The Protection of Endemic and Small-ranged Mammal Diversity in Central America

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Abstract

Central America is exceptionally rich in biodiversity but varies widely in the attention its countries devote to conservation. We assessed how well the protected-area system of Central America includes the region's endemic and small-ranged mammal diversity. This first required a refinement of existing range maps to reduce their extensive errors of commission (i.e., predicted presences in places where species do not occur). We refined the existing range maps using ecological limits in a deductive model using elevation and land cover data and then compared these maps with the locations of protected areas to measure the habitat protected for each of the region's 250 endemic and 174 small-ranged mammals. The species most vulnerable to extinction – those with small ranges – are largely outside protected areas. However, the most strictly protected areas [(i.e. IUCN (World Conservation Union) categories I to IV)] tend to include areas with many small-ranged species. To improve the protection coverage of mammal diversity in the region, we identified a set of priority sites that complement the existing protected areas. Protecting these new sites would require a relatively small increase in the total area protected but could greatly enhance mammal conservation.

Background

Protected areas are the cornerstone of biodiversity conservation. Not all species are of equal concern for conservation. Endemic and small-ranged species (fig. 1) are likely to face a higher risk of extinction than generalist species with larger ranges. Range size is one of the most important factors predisposing a species to extinction (Manne & Pimm 2001). If the concern is preventing extinctions, then perhaps species with small ranges should be a priority (e.g., Ceballos 2007). To explore the potential of protected areas to conserve biodiversity in Central America, we evaluated how inclusive they are of the region's endemic and small-ranged mammal diversity.

Approach

The source of original geographic range maps was the NatureServe database (Patterson et al. 2005). Based on those maps, 250 species are endemic to the study area. Our study area cover eight countries in Central America (fig. 2).

For each species, we refined the maps by using ecological limits in a deductive model using elevation and habitat types (fig. 3). Land cover data were from two sources, one for Mexico only, and one for the rest of Central America (Giri & Jenkins 2005) (fig. 4). Shuttle Radar Topography Mission (SRTM) elevation data was downloaded from the Global Land Cover Facility (http://www.landcover.org). Data for protected areas were obtained from the 2006 World Database of Protected Areas (http://sea.unep-wcmc.org/wdpa).

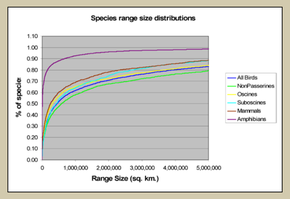

Figure 1. Majority of the species of birds, mammals, and amphibians in North America have small geographic range and only few of them are generalists.

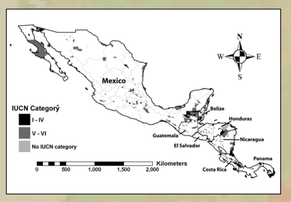

Figure 2. Study region and protected areas in Central America. Countries have black outlines and Mexican states have gray outlines. Protected areas are shaded according to IUCN protection category.

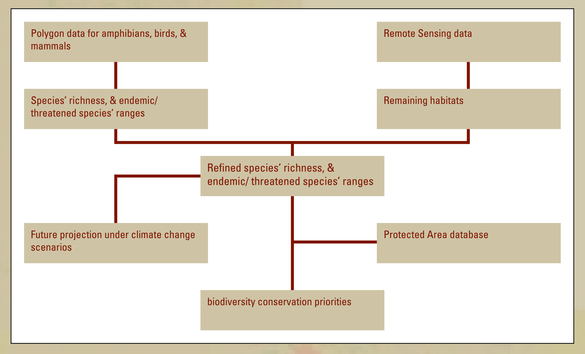

Figure 3. Flowchart of methodology used in the study.

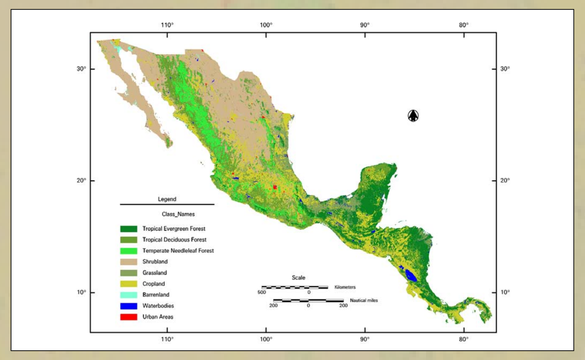

Figure 4. Land cover map prepared using MODIS 500-m satellite data.

Results

Our refinement models decreased the size of a range an average of 39.1% (Table 1). Elevation and land cover accounted for roughly equal portions of this reduction on average. Patterns differed for large, and small-ranged species, with greater decreases for large-ranged species due to land cover and greater decreases due to elevation for small-ranged species.

