Climate > Habitat > Populations:
Scale, Uncertainty, Mechanisms

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Three Topics

- Potential Biome shifts -
  - National Wildlife Refuge System
- Associations and Mechanisms
  - Caribou – mobile generalist herbivore
- Projections
  - Climate > forage availability
  - Forage availability > Caribou energetics

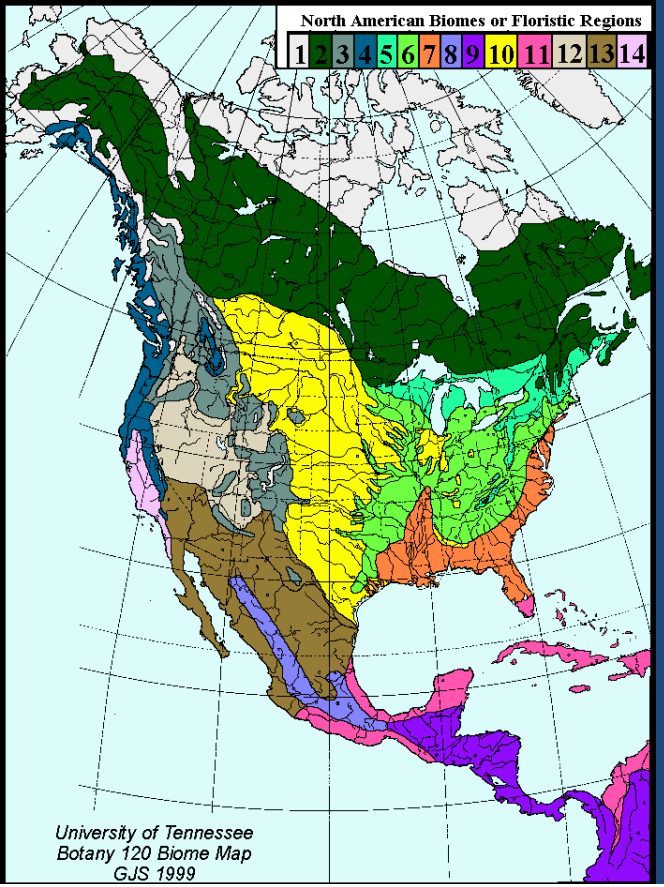
I. Potential Biome Shifts

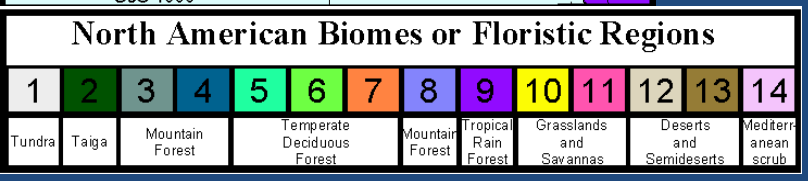
- CCSP, Synthesis and Assessment 4.4
  - Climate change adaptation options for the National Wildlife Refuge System
  - How pervasive is the problem?
    - National strategic focus

Biome

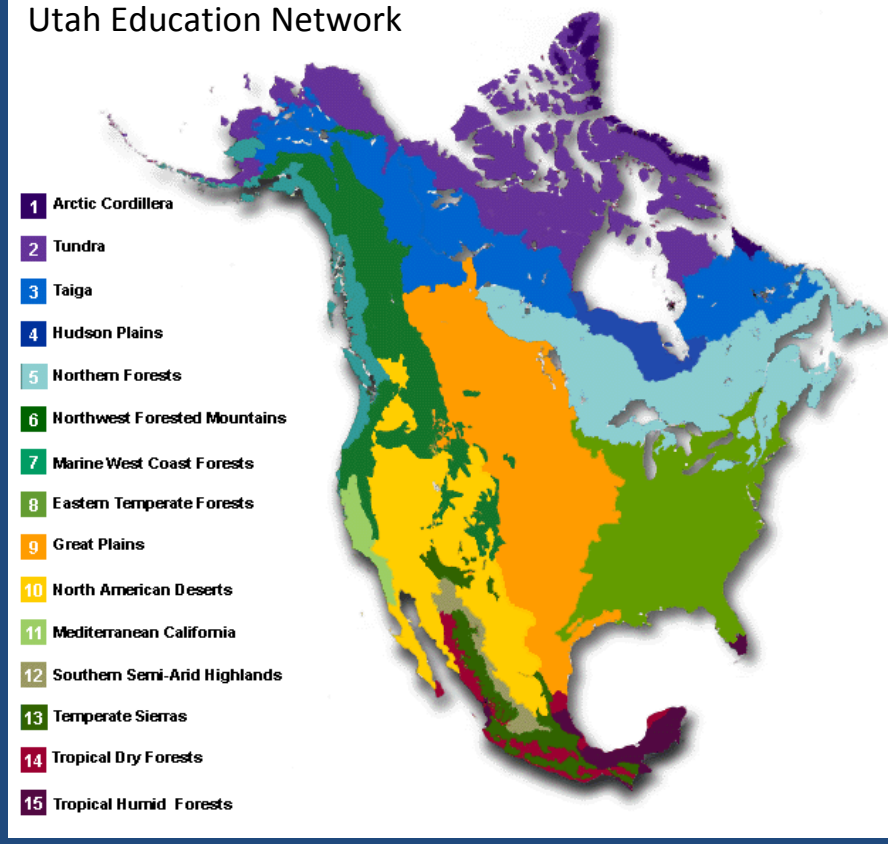
- *Potential* natural vegetation
  - Characteristic:
    - Climate
    - Soils
    - Fire frequency
    - Animal communities

