COAT

«Climate-Ecological Observatory for Arctic Tundra»

A plan for adaptive climate-impact monitoring of terrestrial food webs in Arctic Norway

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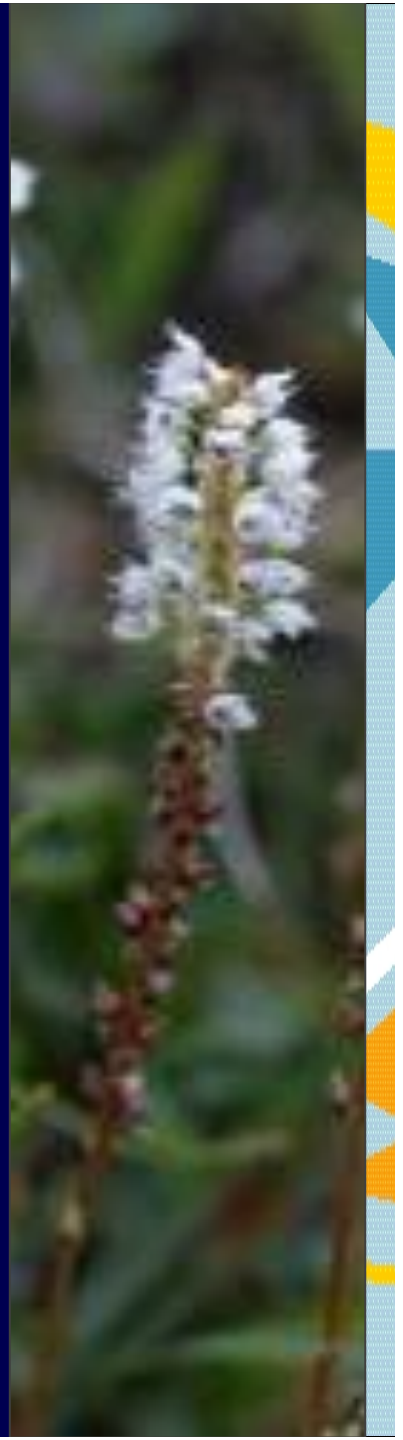
Fram – High North Research Centre for Climate and the Environment

Photo: C. Hübner, T. Nordstad, B.E. Sandbakk; K. Blom

The 5 questions …..

1. What defines EBM and what are optional approaches?
2. What is the EBM approach adopted in the ongoing programs?
3. Are adaptivity and management options included in ongoing programs and eventually how?
4. What are the key insights gained so far from ongoing programs and approaches?
5. To what extent do the ongoing programs reflect site-specific idiosyncrasy versus biome scale generality?



The COAT Science Plan

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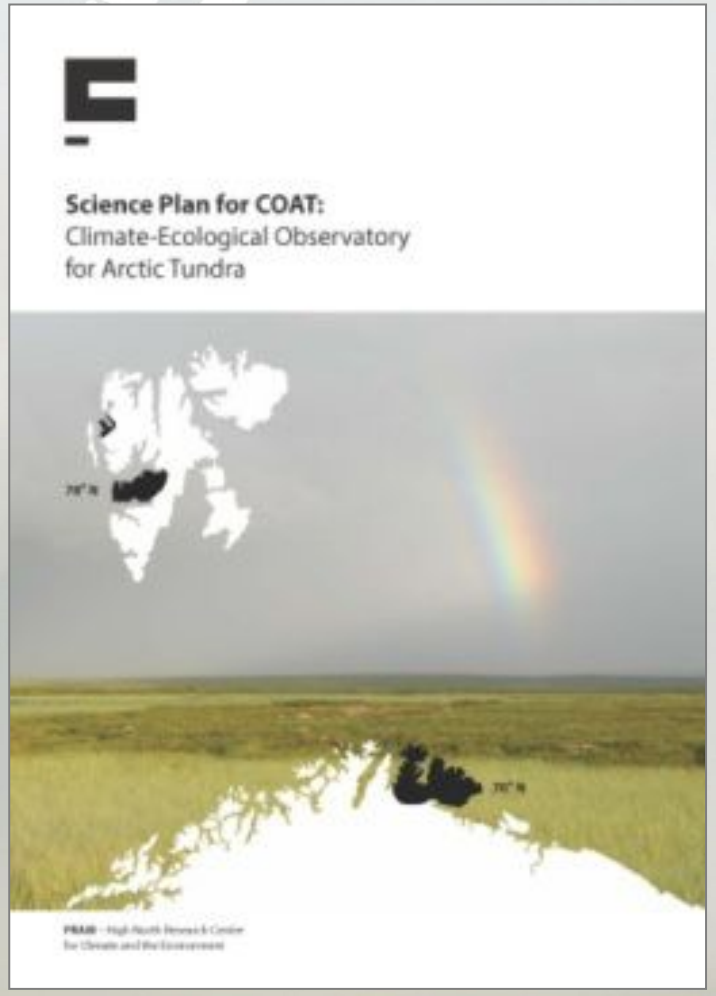

