CARMA's integrated landscape model to assess cumulative effects of development and climate change on migratory tundra *Rangifer*

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Leonardo Frid, Colin Daniel (APEX RMS)

CARMA

CircumArctic Rangifer Monitoring & Assessment Network

Many thanks to funders..

Core funding

- Canadian High Arctic Research Station (CHARS)
- GNWT Cumulative Impacts Monitoring Program (CIMP)
- Government of GNWT Department Environment and Natural Resources
- Porcupine Caribou Management Board (PCMB)
- MMG (Izok Lake - EDI) – demographic model

Guinea Pigs:

- Baffnland (Mary River),
- AREVA (Kiggavik) [EDI]

CircumArctic Rangifer Monitoring and Assessment Network
CARMA

- **FORMED 2004**

- **MISSION:** ***Monitor and assess the impacts of global change on Human-Rangifer (reindeer, caribou) systems across the circumarctic, through cooperation, both geographically and across disciplines***

Mammal priorities CBMP

Highest priority

- a. What are status and trends

ARCTIC REPORT CARD

- b. Where are the populations changing?

Secondary priority

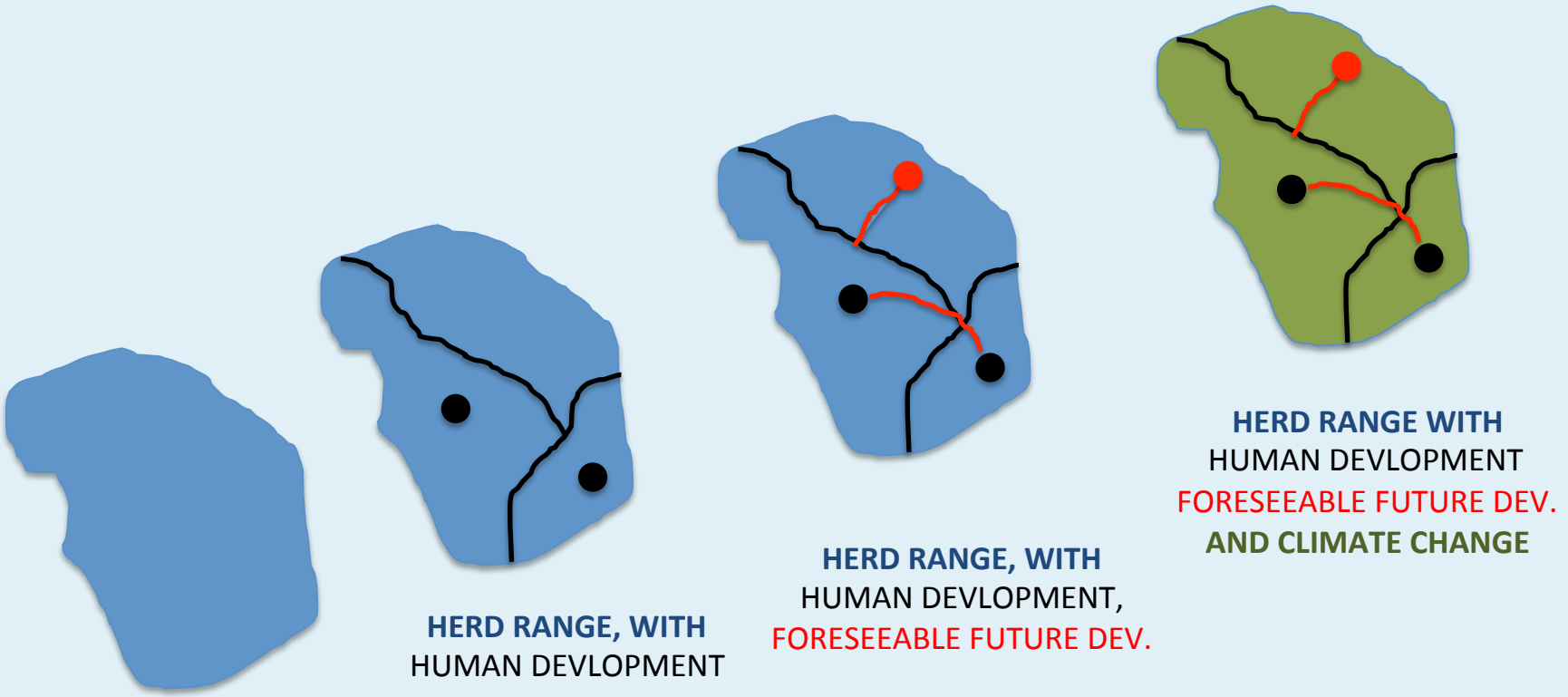
- What and how do global drivers influence caribou and wild reindeer?
- What drivers impact important habitats?
- What is total area of important region?

THIS TALK

CARMA's integrative CE model

- Overall goal is to:
  - discriminate natural variability from the CE of development and climate change, and
  - Assess CE at population level
  - Focus on mitigation and management effects

Our challenge is to project future population size of a herd with respect to:



