The biodiversity data knowledge gap: Assessing information loss in the management of Biosphere Reserves

Andrea Pino-Del-Carpio, Arturo H. Ariño *, Ana Villarroya, Jordi Puig, Rafael Miranda

Department of Environmental Biology, University of Navarra, Irunlarrea 1, E-31008 Pamplona, Navarra, Spain

ABSTRACT

The knowledge of biodiversity within an area is vital if we want to develop adequate conservation strategies. Biosphere Reserves are purposefully established for the sustainable use of their resources, and therefore their biodiversity should be well known. We compared and evaluated information available for Mexican Biosphere Reserves on threatened and non-threatened vertebrate species records from three different sources – the corresponding Biosphere Reserves management plans (MPs), the Global Biodiversity Information Facility index (GBIF), and scientific literature, in order to find potential knowledge gaps. Our results suggest that there were varying gaps in information among sources according to vertebrate group. For each group of vertebrate species, management plans held the largest subsets of information but were not complete, ranging from 89.6% of the combined known species of birds to 70% for amphibians and freshwater fishes. However, both GBIF and literature included data absent from MPs, and GBIF included data not otherwise available, proving it as important as literature or other data sources (e.g. field data) used for crafting such plans. Moreover, we found references to threatened species that were not listed in the MPs, reaching to as many as 50% of the total known species of fish. Species information shared by all three sources ranged from 28% for amphibians to 72.5% for birds. Conservation efforts should therefore take into account that possibly less charismatic taxa such as amphibians, reptiles and freshwater fish lack more information than birds or mammals. The disparity observed in the vertebrate species information constitutes an information gap that could (or should) be solved by scientists and managers alike.

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1. Introduction

Over the past decades, biodiversity, defined by the diversity of genes, populations, species, communities and ecosystems, is assumed to be disappearing at an unprecedented rate (Butchart et al., 2010; Rands et al., 2010). The cause of this decline is the increasing development of human activities and their potential impacts, such as land conversion, invasion by exotic species, pollution, and climate change (Lawler et al., 2006) among others. It seems therefore imperative to establish priorities and take precise decisions to mitigate these losses.

An early step to protect this biodiversity was the establishment of protected areas, among which Biosphere Reserves were created with the aim of reconciling biodiversity conservation with the sustainable use of the resources contained within. We should thus assume that the knowledge of their biodiversity would be high, which make them sites of excellence to explore and demonstrate

approaches to conservation (UNESCO, 1996). However, to our knowledge the extent to which biodiversity within these sites is known had not yet been assessed.

Therefore, we decided to evaluate the knowledge of vertebrate species occurrence in Mexican Biosphere Reserves. Mexico has the third highest number of Biosphere Reserves (41) in the world and has made freely available all documents about their management plans (CONANP, 2011; INE, 2011). Moreover, Mexico has excellent information about its biodiversity. We focused on species richness, as ecosystem-level or genetic diversity, much harder to measure, have yet to produce a comparable body of data.

We assessed the records of vertebrate species within Biosphere Reserves' Management Plans (MPs) with the aim of detecting gaps in the information available in alternative sources of information like existing literature and the databases shared through the Global Biodiversity Information Facility (GBIF, 2011), and to expose the implications of these gaps in the management and conservation of species within the reserves. A previous research carried out in freshwater fish species within Mexican Biosphere Reserves, demonstrated that there is indeed a communication gap among these sources of information (Pino-del-Carpio et al., 2011).

* Corresponding author. Address: Department of Zoology and Ecology, University of Navarra, Irunlarrea 1, E-31008 Pamplona, Navarra, Spain. Tel.: +34 948 42 56 00 x806296; fax: +34 948 42 56 49.

E-mail address: artarip@unav.es (A.H. Ariño).

Management plans are documents that should identify administration necessities and resources, highlighting specific actions to direct and control the conservation and sustainable use of natural resources (Ortega-Rubio and Arguelles-Méndez, 1999). In turn, scientific literature is an accessible source of information which provides a record of scientific progress (Lawler et al., 2006). Finally, GBIF facilitates access to nearly 4×10^8 specimen or observation records (GBIF, 2011) existing in databases in many countries and institutions (Arzberger et al., 2004) that have decided to publish them. GBIF mobilises the data through a common portal, covering an ever-increasing fraction of all existing data (Ariño, 2010) and including vast amounts of georeferenced records (Soberón et al., 2007). One important set of databases sharing data through GBIF in the context of our work is that of the Mexican National Biodiversity Knowledge and Use Commission (Comisión Nacional para el Conocimiento y Uso de la Biodiversidad, CONABIO).

We focused on vertebrates, as they are perhaps one of the best known groups besides plants in terms of biodiversity and their pressures are relatively well known. While one-fifth of all vertebrate species are increasingly being threatened, a trend only partially curbed by conservation efforts (Hoffmann et al., 2010), many vertebrate species (such as fish and mammals used for food or sport) are important resources for the livelihood of people (Hawksworth and Bull, 2007). Therefore, assessing what vertebrate species are actually present in Biosphere Reserves could help direct conservation efforts that take into account how they are used.

