Stable Isotope Analysis of Moose Forage Species in NE MN

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Introduction

- Recent declines in NE MN moose population; 2005 =8,200 → 2016 = 4,020[2].
  - Factors influencing the abundance and distribution of moose: availability and quality of food, climate, and habitat composition[3].
- The use of stable isotope ratios to estimate diet helps understand nutritional ecology. Differences in $\delta^{13}C$ values between different plant species allows for identification → diet composition estimates.
  - Factors influencing diet composition: quality and availability of forage which are affected by precipitation, soil characteristics, and nutrient availability[1].
- Northeastern Minnesota spans a 6°C summer temperature gradient. For this study, we segmented the moose's range into two temperature regions based on mean summer temperature – warm and cold (Fig. 1).
- Comparing the differences in diet composition across the thermal landscape can provide insight into how temperatures affect habitat-use behavior.
  - Heat affects moose directly: summer heat stress causes weight loss, decreased pregnancy rates, and heightened vulnerability to disease because when it gets too warm, moose seek shelter rather than forage for nutritious food[4].

The primary objective of this study was to determine if moose diets in Minnesota vary as a function of temperature.

Methods

Data Collection
- **Forage:** Collected 597 samples from 7 species to estimate diet (Fig. 2)
- **Moose:** Hair samples were collected from 101 moose

Data Prep and Analysis
- Forage and moose hair samples were prepared and analyzed using previously established methods.

Data Interpretation
- SIAR was used to estimate diet composition using stable isotopes of C and N

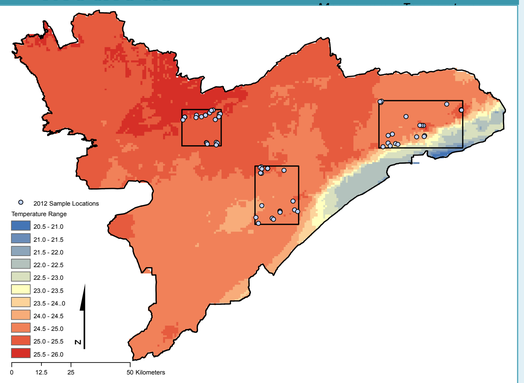

Figure 1: The range from which samples were collected, colors indicating the two temperature regions – warm and cold

Results

Species	Rank
Balsam fir (bf)	-
Mountain maple (mm)	6
Juneberries (amel)	7
Paper birch (pb)	4
Beaked hazel (bh)	10
Trembling aspen (ta)	2
Mountain-ash (ma)	5

Figure 2: Summer browse species from moose feeding sites in Northeastern Minnesota that were tested in this study[5]

The proportions of forage species vary significantly between the two temperature regions.

- The most notable difference is seen in mm; it is by far the most ingested in the cold region but among the least in the warm region.
- Ta, pb, bf, and amel have much greater proportions in the warm region than the cold.
- Bh and ma are the only species with similar proportions in both region.

