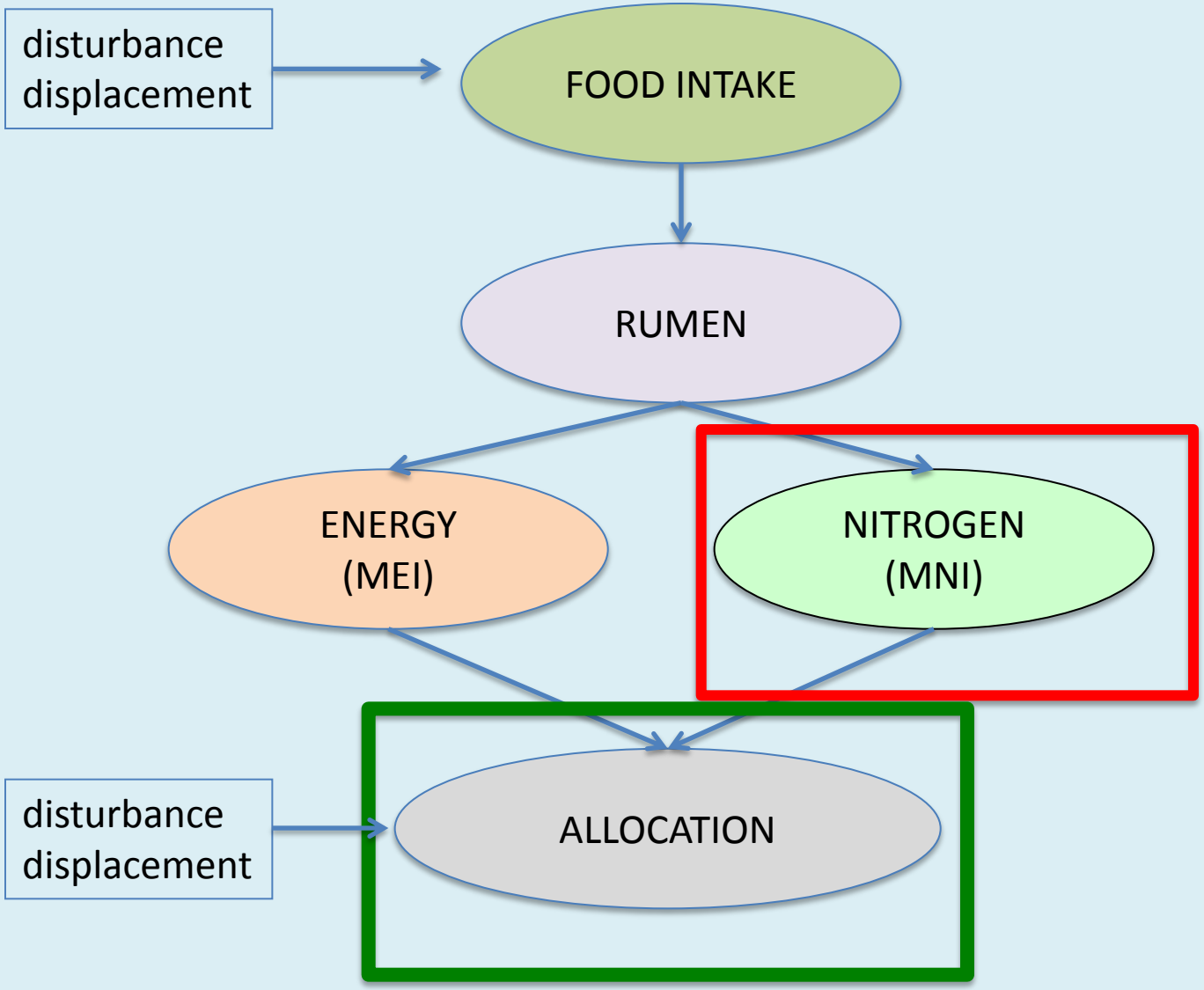
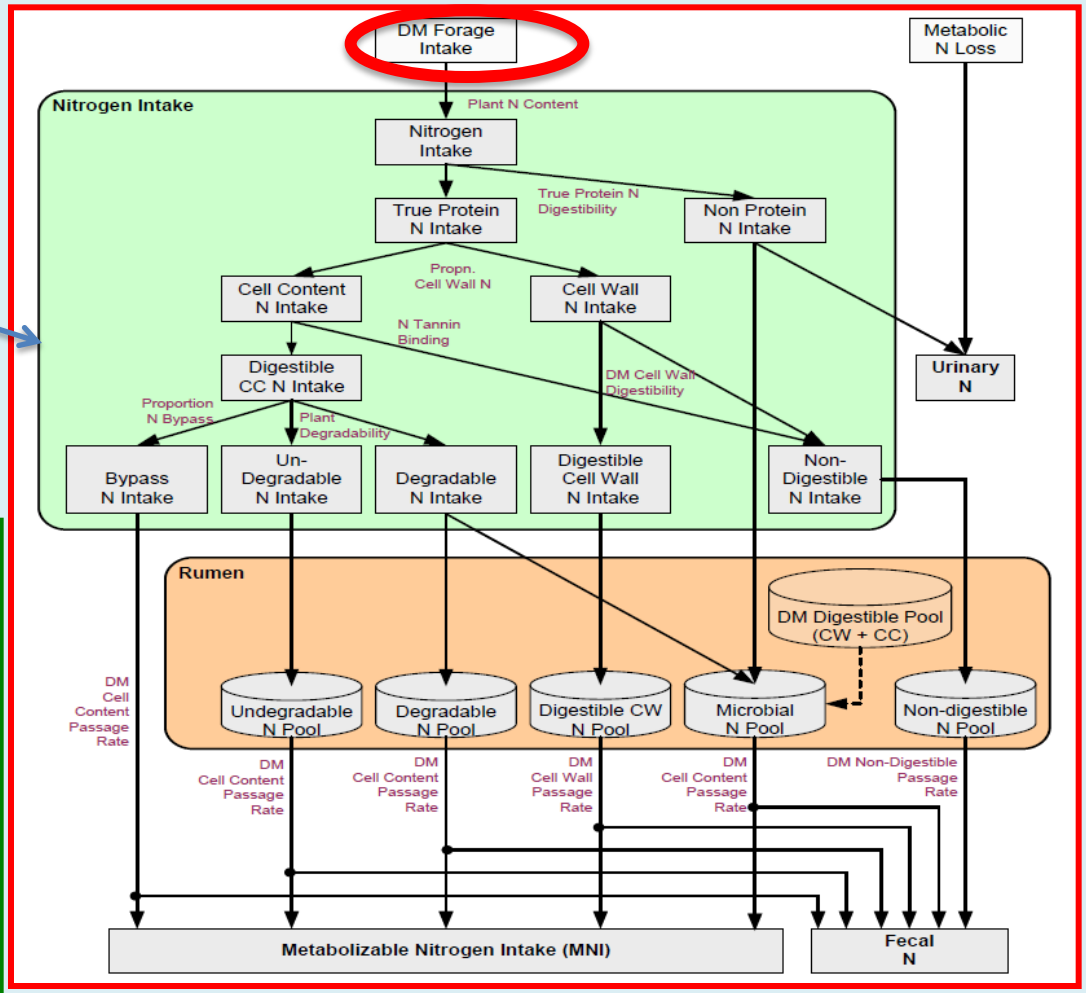
Protein/Energy Model: Applied to cumulative effects assessment

