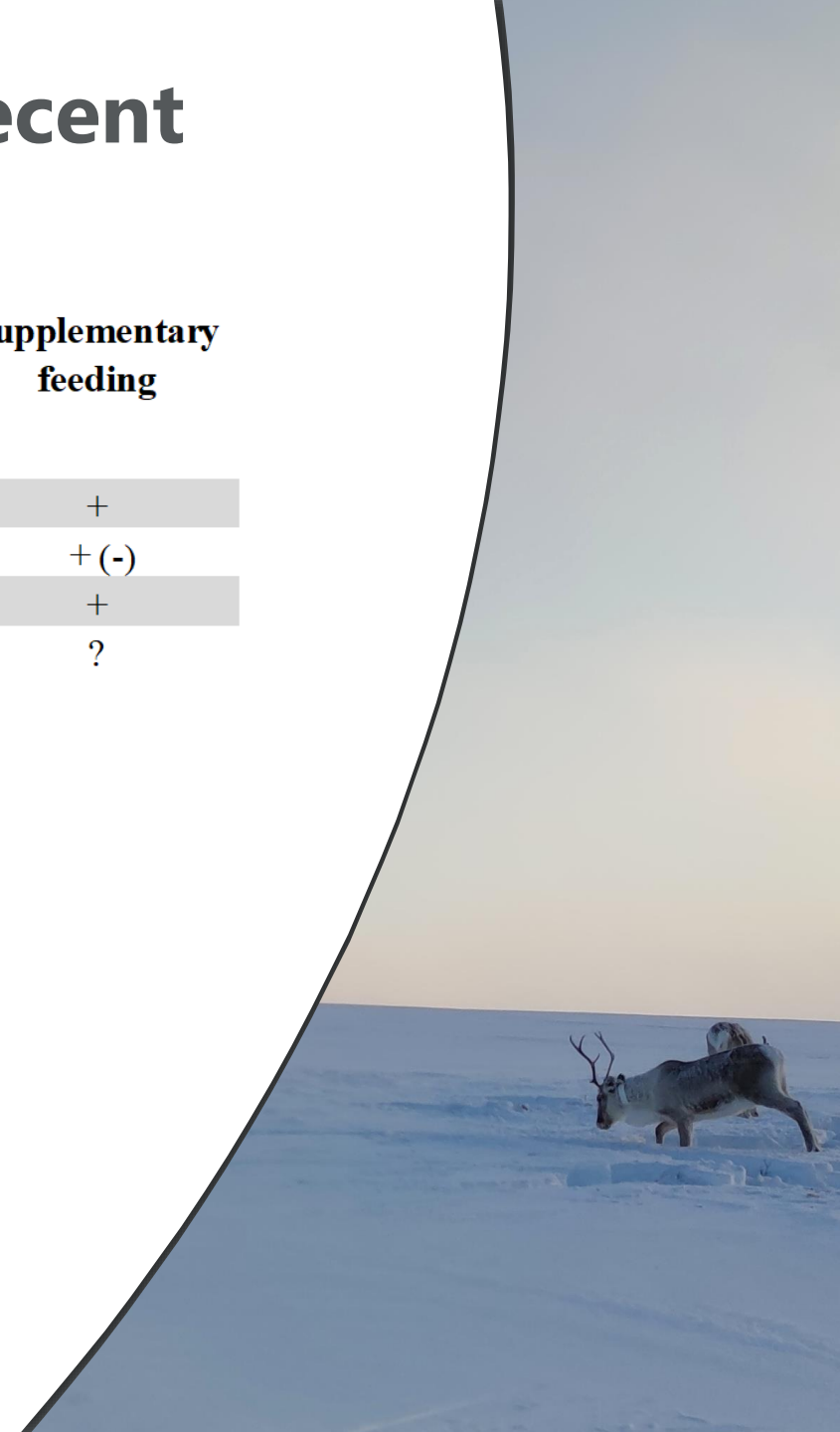
	Reindeer numbers	Lichen biomass	Net revenues	Supplementary feeding
Changes in natural conditions:				
Decreasing area of old pine forests	-	-	-	+
Decreasing area of old spruce forests	-	- (+)	-	+ (-)
Increasing stochastic variation in winter conditions	?	?	-	+
Increasing predation mortality	-	-	-	?