  - Examples
    - Tundra and Alpine
    - Grasslands
      - Temperate
      - Tropical
    - Desert
    - Temperate Shrubland
    - Tropical Woodland
    - Forests
      - Boreal Conifer (Taiga)
      - Temperate Conifer
      - Temperate Broadleaf
      - Temperate Mixed
      - Tropical Deciduous Broadleaf
      - Tropical Evergreen Broadleaf





Utah Education Network



Wikipedia

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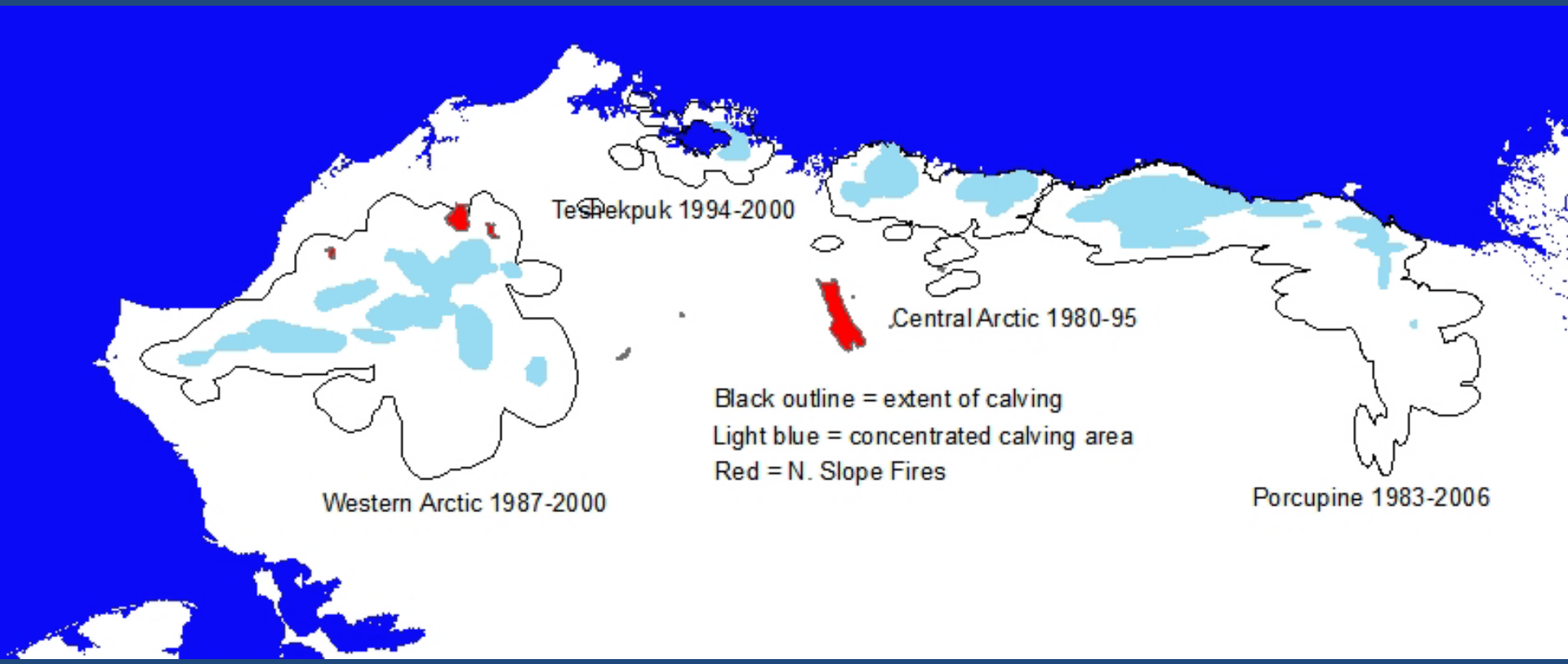
Projecting Heterogeneity in Vulnerability to Biome Shifts

(Gonzalez, Neilson et al. *in prep*)

- Components:
  - Projected changes in temp and precip
    - 3 Global Climate Models
    - 3 Emission scenarios
  - Global Vegetation Model (MC1) – 50km cells