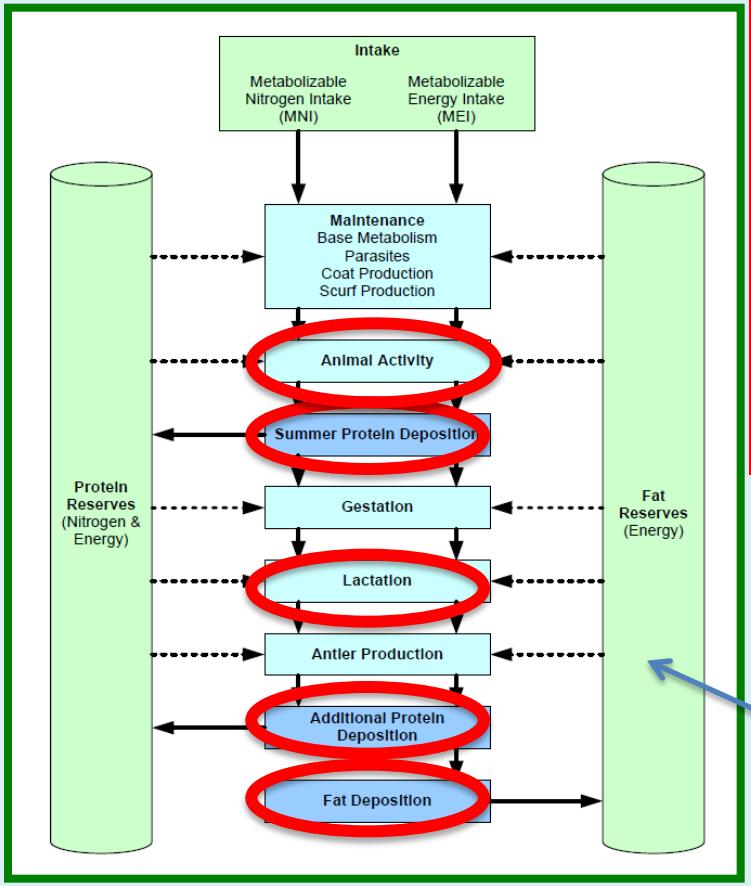
Energy – Protein model

Model structure



NITROGEN (MNI)



