Spatiotemporal prevalence of parasites with mammal community turnover and woody encroachment in the Great Plains

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Goals

1. Investigate the prevalence of endo- and ecto-parasites across small mammal species, and relative distribution of parasites across habitats.
2. Assess changes in endo- and ecto-parasite prevalence in relation to habitat and small mammal densities through time.
3. Assess prevalence of major ectoparasite groups (fleas, ticks, mites, lice) across habitats.
4. Investigate changes in zoonotic "potential" across both habitats and years.

Introduction

Human-induced environmental changes including development, agriculture, changing climate and cessation of burning have fragmented native prairie grasslands through the Great Plains. Consequences include extensive woody encroachment and an increasingly complex mosaic of grassland and woodland communities, including non-volant small mammals and their associated biodiversity. **This region is also predicted to become a hotspot for emerging small mammal reservoirs of zoonotic disease in the near future (Fig. 1).** Konza tallgrass prairie long-term research area in northeastern Kansas (star in Fig. 1) constitutes an experimental system that reflects major processes of community change, and an area of increasing specimen resources for eco-evolutionary investigations. Long-term mammal sampling through this study recorded two near-record high density years followed by a presumed climate-related population crash in the third year of sampling, allowing an exploration of interdependent biodiversity responses.

Hypotheses

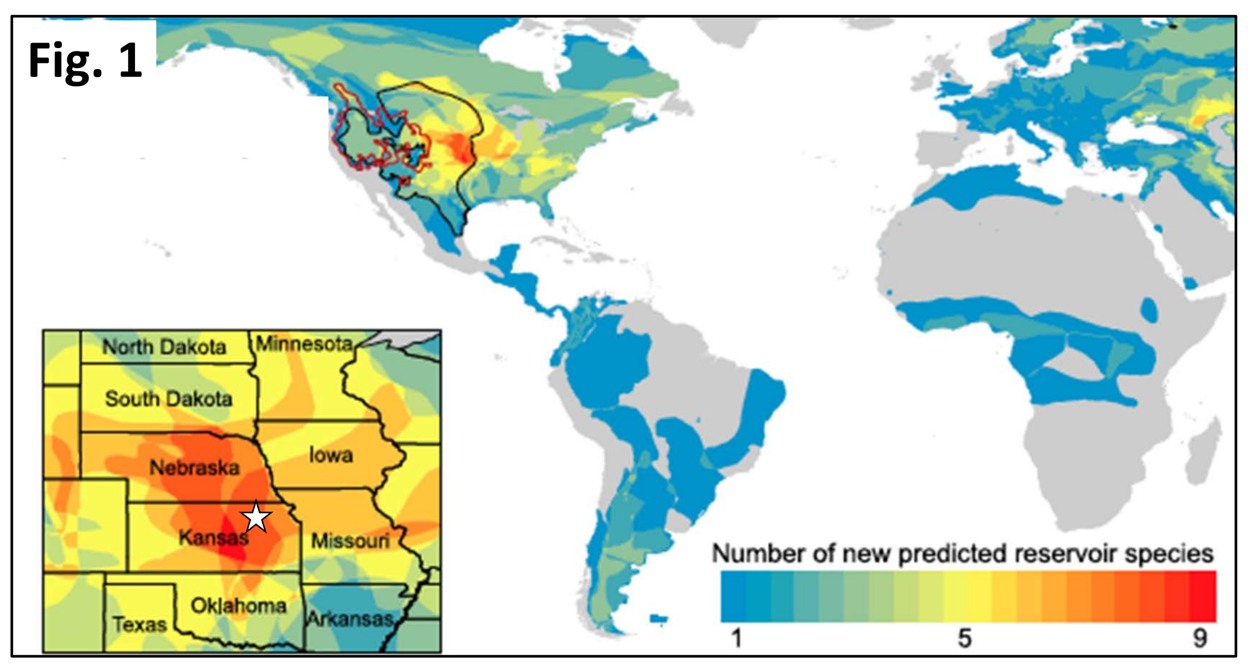
H_0: Distribution of parasites will be uniform across habitats (suggesting host/habitat generalists).