II. Associations vs. Mechanisms Arctic Calving Caribou

- Heterogeneity in associations
  - Food Habits
  - Population characteristics
    - Size, Rate of change
- Mechanisms
  - Forage quantity and quality
- Commonality
  - Biomass trends on calving grounds



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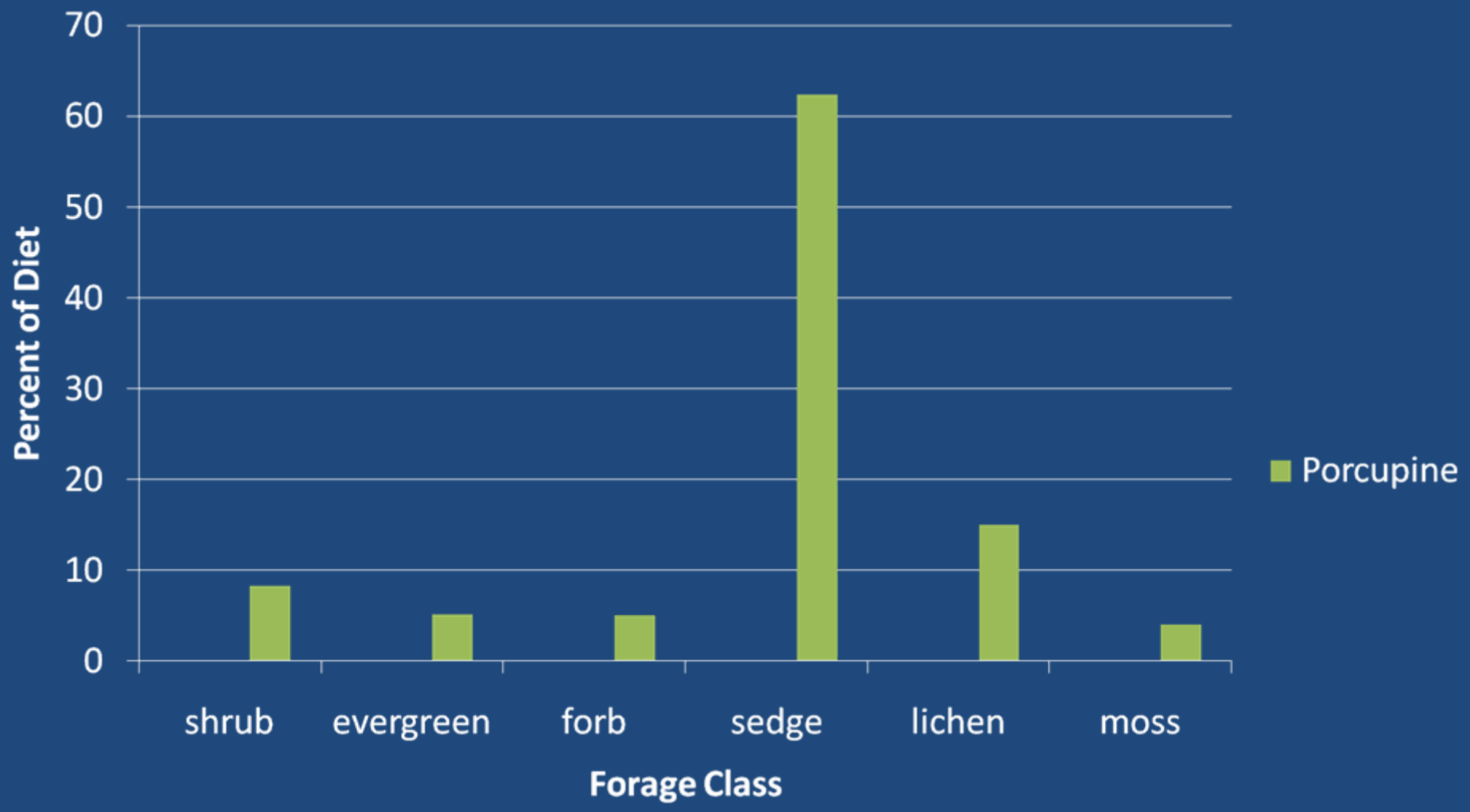
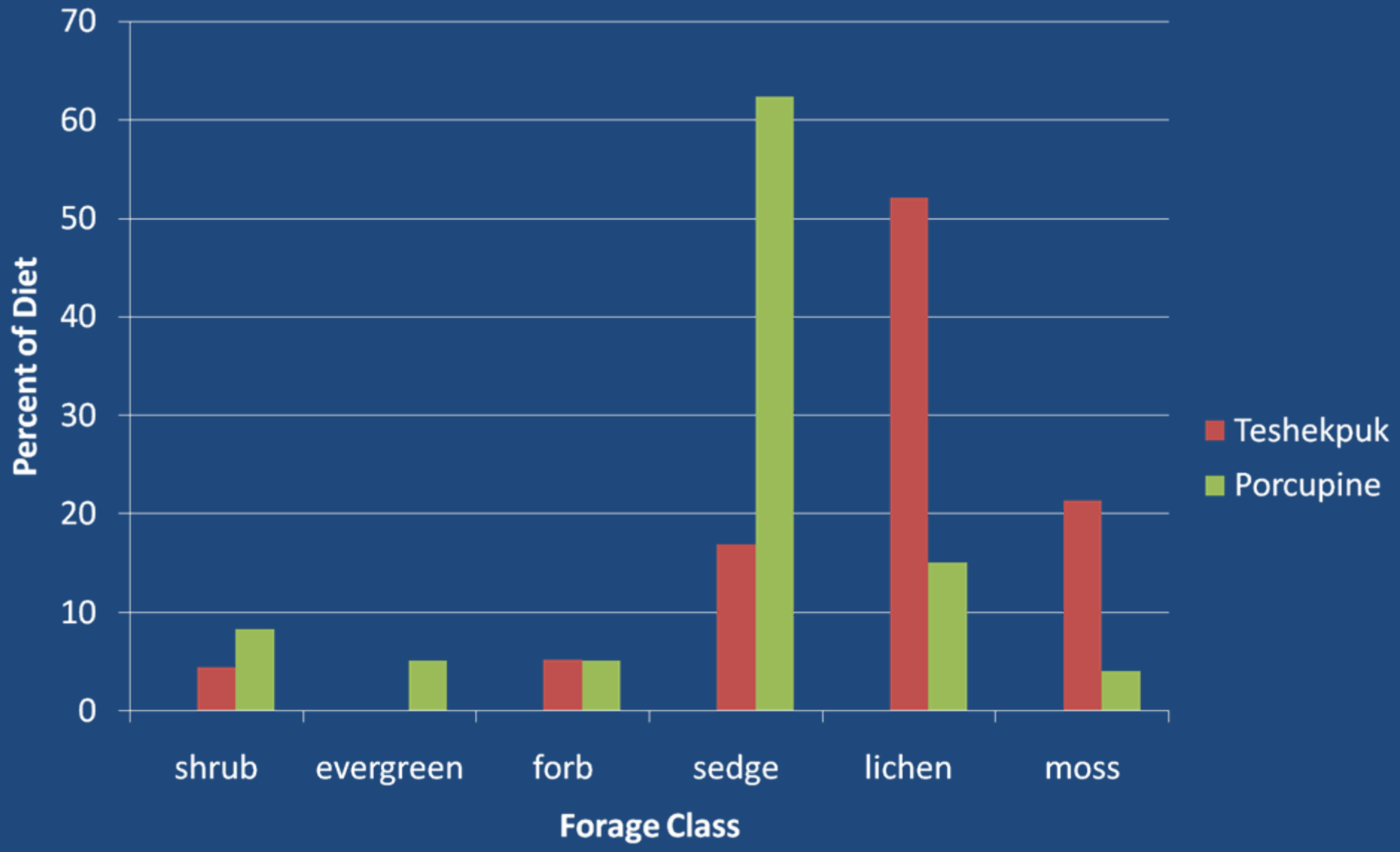

