Modeling Energy and Protein Costs of Parasites in Caribou and Reindeer

Robert G. White[1], Colin Daniel[2], Anne Gunn[3], Christine Cuyler[4], Don E. Russell[5 1]
Office of Research and Graduate Studies, University of Alaska Anchorage, Anchorage, AK, USA, [2]Apex Resource Management Solutions, Ottawa, ON, Canada, 3, [3]Salt Spring Island, BC, Canada, [4]Greenland Institute of Natural Resources, DK–3900 Nuuk, Greenland, [5]Yukon College, Whitehorse, YT, Canada.Contact: rgw bob.white@alaska.edu

Introduction

For Arctic ungulates infestation by gastro-intestinal and external parasites can exert variable costs on the host:
•behavioral responses: increase energetically costly activities and reduced foraging.
•Within the host, parasite energy and protein requirements must be met by the host: energy and protein costs of an immune response and hosting the parasite.
In livestock gastrointestinal nematodes can increase maintenance energy requirements by 20% & protein requirements by >60% in late gestation and >200% in early lactation.

OBJECTIVE: To assess the possible costs of hosting external and internal parasites on productivity of *Rangifer* (caribou and reindeer) where seasonal food availability can limit compensatory increases in intake to meet environmental demands.

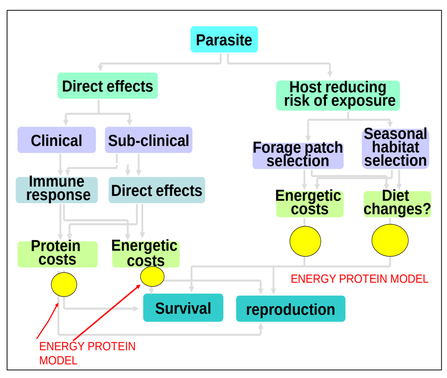
Methods

In this study we are using an energy-protein model that simulates foraging, digestion and metabolism on a daily time-step tracking body weight, body composition and productivity in an individual caribou or reindeer (*Rangifer tarandus*). To this basic model we are developing the algorithms to simulate energy and protein requirements of populations of internal (abomasal nematodes) and external (warble, bot, mosquito) parasites

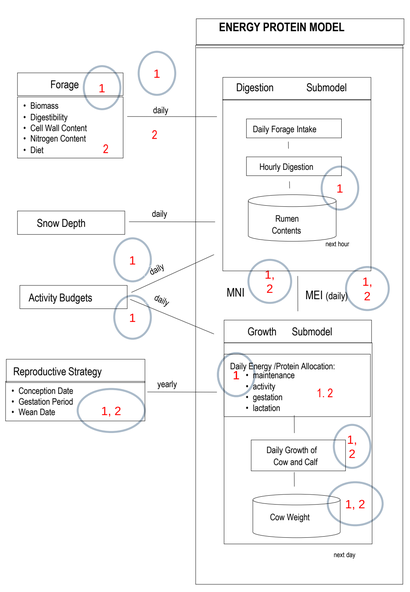
MODEL CONCEPTS

POINTS OF INLUENCE OF PARASITES

ECOLOGICAL INTERACTIONS



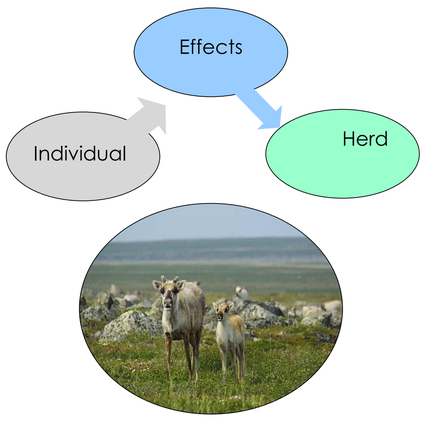
ENERGY PROTEIN MODEL



1, External/growth (warble, bot)

2, Intestinal/growth (nematodes)

MIN, Metabolizable N Intake
MEI, Metabolizable Energy Intake



Results

Both warble and internal parasite submodels are being tested for responses that match extant data. and those data collected through CARMA (CircumArctic Rangifer Monitoring and Assessment) Network.
Warbles: Body warble burden and body fat levels
Intestinal parasites: Body mass and body fat comparisons of control and anthelmentic treated reindeer (Stien et al., 2002)