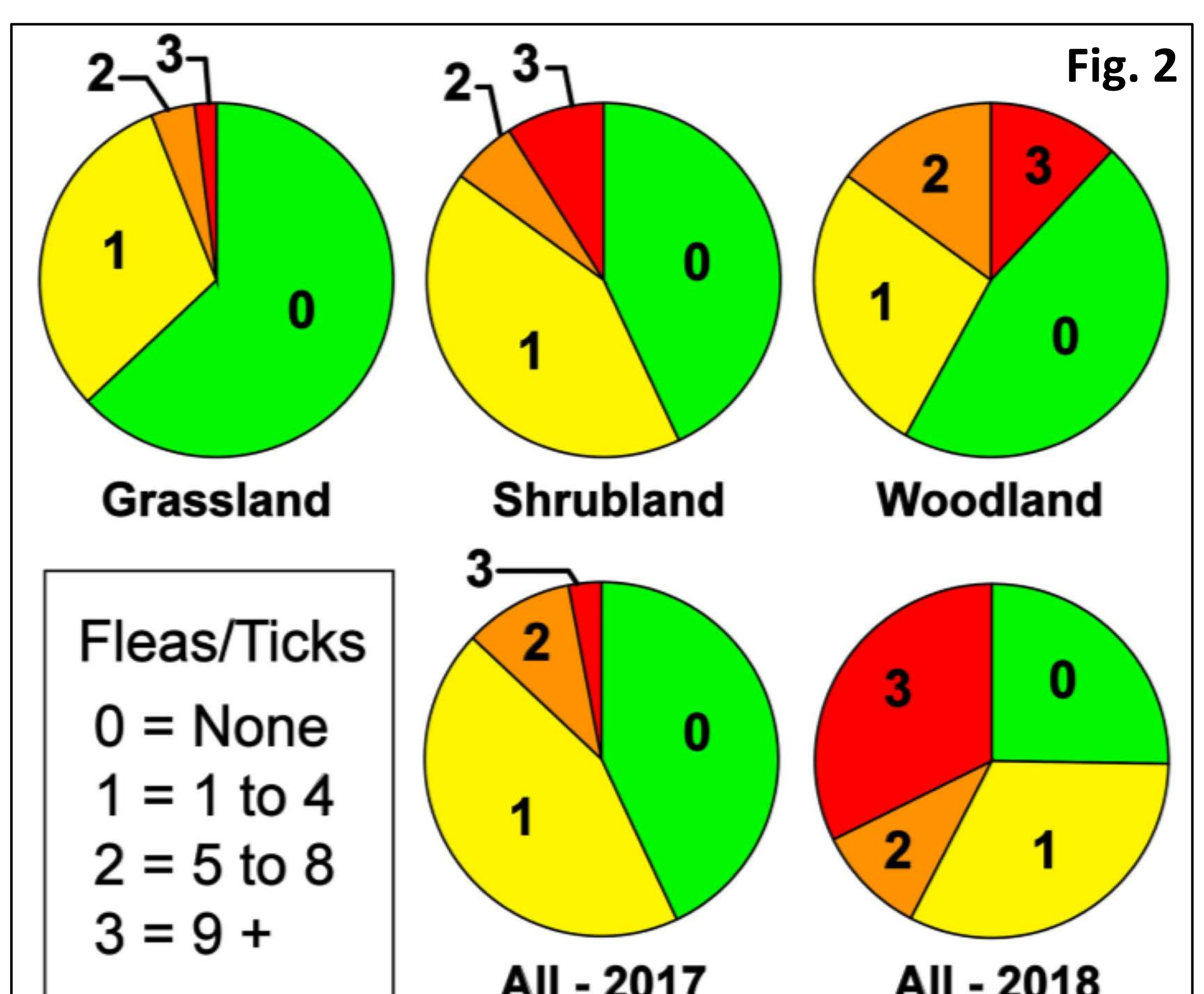
H_1: Parasites will exhibit greater prevalence and densities in woody habitats (reflecting increases in woody encroachment and vector-borne disease).