HERD RANGE

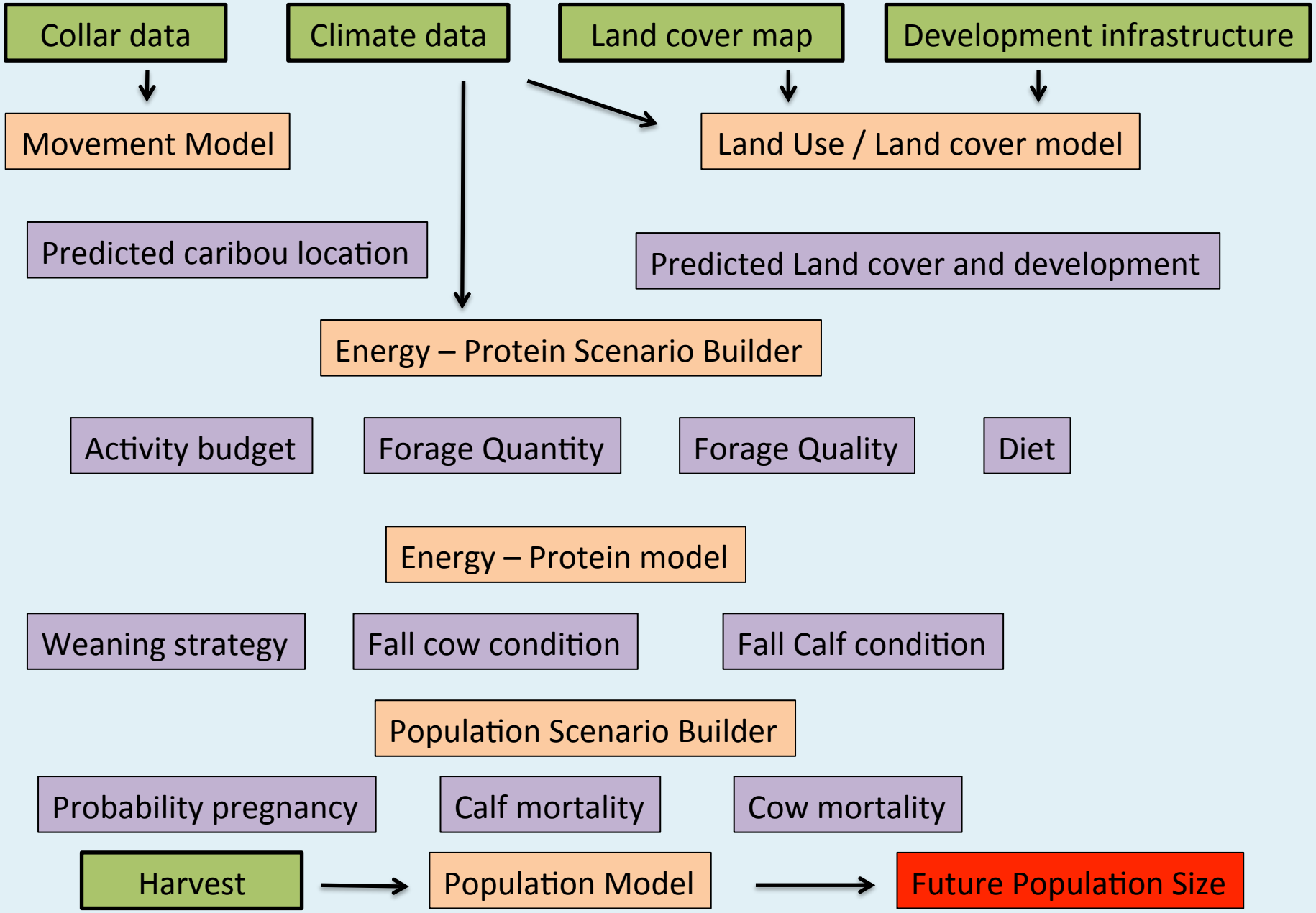
HERD RANGE, WITH
HUMAN DEVLOPMENT

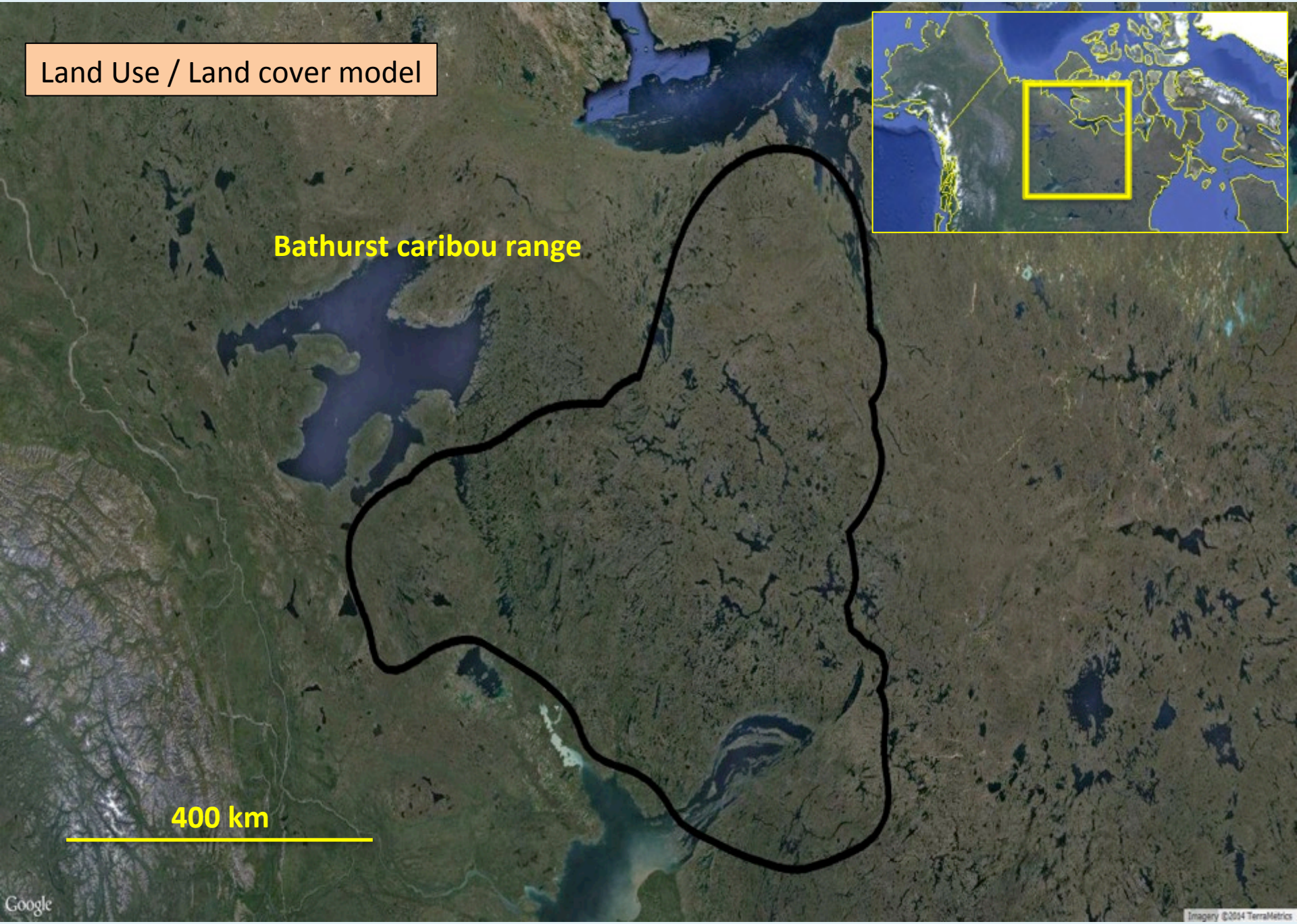
HERD RANGE, WITH
HUMAN DEVLOPMENT,
FORESEEABLE FUTURE DEV.