- Outlines implementation of an **adaptive monitoring system** that documents how focal components of Norwegian tundra ecosystems respond to climate change
- Is currently a plan for a substantial expansion of ongoing monitoring in low- and high-Arctic Norway
- Builds on ongoing research and long-term monitoring of focal species
- Target two focal tundra ecosystems in the Norwegian Arctic

2013 : Final Plan Published
Fram Centre report series no.1, http://www.aminor.org/coat

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University of Tromsø · NINA · Meteorologisk institutt · UNIS · Framsenteret

The focal ecosystems

Varanger Peninsula

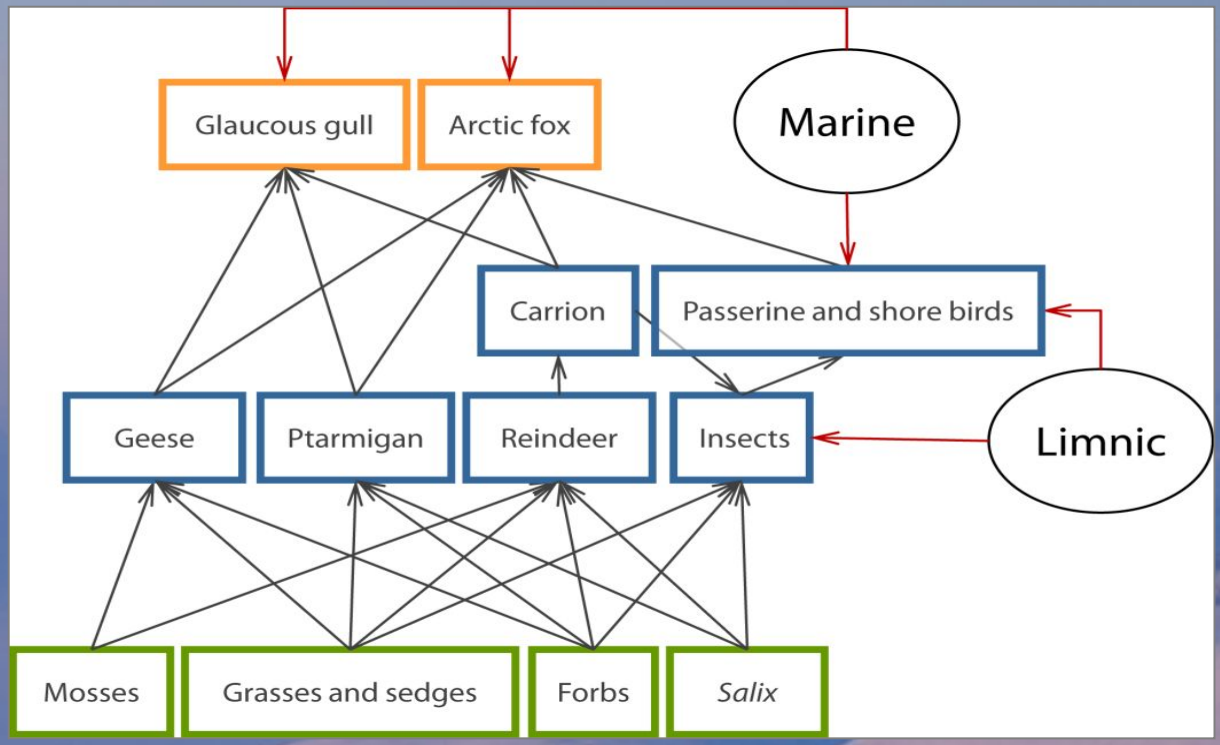
Low arctic – bordering sub-arctic

Svalbard

High Arctic - 2 bioclimatic zones
(middle & northern Arctic tundra zones)

COAT Svalbard - used to illustrate the approach

The tundra food-web in Svalbard



- The relatively simple plant based terrestrial food web
- Lack rodents, lemmings and specialist predators
- BUT houses local managed herbivores and the apex predator

Photo: E. Fuglei ; figure from Ims et al. 2013

COAT focus on 2 drivers of ecosystem changes-
«Climate change» and **«local management»**

COAT applies a «**Food-web approach»**
that targets climate senstive species and functional groups that are and/or can be locally managed

COAT is …..