Among vertebrate species, amphibians are more threatened than birds or mammals (Stuart et al., 2004) while reptiles, although poorly studied at least in the context of protected areas (Koleff et al., 2009), are equally or more threatened than amphibians, as they suffer from, and are vulnerable to, the same types of threat (Gibbons et al., 2000; Gardner et al., 2007). Both groups account for about a quarter of all the vertebrate species in the world (IUCN, 2011) but they are less studied worldwide than birds or mammals (Gardner et al., 2007; Urbina-Cardona, 2008) in spite of their vulnerability to habitat degradation (Koleff and Urquiza-Haas, 2011).

Freshwater fish are under threat as a result of human disturbance in freshwater habitats (Saunders et al., 2002; Clavero, 2011) and their study is important, as they are good indicators of the health of the environment (Hermoso et al., 2010). Additionally, freshwater fish are vulnerable to the effects of pollution, disease, and introduction of non-native species among others (Allan and Flecker, 1993); similar threats, and some others such as hunting, have been also reported for birds (Naranjo and Dirzo, 2009).

2. Methods

2.1. Study design

We drew information on vertebrate species in the Biosphere Reserves from their MPs. These plans were obtained from the Web-Pages of Mexican Administration (Instituto Nacional de Ecología (INE, 2011) and Comisión Nacional de Áreas Naturales Protegidas (CONANP, 2011) (Table A1). The various plans included lists of species compiled from a wide variety of sources, including (but not limited to) inventories and catalogues, field work, monitoring reports, scientific papers, or distribution estimations.

Independently from MPs, literature data was harvested from ISI Web of Knowledge (Thomson Scientific, 2009), Google Scholar, other databases, other literature, and authors. A full list of reviewed literature is given in List A4.

Information retrieved from GBIF-mediated databases was acquired using the geographic coordinates provided as a bounding box in MPs or in the UNESCO's Biosphere Reserve database (UNESCO, 2011).

To ensure that georeferenced records fell within the areas of interest, boxes were checked against the actual shape files of the Reserves in .shp format provided by CONANP using ArcView 9.1. In cases where the bounding boxes did not enclose the shape files, the boundaries were extended by a small buffer zone to ensure full coverage of each Reserve's area, following Pino-del-Carpio et al. (2011). Records with coordinates falling either outside the buffer zones or outside the boundaries of the reserves were discarded. This conservative method discarded potentially valid records, but increased the quality of the remaining ones.

Each of the three sources (MPs, GBIF and literature) produced a different list of vertebrate species for every Reserve. These lists were combined into one single dataset, where we identified the source(s) of the vertebrate species records. We then analysed the number and extent of coincidences among sources and tabulated the species mentioned in one, two, or all three sources.

We also produced summary data of the vertebrate species lists taken separately (e.g. average number of species in the reserves according to each source).

2.2. Taxonomic review

A taxonomic review was carried out on the species lists, and scientific names were validated according to the W.N. Eschmeyer's Catalogue of Fishes (Eschmeyer, 2011), International Ornithological Congress (Gill and Donsker, 2012), Birdlife International (Birdlife, 2011), Mammals Species of the World (Wilson and Reeder, 2005), The Reptile Database (Uetz et al., 2007) and Amphibian Species of the World (Frost, 2011).

2.3. Threat status of species

We consulted the International Union for Conservation of Nature (IUCN) Red list (IUCN, 2011) and Mexican Standard Normative (Diario Oficial de la Federación, NOM-059-SERMANAT-2010), which list wildlife species under a category of risk, to find catalogued species and their conservation status with the aim to discuss the MPs from a conservation point of view.

3. Results

3.1. Sources of information

As stated by the Mexican National system of protected areas (SINANP), there are 41 Biosphere Reserves in Mexico. We selected 25 for the analysis of birds, mammals, amphibians and reptiles and 21 for the analysis of fish. Eight Biosphere Reserves were not eligible because of lack of MPs or because a list of the species recorded in the area was not available (four in the case of freshwater fishes). Regarding scientific literature, we reviewed 197 papers. Searches in GBIF-mediated databases produced 68,929 occurrence-based records, which represented 1776 species for all taxa. After analysing the species data obtained from the three sources of information, we worked with 3598 records for mammals, 14,368 for birds, 2170 for reptiles, 1369 for fishes and 821 for amphibians.

For each group of vertebrates, the most extensive information on species presence came from the management plans although at different rates according to the taxonomic group.

3.2. Biosphere Reserves

When all Biosphere Reserves are taken as a whole (i.e. data from all reserves are pooled together), MPs accounted for 89% of bird species know to occur in Biosphere Reserves, 81% of mammals, 80% of reptiles, 70% of amphibians and 70% of fish. In the case of