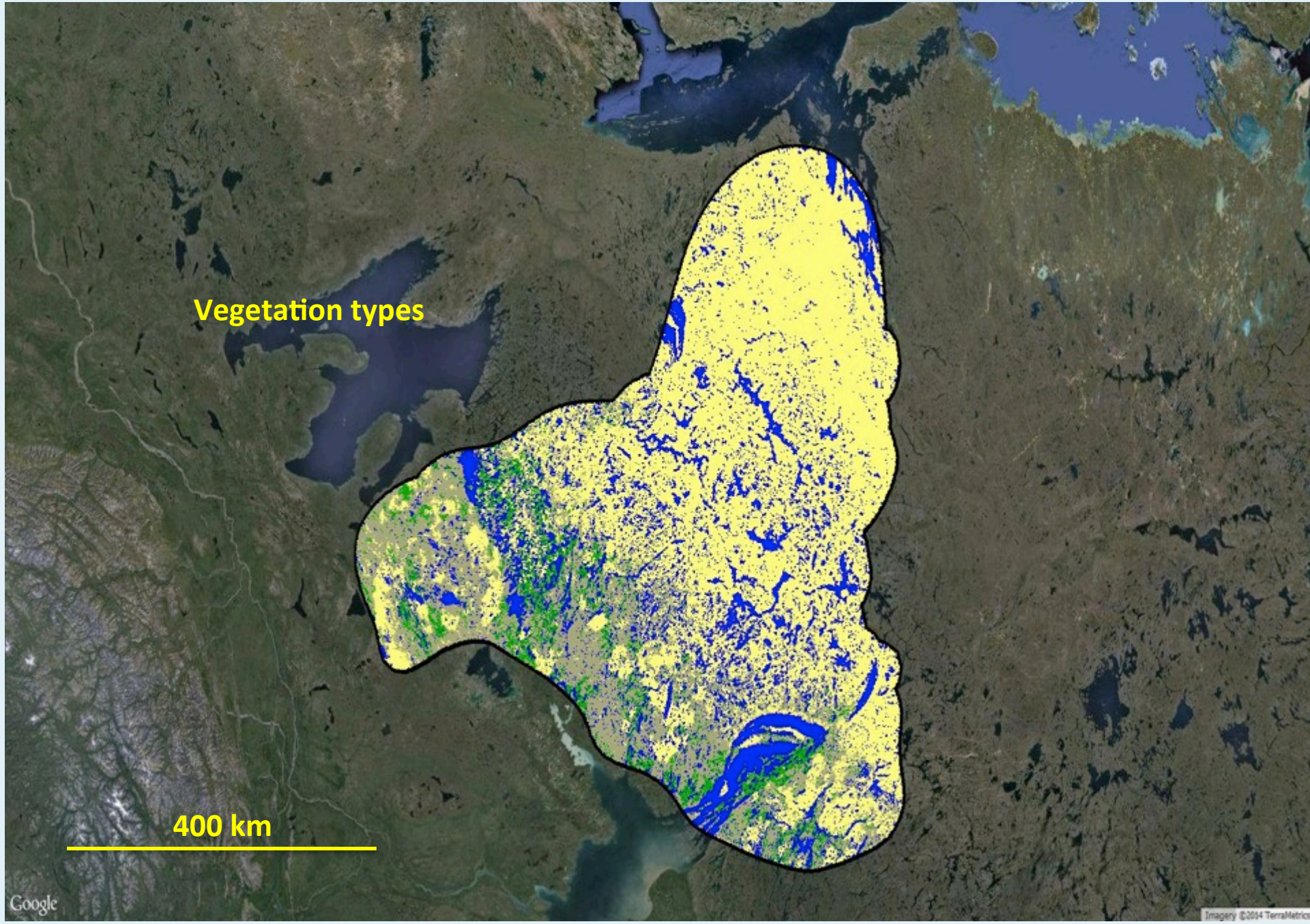
HERD RANGE WITH
HUMAN DEVLOPMENT
FORESEEABLE FUTURE DEV.
AND CLIMATE CHANGE

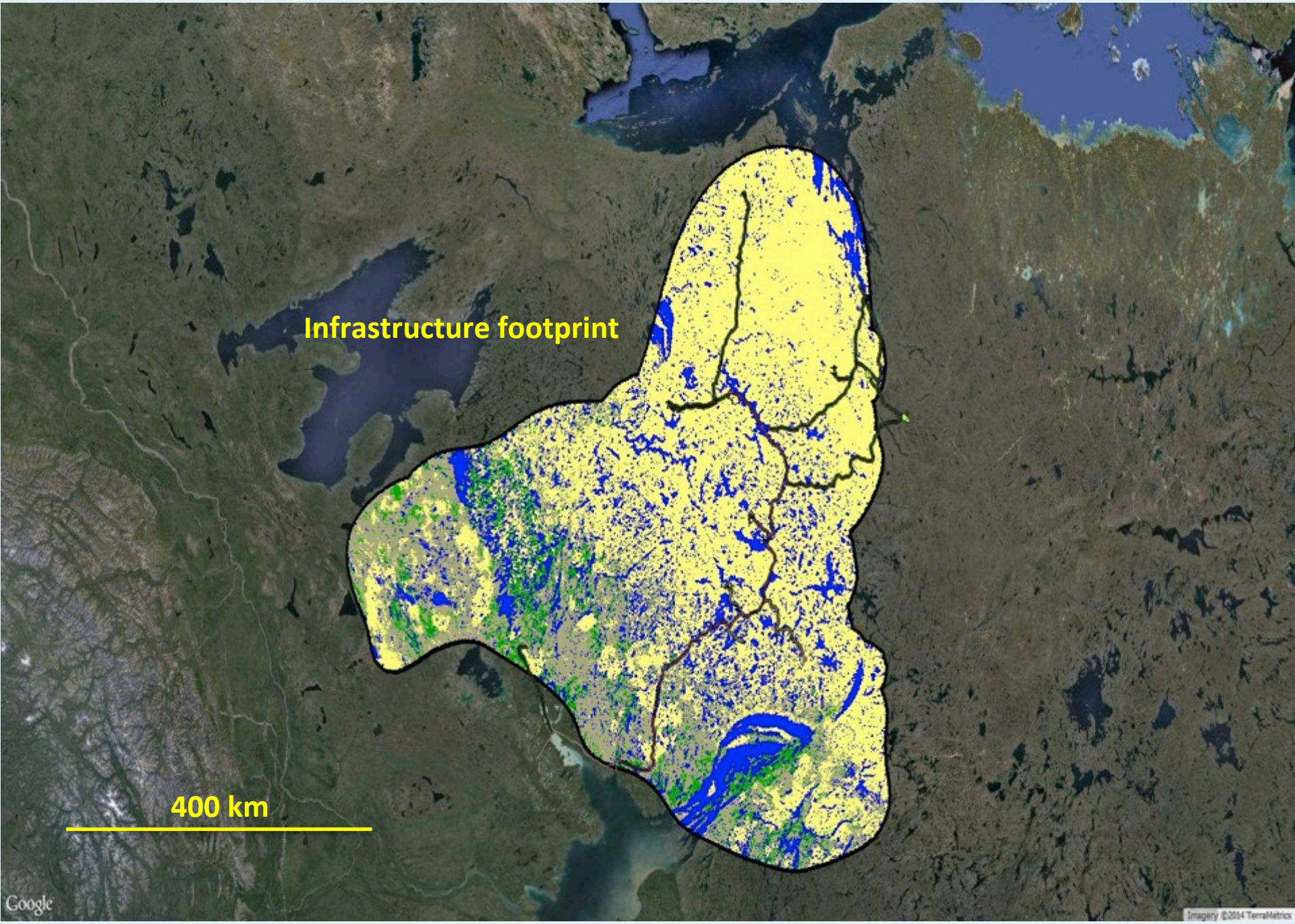
…and assess the implications of management actions and mitigation measures to reduce effects of global changes

