Simulating The Effect of Possible Future Changes in Vegetation on Arctic Caribou Energetics

Caroline Lundmark[1], Eugénie Euskirchen[1], Brad Griffith[2]

[1]Institute of Arctic Biology, [2]U.S. Geological Survey, Alaska Cooperative Fish and Wildlife Research Unit
University of Alaska, Fairbanks

Introduction

Within arctic areas, the accelerating changes in climate are inducing complex responses within both plant and animal communities. As arctic ecosystems are especially vulnerable, there is a need to couple the effects of warming on plant communities to the implications of these changes on wildlife communities.

The objective of this project is to model habitat and performance of caribou within the Arctic region of Alaska, by linking two existing models: the dynamic vegetation model (TEM-DVM) and the caribou energetics model (CARMODEL). By connecting the models, we will be able to estimate how climate induced changes in quality and abundance of forage plants will affect the seasonal changes in energetics of *Rangifer.*

Study area and Methods

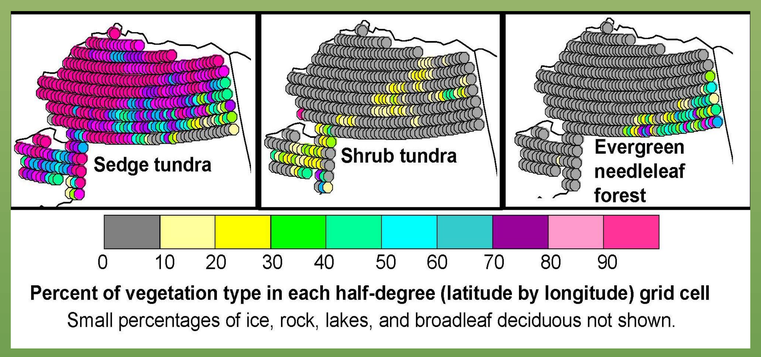


Figure 1. The study region in northern Alaska is classified as 77% sedge tundra, 13% shrub tundra, and 8% evergreen needleleaf forest

The study area includes the annual ranges of the Porcupine, Central Arctic, Teshekpuk and Western Arctic caribou herds, and the ranges of domestic reindeer herds on the Seward Peninsula (Figure 1).

As a first step of the project, we will model the annual range of the Porcupine caribou herd (PCH) within the sedge tundra of the Arctic coastal plain.

The outputs of TEM-DVM (Figure 2) will be modified to match the input variables of the CARMODEL (Figure 3).

For the initial parts of the study, we have considered the effects of changes in nitrogen (N), showing the variations in vegetation N from year 1970 to 2100, and the subsequent effects on intake of metabolizable N for year 1970 and 2100.

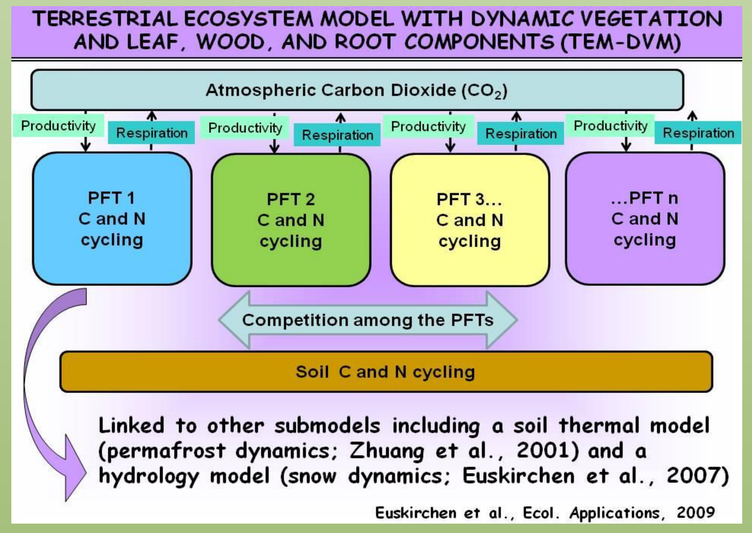


Figure 2. TEM-DVM projects the effects of climate change on the seasonal biomass of up to nine plant functional types in a given ecosystem. The DVM is parameterized and simulated for the PFTs differently depending on the ecosystem type in which they fall.