70
60
50
40
30
20
10
0
Percent of Diet
shrub
evergreen
forb
sedge
lichen
moss
Forage Class
Porcupine



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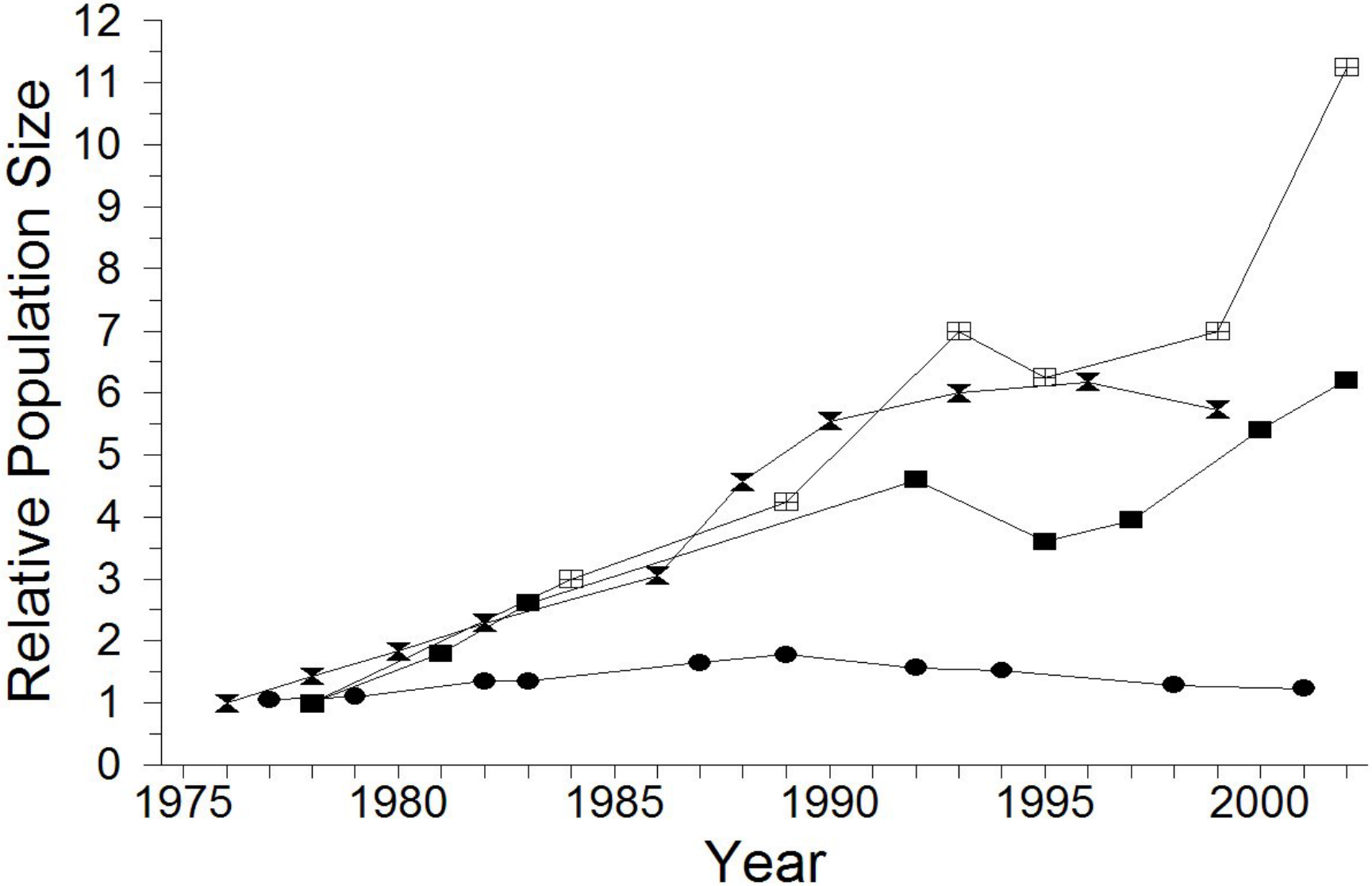

