Global population dynamics and climate change:
Comparing species-level impacts on two contrasting large mammals

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Background

- Climate change will likely cause shifts in species’ distribution and abundance across the globe.
- To date, most studies of population dynamics focus on single populations of animals, over limited time scales.
- Predictions from these population-level models fail to capture historical (Pleistocene) or current changes to species ranges (Schmitz et al. 2003).
- The mechanisms that generate global patterns of species distribution and abundance remain unclear (Fig. 1).

Research Questions

Q1: How do landuse and climatic change affect species’ niche throughout their ranges?
- Model both the fundamental and realized niche to determine what environmental factors, particularly human landuse, contribute to species’ distribution and abundance (Fig. 3).
- Fundamental niche: set of abiotic factors, regardless of biotic factors, in which a species may theoretically occur.
- Realized niche: area where the abiotic and biotic conditions are favorable for occurrence.
- Examine the spatial and temporal relationships between remotely sensed forage availability data (e.g., NDVI) and field measures of forage biomass/quality.

Q2: How does climatic influence vary across a species’ range and globally after accounting for biotic interactions?
- Consider the effects of competition for forage (density-dependence), predation, forage quality and climate on population dynamics.
- Examine the interactions between predation and density, climate and density with and without predators to determine how biotic and delayed abiotic processes influence the relative impact of predation.
- Test whether the strength of density dependence varies inversely with primary productivity (Fig. 4).
- Highlight climate change hotspots by incorporating climate into population dynamics models with predation, vegetation and interactions among these terms (Fig. 5).
- Determine the relative pathway of climatic influence on ungulate population dynamics.
- Assess the direct and indirect (through predation and/or forage) effects of climate on population dynamics.
- Model the spatial and temporal responses to climatic change on a global scale.

Q3: How does the spatial scale of population synchrony vary with climate change?
- Synchrony among populations positively correlated to extinction rate (Heino et al. 1997).
- Explore the role of climate in determining synchrony across a species range.
- Determine the relative contribution of dispersal and environmental (climatic) induced synchrony in a warming climate.
- Investigate change in the spatial scale of synchrony over time with climate change.

Study Species

- Related, but ecologically contrasting large generalist herbivores with well-known life history.
- Circumpolarly distributed large herbivores likely to be differentially affected by climate change (Fig. 7).
- Differ in past and anticipated responses to climate change.
- Offer a powerful contrast to understand the interplay of climate and biotic factors in driving climate response

Conclusions

- Improved understanding of the mechanics of the effects of climate change on two economically important species at continental scales.
- Link global MODIS (and other) datasets to biodiversity responses to climate.
- Evaluate effects of future climate change projections (CMIP 5 assessments) on these two contrasting species from niche model to global population dynamics.
- Global impacts of climate on wildlife is a critical knowledge gap because of the key role wildlife play in the public’s perception of climate impacts and shaping climate policy (Spohnberg 2007).

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Literature Cited