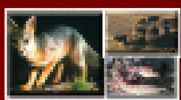
PATTERNS OF TERRESTRIAL VERTEBRATE RICHNESS AND FIRE IN THE ARID AND SEMI-ARID WESTERN UNITED STATES



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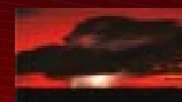
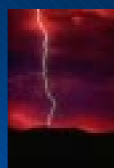


1 INTRODUCTION



Fire plays an important or essential role in many natural communities (Wright and Bailey 1982), particularly those with extended dry seasons (Maselli 1994). However, fire’s influence on patterns of vertebrate species at broad spatial scales has not yet been explored. With recent advances in computing power and increased availability of spatial data it is now possible to examine the influence of fire, and other factors, on broad-scale patterns of terrestrial vertebrate species richness.

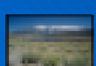
OBJECTIVES

To quantitatively assess which biotic and abiotic factors contribute most to differences in species richness across the arid and semi-arid western United States.

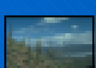
To specifically examine the extent to which fire may affect species richness in this landscape.

2 STUDY AREAS

Portions of the Snake River/High Desert Ecoregion, Northern Basin and Range Ecoregion, and the Southern Deserts Ecoregion, within the EMAP hexagons shown above, were selected for analysis based on ecological variables and data availability. Research is ongoing and only the results for the Northern Basin and Range Ecoregion and the Southern Deserts Ecoregion are presented here.

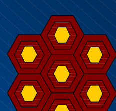


The Northern Basin and Range Ecoregion is made up of separate interior basins which have heavy alkaline accumulations. The climate is semi-arid and there are very few permanent streams. Sagebrush spp. (*Artemesia spp.*) dominate at lower elevations and conifers such as Juniper spp. (*Juniperus*) and Pinyon (*Pinus edulis* and *P. monophylla*) are prevalent at higher elevations.



The Southern Deserts Ecoregion is characterized by high hills to high open mountains with an arid climate and sparse vegetation cover consisting of a variety of shrubs, yuccas, and cacti. In the valleys and flats, creosotebush (*Larrea tridentata*) dominates the landscape in almost pure stands.

3 METHODS



Environmental Monitoring and Assessment Program (EMAP) hexagons (640km^2) were obtained from the Environmental Protection Agency (EPA) and used as sampling units. To assess the sensitivity of sampling unit size on our results, 2 smaller hexagon layers (i.e., 220km^2 and 71km^2) were also used as sampling units. Because these sampling layers yielded results which were nearly identical to those found for EMAP hexagons, only the results for EMAP hexagons are reported here.

Species richness maps were compiled from state GAP analysis projects (avifauna were excluded). Variables which have the potential to influence species richness were identified from the literature and geographic coverages of these variables were obtained or compiled.

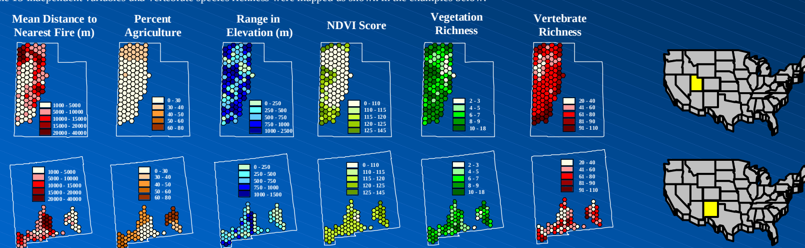
GEOGRAPHIC COVERAGES

- Agricultural production (% of land)
- Stocking rate (# of livestock)
- Median elevation (m)
- Range in elevation (m)
- Median precipitation (mm/year)
- Range in precipitation (mm/year)
- Latitude and longitude (m)
- Fire (Average distance to nearest fire, 1980-1996)
- Population (Average distance to nearest population center)
- Roads (Average distance to nearest road at 1:2,000,000)
- May NDVI score (Normalized Difference Veg. Index)
- Available water capacity (Water available to plants)
- Streams (Average distance to nearest stream at 1:2,000,000)
- Vegetative richness (# of unique cover-types)

All data layers were either developed or resampled to a resolution of 1km^2. Mean or median values for each geographic coverage were then generated for EMAP hexagons.