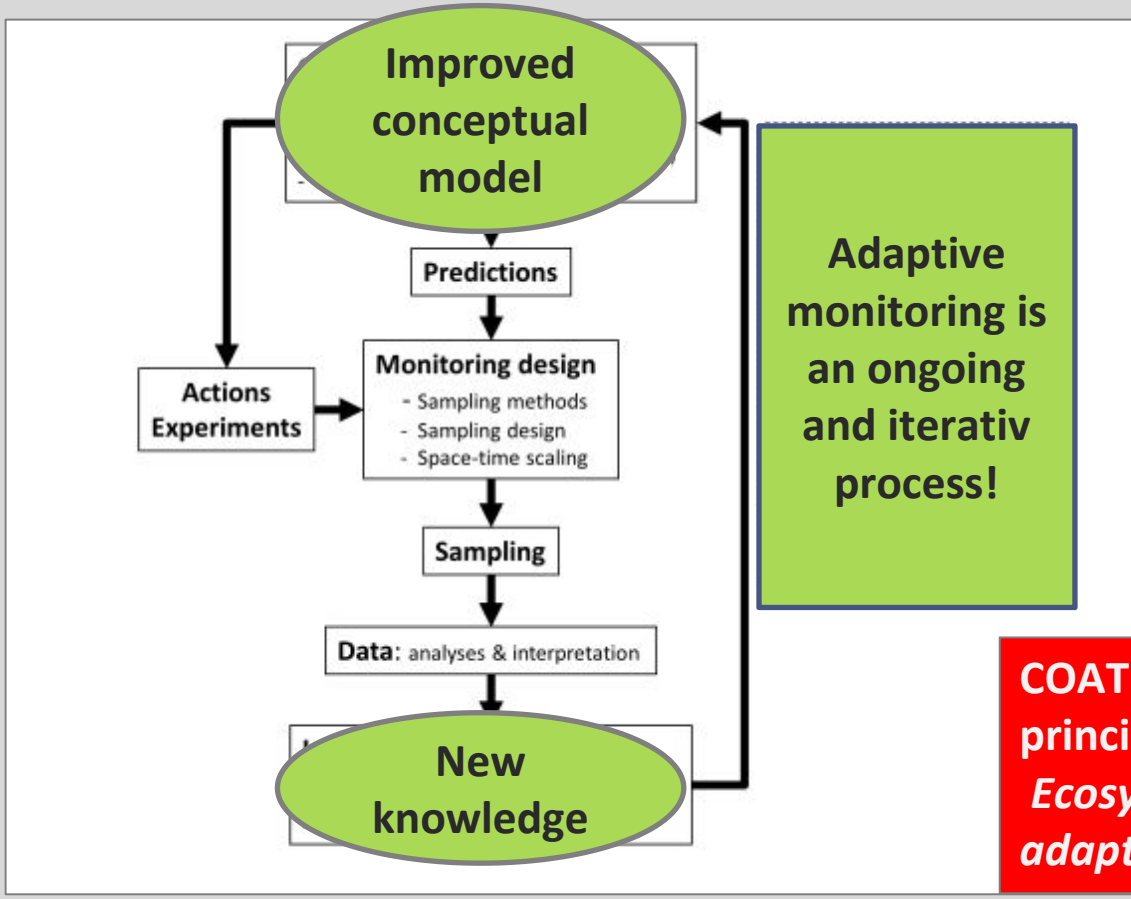
Ecosystem-based with focus on:

- Key-ecosystem services and management relevance
- Key species and assemblages in the ecosystem
- Processes with a high sensitivity to climate change
- Active involvement of stakeholders

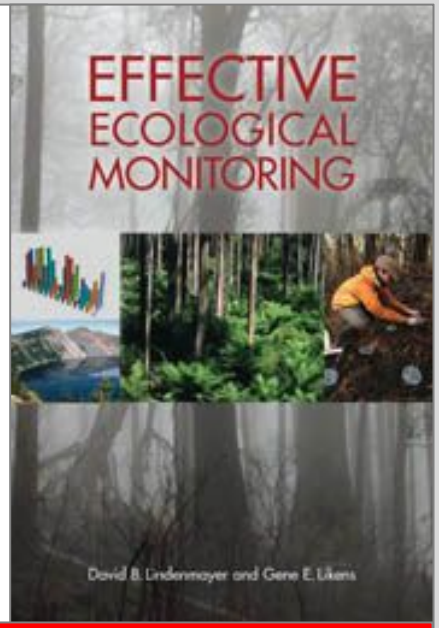
Adaptive with focus on:

- Principles of *Ecosystem-based adaptive monitoring*

Adaptive monitoring (Lindenmayer and Likens 2009)



Adaptive monitoring is an ongoing and iterativ process!