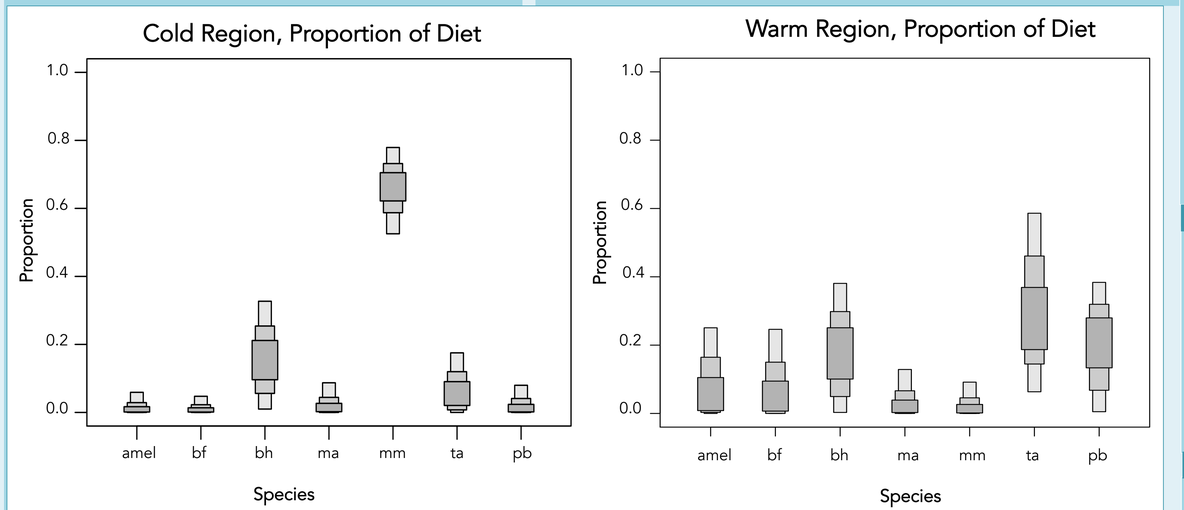

Figure 3: The above graphs were created within the SIAR library of R-studio. They demonstrate the proportions of various forage species that were ingested. The full names of the forage species are located in Figure 2.

Discussion

We found that moose diets vary as a function of temperature due to two possible explanations
1. Forage availability may vary as a function of temperature
2. Moose are selecting for different food items in different parts of their range

- While work related to this study suggests that forage availability does indeed vary, variation in diet composition does not align with variation in availability. The following are examples:
  - In the cold region, mountain maple was the most preferable browse while it was the most scarce
  - In the warm region, beaked hazel was a high preference browse, but it was the most scarce
  - Paper birch, trembling aspen, juneberry, and balsam fir composed a much greater proportion of the warm region diets than the cold region without any correspondence in availability variation variation
- This suggests forage selection by moose varies as a function of temperature, and there are numerous possible explanations:
  - Plant Secondary Compounds (PSCs), that can make plants more toxic to foragers with elevated temperatures, known as "temperature-dependent toxicity" → potentially limiting moose to forage that is not toxic to avoid getting sick
  - Habitat preferences can also vary with temperature fluctuation → moose may hangout in different areas when trying to cool off, and browsing on nearby forage in that area
- While according to previous research, the seven forage species tested in this study compose the vast majority of moose diets, there are other possible sources of forage that were not tested, causing a potential bias in this study.

Future Research: Expansions of this study could entail the analysis of Plant Secondary Metabolites (PSMs) to investigate forager responses to ingestion of PSCs. Another possibility is investigating the change in recovery period as a function of disturbance type (i.e. clear-cut, burned, pest-infested) to determine the point at which the mean isotopic signatures of disturbed plots resemble those of undisturbed plots. The results would inform how long it takes for disturbed forests to become isotopically indistinguishable from undisturbed areas. There is also the option of adding all possible forage species to the presented study to form a more complete analysis.

Resources

1. Ben-David, Merav, Einav Shochat, and Layne G. Adams. 2001. "Utility of stable isotope analysis in studying foraging ecology of herbivores: examples from moose and caribou." *Alces*. 37(2):421-434.
2. DelGiudice, Glenn D. 2016. "2016 Aerial Moose Survey." *Minnesota Department of Natural Resources.*
3. Lenarz, Mark S., Michael E. Nelson, Michael W. Schrage, Andrew J. Edwards. 2009. "Temperature Mediated Moose Survival in Northeastern Minnesota." *The Journal of Wildlife Management*. 73(4):503-510.
4. National Wildlife Federation. Global Warming and Moose. N.p., Web https://www.nwf.org/Wildlife/Threats-to-Wildlife/Global-Warming/Effects-onWildlife-and-Habitat/Moose.aspx. Accessed 10 Apr. 2016.
5. Peek, James M., Urich, David L., and Richard J. Mackie. "Moose Habitat Selection and Relationships to Forest Management in Northeastern Minnesota." *Wildlife Monographs* 48 (1976): 3-65. Print.

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