4 DATA MAPPING AND STATISTICAL ANALYSES

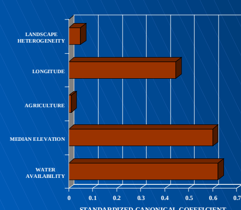
- The 15 independent variables and vertebrate species richness were mapped as shown in the examples below.



- To reduce the number of variables and to eliminate issues of multicollinearity Factor Analysis was performed using all 15 independent variables.
- These factors were then entered into a multiple regression model and canonical correlation was used to interpret the results (Booth et al. 1994).

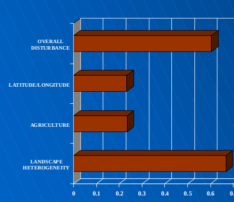
5 RESULTS

NORTHERN BASIN AND RANGE ECOREGION



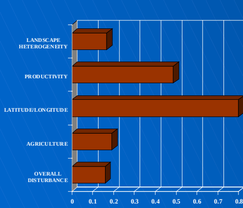
There was a significant correlation between species richness and the explanatory factors (Wilks’ Lambda = 0.6956, $P < 0.0001$). A water availability factor which was composed of streams and available water capacity (Squared Multiple Correlation = 0.7150) had the highest standardized canonical coefficient. Median elevation was an important factor by itself. Longitude was a primary variable in the analysis but was secondary to water availability and elevation. Landscape heterogeneity, which was the most important factor in the Southern Deserts Ecoregion was not influential here.

SOUTHERN DESERTS ECOREGION



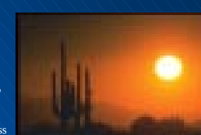
There was a significant correlation between species richness and the explanatory factors (Wilks’ Lambda = 0.8202, $P = 0.0071$). A landscape heterogeneity factor which was composed of vegetative richness, range in elevation, and range in precipitation (Squared Multiple Correlation = 0.8474) had the highest standardized canonical coefficient. An overall disturbance factor, composed of fire, human population, and roads (Squared Canonical Correlation = 0.8627) also had a relatively high canonical coefficient.

NORTHERN BASIN AND SOUTHERN DESERTS COMBINED



There was a significant correlation between species richness and the explanatory factors (Wilks’ Lambda = 0.6874, $P < 0.0001$). The geographic position (i.e., latitude/ longitude), and productivity (a factor comprised of NDVI and median precipitation [Squared Multiple Correlation = 0.9340]) of sampling units were the dominant variables in this analysis. Disturbance and landscape heterogeneity had only a secondary role when examined across multiple ecoregions.

6 DISCUSSION



Understanding variations in patterns of species richness is central to ecology and conservation biology (MacArthur 1975, Colwell and Hurtt 1993). Currie (1991) found that a single variable, evapotranspiration, explained 80% - 93% of the variability in species richness across the continental United States but speculated that patterns in species richness at local and regional scales are controlled by different factors. Our results support the notion that at regional scales, even within the limitation of arid and semi-arid systems, climatic factors, represented here via geographic positioning of sampling units (i.e., latitude and longitude) and productivity, are driving the patterns of species richness. Fire, and other disturbances may be important in maintaining the number of species which currently exist in these regions by creating landscape heterogeneity, however, at the scale of multiple ecoregions fire’s role may be small when compared to climate. At more local scales (i.e., a single ecoregion) it appears that a variety of factors can influence species richness, again suggesting that certain local factors only operate within the context of a given climate.

In the Northern Basin and Range Ecoregion, water availability and elevation appear to be influencing patterns of species richness, not fire, or landscape heterogeneity. However, our species richness map shows that the sampling units with the most species in this ecoregion are on the periphery. This suggests that the climatic ecotone of the Northern Basin with the Rocky Mountain Region to the east and the Mojave Desert to the south, both of which have different median elevations and water availability, may be the driving force of species richness patterns in this ecoregion. In the Southern Deserts Ecoregion, where the surrounding areas are not as dissimilar as they are in the Northern Basin, there does not appear to be heightened species richness values along the periphery. Furthermore, fire and other disturbances as well as landscape heterogeneity appear to be influencing patterns of species richness in this region. Thus, fire may be influential in determining species richness patterns in the arid and semi-arid West but only at local scales where climatic conditions are relatively similar.

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