+ driver increases the target variable

- driver decreases the target variable

? unsure direction or not studied

() effect during transition phase may be opposite to steady-state effect



4. Drivers in Reindeer Husbandry over Recent Decades

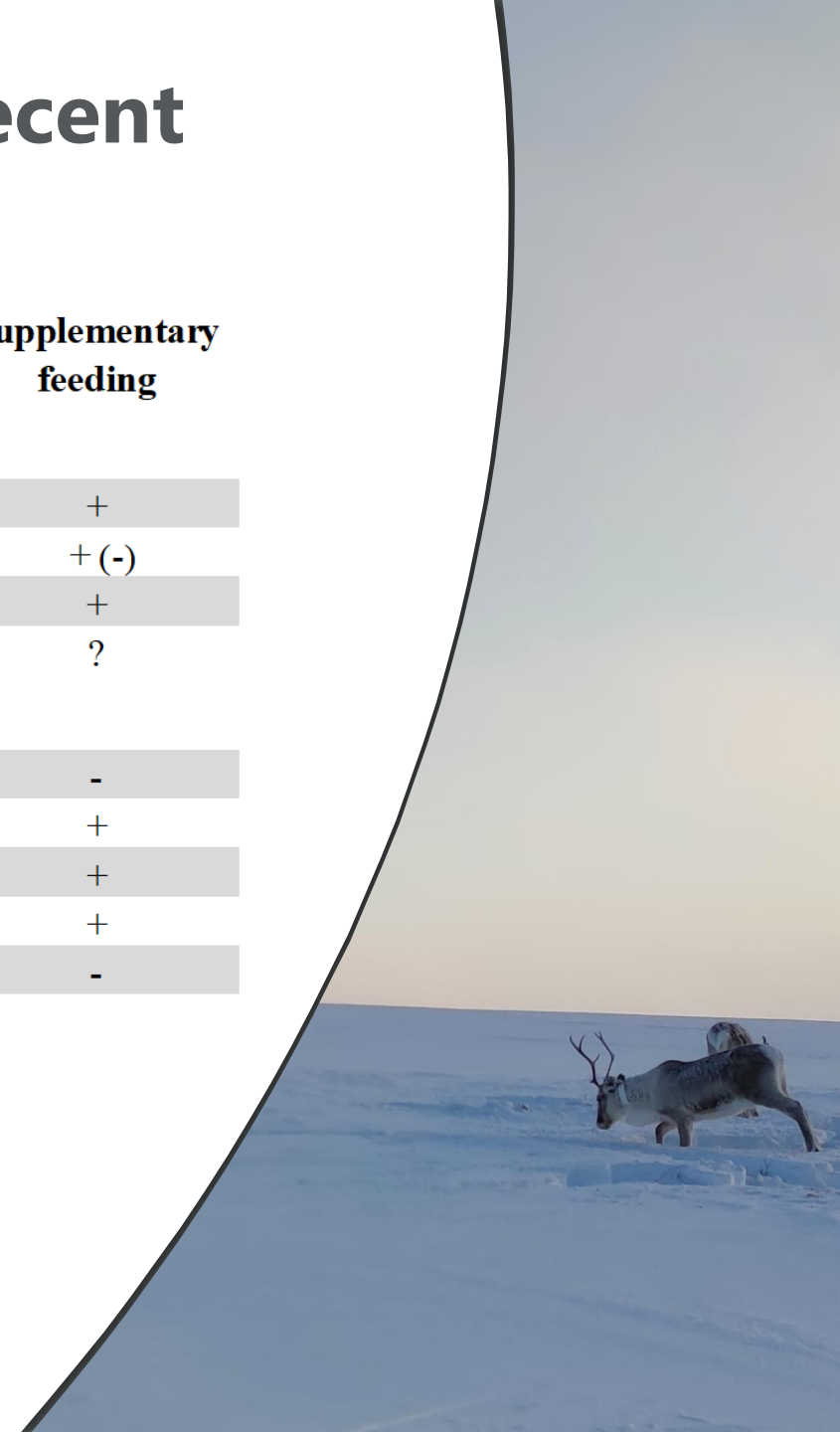
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Decreasing area of old spruce forests	-	- (+)	-	+ (-)
Increasing stochastic variation in winter conditions	?	?	-	+
Increasing predation mortality	-	-	-	?
Changes in mangement and economics				
Increasing management costs	-	+	-	-
Increasing meat price	+	-	+	+
Decreasing costs of supplementary feeding	+	-	+	+
Increasing governmental subsidies	+	-	+	+
Increasing use of pasture rotation system	+	+	+	-

