

Analyzing Predator Impacts on Biomass in a Grassland System

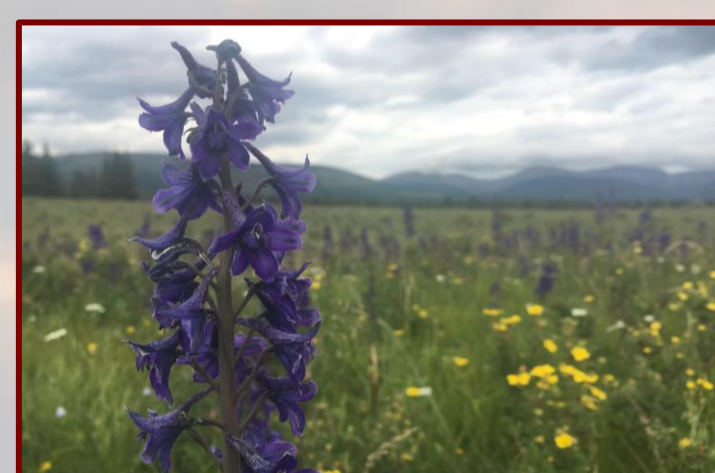


Trevor C. Weeks¹, Mark Hebblewhite¹, Sara H. Williams¹, Evelyn H. Merrill²
¹Wildlife Biology Program, W.A. Franke College of Forestry and Conservation, Missoula, MT 59812
²Department of Biological Sciences, University of Alberta, Edmonton, AB., T6G 2E9



1. INTRODUCTION

- **Trophic cascades** are top-down effects of predators on plant biomass, abundance or productivity in a food web¹.
- **Bottom-up effects** are well established in grasslands, but little is known about **top-down effects** in these systems, though grassland biomass is known to respond non-linearly to grazing pressure^{2,3,4}.
- Evidence of top-down effects will help inform **predator management strategies** throughout North America.
- The **Ya Ha Tinda (YHT) Elk Study**, located just outside of Banff National Park, Alberta, includes **20 years** of elk, wolf, and vegetation data in a mountain-prairie ecosystem.



2. OBJECTIVE

- Test the trophic cascade hypothesis for grassland biomass at the YHT, versus the alternative hypothesis of bottom-up effects driven by precipitation, versus the alternative non-linear intermediate grazing hypothesis.