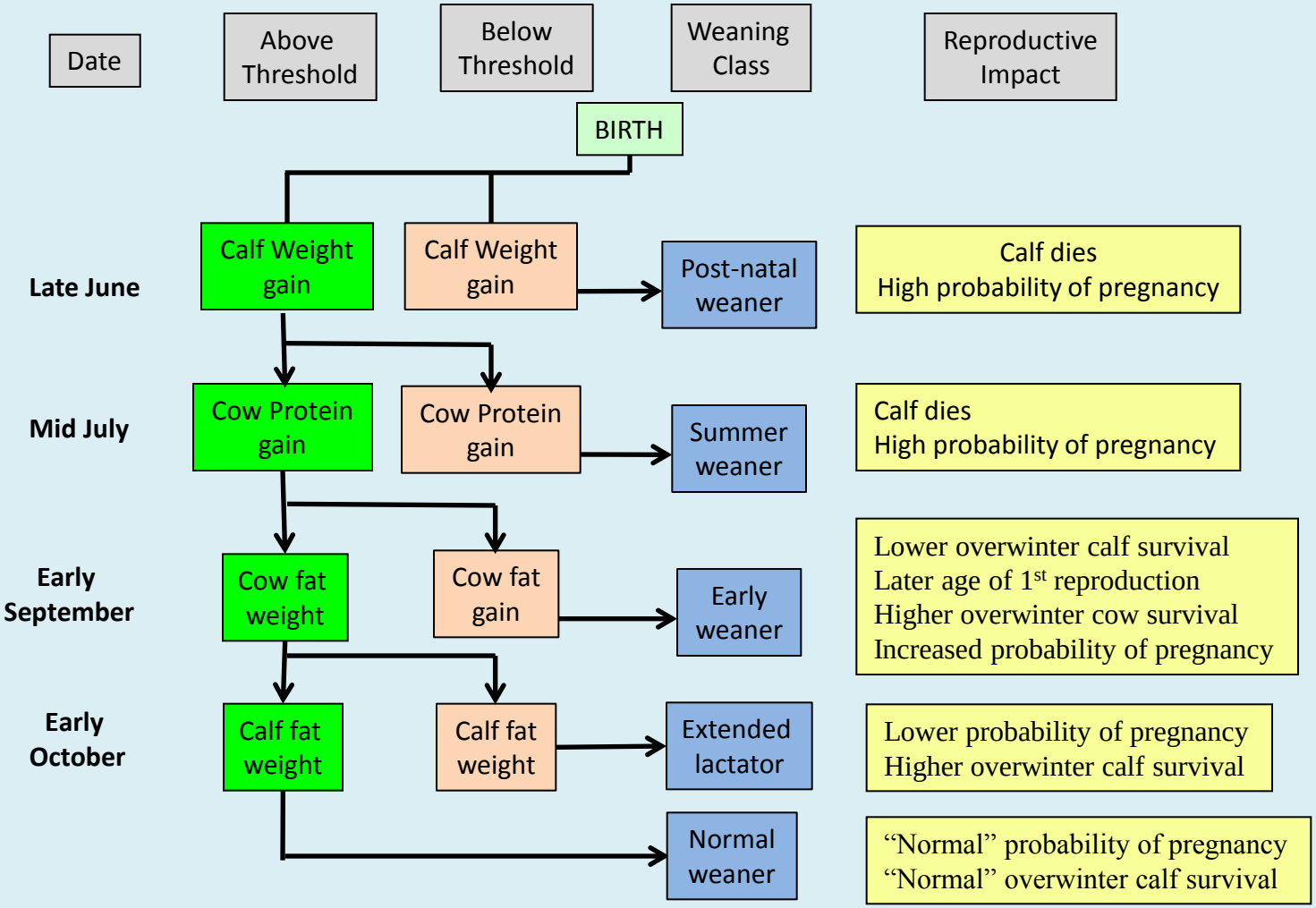


ALLOCATION (FAT AND PROTEIN)

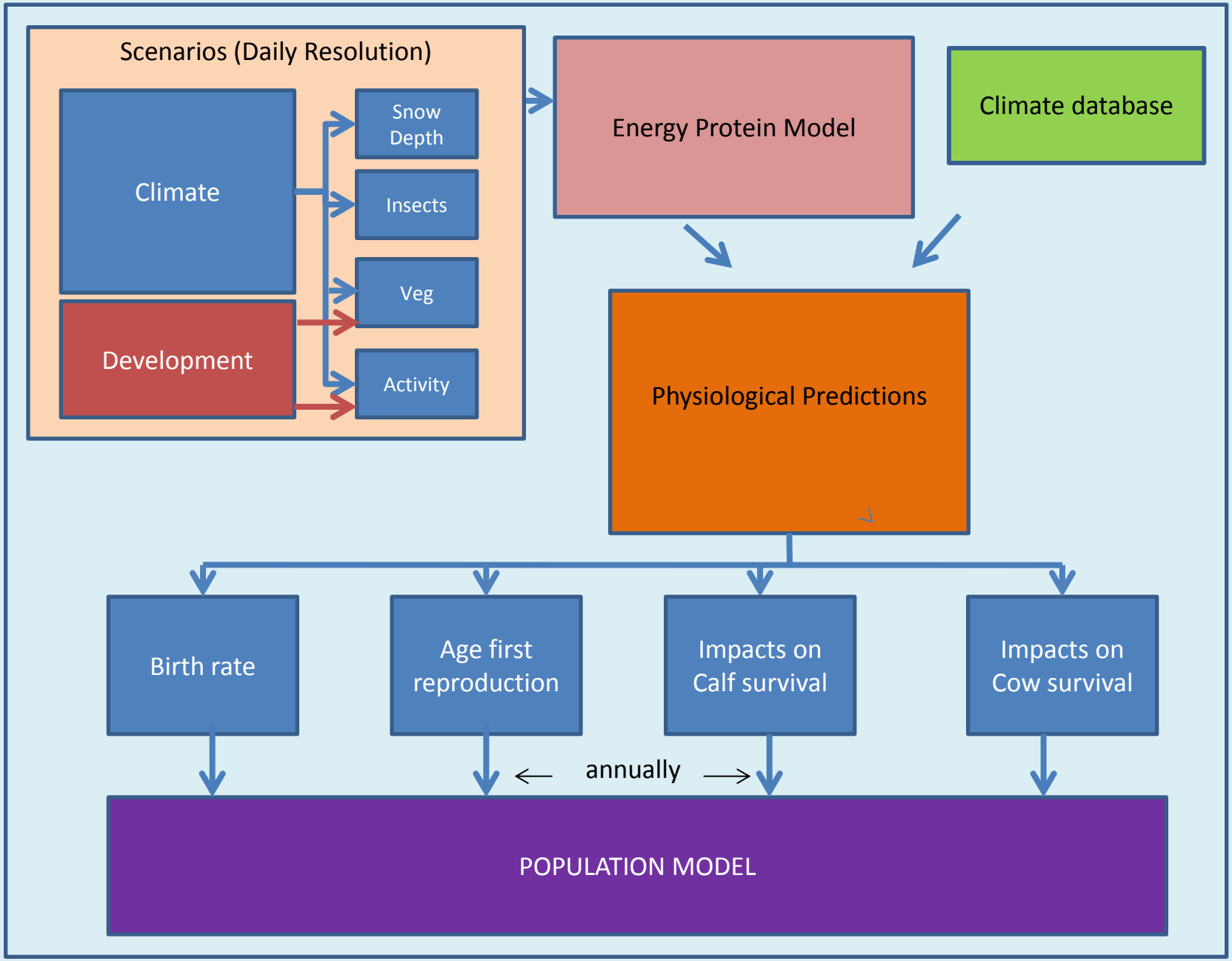
Why Protein?