COAT is anchored in the principles of *Ecosystem-based adaptive monitoring*

Lindenmayer & Likens 2009a,b, 2010, 2011

Q 3: *Are adaptivity and management options included in ongoing programs and eventually how?*

4 Svalbard

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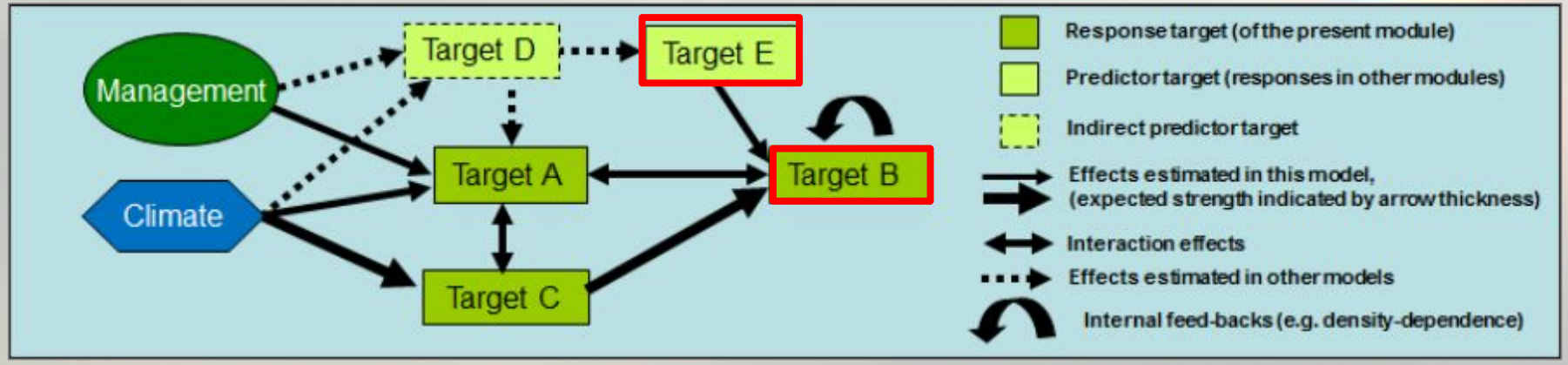
COAT conceptual models

Common structural model framework =
climate and management impact path models

- Response and predictor targets
- Internal interactions within and among targets (e.g. competition, trophic)



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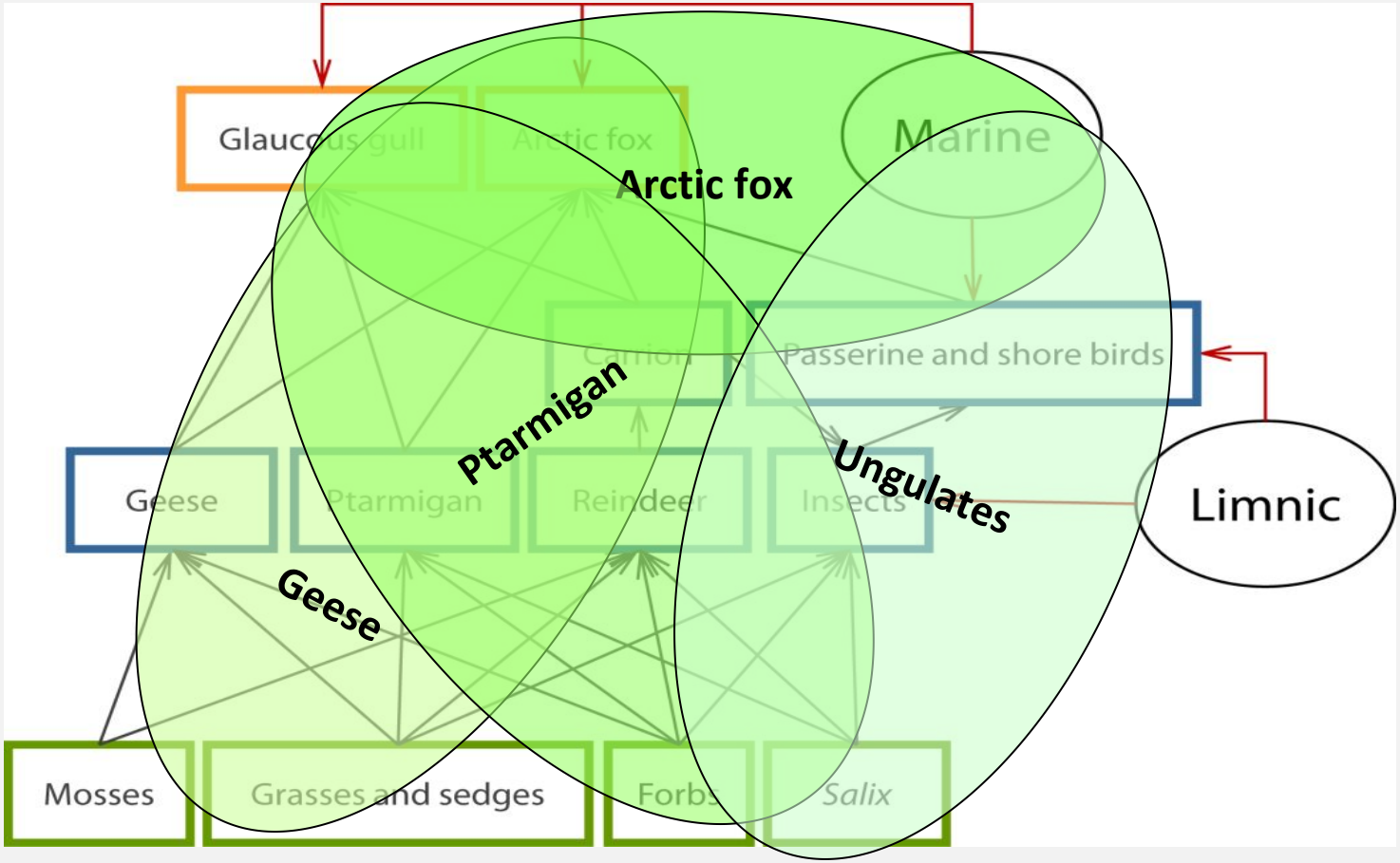
7 Varanger Peninsula

