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Monitoring birds in the Atlantic Forest: A proposal for the Brazilian protected areas

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Protected areas (PAs) are widely considered as the first line of defense in a world-wide effort dedicated to the protection of biodiversity (Jenkins & Joppa 2009). According to the Brazilian National Protected Areas System (SNUC), protected areas were created as the main means of conserving biodiversity (Brasil 2000), in accordance with the Convention of Biological Diversity, which is also concerned with the assessment and monitoring of biological diversity (Sheil 2002). In fact, several monitoring programs have been implemented, mainly in developed countries, to assess spatial and temporal trends in biological diversity, with emphasis on evaluating the efficiency of management policies (Yoccoz *et al*. 2001). Apart from a few studies on management efficacy (e.g., Pavese *et al*. 2007), there are no data from Brazil to evaluate the *in situ* effectiveness of these PAs in the conservation of the biodiversity they harbor.

Although virtually non-existent in developing countries, including Brazil, long term monitoring studies of wildlife oriented towards biodiversity and PA management are essential (Terborgh & Davenport 2003). Apart from integrated initiatives undertaken in the Amazon since 2003 (Program PPBIO), and, of late, in other Brazilian biomes, only isolated monitoring programs have been initiated in the Atlantic Forest. Furthermore, these programs, mainly addressed to academic questions, do not offer support to PAs and biodiversity management.

The Brazilian Federal Agency in charge of biodiversity conservation, the Instituto Chico Mendes de Conservação da Biodiversidade (ICMBio), currently manages 77 PAs in the Atlantic Forest, corresponding to 30,085 km^2 (~ 2.3% of the original area), including both sustainable use and restricted PAs. However, as the coverage of PAs is still limited, and their real importance in the maintenance of *in situ* biodiversity unknown, there is a need for implementing an effective local biodiversity-monitoring program, feasible for incorporation as a routine activity, and easily accessible for implementation, not only by the PA staff, but also by residents in the surrounding

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neighborhood. An additional attribute would be the generation of proposals capable of guiding management action.

The ICMBio and a German agency for international development (GIZ), with the support of the project Probio II Mata Atlântica/MMA/MCTI/JBRJ/UFRJ, held a workshop in Rio de Janeiro in 2011. One of the main objectives was to establish general guidelines for *in situ* biodiversity monitoring in federal PAs. 88 participants from 28 academic and governmental institutions, including the authors of this Policy Forum, were split into working groups focused on either birds, mammals, or plants. In the present article, we proposed guidelines for *in situ* monitoring of birds, oriented towards PA management.

Birds as environmental indicators

The complete monitoring of biodiversity at any scale is usually unfeasible, and even more so on a larger scale. A plausible option would be to identify surrogates, which are both measurable and representative of certain aspects of biodiversity. Caro (2010) defines surrogates as species that can be used to represent other species or aspects of the environment, and environmental indicators as a type of surrogate devised for assessing changes in the environment.

In this context, birds undoubtedly represent one of the most appropriate animal groups for use as environment indicators, since 1) they are taxonomically well-known; 2) they are easy to sample (simple and inexpensive techniques allow for obtaining meaningful data); 3) they present conspicuous and easily observable behavior; 4) they also present a variety of responses brought about by environmental changes (Stotz *et al*. 1996)

The propositions

Prior to proposing birds as targets for PA management, we first examined the various processes at different scales, and then identified the main threats to biodiversity that operate at each scale. Thus, we suggested a set of main targets, according to the scale and problem. We also proposed the indicators for assessing each group to be monitored, as a means of obtaining answers to questions from the monitoring program, and the methods to apply for acquiring data.

Large scale (global warming)

Global warming in the tropics comprises a threat to biodiversity, especially to birds with narrow elevational ranges (elevational specialists; Şekercioğlu *et al*. 2012). This is the case for dozens of endemic Atlantic Forest birds that only occur in lowlands, cloud forests, or high mountainous grasslands. Warming temperatures force species towards higher altitudes, thus reducing their ranges, sometimes entirely. Highland birds may have no further available habitats for migration, and lowland specialists are unable to move, due to landscape fragmentation and isolation of their lowland areas (Şekercioğlu *et al*. 2012). For these species, the proposal declares that specific monitoring should be undertaken through occupancy surveys (the probability that a given site is occupied by a species). Detection/non-detection surveys have been recommended or used worldwide in various large-scale monitoring programs (MacKenzie *et al*. 2006).