Figure 5 summarizes the results at each level of refinement. The richness of small-ranged species differed markedly from overall richness, and several concentrations of small-ranged mammals were evident (fig. 5c). Incorporation of suitable elevation (figs. 5d & 5e), and likely habitat (figs. 5f & 5g), showed an overall drop in richness. Most of the areas with small-ranged species though were outside of protected areas, and many protected areas had no small-ranged mammals at all (fig. 6 & 7).

Table 1. Effects of habitat refinement models on species ranges. The effect of land cover applies only after the effect of elevation.

	All species	Large-ranged species	Small-ranged species
Median geographic range size (km2)	23,750	271,000	8,338
Avg. decrease in area due to elevation (%)	22.8	11.5	27.7
Avg. decrease in area due to land cover (%)	22.6	31.6	18.6
Avg. decrease in area from geographic range (%)	39.1	38.7	39.3
Median amount of remaining habitat protected (%)	7.8	10.2	7.1

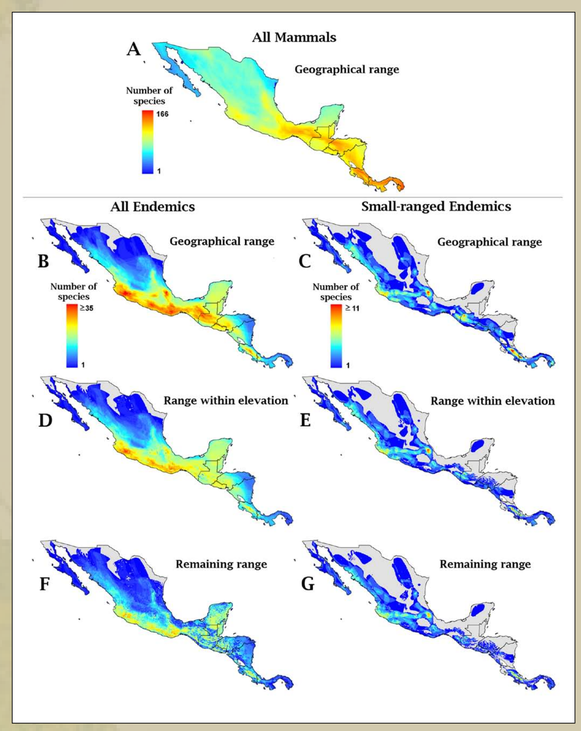

Figure 5. Mammal diversity in Central America: (a) Richness of all mammals based on unrefined geographic ranges. (b-g) richness of all endemic mammals (maps on left) and richness of small-ranged endemics only (< 100,000 km2) (maps on right). "Geographic range" refers to original unrefined range maps. "Range within elevation" refers to maps refined with elevation. "Remaining range" refers to maps refined with both elevation and land cover. In all maps, species richness increases from blue (1 species) to red (166 for all mammals, ≥35 for endemics, and ≥11 for small-ranged species). Areas with no endemic species are grey.

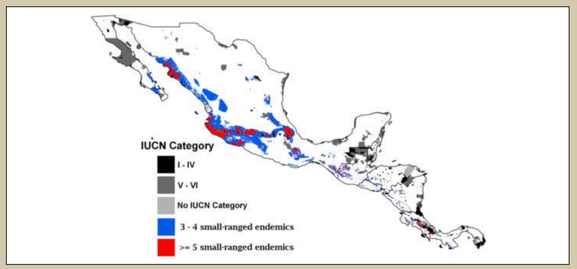

Figure 6. Protected area coverage of vulnerable mammal diversity. Colored areas have small-ranged mammals, with the intensity of red or green corresponding to the number of species. Red areas have no protection, whereas green areas do. Grey areas have protection but no species of mammals with small-ranges.

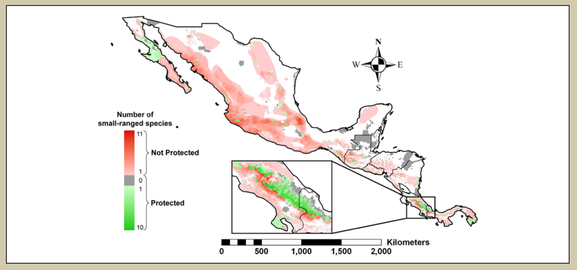

Figure 7. Protected area coverage of vulnerable mammal diversity. Colored areas have small-ranged mammals, with the intensity of red or green corresponding to the number of species. Red areas have no protection, whereas green areas do. Grey areas have protection but no species of mammals with small-ranges.

Conclusion

1. Our study produced a dramatically different picture of biodiversity patterns compared to unrefined range maps.

2. Central America contains many vulnerable endemic and small-ranged species, ones that can be protected nowhere else, that are not being protected under the existing protected areas system of the region.

3. The identified regions with exceptionally high concentrations of endemic and small-ranged species should be conservation priorities.

References:

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