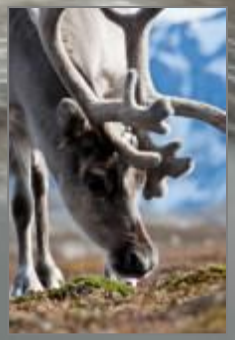
Modules cover 4 overlapping compartments of the food web



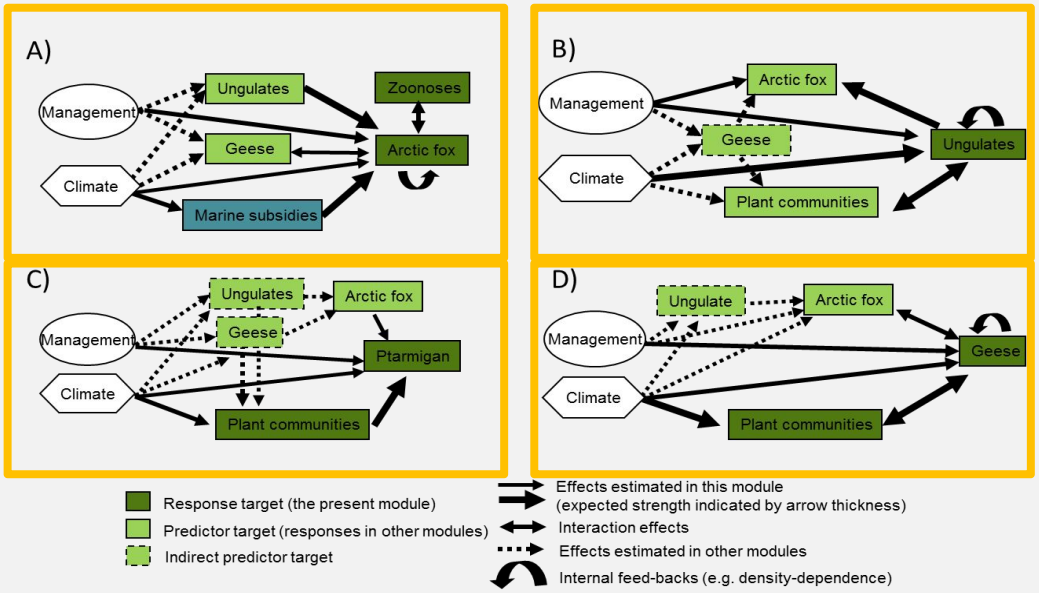
Modules overlap and are linked by trophic and non-trophic interactions

Modules contain

- Locally managed and harvested species
- Large parts of the «Plant based terrestrial food web»




4 food web based modules with 7 response targets



‘Arctic fox’

‘Ptarmigan’

‘Reindeer’

‘Geese’