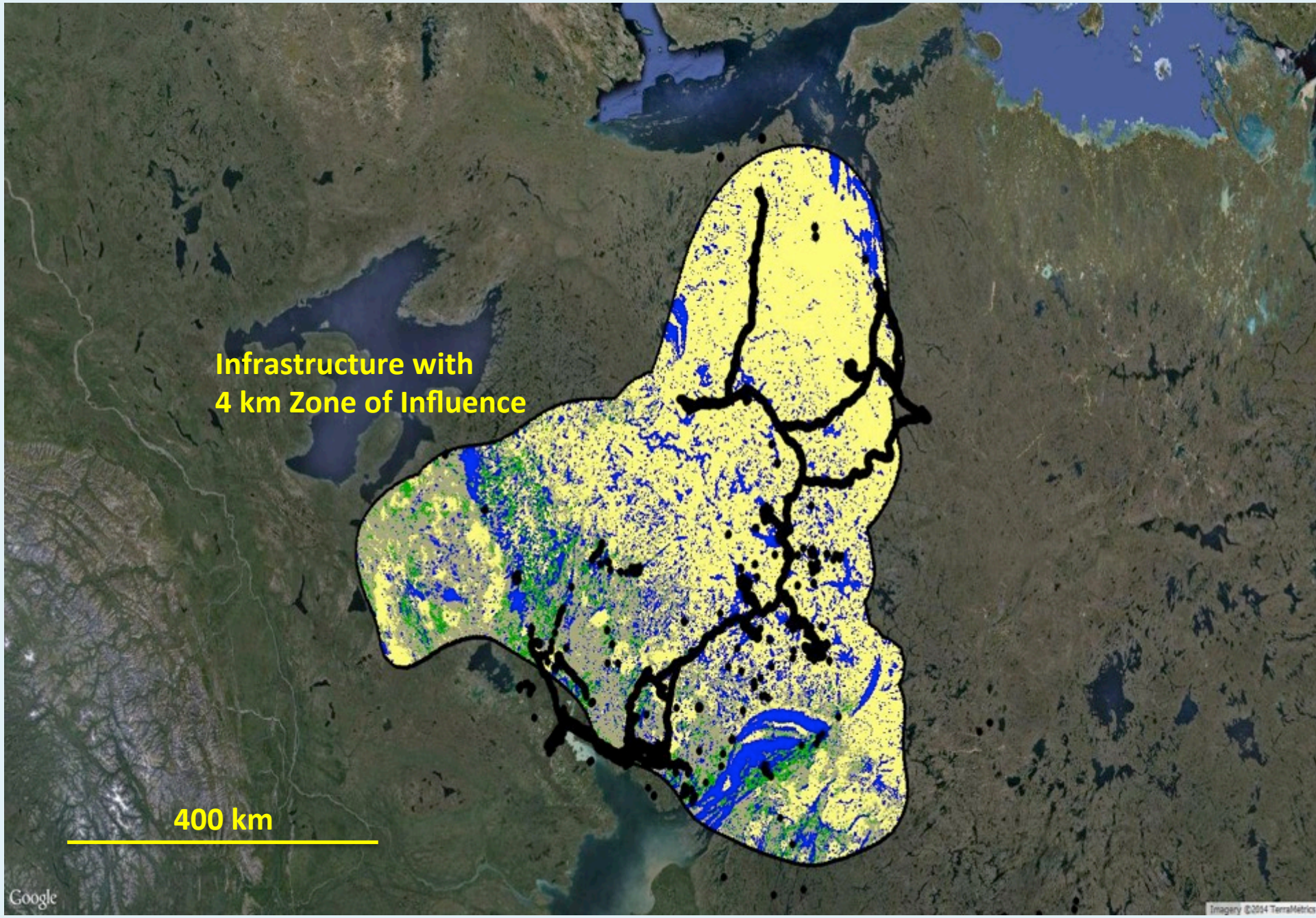
Integrative model components

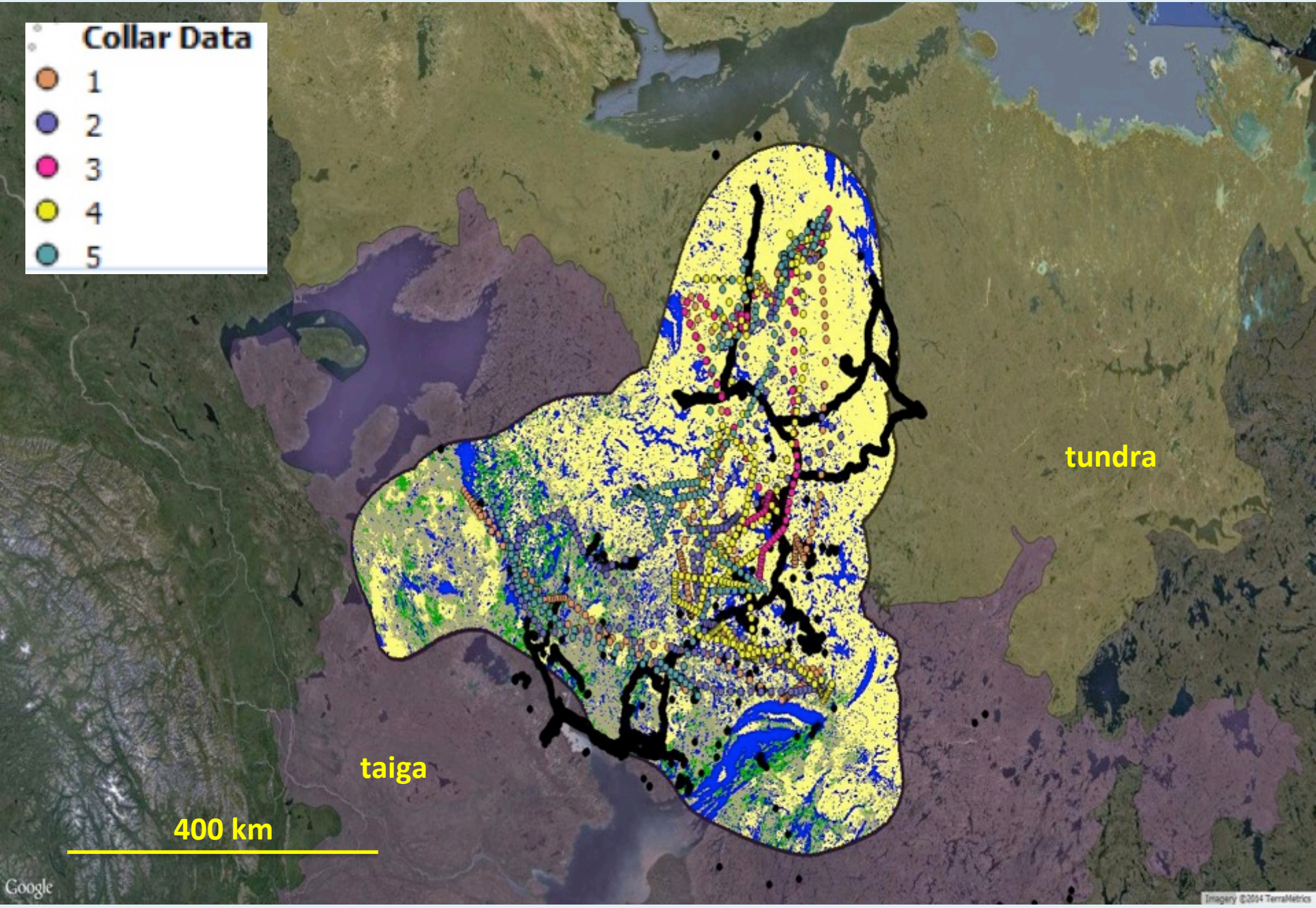



Land Use / Land cover model
Bathurst caribou range
400 km
Google
Imagery ©2014 TerraMetrics


Vegetation types
400 km
Google
Imagery ©2014 TerraMetrics

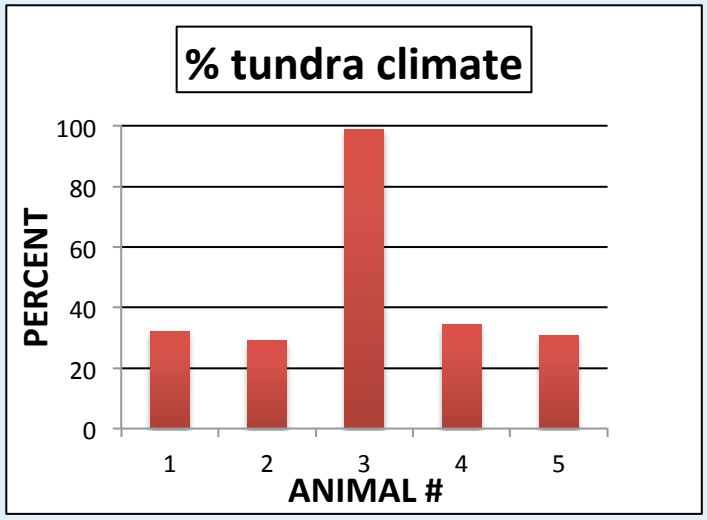

Infrastructure footprint
400 km
Google
Imagery ©2014 TerraMetrics

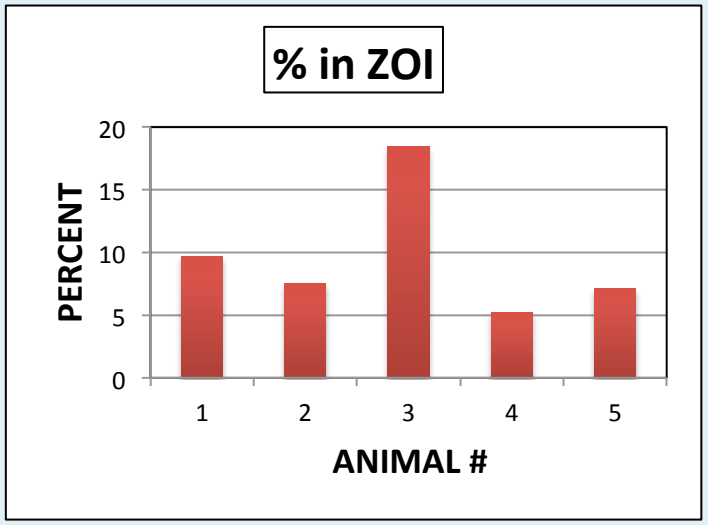

Infrastructure with
4 km Zone of Influence
400 km
Google
Imagery ©2014 TerraMetrics

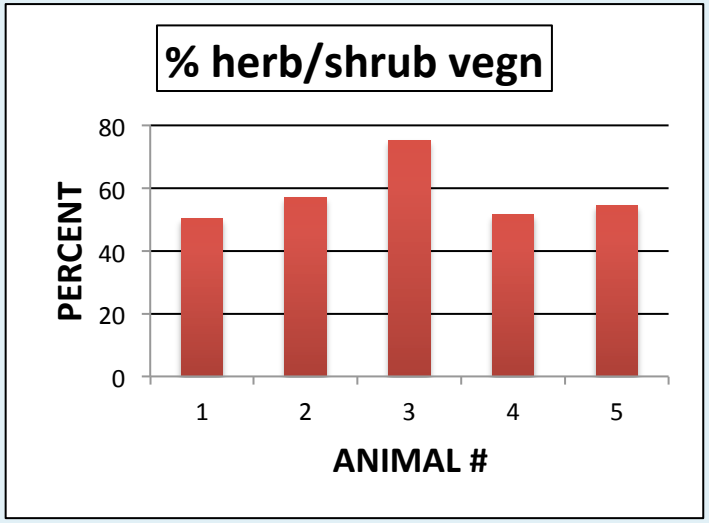

Collar Data
1
2
3
4
5
tundra
taiga
400 km
Google
Imagery ©2014 TerraMetrics

Movement Model

Our 5 animals spent……..