- By ignoring protein, we assume the growth of the fetus, the production of milk and the replenishment of muscle tissue is entirely dictated by available energy. NOT TRUE
- An integral part of the weaning strategy in caribou – critical to buffer environmental change
- While energy may be the key nutrient in winter, protein is the key nutrient in summer
- *"The resilience of Rangifer populations to respond to variable patterns of food supply and metabolic demand may be related to their ability to alter the timing and allocation of body protein to reproduction."*
  - *Barboza 2008*

DECISION TREE FOR CARIBOU WEANING STRATEGIES



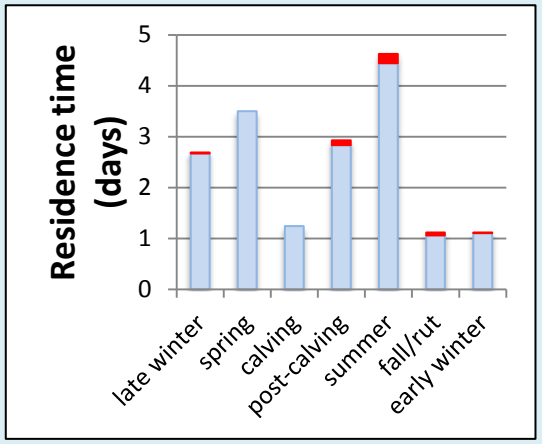
Linking energy-protein model with a population model

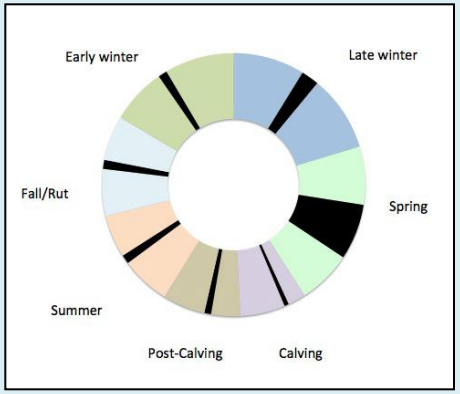


Model applications

- Porcupine
  - 1002 development
  - Climate change
- George River
  - Vehicle for data integration
- Bathurst
  - Cumulative effects pilot project
- Central Arctic
  - Prudhoe Bay oil development
- North Baffin
  - Baffinland's Mary River project
- Qamanirjuaq
  - AREVA's Kiggavik project

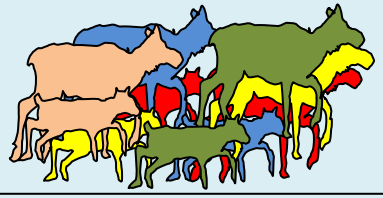
Kiggavik assessment approach





Energy Protein Model

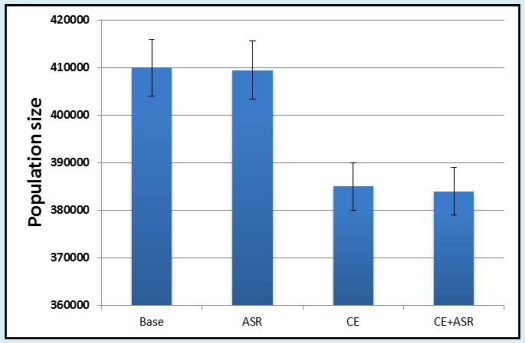
Climate database (average)