Monitoring targets = state variables

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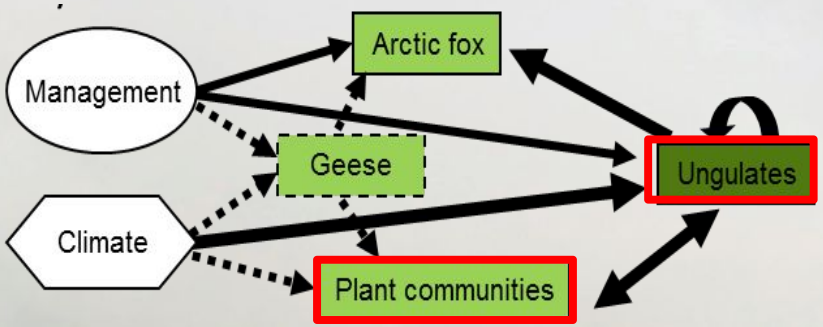
Each **response a**nd **predictor target**, and **climate** and **management impacts** are measured in terms of **state variables**



Response target = Svalbard reindeer

Target	State variable	Interval (start)	Methods (references)	Module
Ungulates	Svalbard reindeer abundance and demographic structure	1 yr (1979)	Population surveys (Solberg et al. 2001, Aanes et al. 2003)	2.5, 2.8
	Svalbard reindeer body mass, pregnancy and calving rates (spring/summer)	seasonal (1995)	Individual-based measures (Stien et al. 2002, Stien et al. 2012)	2.5, 2.8
	Svalbard reindeer habitat use	Seasonal	GPS collared individuals (Stien et al. 2010a)	2.5

Predictor target = plant communities

Target	State variable	Interval (start)	Methods (references)	Module
Plant communities	Quantity and quality of goose and reindeer forage plants in marshes: Grasses/sedges	1 yr	Biomass/leaf area index and protein content in selected plants and plots at time of hatch (Pettorelli et al. 2011; ITEX Protocol, www.geog.ubc.ca/itex; Madsen et al. in prep.)	2.5, 2.7
	Pink-footed goose grubbing impact on fen habitats	1 yr (2003)	Quadrat and point-intercept sampling of vegetation cover and composition on fixed transects along altitudinal transects (Madsen et al. 2011)	2.6, 2.7
	Abundance (biomass) and phenology of spring/summer herbivore forage plants: Altitudinal gradients: Polar willow (Salix polaris) and Bistorta (Bistorta vivipara)	1 yr	Abundance estimation by: point intercept method (Bråthen and Hagberg 2004) Estimation of phenology-temperature curves	2.6, 2.7

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Quantitative analyses

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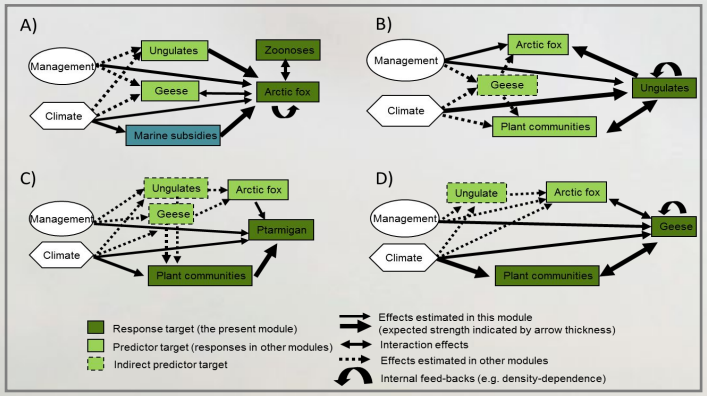
Conceptual models



State variables

Target	State variable	Interval (start)	Methods (references)	Module
Plant communities	Quantity and quality of goose and reindeer forage plants in marshes	1 yr	Biomass/leaf area index and protein content in selected plants and plots at time of hatch (Pattenaik et al. 2011; ITEX Protocol, www.geog.ubc.ca/itex, Madsen et al. in prep.)	2.5, 2.7
	Grasses/sedges			
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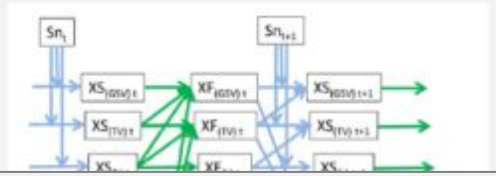
			Estimation of phenology-temperature curves	

Statistical models



Structural equation models

- State space approach
- Measurement errors
- Autocorrelation
- Bayesian updating