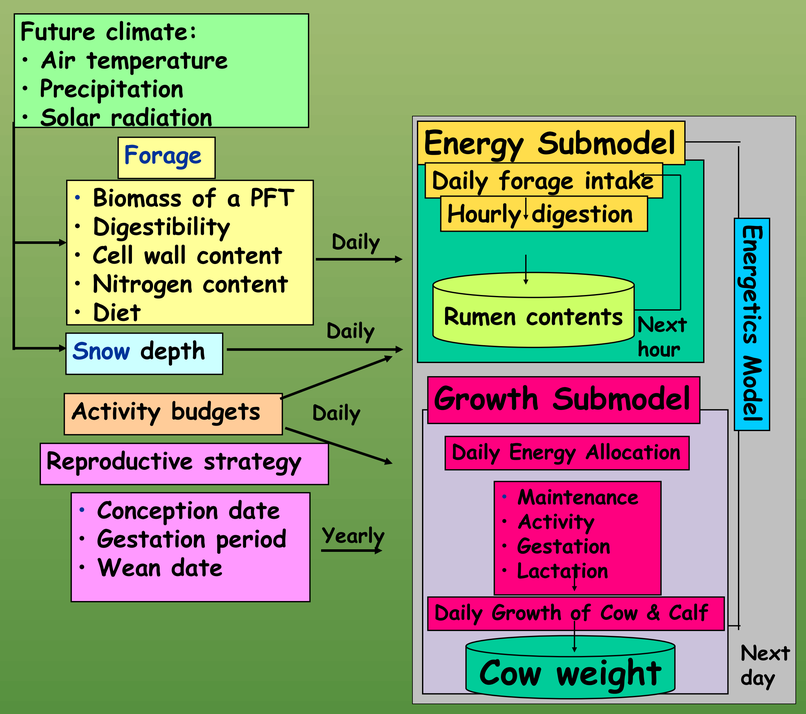


Figure 3. CARMODEL predicts the daily growth of a caribou cow and her calf, as a function of activity budgets as well as quality- and quantity of forage.

Results

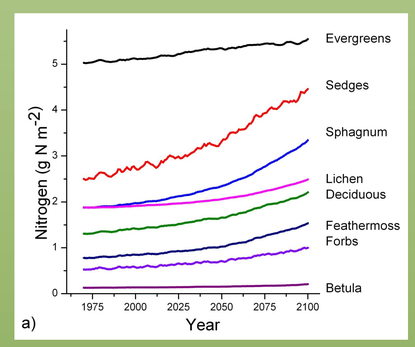
Within ranges used by the Porcupine Caribou Herd, the result of the TEM-DVM model runs showed that plant nitrogen concentrations increased significantly ($p < 0.01$, Figure 4a) for all plant functional types (except evergreen species) between the years 1970 – 2100, and that C/N ratios varied (Figure 4b).

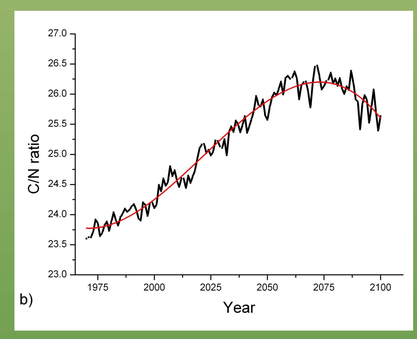
Vegetation nitrogen from the TEM-DVM input into the CARMODEL revealed a substantial increase in the potential intake of metabolizable N by *Rangifer* between 1970 - 2100 (Figure 4c).

Future modeling

The results of the initial model runs showed that climate induced changes in vegetation can potentially increase nitrogen intake of *Rangifer*. Our next step now, is to expand the aspects of vegetation quality, to incorporate changes in not only nitrogen, but also carbon, secondary plant compounds, fiber, and biomass.

We will then expand the study to include the other three arctic caribou herds within our study area, as well as the domesticated reindeer herds on the Seward Peninsula.





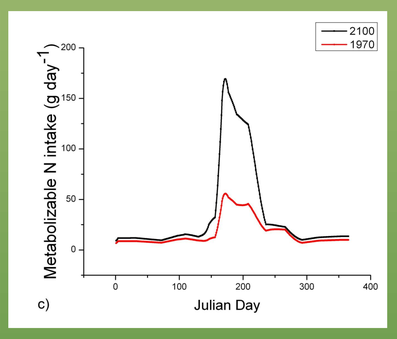


Figure 4. a) Increase in nitrogen (N) content in plant functional types within the ranges of PCH. Average N is calculated for the wet sedge tundra ecosystem during the summer months of year 1970 to 2100.
b) Carbon/Nitrogen (C/N) ratios between year 1970 and 2100.
c) Metabolizable N intake by Julian day for year 1970 and 2100

Acknowledgements

Alaska Department of Fish & Game.
Arctic National Wildlife Refuge.
CARMA Network. N. Res. Center. Yukon College.
North Slope Borough.
Department of Environment, Yukon Govt.
US Fish & Wildlife Service.

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