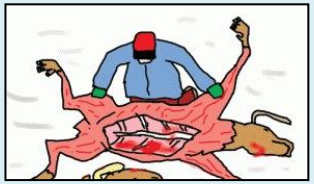
- 100 cows/scenario
- Weaning status
- Fall body weights

pregnancy

calf mortality

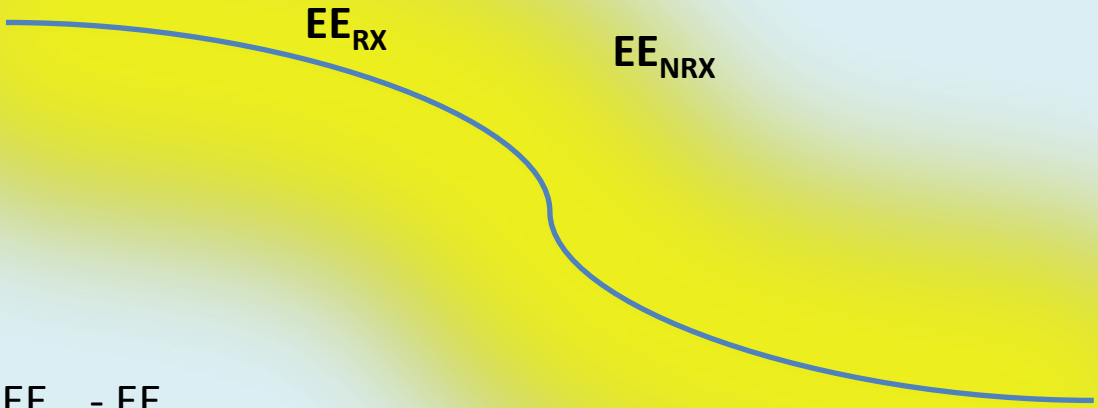


Population model projected to 2050



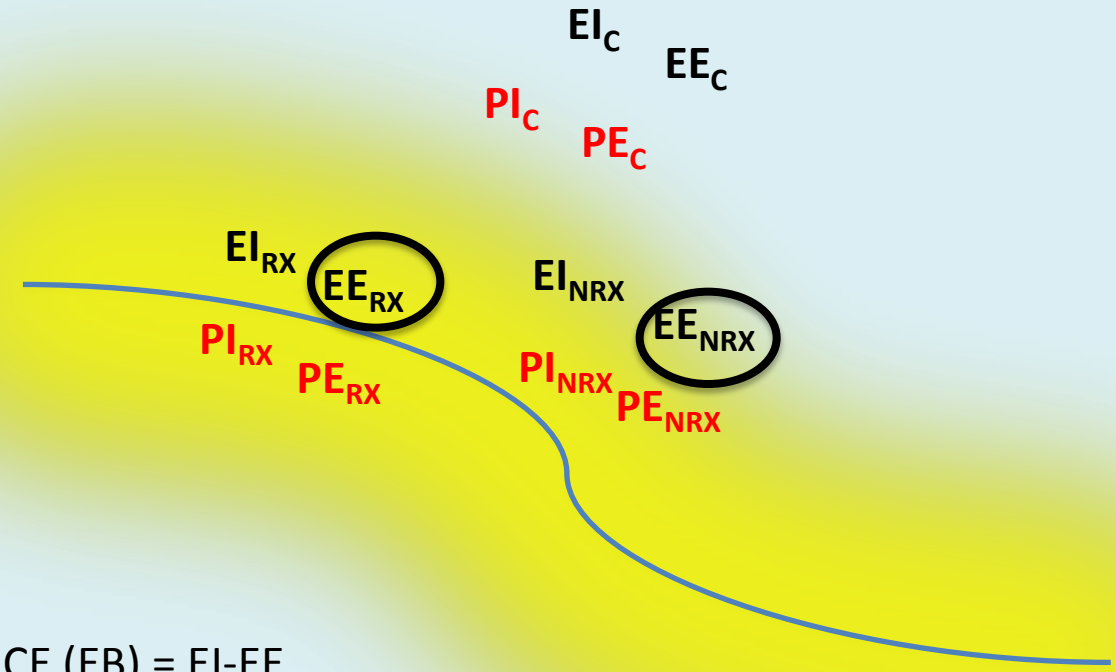
Harvest adjustment needed to offset development effects

