Biological Conservation 142 (2009) 1138–1140

Contents lists available at ScienceDirect

Biological Conservation

journal homepage: www.elsevier.com/locate/biocon

Editorial

Conservation issues in the Brazilian Atlantic forest

In 2000, a Special Issue of the journal *Biotropica* focused on the natural history and ecology of Brazil's Atlantic forest (Morellato and Haddad, 2000). After nine years, it is time to again analyze this endangered forest, but now emphasizing the implications of the ecological knowledge for its conservation and restoration. Further, the lessons from the Atlantic forest can also supply lessons for conservation in other tropical forests around the world.

The Brazilian Atlantic forest is a vast heterogeneous region (1,481,946 km^2, approximately 17.4% of the Brazilian territory), including a large variety of forest physiognomies and compositions distributed through >3300 km along the Brazilian Atlantic coast, from 3°S to 30°S and from the sea level up to 2700 m. These forests are distributed in different topographic and climatic conditions, encompassing lowlands and coastal mountain regions with high levels of precipitation, as well as interior plateaus with long (>5 months) dry periods. The Atlantic forest region also includes communities living in different socio-economic conditions, from large urban areas of São Paulo and Rio de Janeiro to rural regions. At least 70% of the Brazilian population (roughly 120 million people) lives in the region.

The Atlantic forest is internationally recognized for its large number of species (1–8% of the world's total species) and high number of endemic species (Myers et al., 2000). A more recent assessment highlighted a huge number of endemic species in several groups, such as 8000 tree species (40% of the total), 200 birds (16%), 71 mammals (27%), 94 reptiles (31%), and 286 amphibians (60%), to mention only the best-known taxonomic groups (Mittermeier et al., 2005). Despite this biological richness, the Atlantic forest is probably one of the most highly threatened tropical forests. Historically, its deforestation has been closely related to the economic exploitation of different commodities. This exploitation includes the logging of the Pau-Brasil tree (*Caesalpinia echinata*) in the 16th century; the introduction of sugar cane in the 18th century; the expansion of pasturelands in the northeastern portion of the country, which began during the first century of colonization and has continued to the present day; coffee plantations developed in the 19th and 20th centuries; and more recently, the expansion of urban areas and *Eucalyptus* plantations (Dean, 1997). Even today, despite severe legal restrictions on deforestation, the rate of forest loss is still high, approaching 0.25% or 350 km^2 per year (Fundação SOS Mata Atlântica and INPE, 2008). As a consequence of this long history of degradation, the Atlantic forest is highly fragmented, and a large number of its endemic species are considered as threatened with extinction.

In the nine years since the first Atlantic forest Special Issue, we have substantially expanded our knowledge of the forest and its functioning. During this decade, several large projects, described in this issue, have increased our understanding of the causes and consequences of Atlantic forest loss and fragmentation, including some of the first multi-taxa projects of the region (Fonseca et al., 2009; Pardini et al., 2009; Metzger et al., 2009; Uehara-Prado et al., 2009). We also now have long-term (Metzger et al., 2009) and large-scale (Galetti et al., 2009) perspectives; and forest restoration projects are becoming more successful as a result of scientists' growing expertise in this field (Rodrigues et al., 2009). For this Special Issue, contributions from well-established research groups in Brazil are presented in order to embrace a wide geographical range from south to north (Fig. 1). Also, by considering different Atlantic forest types and contexts (e.g., remaining forest cover, matrix type) and highlighting especially those projects that look at multiple taxa or that are long-term or large-scale projects with clear focus on conservation, these studies can provide clear recommendations for biological conservation. Several of the contributions to this issue are the first syntheses of large projects, and for this reason present multiple authors from different institutions. The 10 papers include almost 80 authors from 15 Brazilian universities and research centers, and four foreign institutions.

The first manuscript of this Special Issue relates for the first time quantitative data about the amount of forest cover and configuration for the whole Atlantic forest region in Brazil (Ribeiro et al., 2009). From the 1,395,849 km^2 of forest in the original study area, only about 163,775 km^2 of forest were left in 2005 (12% of the original area; Fig. 1). The spatial configuration shows how critical the situation in the region is, where more than 80% of the fragments are <50 ha and almost 50% of the forest is <100 m from the edge, which subjects it to significant pressure by the surrounding human-dominated landscape. Furthermore, the present nature reserve network is inadequate to protect this forest, covering only 1% of its original distribution (Fig. 1). In this situation, conservation of forest biodiversity is a huge challenge.