Porcupine — PCH-178K

Western Arctic — WAH-463K

Central Arctic — CAH-31K

Teshekpuk — TCH-45K

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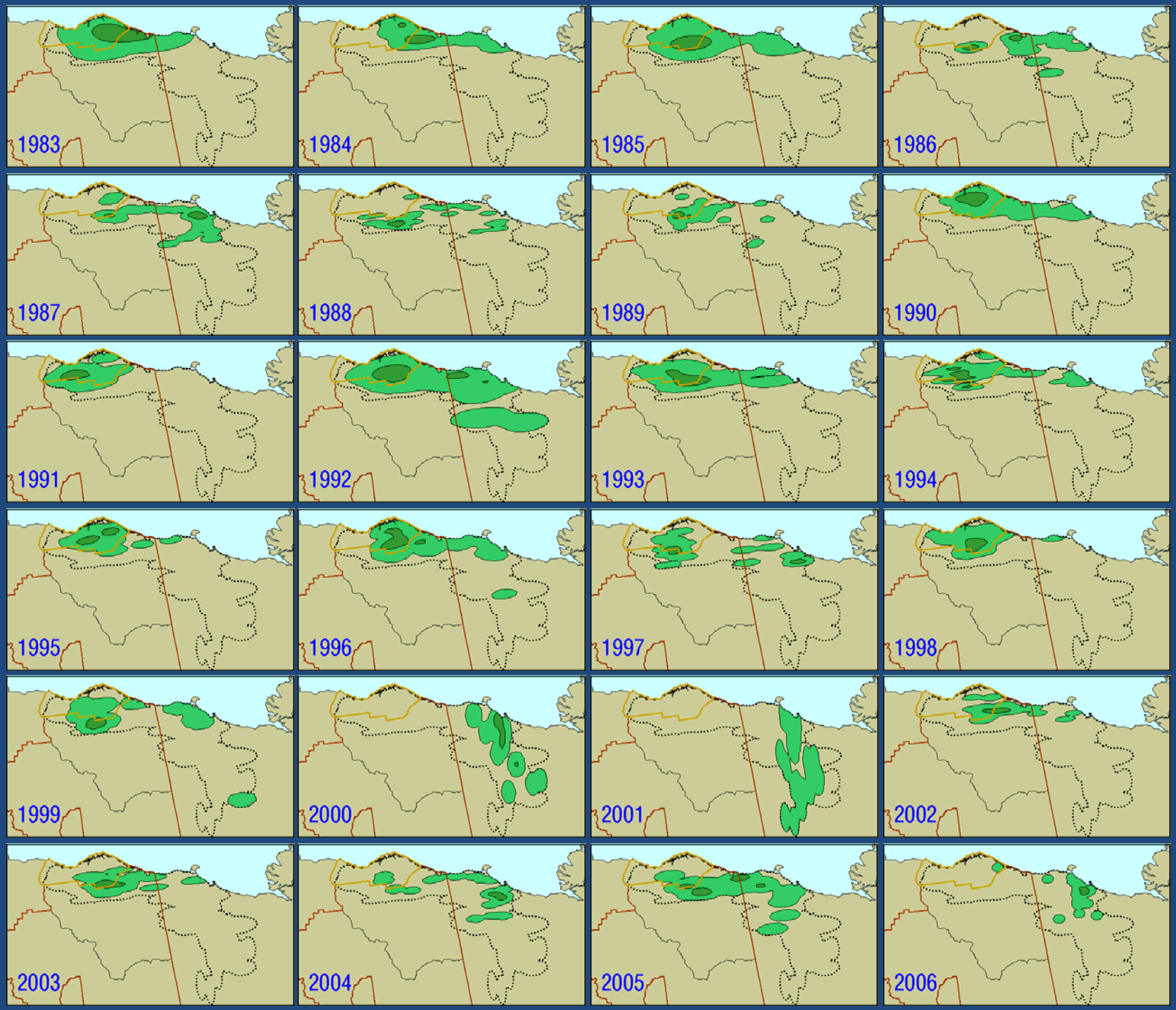


