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Unraveling the conservation status of Data Deficient species

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ABSTRACT

Many species are classified as Data Deficient, because there is a knowledge gap about distribution range and population size and trends.

This situation may be a problem in conservation, because the extinction risk of these species is unknown. In the present study, we analyzed all Brazilian anuran species classified as Data Deficient in the IUCN Red List to propose a method to know the conservation status of Data Deficient species. We used the time since species description coupled with the known current species distribution size to indicate the potential conservation status of Data Deficient species. We considered 231 Data Deficient anuran species in Brazil, in which most species ($n = 166$ spp.) are newly described and restricted geographically (Group D). Group A ($n = 9$ spp.) and C ($n = 18$ spp.) were composed by species widely distributed and Group B ($n = 37$ spp.) was composed by species described more than 50 years ago and geographically restricted. Data Deficient is not a threatened category, however it indicates a need to obtain more information about the species listed, but unfortunately financial resource is limited. We suggested that the species allocated in the group B in our analyses must be priorities in future studies, because it is possible that these are threatened. Our analysis used the amphibian anuran from Brazil as model to propose some action that may be useful to known the conservation status of Data Deficient species.

1. Introduction

Currently, the IUCN Red List of Threatened Species (IUCN, 2012) is the most important mechanism for classifying species based in their extinction risk (Rodrigues et al., 2006; Hoffmann et al., 2008). Within its framework, it is possible to classify species into different threat categories that vary from high to low expectation of extinction (IUCN, 2001, 2011). However, when the data available during the assessment process is not adequate to determine the category of a given species, it is classified as Data Deficient (IUCN, 2001). According to IUCN (2001, 2011), the liberal use of the Data Deficient is controversial and discouraged (IUCN, 2011).

There are not resources available to protect all biodiversity features due to time and money limitations (Brooks et al., 2006). Therefore, difficult resource allocation decisions must guide government agencies and conservation organizations to guarantee the best choice to decision makers. In this context, red lists are important tools used to help in decision making both at the global level (Gärdenfors, 2001; Possingham et al., 2002; Rodrigues et al., 2006), and at the regional/national levels (Brito et al., 2010; IUCN, 2010). Currently, governmental and international environmental agencies have considered the extinction risk of species as an important parameter when allocating financial resources for their conservation. Species classified as threatened (Critically Endangered, Endangered, or Vulnerable) are prioritized in conservation action plans (Possingham et al., 2002). According to IUCN (2001, 2011), the Data Deficient species should also be prioritized by the scientific community, in order to generate data that will allow their proper classification into a threat category (Bland et al., 2012). Unfortunately, only rarely funds are specifically directed to tackle the Data Deficient issue (Garnett et al., 2003; Pimenta et al., 2005; Hoffmann et al., 2008).

Amphibians are the terrestrial vertebrate group with the highest proportion of species listed as Data Deficient (Hoffmann et al., 2010; IUCN, 2012). However, the current strategic plans for the conservation of amphibians do not put the Data Deficient issue at the forefront of conservation agenda (e.g. Gascon et al., 2007; Verdade et al., 2012), even though it might undermine the efficiency of conservation actions (Trindade-Filho et al., 2012). Approximately 5970 anuran species have been described in world (Frost, 2013), 1446 of which are listed as Data Deficient (IUCN,

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2012). Recently, population declines have been reported in several Data Deficient species (Lips et al., 2005), where habitat loss, diseases (e.g. chytridiomycosis), climate change, and pollution are identified as potential threat factors (Lips et al., 2005; Pounds et al., 2006; Eterovick et al., 2005; Verdade et al., 2012). This stresses the fact that some of the species currently listed as Data Deficient, in reality, might be threatened.

Brazil harbors the richest amphibian diversity in the world (≅950 species) (Segalla et al., 2012) and it is at the forefront in discussions of global amphibian conservation (Pimenta et al., 2005). Despite of the high amphibian diversity, organized biological and conservation information about this group are yet sparse in Brazil (Silvano and Segalla, 2005; Verdade et al., 2012). Nowadays 31 of the Brazilian anuran species are listed as globally threatened (IUCN, 2012), and 16 as nationally threatened (Haddad, 2008). Even though the number of threatened species in Brazil has been a matter of debate (Pimenta et al., 2005; Stuart et al., 2004, 2005; Morais et al., 2012), a high proportion (25%) of species listed as Data Deficient may be found in Brazil and it indicates a high level of uncertainty about the conservation status of amphibians within the country and may affect the effectiveness of conservation actions (Trindade-Filho et al., 2012; Verdade et al., 2012). Herein, our main objective is to suggest a strategic framework to help overcome the uncertainty regarding the conservation status of species, using anurans in Brazil as a case study.

