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Reply to Biodiversity conservation gaps in Brazil: A role for systematic conservation planning

Fonseca and Venticinque (2018) (hereafter FV) present a critical assessment of a paper in which we attempt to estimate the biodiversity coverage of the Brazilian conservation units (Oliveira et al., 2017). We appreciate their contribution to this important debate. We have no doubts that conservation planning should be based on a variety of information sources, including not only the coverage of species' ranges but also the contribution of each area to the preservation of ecosystem services, landscape features and socioeconomic and cultural aspects. This systematic and integrative conservation planning is certainly a complex process, which requires the contribution of experts from different fields. However, we have shown, in this reply, that our paper (Oliveira et al., 2017) aims to quantify the knowledge and protection gaps of biodiversity in protected areas, not to propose priority areas or to test whether the current proposal of priority areas is efficient. Objectives and the conclusions of our paper. We hope this short response can clarify this debate.

FV's characterizes the dataset analyzed in our paper as "*. . .an arbitrary set of widespread, abundant, and nonthreatened species. . .*", and state that any study like ours should be based on species listed as threatened in red lists. Our study was based on the best database on Brazilian biodiversity we could assemble. We have compiled data from the literature and scientific collections of a variety of taxonomic groups, and the dataset was exhaustively checked for taxonomic and geographic accuracy. Thus, it is not an arbitrary set of species, but the most comprehensive database on Brazilian biodiversity assembled so far. We understand the reasons to evaluate conservation gaps based only (or mostly) on threatened species, but in our opinion such procedure would miss an important portion of the Brazilian biodiversity. As we demonstrated earlier (Oliveira et al., 2016). Brazilian biodiversity is incompletely known and this shortened data on species distribution and natural history are used to assess threat levels. Therefore, we think many species could be currently threatened but not recognized as such due to deficient data. Arthropods (the largest group of living forms), in particular, are poorly represented for the production of these lists. Although red lists usually include species classified as "Data Deficient", we think only a fraction of the species currently known are effectively evaluated for the production of those lists. Thus, restricting our analyses to species officially recognized as threatened could miss a significant portion of the Brazilian biodiversity and bias our results towards better known species. Even in Europe, knowledge of threat status is incomplete, e.g., for bees: "for 1101 species (56.7%) in Europe and 1048 species (55.6%) at the EU 27, there was not enough scientific information to evaluate their risk of extinction and thus, they were classified as Data Deficient" (see: https://www.iucn.org/content/european-red-list-bees). FV also questioned the inclusion of only eight plants families in our analyses, which was a consequence of the data availability. However, their assertion that our analyses miss "*. . .a great deal of the phylogenetic diversity*" of Brazilian plants would be true for any biogeographic or macroecological study (including, for instance, species threat evaluation). No study published so far was based on an absolutely complete database, but our plant database is significantly more comprehensive than any other analyzed before. Additionally, FV's critique of the use of species occurrence data alone does not match what we presented in the methodology of our study, as we also use phylogenetic data.

Concerning our analyses based on species distribution models, we must reinstate that the use of only species with more than 15 occurrence points was due to the statistical limitations of the methods used (Pearson et al., 2006). FV argue that our minimum record number criterion result in restricting our analyses to widely distributed species, which is far from true. FV's critique seems very simplistic, since restricted species can present multiple samples in the databases (for example, in our data, 10% of species with more than 15 occurrences have a restricted area, less than 2500 km^2) as is evident upon a detailed examination of our study. Additionally, we explicitly quantified the endemism level of each species analyzed through the Weighted Endemism Index, which was used to measure how much of the endemic species is currently protected. In fact, many species we modelled have a restricted distribution (see results in Oliveira et al., 2017). Thus, species with a more restricted distribution were analyzed differently from those of wide distribution. Our quantitative endemicity approach was implemented to avoid subjective application of terms like "*highly endemic species*", and we used the complete database to evaluate sample effort so as to use all available evidence. FV advocate using surrogates in preference to our approach but we chose not to since there is no strong evidence of its efficiency in the tropics (Oliveira et al., 2016). Furthermore, there is strong evidence that groups used as surrogates suffer from the same sampling bias as less-studied groups such as arthropods (Oliveira et al., 2016).

Most of FV's paper is a description, with examples, of the procedures adopted by the Brazilian Ministry of Environment to define priorities for conservation. We applaud these initiatives and hope they continue to be implemented and improved as new tools and data sources emerge. However, FV does not provide a direct comparison between the conclusions of these initiatives and our results. Thus, it was not demonstrated that our results are in conflict with the recommendations from ME procedures. Even if that comparison is made, we must emphasize that our objective was never to propose priority areas for conservation, but only to answer the question "hoe much of the Brazilian biodiversity (as far as we could measure it) is currently protected in conservation areas?" Once again, we are aware of the importance of evaluating multiple

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dimensions of biodiversity for conservation assessment, but we do not see a direct conflict between Brazilian conservation initiatives and our results. Our approach quantified phylogenetic diversity, phylogenetic endemism, index of endemism and approaches to reduce effect of sampling bias in analysis. We point out in our discussion the importance of current conservation units. Our results exemplified a lack of knowledge about the biodiversity of protected areas. Thus, we point out that existing protected areas can preserve a portion of the biodiversity that we still do not know. In addition, we have pointed out the need to create more protected areas. FV's say that we use only data available online. However, in our paper, we indicate that a portion of the data comes from data from the scientific literature and examination of collections material that were compiled and data from online databases were meticulously checked for their geographic and taxonomic accuracy.

Finally, FV seem to have misinterpreted our statement that "*. . .the recent expansion in PAs in Brazil has not resulted in a comparable increase in biodiversity protection*". Of course, our statement concerns the dimensions of biodiversity that we have evaluated (number of species, species ranges, phylogenetic diversity, endemism and phylogenetic endemism), and we have made it clear that PAs play an important role in maintaining habitats and, as showed by our results, may be protecting species and populations as yet unknown. To state that our paper could be used as ammunition for a anti-conservation agenda grossly misrepresents our conclusions. Our approach was only aimed at quantifying gaps to improve the system of protected areas which, as we have discussed, requires the creation of more conservation units. We also strongly advise the intensification of research effort inside conservation units, in order to improve the assessment of conservation gap analyses (either through ours or any other approach). We hope that despite critiques raised by FV, valid or otherwise, that our study can contribute to conservation planning to achieve goals of Ministry of the Environment. Our research group is developing papers that focus specifically on the identification of areas with highest biological relevance. These studies could be used in future analyses of priority areas carried out by Ministry of the Environment.

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