Porcupine Caribou Herd Calving Distributions 1983-2006

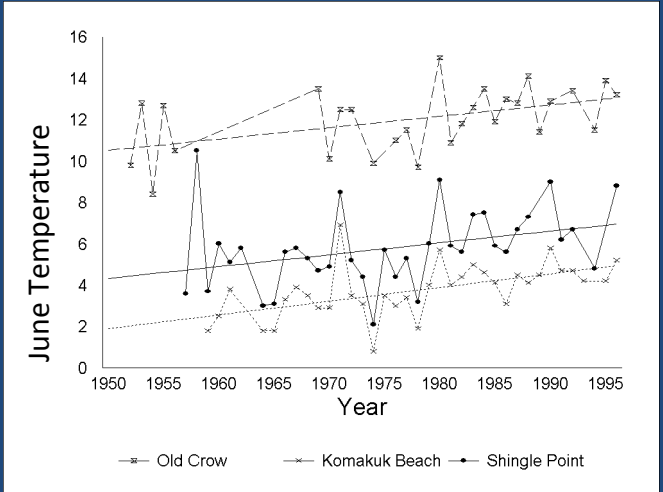
Dark Green: Concentrated Calving

Light Green: Annual Calving

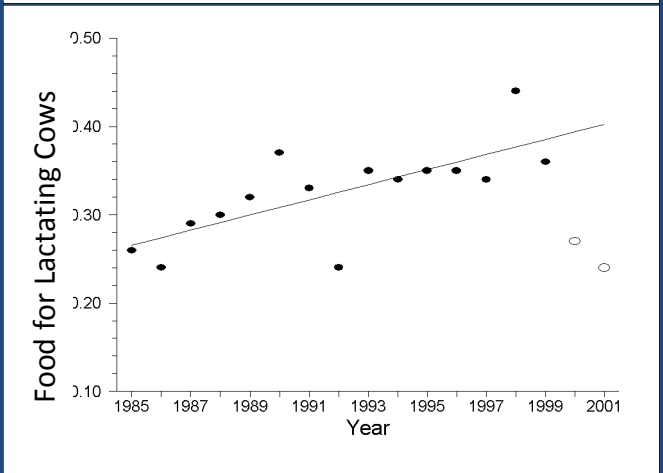
Dashed Line: Extent of Calving 1983-2006