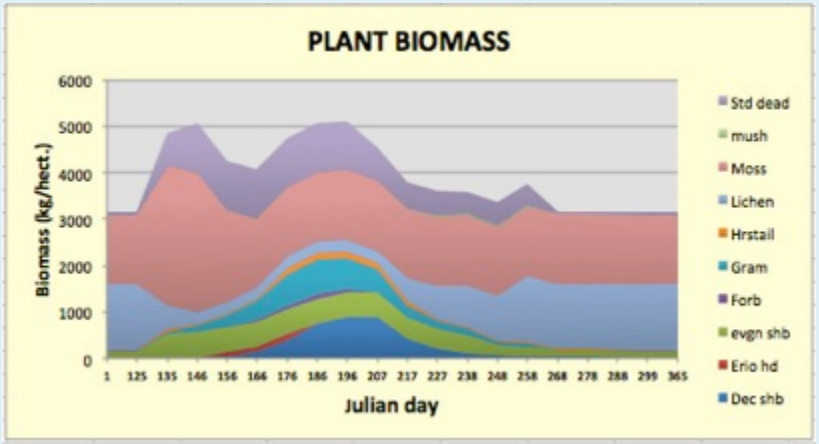




..then by assigning a biomass of major plant types (e.g. lichens, moss, forbs etc)..

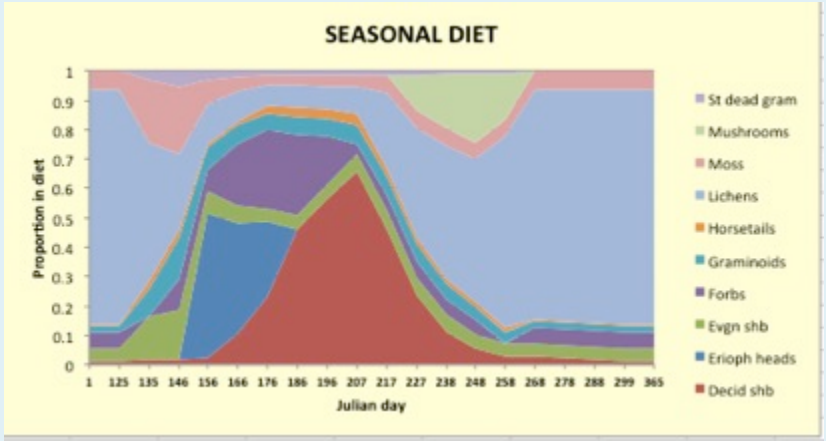
Energy – Protein Scenario Builder

e.g. Generating diet from biomass



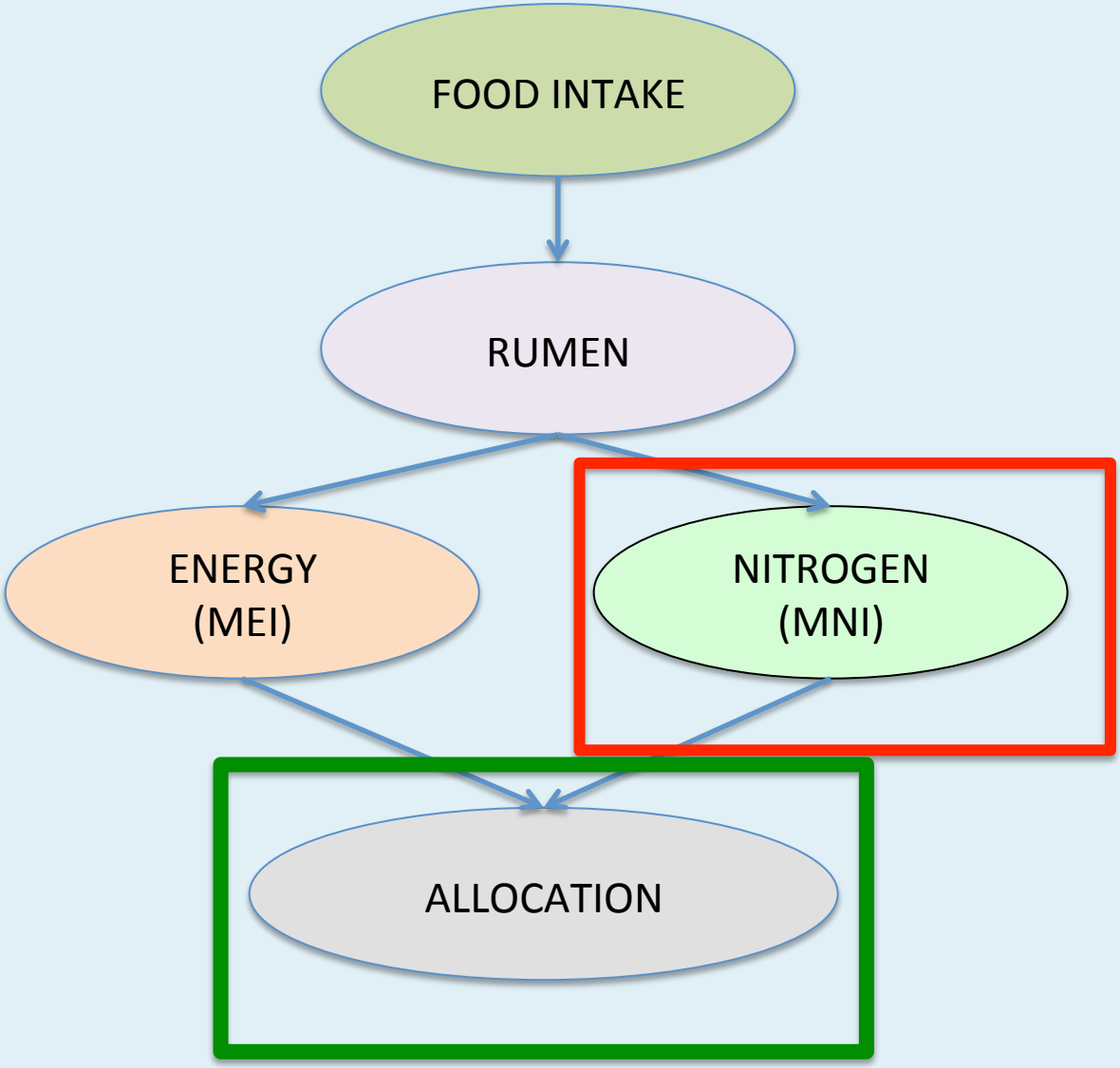
MODELING CARIBOU RESPONSE TO [illegible]ASONAL AND LONG-TERM CHANGES INVEGETATION:
I. DEVELOPMENT OF AN ALGORITHM [illegible]O GENERATE DIET FROM VEGETATION COMPOSITION
AND APPLICATION T[illegible]PROJECTIONS OF CLIMATE CHANGE

R. G White[1], J. Johnstone[1], D.E.Russell[2], B[illegible]th[3], H. Epstein[4], M Walker[5], F. S. Chapin III[1] & C. Nicolson[6].

