

BIOGEOGRAPHY OF MAMMALS IN ROCKY MOUNTAIN NATIONAL PARKS

SUSAN M. GLENN ♦ BRIAN CHAPMAN ♦ REBECCA RUDMAN ♦ IAN BUTLER
OKLAHOMA BIOLOGICAL SURVEY ♦ UNIVERSITY OF OKLAHOMA
NORMAN

♦ INTRODUCTION

The equilibrium theory of island biogeography proposes that on an island of a given area, there exists an equilibrium number of species when the rates of immigration and local extinction of species are equal (MacArthur and Wilson 1967). This theory has been applied to park systems because parks may act as functional islands when surrounding unprotected land is cleared of natural vegetation. Alteration of these surrounding habitats isolates these parks and reduces the effective area, causing a decrease in the equilibrium number of species. In animal communities, this process is called faunal collapse (Soule et al. 1979).

The effects of park isolation and faunal collapse have been studied for mammals in Rocky Mountain parks (Picton 1979, Newmark 1986, Glenn and Nudds 1989). In western U.S. parks, extinctions were more numerous in smaller or older parks (Newmark 1987). Area, topographic diversity, and habitat diversity have been correlated with mammal species richness in western North American parks (Picton 1979, Newmark 1986). Initial population size was also related to the extinction probability of a species (Newmark 1986). It has been proposed that all parks in a region are subject to similar factors influencing local extinctions, and therefore a similar suite of species should become locally extinct in all parks (Patterson and Atmar 1986, Patterson 1987).

This means that a nested subset pattern is produced, where parks with low species richness contain mainly species already present in parks with high species richness. This pattern was not found for Canadian parks, where even small parks contained different species assemblages (Glenn 1990).

The objectives of this three-year study are to: (i) identify mammal species that have become locally extinct in each of the Rocky Mountain National Parks; (ii) distinguish between hypotheses regarding the causes of these local extinctions in National Parks; (iii) determine if the same species become locally extinct in all parks; and (iv) identify potential sites for future protection of species prone to extinction.

♦ METHODS AND PRELIMINARY RESULTS

A Geographic Information System (GIS) is being created that covers the entire Rocky Mountains. The Rocky Mountain region corresponds to the U.S. portions of the Montanian and Coloradan mammals provinces developed by Hagmeier (1966) based on mammal distributions. The region was divided into 50 by 50 km grid cells for defining general pre-settlement distributions (Fig. 1). Finer resolution is not warranted given problems in defining range maps.

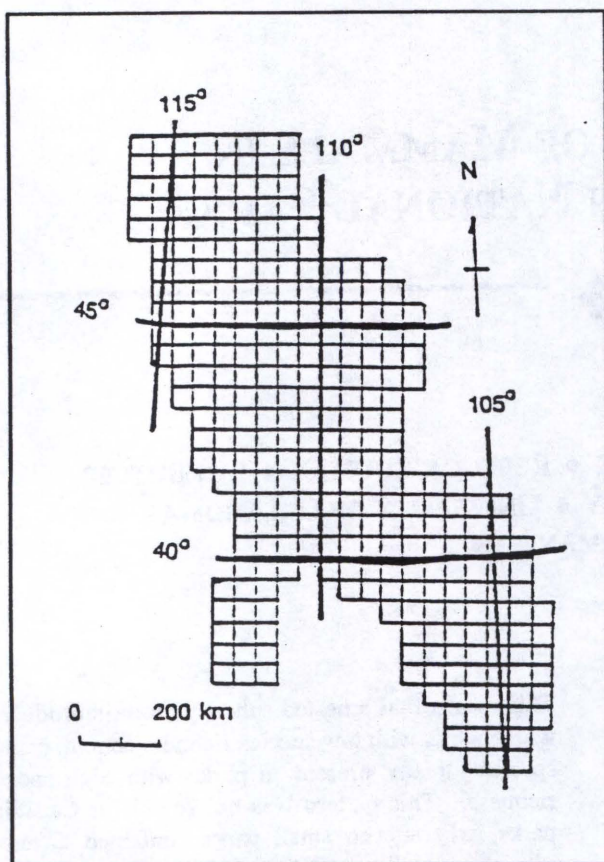


Figure 1. Rocky Mountain region of the United States defined by Montanian and Coloradan homogeneous mammal provinces (Hagmeier 1966). Species distributions were mapped in the 50 by 50 km grid cells shown.