The core of this Special Issue is composed of four articles focused on forest fragmentation and the establishment of a solid ecological framework for supporting conservation and management actions in this condition. These articles embrace a large range of forest cover, from severely degraded landscapes (Lopes et al., 2009) to others less impacted (Fonseca et al., 2009; Pardini et al., 2009). The landscape matrix also varies from somewhat uniform and permeable second-growth forests, to less favorable matrixes, such as settlements and cattle ranches, with some intermediate conditions (ecologically managed tree plantations). Most fragmentation projects work with very small fragments of <100 ha, which effectively represent 92% of the remaining Atlantic forest frag-

0006-3207/$ - see front matter
doi:10.1016/j.biocon.2008.10.012

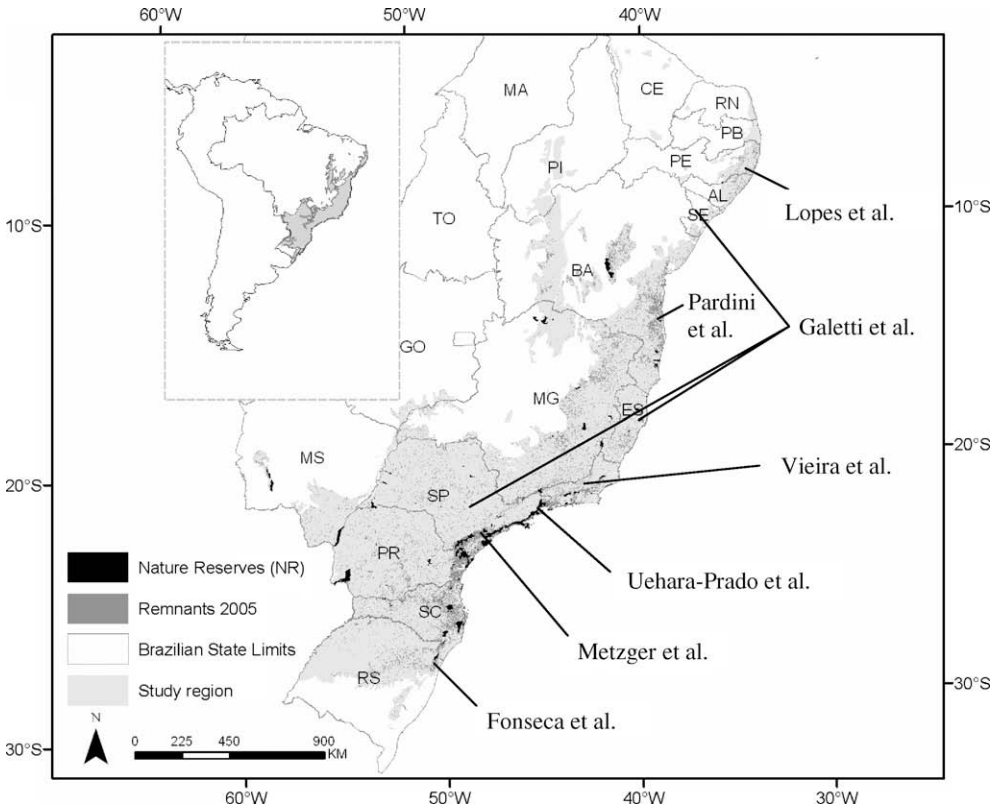

Fig. 1. Location of the field research sites included in this Atlantic forest Special Issue. This figure was modified from Ribeiro et al. (2009). Abbreviations for Brazilian states names are: AL = Alagoas, BA = Bahia, CE = Ceará, ES = Espírito Santo, GO = Goiás, MA = Maranhão, MG = Minas Gerais, MS = Mato Grosso do Sul, PE = Pernambuco, PB = Paraiba, PI = Piauí, PR = Paraná, RN = Rio Grande do Norte, RS = Rio Grande do Sul, SC = Santa Catarina, SE = Sergipe, SP = São Paulo, and TO = Tocantins.

ments (Ribeiro et al., 2009). Aside from such small fragments, all fragmentation projects also consider a control area >1000 ha.

Most fragmentation studies found clear evidence of species composition alteration in fragmented conditions. Lopes et al. (2009) predict that in highly fragmented landscapes, there will be a huge composition and functional impoverishment in tree assemblages, with a reduced diversity of pollination systems, a higher abundance of reproductive traits associated with pollination by generalist diurnal vectors, and an elevated abundance of hermaphroditic trees. Uehara-Prado et al. (2009) also suggest that fragmented communities will be particularly affected by exotic species.