2. Materials and methods

We found 237 Brazilian anuran species listed as Data Deficient (DD) (IUCN, 2012), however, six anuran species (*Calamita melanorabdotus*, *Gastrotheca flamma*, *Gastrotheca pulchra*, *Hypsiboas albovittatus*, and *Scinax strigilatus*) were excluded of our analysis because there is no distribution information available for these species. We used the time since species description (Frost, 2013; IUCN, 2012), coupled with the known current species distribution size (IUCN, 2012) to indicate the potential conservation status of Data Deficient species.

The rationale of this approach is based on the criteria IUCN uses to determine a species threat category (IUCN, 2001, 2011). The lack of population size estimates and estimates of rates of population trends for the majority of Brazilian anurans prevents the use of criteria A, C, D and E of the IUCN Red List to infer threat categories. However, range distribution data is available for most species, allowing the adoption of criteria B to infer species conservation status (particularly of criteria B1 which uses extent of occurrence). The time since species description gives us an idea of the temporal opportunities that herpetologists had to record occurrence sites of the species. Therefore, one would expect range sizes of "older" species to be more robustly defined than range sizes of newly described species. We adopted a time-frame threshold of 50 years to classify species as "young" or "old", based on the publication of the first Red Data Book on Threatened Species (e.g. IUCN, 1994) and on the growth of herpetological inventories and fieldworks in Brazil since the 60s (e.g. Nascimento and Oliveira, 2007). Regarding the spatial threshold, we followed IUCN's B1 criteria, that uses an extent of occurrence (EOO) threshold of 20,000 km^2 to list a species as threatened, since it will be categorized within the Vulnerable category (IUCN, 2001).

We use quantile regression (Cade et al., 1999; Cade and Noon, 2003) to model a relationship between the time since species discovery and (log-transformed) range-size of the anuran species. Since an increase in sampling effort may allow the discovery of more restricted species over time, it is expected that recently discovered species should present smaller geographical range, but this do not impose any limit to its maximum range-size. Thus, a heteroscedasticity in the relation was expected, which do not follow the assumption of standard regression techniques, but favoring an "envelope" distribution of range-size in relation to time. Quantile regression is especially suited for this situation (Cade et al., 1999; Tôrres et al., 2012) also permitting to evaluate the behavior of the dependent variable at different level (quantiles). Here we follow Cade and Noon (2003) including several quantiles (5%, 10%, 50%, 85%, and 95%) to a better description of the whole relation. For this analysis we considered all Brazilian anuran species (n = 552 spp.) listed as Critically Endangered, Endangered, Vulnerable, and Least Concern (IUCN, 2012).

Then, we established the following groups: (A) species that were described less than 50 years ago and have an EOO of less than 20,000 km^2; (B) species that were described more than 50 years

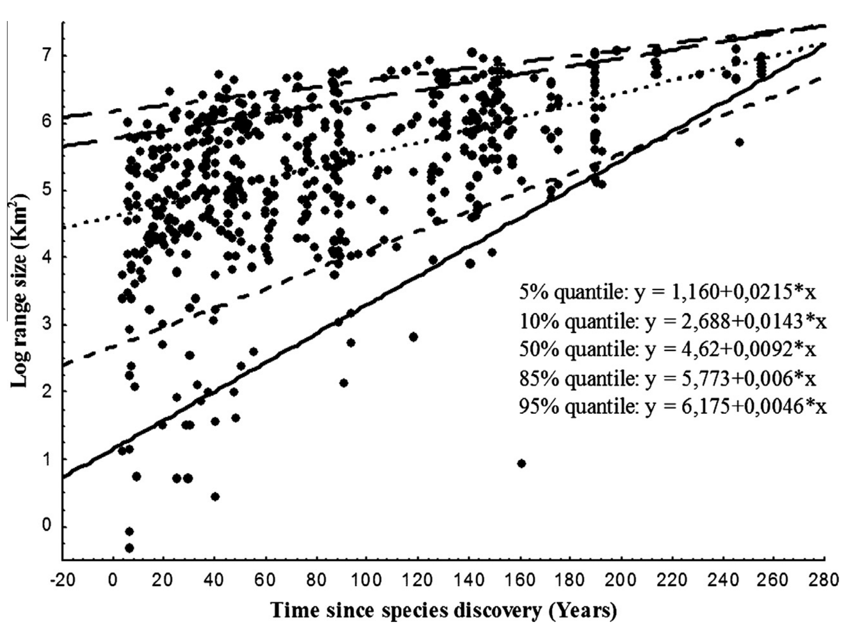

Fig. 1. Relationship between time since species discovery and geographic range size across 552 non-DD anuran species from Brazil.