Use various ***state-of-the-art*** *statistical methods*

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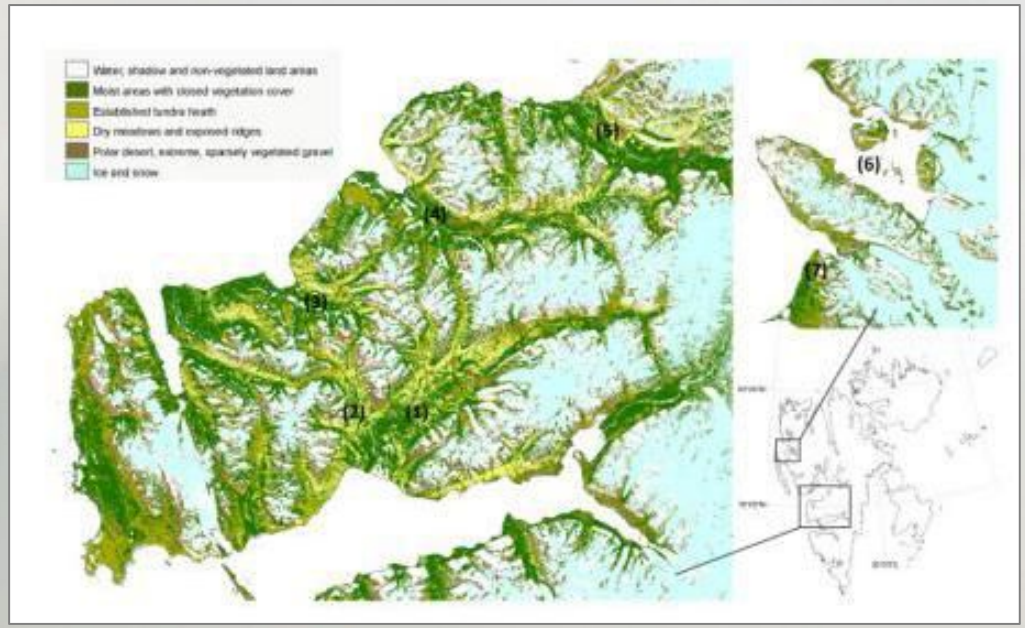
Monitoring design

A hierarchical design with two main levels of sampling intensity



Intensive sites: targets with **rapid response** to climate impacts (monthly – seasonal – annual)

Extensive sites: targets with **slower response** to climate impacts
(5-year intervals)

5valleys in Nordenskiöld Land (Middle Arctic zone) and 2 areas in Brøgger Peninsula (High-Arctic zone)

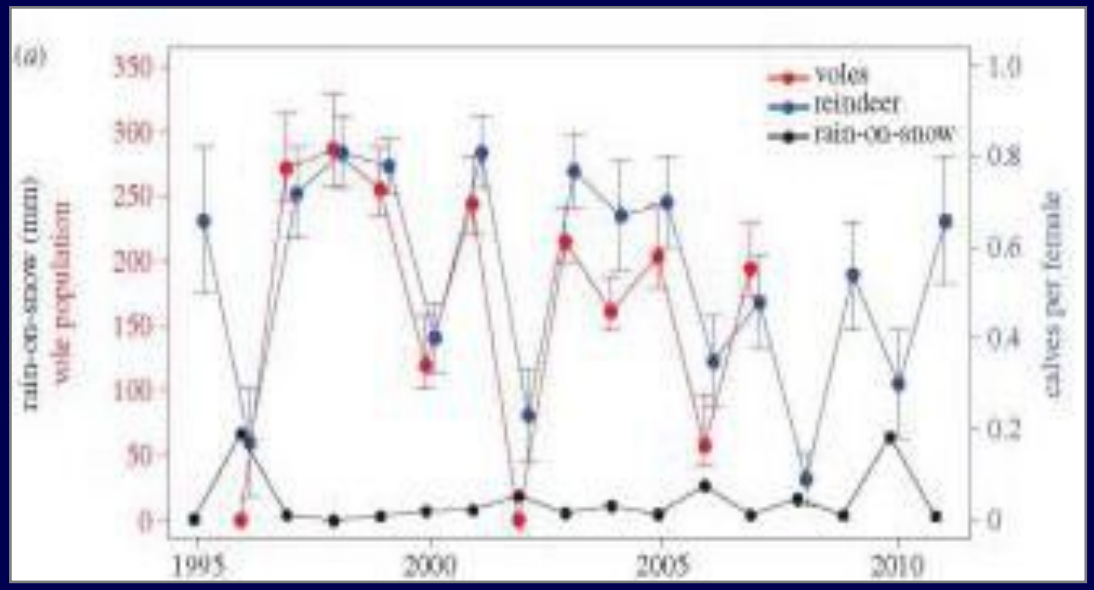
Emperical base-line Svalbard

A common climate impact in 3 modules – 'rain-on-snow' (ROS)