Jay assessment components



ENERGY COST = EE_{RX} - EE_{NRX}

Kiggavik assessment components



ENERGY BALANCE (EB) = EI-EE

ENERGY "COST" for RX caribou = $EB_C - EB_{RX}$

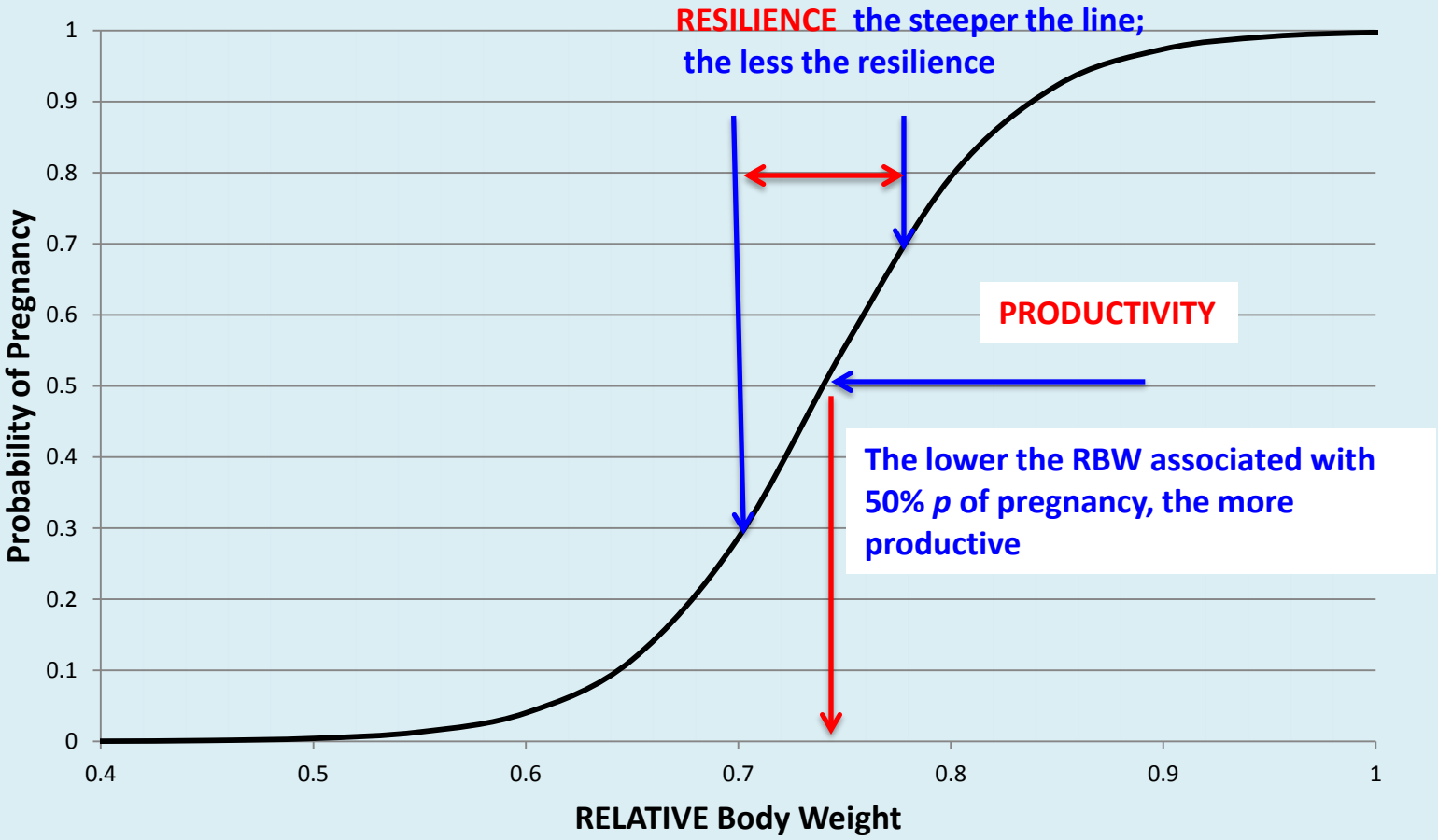
ENERGY "COST" for NRX caribou = $EB_C - EB_{NRX}$