Porcupine Caribou Herd

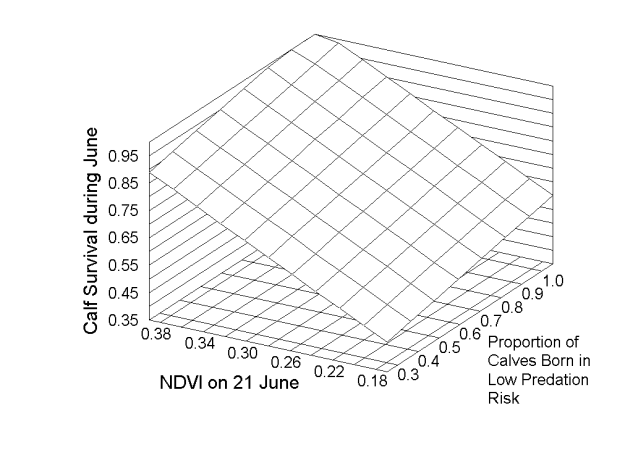
Spring Temperature Increases



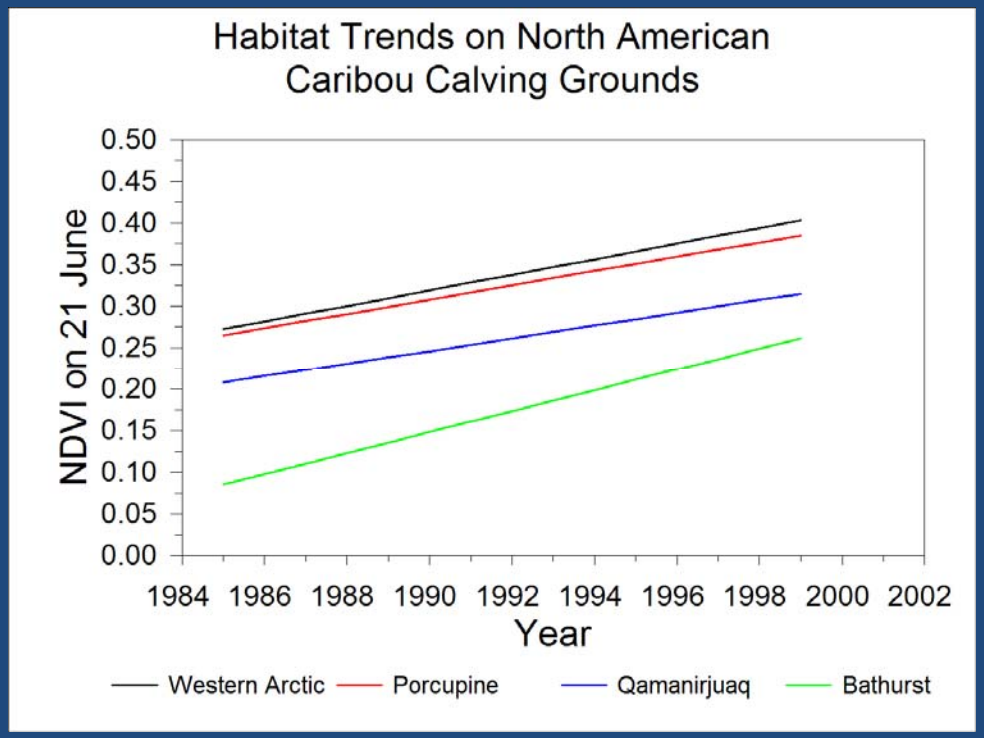
Food for nursing cows increases

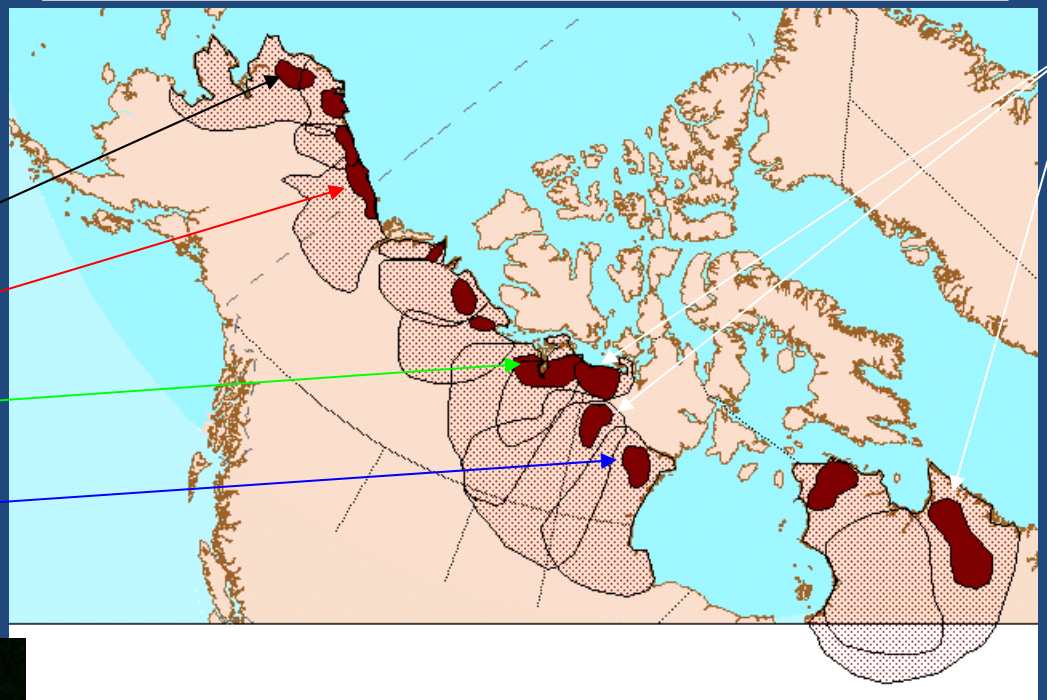


Calf Survival increases



Griffith et al 2002 USGS BSR2002-0001





No Trends

Western Arctic

Porcupine

Bathurst

Qamanirjuaq

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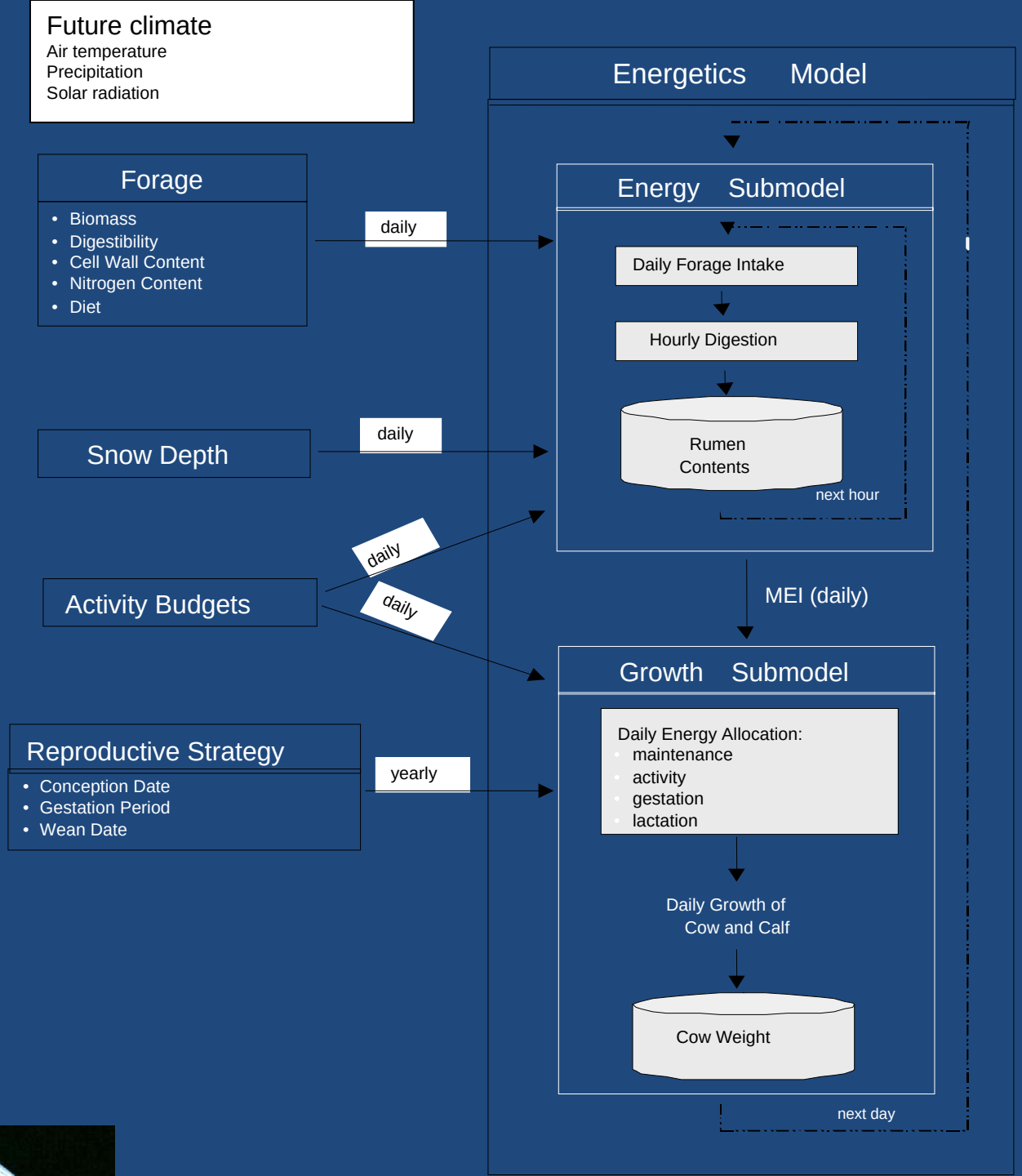
III. What to Expect with Warming Climate?

- Projections
  - Climate > Forage > Caribou Performance
  - Using Linked Mechanistic Models
- Dynamic Vegetation Model (TEM)
  - Project changes in seasonal composition of forage
    - Species groups, nutritional quality
- Caribou Energetics Model (CARMODEL)
  - Assess seasonal implications of forage changes for
    - Weight, conception, calf weight……


Future climate
Air temperature
Precipitation
Solar radiation
Energetics Model
Forage
Biomass
Digestibility
Cell Wall Content
Nitrogen Content
Diet
daily
Energy Submodel
Daily Forage Intake
Hourly Digestion
Rumen Contents
next hour
Snow Depth
daily
daily
Activity Budgets
daily
MEI (daily)
Growth Submodel
Reproductive Strategy
Conception Date
Gestation Period
Wean Date
yearly
Daily Energy Allocation:
maintenance
activity
gestation
lactation
Daily Growth of Cow and Calf
Cow Weight
next day

Thank You!

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