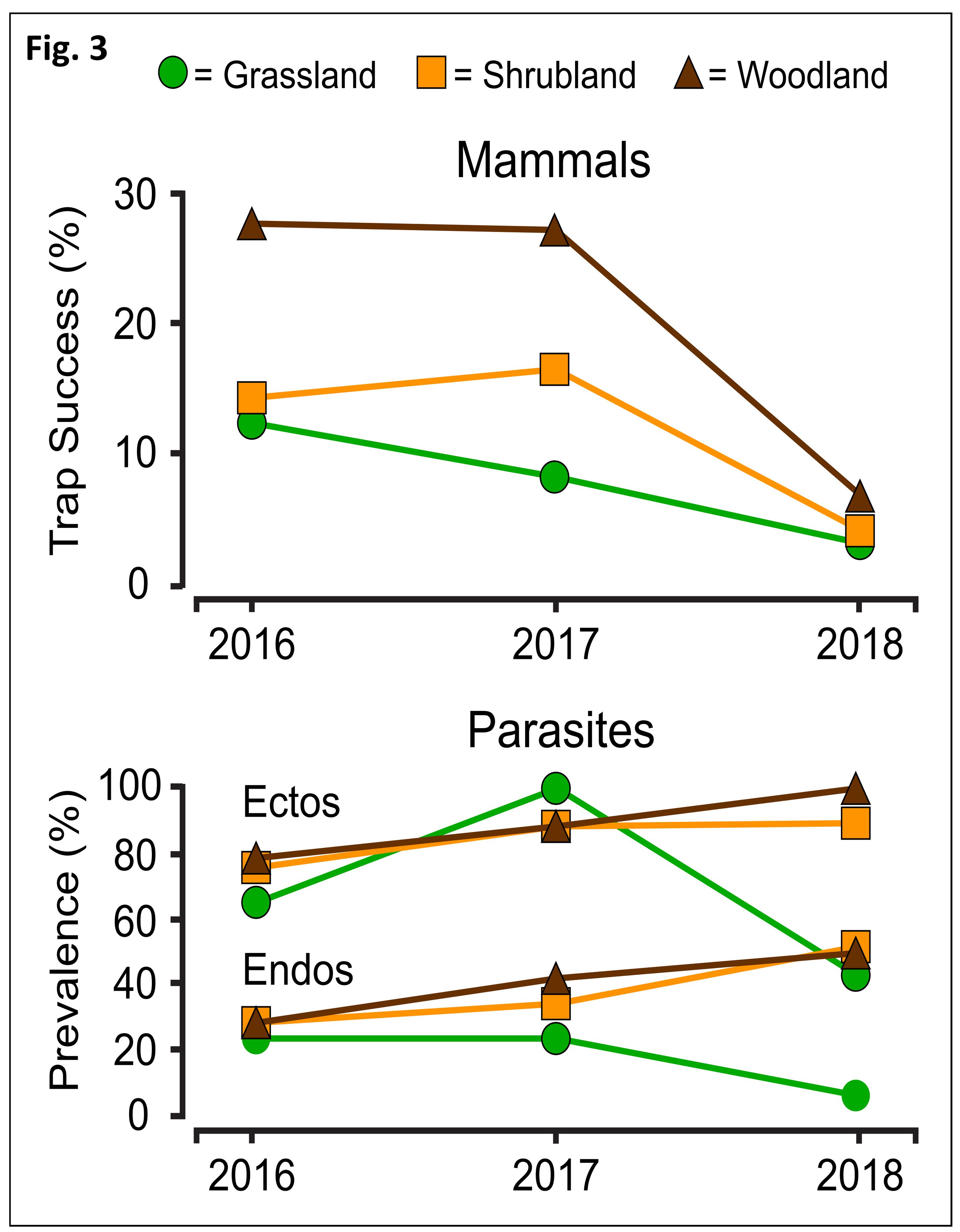
H_2: Relative prevalence of parasites will depend on multiple factors including parasite group, small mammal host, habitat, and inter-annual environmental change.