We acquired listings of mammals from the Heritage Programs in Montana, Idaho, Wyoming, and New Mexico. We also searched published literature for information on mammal distributions in the region. From these sources, we compiled a list of 143 species of mammals found in the region, including species in the immediate vicinity that were found on the edge of this region. General distribution of each species was mapped over the 50 by 50 km grid cells. Grid cells falling at the edge of a species range have been identified. Maps of both current and historical distributions, when known, have been completed for all 143 species. These maps will be digitized.

We acquired 3-arc second digital elevation data of the study area and will acquire AVHRR satellite data to determine land cover types. These auxiliary

data layers will be used to refine the mammal distribution maps. We are currently completing a database on habitat and elevation range tolerance of each species.

Pre-settlement range maps will be used to determine potential mammal species lists and species richness for each park. Pre-settlement range maps will be subtracted from current range maps to determine where species may have become locally extinct. When these extinction maps are examined at the park locations, it will be possible to identify those species that may have become locally extinct from the vicinity of the park. Conservative extinction maps will be produced by subtracting pre-settlement maps from current center-of-range maps. This analysis will eliminate edge-of-range local extinctions. Current park species lists will be compared to pre-settlement species lists in grid cells containing the parks to identify possible local extinctions from the actual parks. A list will be produced for each park of species that were not on the edge of their range and are no longer found in the park. Therefore, by using the differences in these lists, the contribution of edge-of-range local extinctions to species loss in National Parks will be identified.

Pre-settlement species-area curves will be constructed for the region based on the GIS of pre-settlement range maps by combining species lists and areas of adjacent grid cells (Glenn and Nudds 1989). This will determine if total richness of native species is significantly different than predicted for a similar-sized area in pre-settlement times.

Each species that has become locally extinct from parks and was not at the edge of its range will be further examined. Initial population sizes of extinct versus extant species will be compared using t-tests to determine if only small populations were prone to local extinction. Additionally, three sites will be selected that are the same size as the park and support species that are locally extinct in the park but were not species at the edge of their ranges. Digital elevation models and land cover maps of each site and park will be analyzed. This information will be refined in ground surveys of each site and park. Indices of habitat quantity and quality will be measured at each site and park and compared to determine which factors may have contributed to local extinctions in parks. Nestedness of species lists will be measured to determine if all parks are missing

the same species combinations (Patterson and Atmar 1986).

Mammal species richness maps will be generated for the Rocky Mountain region reflecting total species, non-exotic species, globally rare species, endangered and threatened species, species not occurring in National Parks, and species intolerant of human landuse in each grid cell. A companion map will be generated for each richness map that designates grid cells with higher than average species richness for rapid assessment of potentially complex patterns (Glenn 1990).

Designating species rich grid cells masks information on species composition. There may be many grid cells with high species richness, but no information is provided indicating which of these grid cells contain different potential species assemblages. Grid cells containing a unique assemblage of species, but with low species richness, will not be identified. Therefore, additional companion maps will be generated for each of the richness maps that designate the similarity of each grid cell to all other grid cells in the region. Jaccard's coefficients will be averaged for each grid cell as a measure of how similar it is to all other grid cells (Digby and Kempton 1987). Grid cells less similar than average will be designated as sites for further consideration because they are more likely to support unusual species assemblages. Species rich grid cells and the most unusual grid cells will be identified for further investigation. These maps may be used for long-term planning by the National Park service and other conservation agencies in the Rocky Mountain region.

This analysis of richness maps is a rapid, economical means of designating potential sites for field inventory. It is currently being developed for designation of National Wildlife Refuges by the US Fish and Wildlife Service under the "Gap Analysis" program (Scott et al. 1990). The technique uses current range maps to identify areas of high species richness that are not currently protected (gaps in protection). This is one of several techniques for identifying areas for protection, and because this is a first step, other methods should be used to further refine decisions regarding site selection (Kirkpatrick 1983, Noss 1987, DeVelice et al. 1988, Hunter et al. 1988, Margules et al. 1988, Eyre and Rushton 1989).

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