WARBLE FLIES

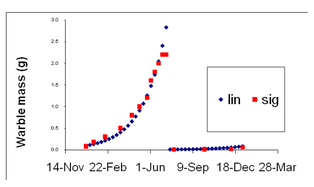
WARBLE MASS v DATE

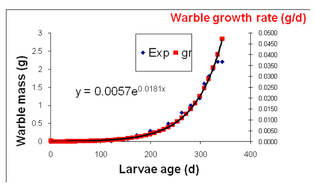
WARBLE GR v DATE

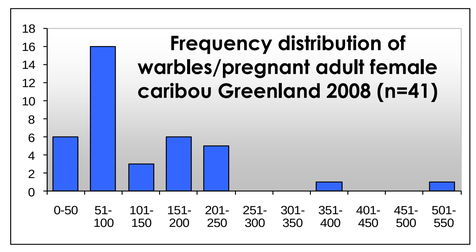
WARBLE METABOLISM
BMR=293*0.2*mass(kg0.75)

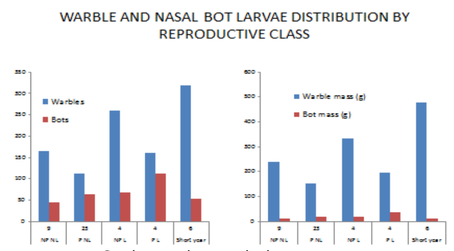
WARBLE GROWTH
NE=g/d*33.16(kJ/g)*0.3(gDM/g)

METABOLIC COST
BMR + NE
(BMR + NE)*# WARBLES





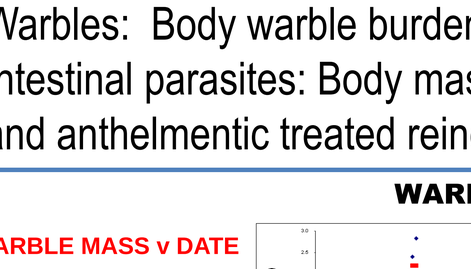




MOST ENERGY DEPOSITION OCCURS WHEN FETAL COSTS ARE HIGHEST

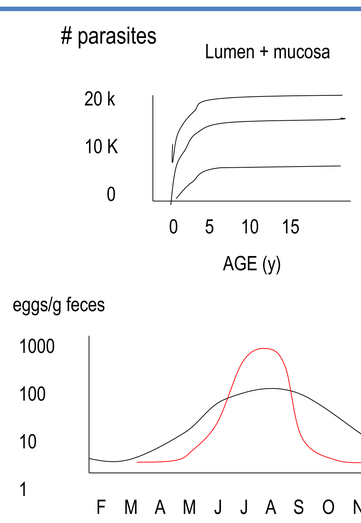
WINTER COSTS FOR SUB-ADULTS CAN AFFECT SURVIVAL & REPRODUCTION

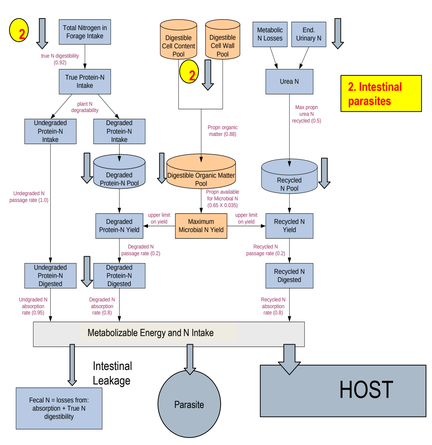
Cuyler et al., unpub.data



EXTERNAL PARASITES

INTESTINAL PARASITES





NOTES: 1. Peak output of intestinal nematode eggs coincides with increased costs for lactation
2. Peak growth of warble and bot larvae coincide with peak growth of placenta

References

Halvorsen et al., 1999. Intl. J. Parasit. 29:567-579.
Russell, D.E., R.G. White, and C.J. Daniel. 2005. Energetics of the Porcupine Caribou herd: A computer Simulation Model. Technical Report Series No. 431. Canadian Wildlife Service, Ottowa, Ontario, 64pp.
Steel et al. 1980. Aust. J. Agric. Res. 31:821-838.
Stein et al., 2002a. J. Anim. Ecol. 71: 937-945.
Stien et al. 2002b. Intl. J. Parasit. 32:991-996.