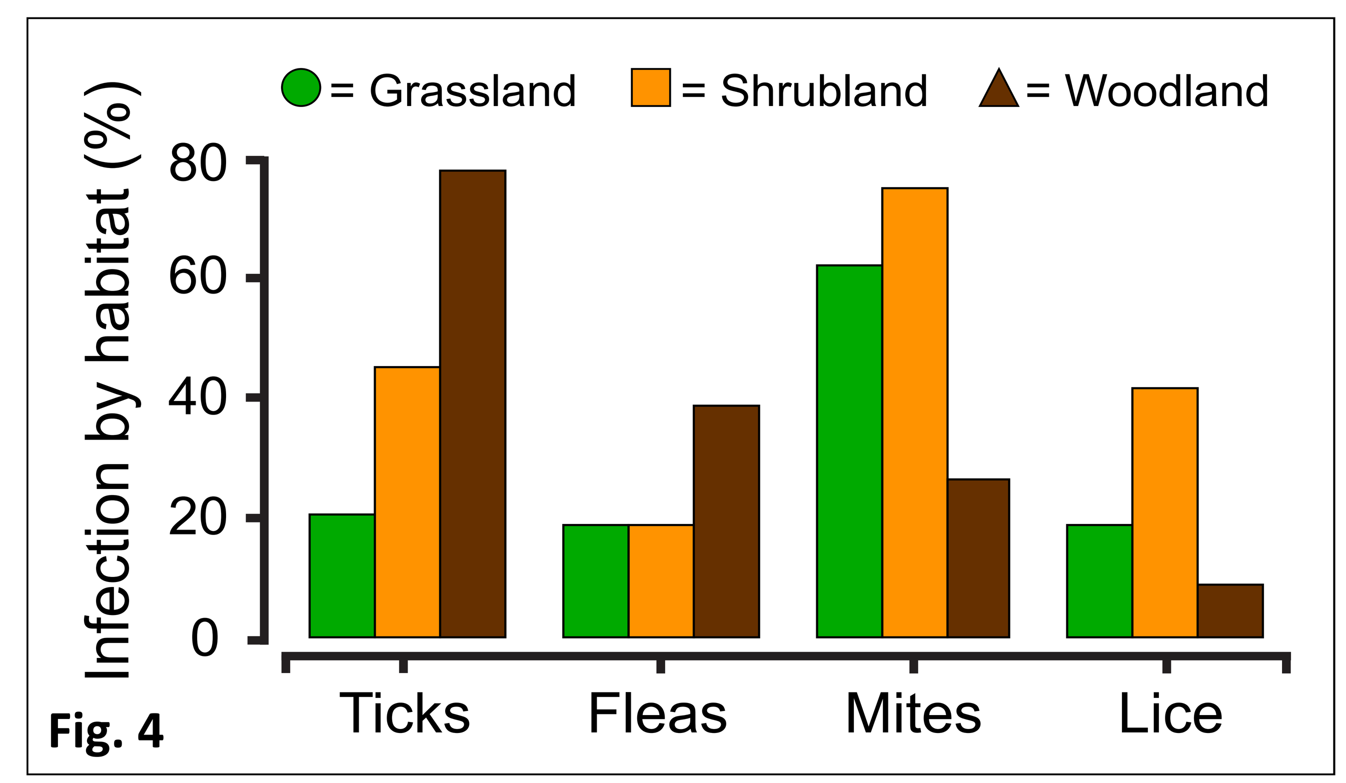
Methods

- Small mammal specimens were collected between 2016 and 2018 from experimental burn treatments (1, 4, and 20-year burns; resulting in grassland, shrubland, and woodland habitats respectively) on the Konza tallgrass prairie long term research area.
- Specimens were processed and preserved, including host and parasite materials.
- Presence/absence of endo- and ecto-parasites were recorded across years. Ectoparasites were categorized by group (ticks, fleas, mites, lice).
- Abundance of vectors (fleas and ticks) were scored as 0 (none), 1 (1-4), 2 (5-8), or 3 (9+) to assess zoonotic potential.
- Analyses tested differences in parasite prevalence between mammal species, across habitats, and across years; And tested for differences in zoonotic potential across habitats. **All were significant.**