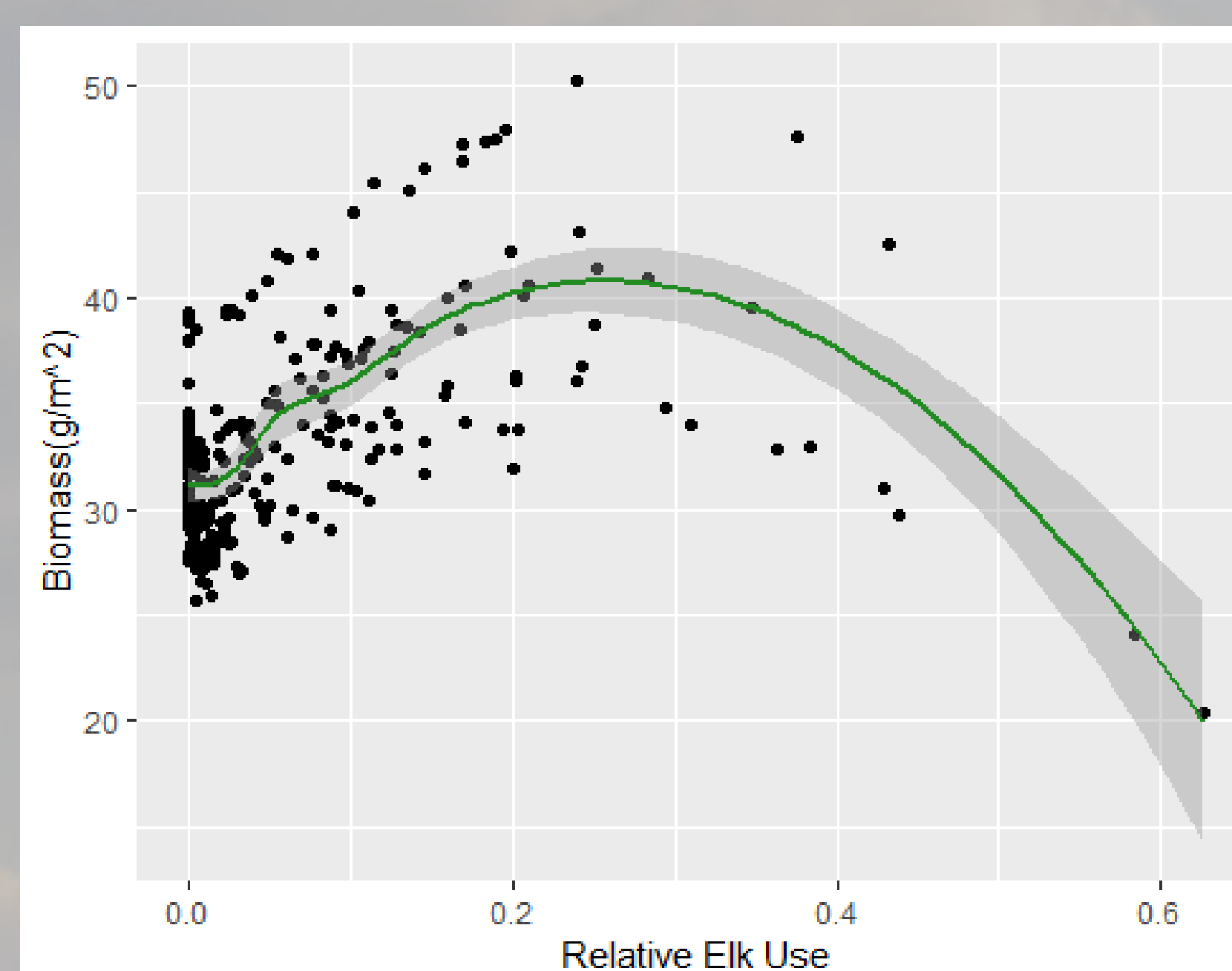
3. RESEARCH APPROACH

- Measured **grassland biomass** using a drop-disc indirect approach during the peak of the growing season, annually from 2006 - 2018 for a mean of **54** annual biomass plots.
- Quantified landscape-level **wolf predation risk**⁵.
- Quantified landscape-level **elk use** with GPS radiocollar data⁶.
- Generated and tested **a-priori models** in R.

4. RESULTS

- The top model for grassland biomass, determined via AIC, incorporates winter precipitation, non-linear effects of elk use, and wolf resource selection.

Model	df	AIC
1. Precipitation only	2	5455.695
2. Wolves only	2	5512.507
3. Precipitation, Elk, & Wolves	4	5379.292
4. Elk only	2	5411.331
5. Precipitation & Elk	3	5382.496
6. Elk & Wolves	3	5405.204
7. Precipitation and Wolves	3	5451.412
8. Quadratic Elk	3	5398.728
9. Precipitation, Quadratic Elk, & Wolves	5	3227.800
10. $y \sim 1$	1	5522.476



- The model shows a non-linear intermediate effect of elk herbivory on biomass (Elk Use $\beta = 1.868$, $p = 1.12e^{-13}$, Elk Use $^2 \beta = -3.734$, $p = 2.71e^{-9}$), consistent with the Intermediate Grazing Hypothesis. This effect is modified by wolf resource selection ($\beta = -0.027$, $p = 0.005$) and winter precipitation ($\beta = 0.047$, $p = < 2e^{-16}$).

5. CONCLUSIONS & IMPLICATIONS

- The model supports the hypothesis that grassland biomass is determined by a **combination of top-down and bottom-up effects**.
- Elk herbivory had the strongest effect, followed by winter precipitation, and wolves had the weakest effect, though all covariates were significant.
- Wolves did not have the positive impact on biomass predicted by trophic cascade theory. Rather, **increasing wolf resource selection led to decreased biomass**. A potential explanation is that in this system, cascading trophic effects of wolves may be **obscured by high human use**.

6. REFERENCES

- ¹ Pace et al. 1999. Trophic cascades revealed in diverse ecosystems. Trends in Ecology & Evolution 14:483-488.
² Robinson et al. 2013. Seasonal, not annual precipitation drives community productivity across ecosystems. Oikos 122:727-738
³ Schmitz et al. 2000. Trophic cascades in terrestrial systems: a review of the effects of carnivore removals on plants. The American Naturalist 155:141-153.
⁴ Frank et al. 1998. The ecology of the Earth's grazing ecosystems. Bioscience 48:513-521.
⁵ Hebblewhite, M., and E. H. Merrill. 2007. Multiscale wolf predation risk for elk: does migration reduce risk? Oecologia 152:377-387.
⁶ Kranstauber et al. 2012. A dynamic Brownian bridge movement model to estimate utilization distributions for heterogeneous animal movement. Journal of Animal Ecology 81:738-746.

7. ACKNOWLEDGEMENTS

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