Biodiversity “hotspots” in Great Basin National Park

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Introduction

Historical impacts of climate change on biodiversity in the Great Basin are well documented through tree rings, lake levels, and *Neotoma* middens. Recent examination of temperature data in Great Basin National Park (GRBA) shows a strong trend toward a warmer and earlier onset of spring (Figure 1), a trend documented across the western US (Stewart et al., 2004).

As an isolated montane national park, climate change is expected to have dramatic effects on biodiversity in GRBA. Historically, several species have suffered local extinctions under past warming climates and published models have suggested that three montane mammal species (ermine, Inyo shrew and water shrew) will not survive a 3°C increase in mean annual temperature (McDonald and Brown, 1992).

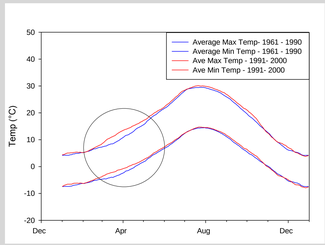

Figure 1. Comparison of mean maximum and minimum temperatures at Great Basin National Park from 1961 - 1990 and 1991 – 2000 (Data from Western Regional Climate Center, www.wrcc.dri.edu).

The use of biodiversity hotspots to prioritize conservation efforts, have been an important, if not controversial step in conservation biology (Myers et al., 2000). Conceptually, biodiversity hotspots recognize economic limits to conservation and the prudent use of these resources to maximize biodiversity conservation.

We examined the relationship between mammal diversity, sampling and habitat to clarify understanding of patterns in small mammal diversity.

Study Site

Great Basin National Park is a high elevation montane park (31,234 hectares) located in Eastern Nevada. The climate is cool and most precipitation falls as snow, with limited precipitation from the Southwest monsoon during the short summer growing season.

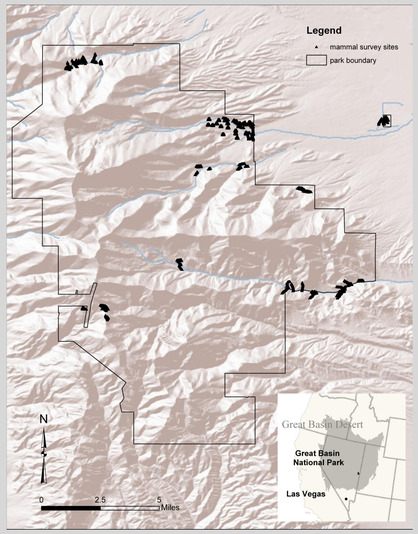

Figure 2. Great Basin National Park small mammal sampling sites.

Methods

Small mammal surveys have been conducted since 2004. Sampling has been primarily focused on documenting NPS sensitive species, understanding the effects of habitat change and restoration, and relationships between small mammals and riparian corridors. Sampling design followed three protocols which varied in configuration and sampling intensity and was conducted with Sherman live traps.

We developed eight *a priori* hypotheses and one post hoc null hypothesis and used Akaike information criteria (AIC) to determine relative support. Response variables for alpha diversity were richness and evenness (Simpson’s index). We predicted positive relationships between alpha diversity, elevation, and habitat heterogeneity and a negative relationship between alpha diversity and distance to perennial streams, after accounting for differences in sampling intensity. We further examined the individual relationships between elevation, stream distance, habitat heterogeneity, habitat type and alpha diversity.

Results

Small mammal surveys were conducted at 78 sites from 2004 - 2009 with a total effort of 40,983 trap nights.

Biodiversity hotspots, defined as greater than 6 species per site, were found in sagebrush steppe habitat, associated with riparian areas, springs and wet meadows and comprised 12% of the total sites sampled (Figure 3). Only one of the three montane mammal species not predicted to survive under published climate models was captured during the survey period.

Using AIC, species richness was best explained by sampling intensity and habitat heterogeneity was an important although non- significant predictor. For evenness, elevation and stream distance were most strongly supported and sampling intensity less supported.

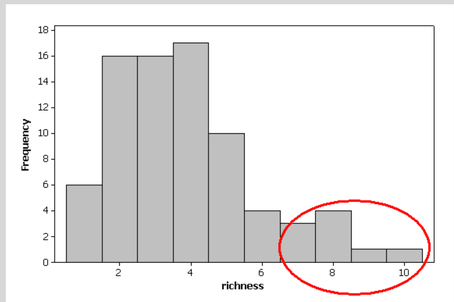

Figure 3. Histogram of small mammal species richness per site.

Richness generally increased with habitat heterogeneity and decreased with elevation and distance to perennial streams. Evenness decreased more linearly with elevation and stream distance and increased with habitat heterogeneity (Figures 4 & 5).