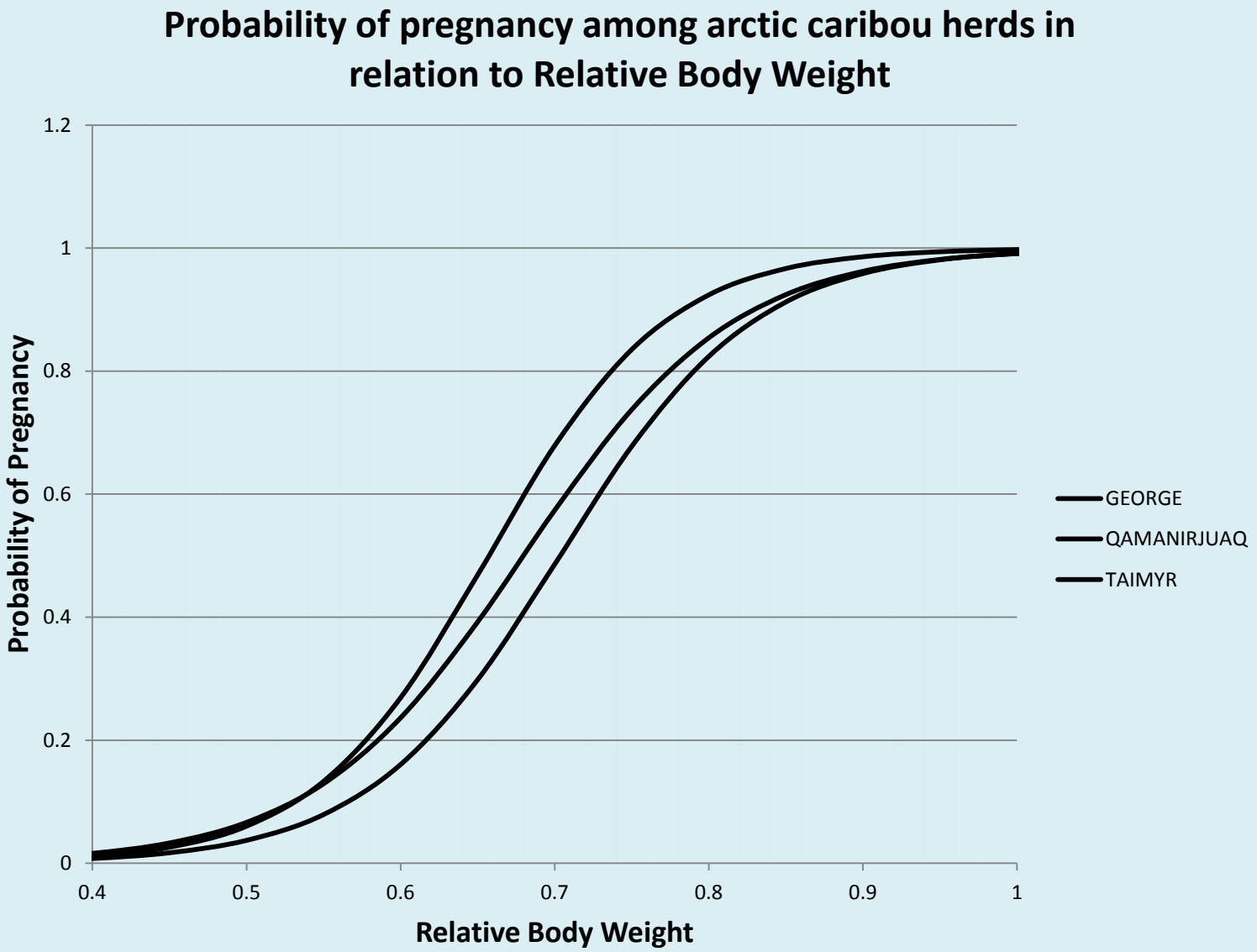
PROTEIN BALANCE (PB) = PI-PE

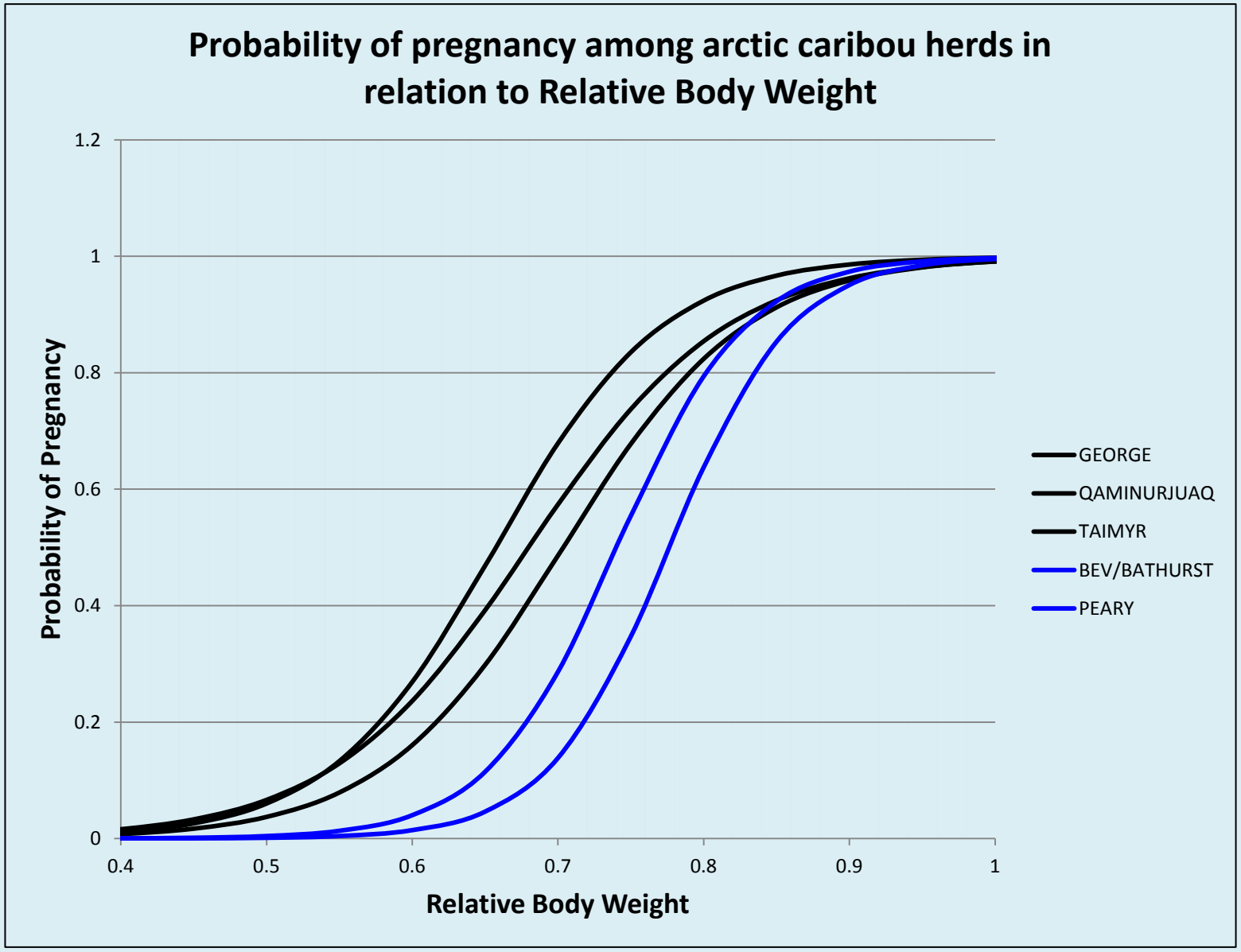
PROTEIN "COST" for RX caribou = $PB_C - PB_{RX}$