Photo: J. Kohler

Q 4: *What are the key insights gained so far from ongoing programs and approaches?*

ROS drives the dynamics of resident vertebrates with highly contrasting life histories



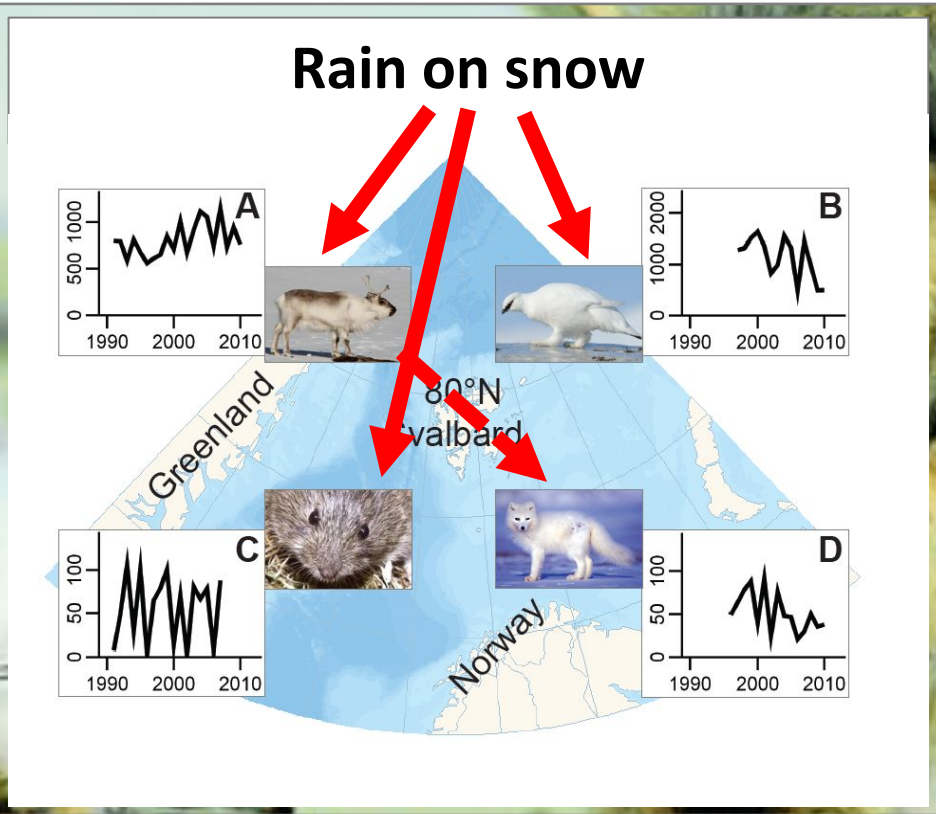
Sibling vole population abundance, reindeer fecundity and 'rain-on-snow' in perfect correlation

Science
AAAS

Climate Events Synchronize the Dynamics of a Resident Vertebrate Community in the High Arctic

Brage B. Hansen *et al.*

Science **339**, 313 (2013);
DOI: 10.1126/science.1226766



Winter rain synchronize population fluctuations across an entire community of resident vertebrate herbivores
(vole, ptarmigan, reindeer) and cause lagged correlations with the secondary-consumer, the arctic fox.

Photo: N. Lecomte

COAT currently develops management / harvesting models aiming to account for effects of ROS

So that management agencies can decide whether to *adapt*, *mitigate* and *conserve*

Photo: R. Eidesen

Idiosynchrasity?

The monitoring is tailored to focal ecosystems – «*one size will not fit all*» (cf. Lindenmayer & Likens)

COAT conceptual models are tailored to the specific food webs for high-arctic Svalbard and low-arctic Varanger peninsula

Q 5: To what extent do the ongoing programs reflect site-specific idiosyncrasy versus biome scale generality?

Biome scale generality?

BUT COAT focus on the impact of …..

- ROS events on ecosystem dynamics (COAT Svalbard)
- Changed phenology and trophic match-mismatch (COAT Svalbard)
- Management-induced herbivore overabundance on tundra vegetation (COAT Svalbard - geese; COAT Varanger – reindeer)
- Climate change on the tundra-forest ecotone dynamics (COAT Varanger)
- Invasive/southern expansive species (insect pest and red fox) (COAT Varanger)
- Dampened lemming cycles on «top-down» and «bottom-up food» web dynamics (COAT Varanger)


Thank you for your attention!
Photo: T. Nordstad