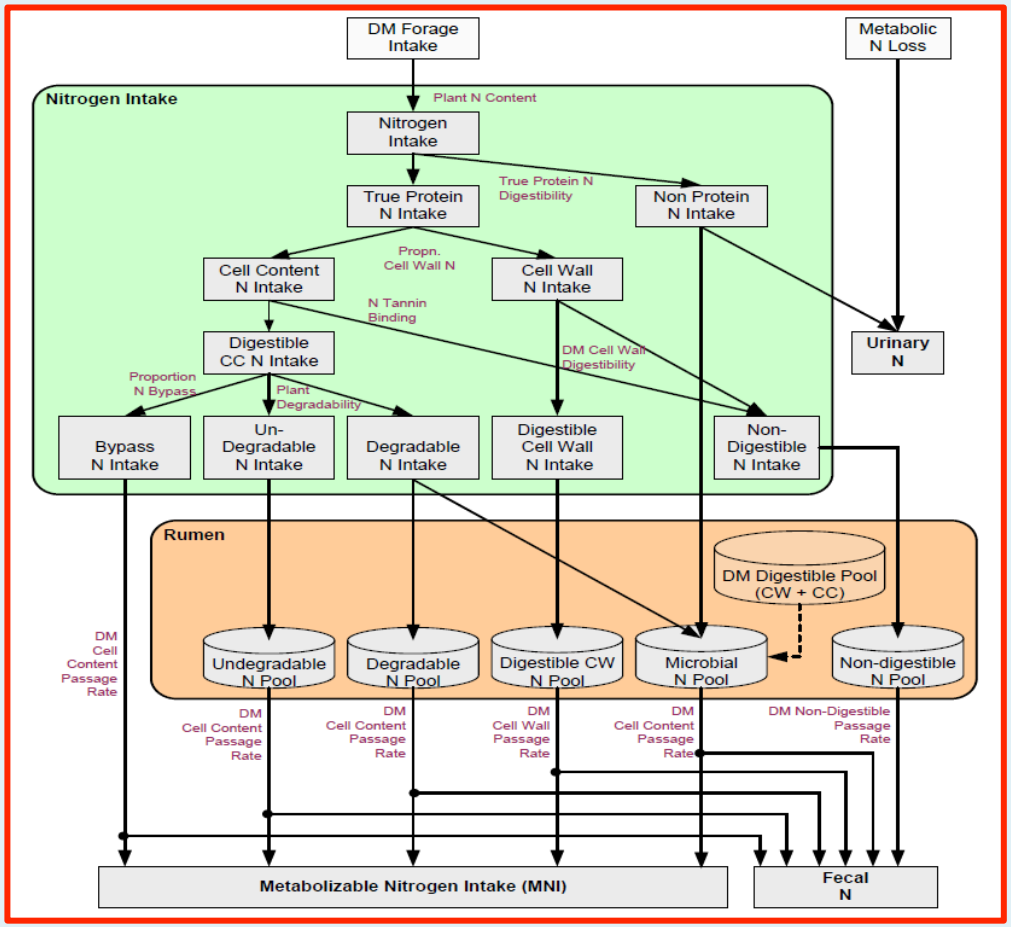


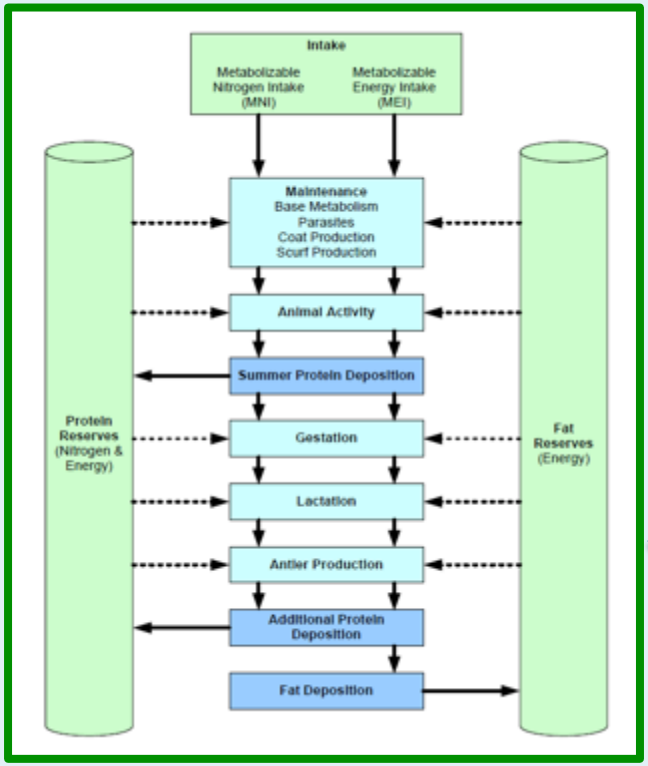
Energy – Protein model

Model structure



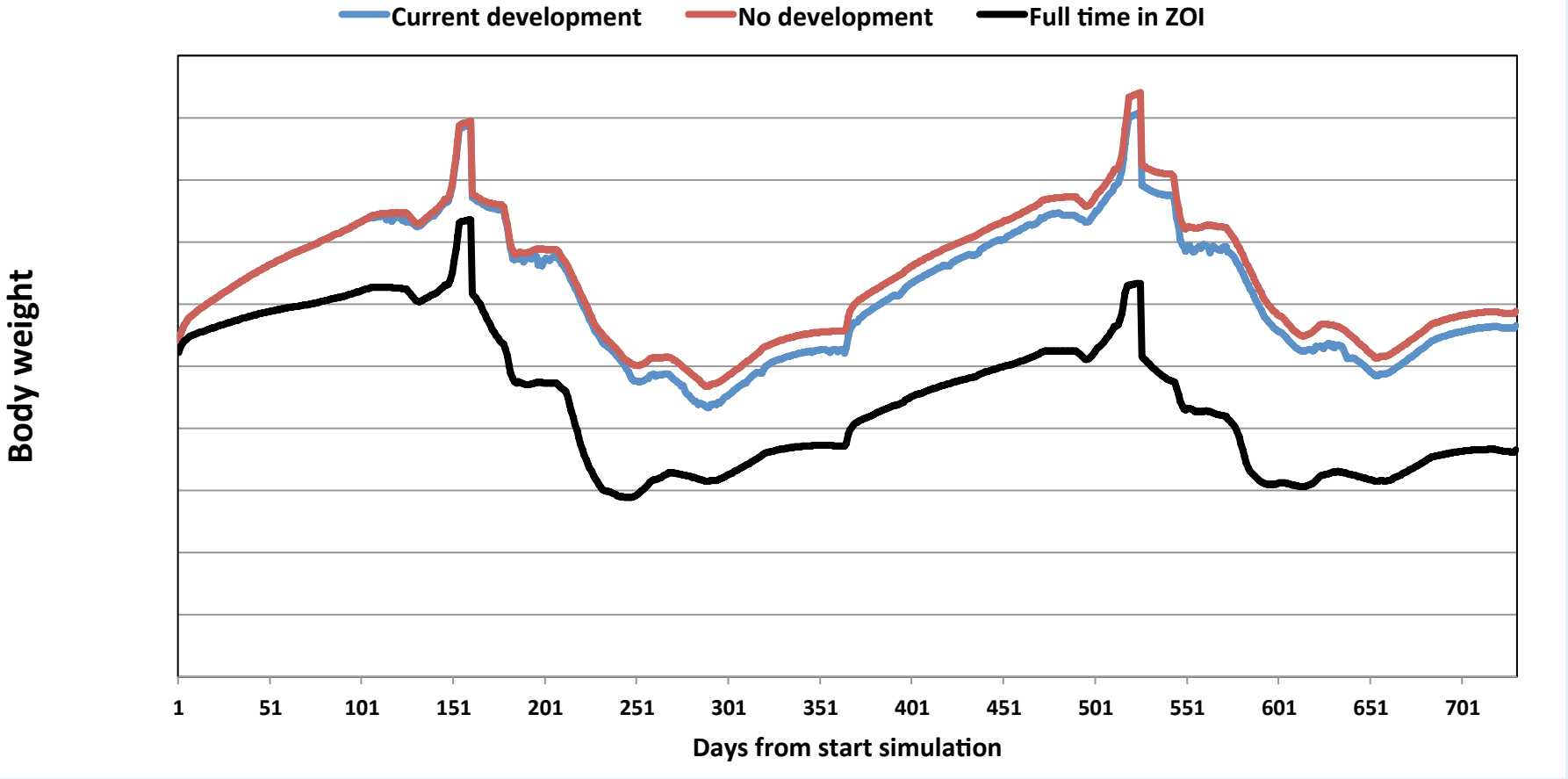
NITROGEN (MNI)



