Isotopic trophic niche dynamics of small mammal communities reveal spatiotemporal complexity across an experimental prairie woodland mosaic

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Background

Great Plains grasslands were historically maintained by a combination of mega-herbivores (e.g. bison) and frequent wildfire, but as human land-use and climate have changed, native prairies are increasingly experiencing fragmentation through development, agriculture, and woody encroachment. Turnover to woodland is accompanied by community change of major consumers and available resources. In the absence of mega-herbivores, we investigate how experimental fire suppression and resulting woody encroachment have influenced the role of small mammals as consumers, and how these vertebrates use resources within alternate habitat states and through time. Konza Prairie Biological Station and the Konza Long-term Ecological Research Program (Fig. 1) constitute a landscape-scale experimental manipulation of habitats through altered grazing and fire regimes, and provides an ideal setting for understanding drivers of ecosystem change, and the complexity of corresponding community dynamics.

Predictions

1. Small mammal species will occupy characteristic isotopic niche space that should remain consistent through time, reflecting habitat associations (e.g., woody or grassland resources), and feeding mode/trophic position (e.g., granivore, insectivore)
2. Community constituents will partition trophic niches to reduce competition for resources
3. Trophic niche breadth will increase with relative disturbance (i.e., fire frequency)

Materials and Methods

- Sampled dominant rodent species in summer over two years, from treatments reflecting annual, 4-year, and 20-year fire intervals
- Fur and liver were sampled from adult specimens, cleaned, dried, and ground by standard methods
- Analyzed Carbon and Nitrogen stable isotope ratios in relation to reference samples (arthropods, C3/C4 plants) to assess spring (fur) and summer (liver) diet
- Statistical analyses (R-package: SIBER) provided standard ellipse areas (SEA) for isotopic niche breadth and position which was compared through time (Fig. 2), among species comprising communities within different habitats (Fig. 3), and within species (Fig. 4)

Deer mouse – *Peromyscus maniculatus*
Granivore/Insectivore; Grasslands

Harvest mouse – *Reithrodontomys megalotis*
Strict Granivore (graminoids); Grasslands

Prairie vole – *Microtus ochrogaster*
Strict Folivore; Grasslands

Hispid cotton rat – *Sigmodon hispidus*
Folivore/Granivore; Shrubland/Woodland

White-footed mouse – *Peromyscus leucopus*
Insectivore/Granivore; Shrubland/Woodland

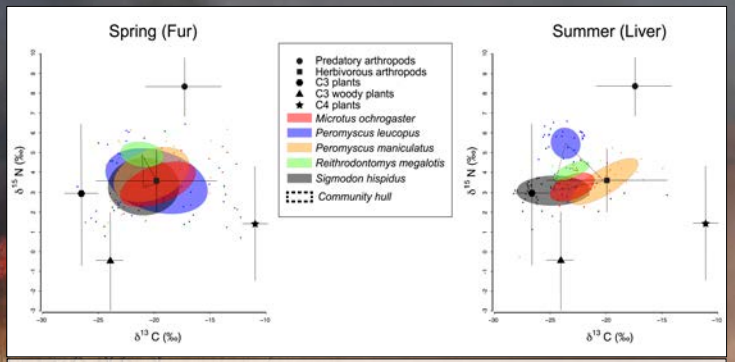


Fig. 2. Stable isotope ratios of C and N for 5 common small mammal species occurring across a prairie-woodland mosaic in northeast Kansas. Standard ellipse areas indicate the core 40% of dietary niche per species as compared with mean and SD values for dietary reference samples. Major changes in niche from Spring (fur) to Summer (liver) include narrower and more stable niche spaces over all species.

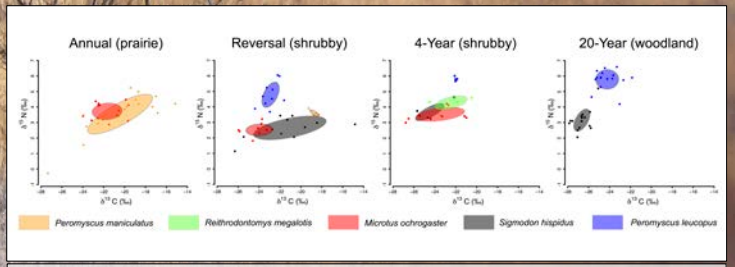


Fig. 3. Summer (liver) stable isotope ratios of C and N, indicating dietary niche overlap among small mammal species comprising different communities (occurring within different treatment habitats). Competition for resources among species is minimized by differences in dietary choice and feeding behavior.

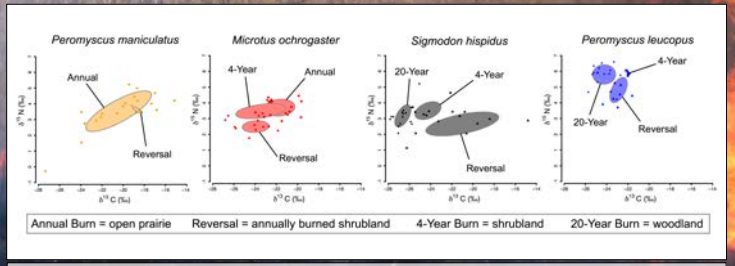
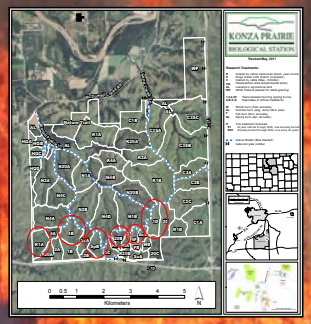


Fig. 4. Summer (liver) stable isotope ratios of C and N, indicating intra-specific changes in niche across different landscape treatments. Increasing burn frequency my shift diet towards C4-grasses.

Discussion

- Spring trophic niche spaces are significantly broader, highly overlapping among species, and more variable across years (not shown) than summer diets (Fig. 2), suggesting early season variability and scarcity of resources in relation to timing of fire and fur molt; Fur may be useful for capturing fundamental trophic niche but not realized niche.
- Summer diets significantly differ among most species and were consistent across years, so may approach realized trophic niche; existing overlap in ellipses may indicate different feeding modes resulting in the same isotopic signatures (Fig. 2, 3)
- Woody encroachment drives community turnover among small mammals, and associated changes in trophic dynamics are narrower, more stable, and highly partitioned diets compared with open native prairie (Fig. 3)
- Against prediction, intra-specific trophic niche varied significantly among habitats, shifting predominantly on the carbon axis from C4 to C3 plants from grassland (annual burn) to shrubland (4-year burn) to woodland (20-year burn), respectively (Fig. 4)
- Although woodland trophic niches tend towards C3 plant diet compared with grassland niches, woodland mammals may not directly consume dominant woody species (Fig. 1).
- A third year of data plus future analysis of dietary composition will strengthen evidence for discrete consumer roles among small mammals occupying native and anthropogenic habitats



Acknowledgements
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Fig. 1. Map of Konza Prairie Biological Station. Circles show treatment habitats sampled.

*Background photo: Prescribed burning of native prairie on Konza Prairie Biological Station (credit: Eva Horne)