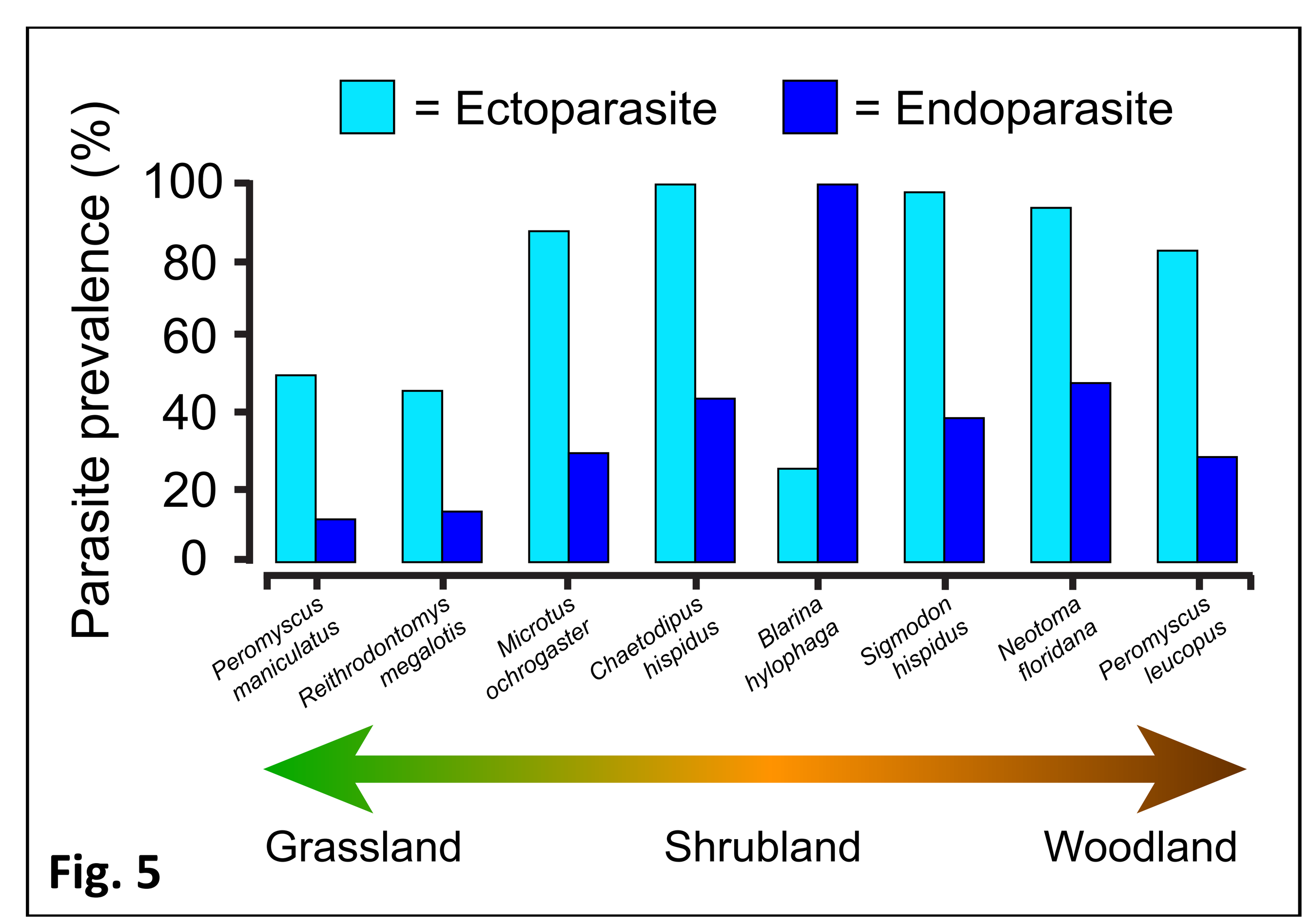


Figure Legend

Fig. 1. Projected rodent zoonotic reservoir species (adapted from Han BA, et al. 2015. *PNAS* 112:7039-44).

Fig. 2. Zoonotic vector scores by habitat and sampling year

Fig. 3. Relative densities of small mammals by habitat type over three years (top); Infection prevalence of both ecto- and endo-parasites by habitat over three years (bottom).

Fig. 4. Relative distribution of ecto-parasite groups across habitats

Fig. 5. Prevalence of both ecto- and endo-parasites by small mammal species. Small mammals include most common species from Konza ordered by habitat association.

Findings and Impact

Parasite prevalence, as well as rodent densities, were highest in woodlands. However, although rodent densities crashed in 2018, prevalence of parasites only declined in grassland, but increased in shrubland and woodland. Zoonotic potential also increased through time, and was significantly higher in woody habitats. As woody encroachment of native grasslands increases, small mammal communities experience turnover, increasing abundance, and increasing infection by parasites. Parasite prevalence appears to be buffered by woody habitats, although additional data is required. **Native grasslands maintained through regular burning appear to provide critical ecosystem services through lower zoonotic potential, whereas woody encroachment substantially increases risks associated with vector-borne disease.**