Biodiversity Concordance and the Importance of Endemism

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Introduction

Global conservation prioritization often focuses on protecting the most species for the money invested (e.g., Myers et al. 2000; Orme et al. 2005; Wilson et al. 2006). Biodiversity hotspots and surrogate species are heralded as promising approaches for achieving this goal (e.g., Rodrigues et al. 2004; Bani et al. 2006; Lamoreux et al. 2006). Although identifying biodiversity hotspots (Myers et al. 2000) may be an effective approach to prioritize conservation efforts in some regions of the world, several types of hotspots have been identified and different types of hotspots may not be congruent (Orme et al. 2005). Likewise, there are different methods for identifying surrogate species for conservation planning (Coppolillo et al. 2004; Mac Nally & Fleishman 2004; Rondinini & Boitani 2006), but there remains considerable debate regarding the effectiveness of surrogate species for achieving conservation goals (Lindenmayer et al. 2002; Roberge & Angelstam 2004; Caro et al. 2005).

Lamoreux et al. (2006) recently produced the first global assessment of biodiversity concordance for terrestrial vertebrates. They report strong positive correlations in patterns of species richness as well as endemism among amphibians, reptiles, birds, and mammals, and suggest that any vertebrate class can act as a surrogate for species richness or endemism patterns in other classes. They also suggest that, in general, endemism is an effective surrogate for conservation of all terrestrial vertebrates. We reanalyzed their data and show that surrogacy of vertebrates cannot be assumed at meaningful planning scales, and provide examples of how focusing on endemism overlooks many other conservation values. Our objective is not to undermine the value of standardized global assessments, but to highlight limitations of such approaches for guiding global conservation efforts.

Methods

Presence and absence data for the world’s terrestrial amphibian (n = 4797), reptile (n = 7497), bird (n = 9470), and mammal (n = 4702) classes were compiled by Lamoreux et al. (2006) by terrestrial ecoregion (Olson et al. 2001). Lamoreux et al. (2006) provided us with area-corrected, proportional species richness and endemism indices for each taxonomic class in each ecoregion.

We separated these data into three categories of total vertebrate species richness: rich (upper 20%), poor (lowest 20%), and moderate (remaining 60%). We hypothesized that patterns of species richness and endemism would vary among these categories because of differences in dominant processes shaping communities. For each richness category, we calculated correlations between species richness of each vertebrate class and the other vertebrates (combined indices of three other classes). To determine statistical significance, we performed 10,000 randomizations of 160 ecoregions (20%) for species rich and poor categories and 479 ecoregions (60%) for species in the moderate category and compared correlations of the three richness categories with the random correlations.

We also calculated the percentage of the Earth’s terrestrial ecoregions that had an endemics index of 0, which indicates an absence of vertebrate endemic species, and the percentage of vertebrate species captured by the ecoregions with no endemic species.

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Table 1. Random and observed Pearson correlations between within-taxon vertebrate richness and richness of the three other taxa for three total vertebrate richness categories (rich, poor, moderate).

<table>
<thead>
<tr>
<th>Richness Category</th>
<th>Amphibians</th>
<th>Reptiles</th>
<th>Birds</th>
<th>Mammals</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>random (SD)</td>
<td>observed</td>
<td>random (SD)</td>
<td>observed</td>
</tr>
<tr>
<td>Rich</td>
<td>0.592 (0.06)</td>
<td>0.261&lt;sup&gt;a&lt;/sup&gt;</td>
<td>0.381 (0.07)</td>
<td>0.148&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td>Poor</td>
<td>0.592 (0.06)</td>
<td>0.407&lt;sup&gt;c&lt;/sup&gt;</td>
<td>0.381 (0.07)</td>
<td>−0.061&lt;sup&gt;c&lt;/sup&gt;</td>
</tr>
<tr>
<td>Moderate</td>
<td>0.592 (0.04)</td>
<td>0.105&lt;sup&gt;d&lt;/sup&gt;</td>
<td>0.380 (0.04)</td>
<td>−0.021&lt;sup&gt;d&lt;/sup&gt;</td>
</tr>
</tbody>
</table>

<sup>a</sup><sup>p</sup> < 0.001.<br><sup>b</sup><sup>p</sup> < 0.001.<br><sup>c</sup><sup>p</sup> < 0.01.<br><sup>d</sup><sup>p</sup> < 0.05.<br>

Results and Discussion

Most species-rich ecoregions for terrestrial vertebrates are considered biodiversity hotspots (Myers et al. 2000; Orme et al. 2005), whereas species-poor ecoregions are biodiversity “coldspots” (Kareiva & Marvier 2003). Species-rich ecoregions exhibited lower positive correlations than expected in richness among classes for amphibians, reptiles, birds, and mammals. Species-poor ecoregions exhibited a weak negative correlation between reptile richness and richness of other vertebrates and significantly lower positive correlations than random among richness of amphibians, birds, and mammals and other vertebrates. For species-moderate ecoregions, we observed weak negative correlations among reptiles, mammals, and other vertebrates and significantly lower positive correlations than random between amphibians and other vertebrates (Table 1). Partitioning the data into richness categories seriously challenges the notion that a given vertebrate class can be used reliably as a surrogate for others.

Endemism also has been suggested as a useful surrogate for conservation (Orme et al. 2005; Lamoreux et al. 2006), yet its application is limited in regions with few endemic species (Kareiva & Marvier 2003). Over one-third (280/799) of the world’s terrestrial ecoregions, covering 36% of the Earth and capturing 38.9% of terrestrial vertebrates, contain no endemic vertebrate species. Most of these ecoregions are in the world’s remaining intact areas and support critical ecosystem services such as water filtration, carbon sequestration, and nutrient cycling, values often overlooked in global conservation planning (Kareiva & Marvier 2003). Furthermore, species in these ecoregions may face high latent extinction risks (Cardillo et al. 2006). Finally, areas overlooked by conventional global prioritization procedures, such as boreal regions of the world, may represent the few remaining areas where proactive planning for conservation is possible (Cardillo et al. 2006) and some of the last opportunities to maintain fully intact species assemblages and ecological processes.

Although Lamoreux et al. (2006) acknowledge that valuing endemism alone is insufficient for achieving conservation goals, their conclusions overstate the case for relying on endemism as a surrogate for biodiversity conservation. Biodiversity hotspots and related surrogates may be effective for stemming biodiversity loss in some regions, but a more comprehensive global strategy must be adopted for effective conservation planning in regions where these approaches fail. For example, there is little overlap between latent extinction hotspots (Cardillo et al. 2006) and current biodiversity hotspots (Myers et al. 2000) (Fig. 1). Multiple approaches are required for global conservation efforts to effectively protect biodiversity, ecological and evolutionary processes, and ecosystem services. Robust conservation science is necessary to support such efforts.

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Literature Cited