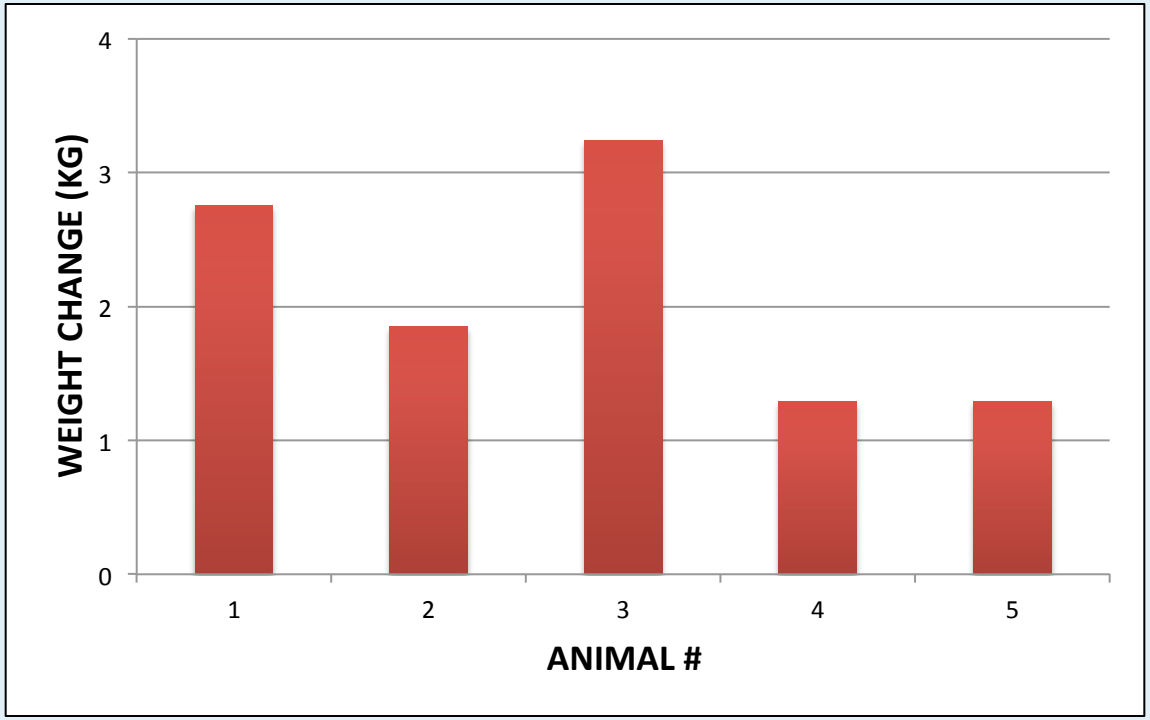


ALLOCATION (FAT AND PROTEIN)

Modeled 2 year body weight profile for three development scenarios (average of 5 modeled caribou)



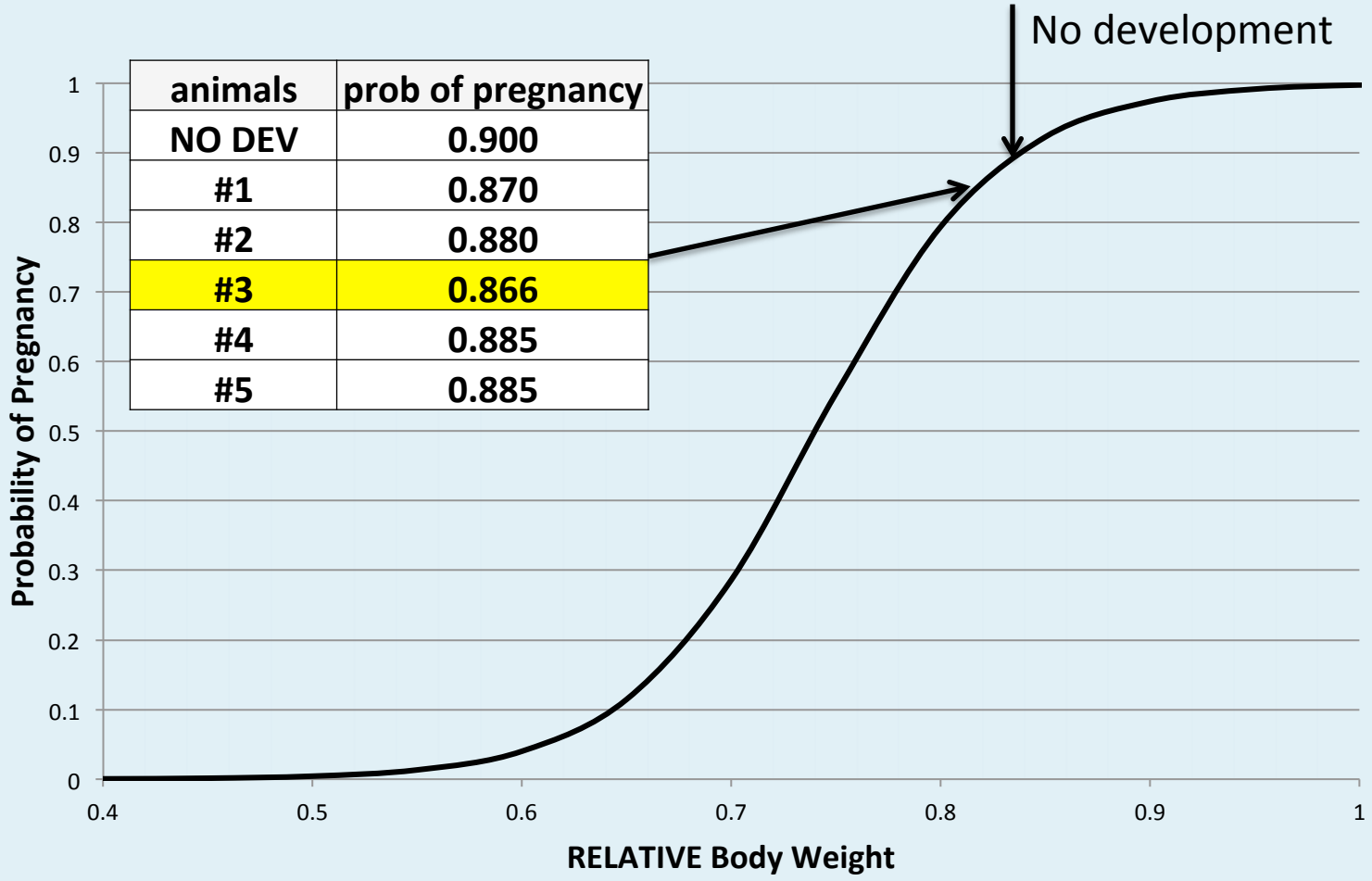
Average weight **LOSS** between “No development” and “Current development” for 5 modeled caribou