PROTEIN "COST" for NRX caribou = $PB_C - PB_{NRX}$

Probability of Pregnancy




Probability of pregnancy among arctic caribou herds in relation to Relative Body Weight
Probability of Pregnancy
1.2
1
0.8
0.6
0.4
0.2
0
0.4
0.5
0.6
0.7
0.8
0.9
1
Relative Body Weight
GEORGE
QAMANIRJUAQ
TAIMYR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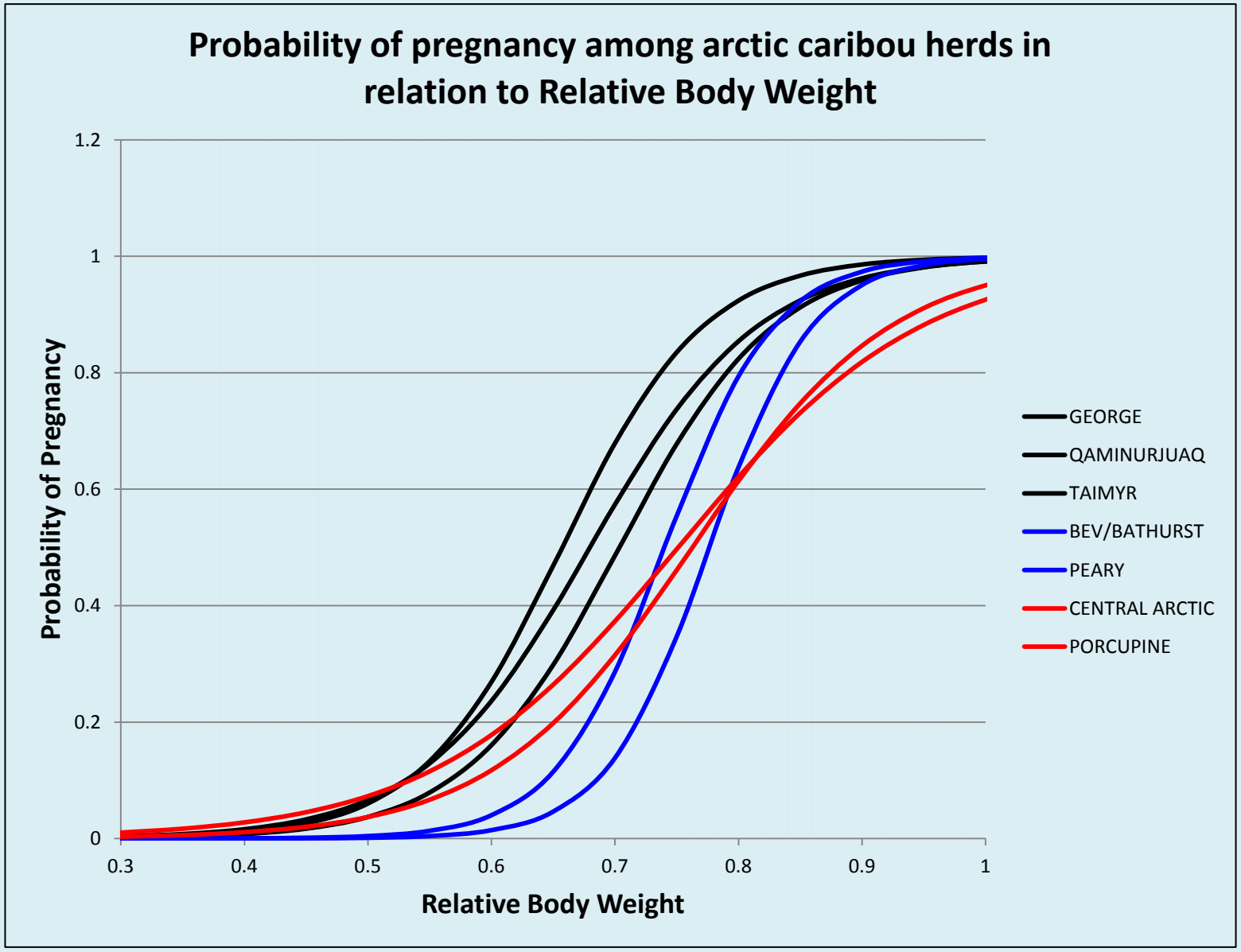
PEARY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TAIMYR
BEV/BATHURST
PEARY
CENTRAL ARCTIC
PORCUPINE

Major advantages of E-P approach linked to a population model

- Accounts for protein dynamics
- Flexible in designing scenarios – ask the “what-if” questions
- Multi-scale: integrates from climate to population – thus can develop scenarios that effect any scale (climate, habitat, behaviour, demography)
- Incorporates age structure – important when populations cycle
- Can model up to 1000 animals at once through a scenario – i.e. can capture the population variability and identify vulnerable cohorts