Results

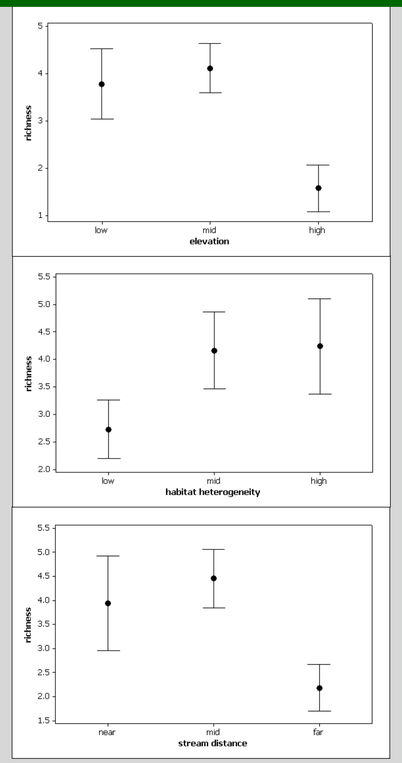

Figure 4. Small mammal species richness by elevation, habitat heterogeneity, and stream distance.

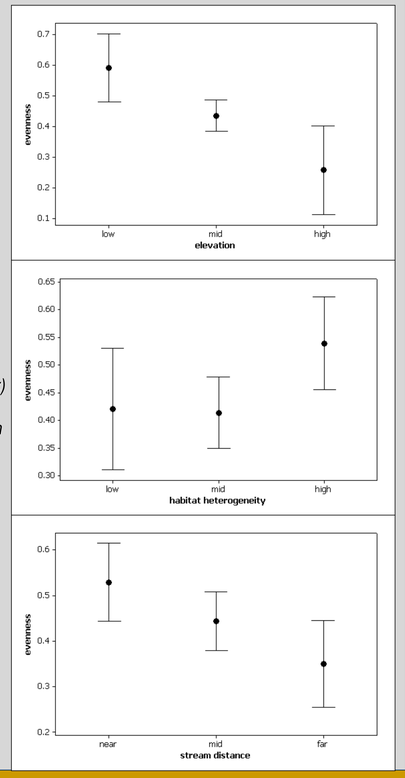

Figure 5. Small mammal evenness (Simpson index) by elevation, habitat heterogeneity, and stream distance.

Conclusions

Small mammal diversity was related to elevation, habitat heterogeneity, and availability of water, variables all sensitive to climate change.

Mammalian biodiversity hotspots at GRBA were found primarily at mid-elevation sagebrush steppe habitats, associated with riparian areas, springs and wet meadows. When compared to high or low elevations sites, mid-elevation habitats harbor disproportionate diversity related to water availability (Hamilton, 2009). These habitats have been dramatically altered by anthropogenic impacts, such as fire suppression, non-native plants, and the development of water resources. Groundwater withdrawal and associated riparian xerification is a looming threat to mammalian diversity in the park. Earlier plant phenology and snowmelt in association with decreased soil moisture and plant productivity from climate induced drought, are also likely mechanisms that would affect small mammal diversity.

Most parks lack sufficient information on biodiversity to address climate change impacts. After six years of sampling at GRBA, only part of the park’s area has been extensively surveyed for small mammals. Still more inventories focused on other species are needed to further understand the relationship between biodiversity and elevation, habitat heterogeneity, and availability of water.

Biodiversity hotpots will be conceptually important areas to monitor the effects of climate change and other anthropogenic impacts on biodiversity. However, National Parks generally have not utilized biodiversity hotspots as a resource management tool, and we argue that satisfying or improving this data set is a worthwhile use of funds particularly in light of climate driven management by the NPS. The Service’s Climate Change Response Program funding may provide support for parks towards this end.

Figure 6. Cliff chipmunks, vagrant shrews and western harvest mice form a portion of small mammal diversity in Great Basin National Park.

Literature Cited

HAMILTON, B. T. 2009. Small Mammals in portions of Great Basin National Park Susceptible to Groundwater Withdrawal: Diversity and Stable Isotope Perspectives. Masters Thesis, Department of Biology, Brigham Young University:1-79.
MCDONALD, K. A., and J. H. BROWN. 1992. Using Montane Mammals to Model Extinctions Due to Global Change. Conservation Biology. 6:409-415.
MYERS, N., R. A. MITTERMEIER, C. G. MITTERMEIER, G. A. B. DA FONSECA, and J. KENT. 2000. Biodiversity hotspots for conservation priorities. Nature. 403:853-858.
STEWART, I. T., D. R. CAYAN, and M. D. DETTINGER. 2004. Changes in snowmelt runoff timing in western North America under a 'business as usual' climate change scenario. Climatic Change. 62:217-232.

Acknowledgements

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