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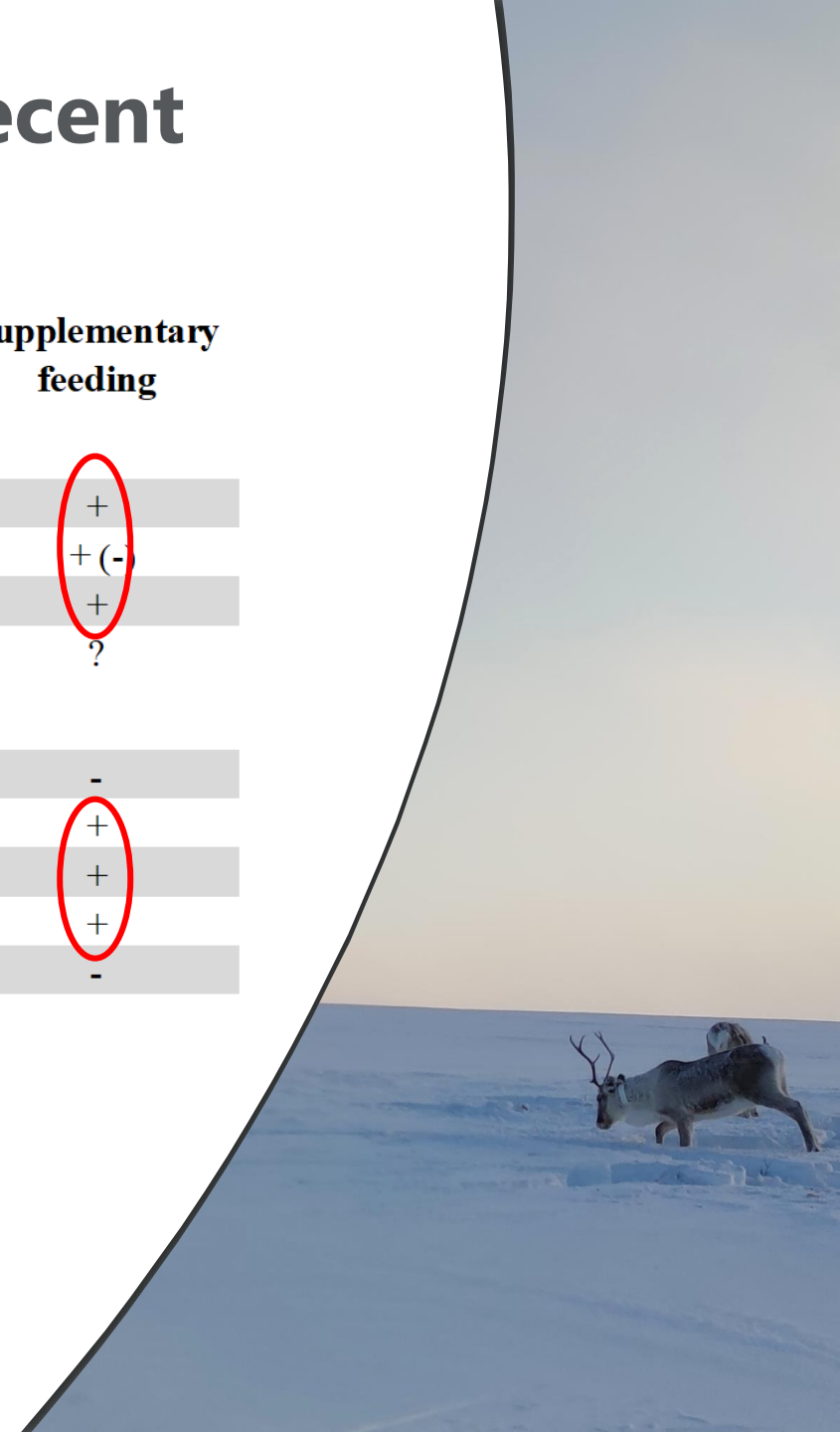
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Thank you!