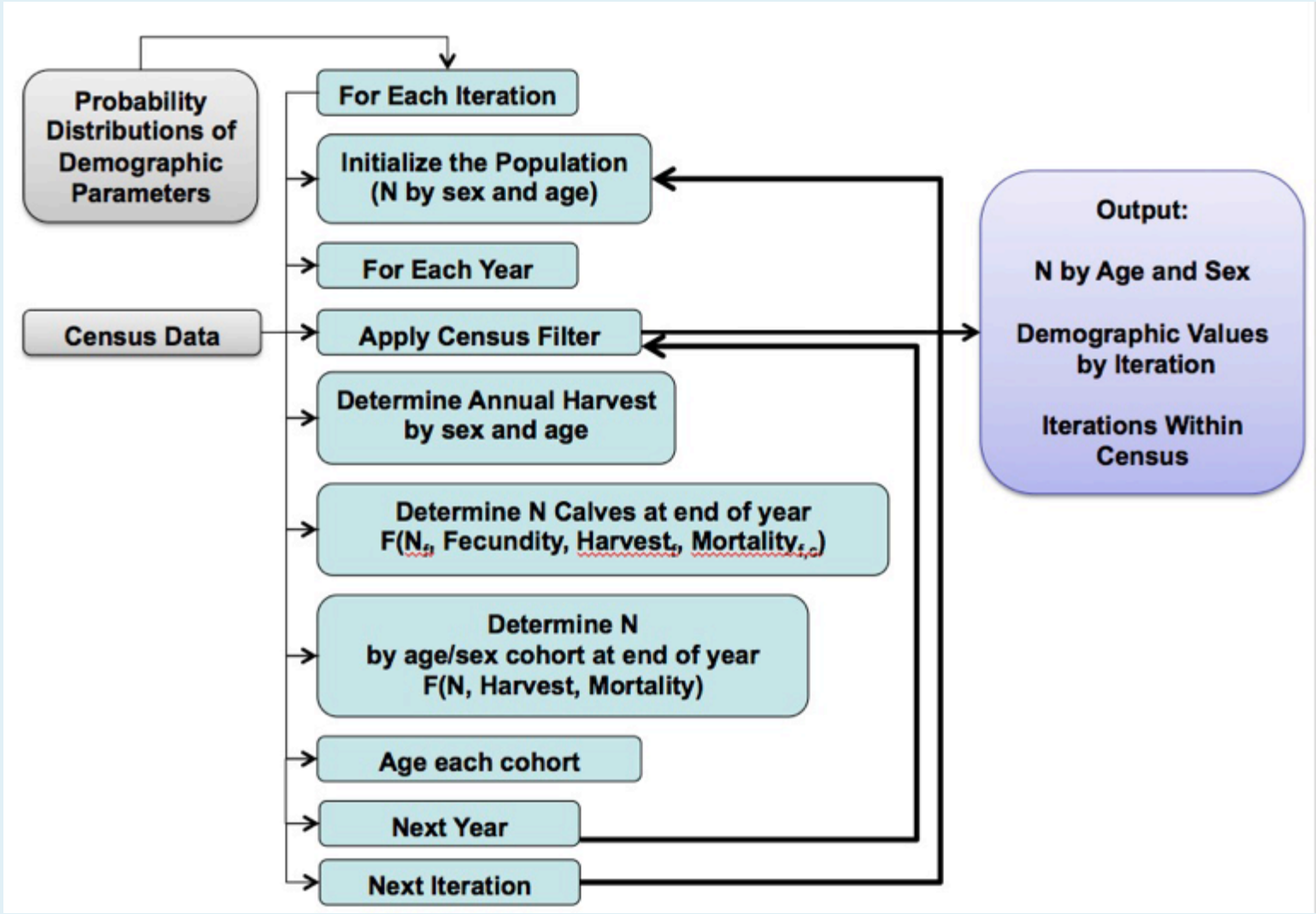
Population Scenario Builder

PROBABILITY OF PREGNANCY VERSUS RELATIVE BODY WEIGHT

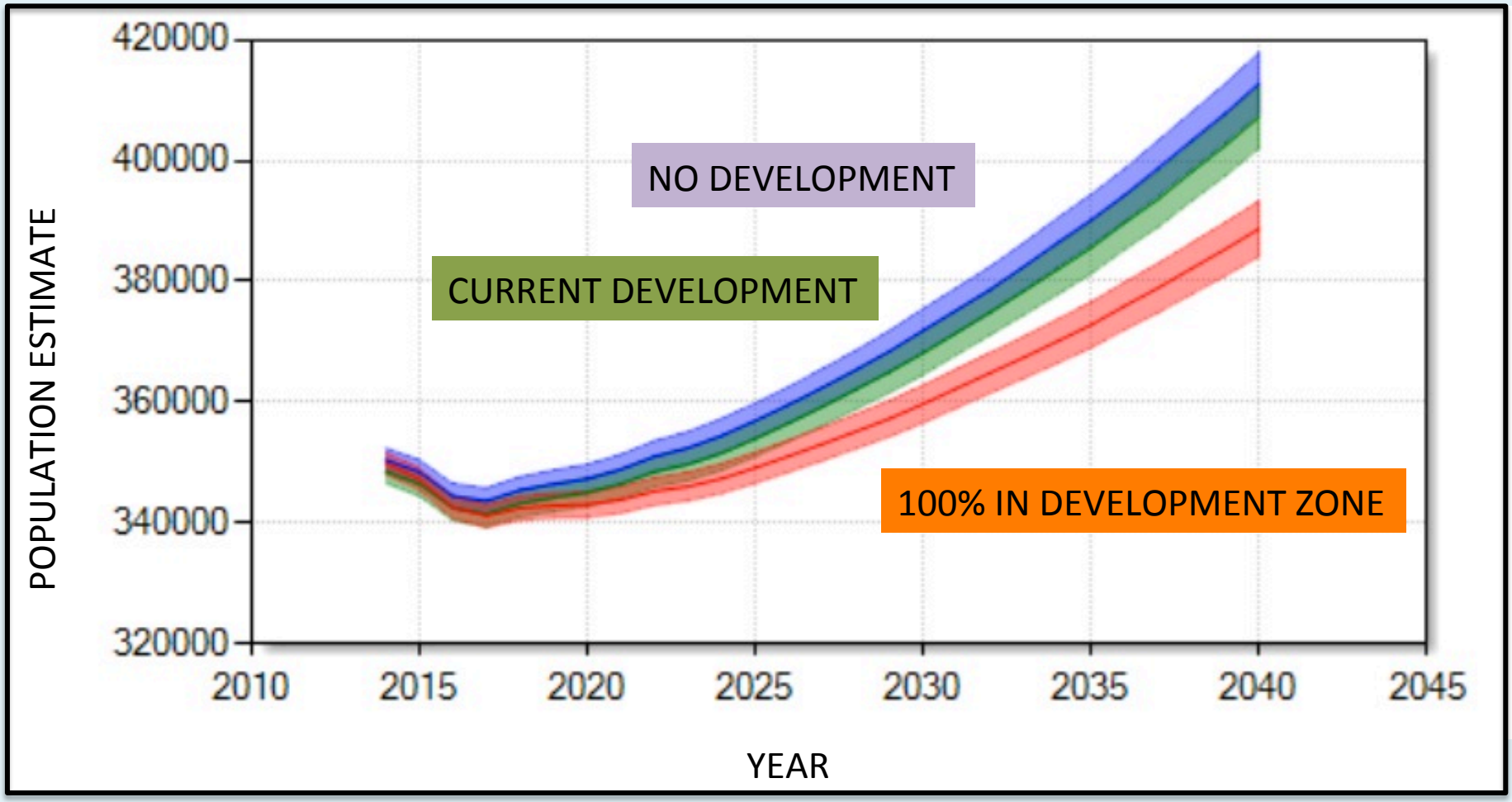
animals	prob of pregnancy
NO DEV	0.900
#1	0.870
#2	0.880
#3	0.866
#4	0.885
#5	0.885



Population Model



Hypothetical future population size



Next Steps

- Current progress reflects a “proof of concept” version of model
- Linkage between models is manual – therefore need to link the models to be capable of running all models seamlessly.
- Fully populate the model – current 4 veg types, 2 climate zones, 5 animals. Current model is not restricted for # veg types or climate zones and can run up to 1000 animals through at once.
- Conduct full cumulative assessment of target herd (Bathurst)

Further steps

- Assess costs and efficiencies of mitigation under different scenarios of climate and range and herd management
- Examine trade-offs between mitigations including off-site versus on-site (reducing scale of foot prints) mitigation
- Examine trade-offs such as road access and harvesting
- Develop input data sets for other priority herds
- Develop a tool for agencies, boards, industry etc to conduct their own assessment based solely on a GIS platform