Those trends could be biased toward the response of small mammals and trees, the predominantly studied groups, which is the common trend in all fragmentation studies (McGarigal and Cushman, 2002). However, there are also important initiatives of multi-taxa studies, which include less frequently studied groups such as spiders, opiliones, ferns, and different kinds of beetles. Some groups of Coleoptera and butterflies can be considered as indicators of forest disturbance, even when those disturbances are low (Uehara-Prado et al., 2009). Furthermore, the response of these groups to disturbed areas did not depend on a species-level classification – even when species were grouped to families or sub-families, they maintain their indication properties (Uehara-Prado et al., 2009). Thus, there is a great potential for using novel taxa as ecological indicators, facilitating our understanding of the forest.

All articles presented here have considered the effects of disturbance on large and heterogeneous landscapes, which is one of the main requirements when analyzing a landscape-scale process such as the effects of fragmentation on biodiversity (McGarigal and Cushman, 2002). However, none of the papers uses long-term field data, which allows the inclusion of a temporal component, a key-component for fragmentation studies. Actually, Metzger et al. (2009) show the importance of historical landscape structure and dynamics, in addition to existing connectivity patterns, in explaining present biodiversity pattern, due to the time-lag in biological responses to changes of landscape structure. Long-term research with an explicit temporal approach should be prioritized in future studies.

The potential for improved conservation practices are great, and in some case, research provides new avenues or new tools/tips for conservation. Most studies reinforce some strong and possibly well-known recommendations for conservation, such as: (i) large, minimally disturbed, and mature forested areas are high priorities for species conservation (Lopes et al., 2009); (ii) a more permeable, heterogeneous matrix, and landscapes with elevate forest cover favor species maintenance in fragmented areas (Pardini et al., 2009; Vieira et al., 2009); and (iii) every effort should be made to prevent rather than repair the effects of fragmentation (Rodrigues et al., 2009). On the other hand, new and challenging ideas are also raised. Particularly, the critical analysis of Scarano (2009) provides a new way of considering priorities for the Atlantic forest. He claims that the usual policy of emphasizing the conservation of the core Atlantic forest formation (i.e., the rainforest *stricto sensu*) and species that are rare/endemic could be wrong. By showing the strict links between core and marginal habitats (e.g., *restingas*, swamps, and high altitude *campos*) he shows the importance of considering all of those different types of vegetation formation. Moreover, he also highlights the important role that common species play as "nurse" species in marginal habitats and perhaps should also be considered as conservation priorities. Another possibly controversial issue is related with the potential of tree plantations to contribute to biodiversity conservation. The results from Fonseca et al. (2009) offer clear evidence that ecologically-

managed tree plantations can be of great help for biodiversity conservation in human-dominated landscapes, and could be considered as a feasible conservation option to adopt in private lands. A third new and controversial issue is raised by Lopes et al. (2009), when they criticize conservation strategies based on the creation of corridors. Corridors are new edge areas, and the functional analysis provided by Lopes et al. (2009) shows that edges can no longer retain the full complement of tree life-history diversity. Thus the usual restoration or management action of linking small or medium fragments through thin riparian corridors may be of limited value for long-term ecological conservation.

The urgency for defining the correct conservation action for reducing the negative effects of the Atlantic forest loss and fragmentation also emphasizes the necessity of having good ecological indicators or short-cuts to support the decision process. One of these short-cuts is the use of species indicators, as presented by Uehara-Prado et al. (2009). Another relevant tool is the development of conservation indices, which can help in detecting high conservation priority areas or in defining the best conservation or management strategy. Galetti et al. (2009) developed this kind of index combining fragment area with the main determinants of medium-sized and large mammal abundance in 38 sites along the Atlantic forest. Their results were particularly useful to order sites along a gradient of management priorities that balances species-focused and habitat-focused conservation actions.

Without any doubt, the Atlantic forest is vanishing, and this critical situation needs urgent conservation actions. One of the top high priorities should probably be to undertake its restoration. The knowledge for a successful restoration has greatly increased in the last 30 years, allowing us to have the current ability not only to restore the forest structure, but also the basic ecological processes, such as dispersal, pollination and herbivory (Rodrigues et al., 2009). Public policies should be used to stimulate large-scale restoration efforts, particularly in some key areas, such as the main gaps between large clusters of remaining Atlantic forest fragments (Ribeiro et al., 2009).

This Special Issue covers some relevant topics for the Atlantic forest conservation, putting together original results, new conservation and restoration initiatives, and some innovative and thought-provoking ideas from leading ecological and conservation researchers in Brazil. I hope that this set of articles can help in the conservation of the region, and also other threatened forests elsewhere. Knowledge obtained in the Atlantic forest region can also help to anticipate problems and plan conservation in other tropical regions that may be less fragmented, but still at risk.

Acknowledgments

My sincerely thanks to the many referees that help us to improve all the papers before submission, and who are mentioned in the individual papers. Many thanks also to all editors of *Biological Conservation* for their support for this Special Issue.

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Available online 13 March 2009