The detection of the presence or absence of elevational specialists should be performed through autonomous recording, camera traps, or points counts, and always with at least a dozen repetitions inside the PA (see Sberze *et al*. 2010). Each area that is defined as of interest by researchers and managers should be sampled for at least five days yearly, preferably during the spring–time, the reproductive season for most of the birds in the Atlantic Forest, and therefore when they are more active and sing more frequently, thus making detection easier. Occupancy data, first obtained from various PAs, should then be compared. Comparison between PAs will be a way to identify impacts as local, regional, or global. The actual gathering of data, in the case of autonomous recordings or camera traps, can be left to members of the community, the PA staff or students that have been trained, and to specialists or those trained to obtain information from point counts.

Regional scale (habitat loss and fragmentation)

In tropical forests, fruits are a temporary and highly variable spatial resource (Loiselle & Blake 1993). Consequently, when the offer is low, fruit-eating birds are obliged to move around within a very wide area in order to obtain food, thus requiring a large and continuous stretch of forest (Willis 1979). In fact, medium-to-large fruit-eating birds tend to disappear in disturbed or fragmented forest areas of the Atlantic Forest (Ribon *et al*. 2003).

It is proposed that monitoring should be performed over time, in order to detect changes in community composition and population abundance of frugivorous birds, hence the recommendation of the use of point counts or line transects, with a minimum of 10 point count stations or five line transects (see Develey 2003 and Peres & Cunha 2011). The gathering of data, occurring annually and lasting five days during the spring, can be undertaken by members of the local community, the PA staff, properly trained students, or specialists. The use of point counts or line transects also allows for absolute density estimates to be made through distance samples (Buckland *et al*. 2001).

Birds that are specialists in eating bamboo fruits tend to gather in bamboo patches, where fructification, besides being extremely irregular, might only occur in several-year-long cycles. Thus, these nomad species are especially vulnerable to regional habitat changes that result in the destruction of bamboo patches (Ribon *et al*. 2003). For these specialists, the proposition is prolonged monitoring to detect changes in community composition and population abundance. Hence, point counts and mark-recapture are recommended, thus facilitating the measurement of abundance as well as the crossing of data regarding bird movement. The sampling of two or more areas inside the PA during three days a month throughout the fructification period is recommended. Collection of the appropriate data can be consigned to students, the PA staff, or specialists.

Hunting (local scale)

The low abundance or even absence of game birds (mainly Tinamidae and Cracidae) in a determined area can be an indication of hunting pressure. The monitoring of species abundance should be through line transects, according to previous suggestions for frugivores. The use of camera traps for detection of the presence or absence of species can also be considered (O'Brien & Kinnaird 2008).

Furthermore, program managers should conceive means of addressing imperfect detectability of organisms in the field. This is of prime importance in any study dedicated to monitoring species abundance, richness, or community composition. Methods such as distance sampling, capture-recapture, and occupancy allow for the elaboration of detectability estimates (Ferraz 2012 and Jones *et al*. 2013).

Concluding remarks

Decisions about which variables to monitor are determined largely by the objectives of the monitoring programs (Yoccoz *et al*. 2001). In the present article, we presented a proposal with birds as indicators, but obviously other organisms can be monitored, such as amphibians as indicators of climate change. Our proposal also does not apply to any specific ecosystem or threat, e.g., aquatic ecosystems or problems such as pollution or the impact of roads on biodiversity. Thus, we do not intend to impose a guideline regarding the three basic questions posed by Yoccoz *et al*. (2001): "why monitor?"; "what should be monitored?"; and "how should monitoring be performed?". Instead, we present an exercise, in response to Brazilian government requirements, thereby proposing a manner to deal with the cited questions ("why?", "what?", and "how?").

As the Brazilian PAs were mainly created to conserve biodiversity and management is considered as "any procedures designed to ensure the conservation of biological diversity" (Brasil 2000), monitoring programs should be set up as continuous checks on whether the goal of biodiversity conservation is being accomplished, and, if not, which management action requires implementation. These ideas are in accordance with those posed by several authors, whereby monitoring programs developed in conjunction with management serve to both identify the state of the system and provide information on system response to management action (e.g. Yoccoz *et al*. 2001; Jones *et al*. 2013). In our proposal, the system state variables are mainly the abundances of a group of target species. Upon perceiving a downward trend in abundance, management action should be directed to reverse such trend.

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