ago and have an EOO of less than 20,000 km^2; (C) species that were described more than 50 years ago and have an EOO of more than 20,000 km^2; (D) species that were described less than 50 years ago and have an EOO of more than 20,000 km^2. According to our rationale, the conservation status of Data Deficient species should be reviewed depending on which group it was classified. Species currently listed as Data Deficient that fall into group A should keep their status and remain listed as Data Deficient, since their recent description date does not allow their range size to be considered as stable due to the ongoing inventories and surveys conducted by herpetologists. Data Deficient species categorized in the group B, should in reality, be listed as threatened according to IUCN's criteria B1, if we consider that enough time has elapsed since their description date in order that inventories and fieldwork produced enough records to provide a range distribution estimate that is close to the species true distribution size. Using the same reasoning, Data Deficient species categorized in group C, should be listed as Least Concern or Near Threatened (depending on their range distribution size; for further details on the use of the Near Threatened category see IUCN (2001, 2011)). The group D species are those that have large home ranges (over 20,000 km^2), despite being relatively new to science, suggesting they are widespread, common and easily identified. Therefore, the group D species should be listed as Least Concern.

3. Results

We found a significant positive relationship between time since species discovery and geographic range size of the non-DD anuran species (for all quantile level $p < 0.05$) (Fig. 1). Additionally, we observed that recently discovered species have both small and large geographic range sizes, whereas species described a long time ago are widely distributed in Brazil (Fig. 1). This analysis indicates that range size of the species described a long time ago is more robustly defined than range sizes of newly described species. Thus, the relationship described above allows us to use time since species discovery and geographic range size to infer the proper red list category of species.

Therefore, our results rearrange the current conservation scenario of anurans in Brazil, providing a clearer picture of anuran conservation status in the country (Appendix, Table A1, Table 1 and Figs. 2 and 3). According to our methodology, only 166 anuran species currently listed as Data Deficient, should continue to be listed as so (group A) (Appendix, Table A1, Table 1 and Figs. 2 and 3). The remaining species should be re-listed as threatened (37 species, group B) or as non-threatened (28 species, groups C and D) (Appendix, Table A1, Table 1 and Figs. 2 and 3). This would more than double the number of threatened anuran species in Brazil and significantly reduce the number of Data Deficient anuran species from 231 species (or 30% of the country's anuran fauna) to 166 species (or 21% of the country's anuran fauna) (Fig. 2).

4. Discussion

Almost one decade has passed since the results of the Global Amphibian Assessment (GAA) have been published, highlighting the high proportion of amphibians listed as Data Deficient (Stuart et al., 2004). The fact that the issue of amphibian species listed

Table 1
Brazilian anuran species listed in group B in the present study.

Species	Category (IUCN 2012)	Category (Morais et al., 2012)	Extent occurrence estimated (km^2)
Aplastodiscus musicus	Data Deficient	Endangered	793.5
Bokermannohyla claresignata	Data Deficient	Endangered	9966.7
Bokermannohyla clepsydra	Data Deficient	Endangered	6150
Brachycephalus nodoterga	Data Deficient	Critically endangered	96.9
Cochranella ritae	Data Deficient	Endangered	2088.4
Crossodactylodes pintoi	Data Deficient	Critically endangered	90.3
Crossodactylus grandis	Data Deficient	Endangered	2392.7
Crossodactylus trachystomus	Data Deficient	Endangered	2044.1
Cycloramphus diringshofeni	Data Deficient	Endangered	5282.6
Cycloramphus duseni	Data Deficient	Endangered	481.6
Cycloramphus granulosus	Data Deficient	Vulnerable	10,914.3
Cycloramphus ohausi	Data Deficient	Endangered	1032.3
Cycloramphus stejnegeri	Data Deficient	Endangered	1240.8
Dendropsophus minimus	Data Deficient	Critically endangered	15.8
Gastrotheca ernestoi	Data Deficient	Vulnerable	6931.4
Gastrotheca fulvorufa	Data Deficient	Vulnerable	9161.5
Haddadus plicifer	Data Deficient	Critically endangered	5.6
Holoaden luederwaldti	Data Deficient	Vulnerable	15,949.2
Hyla imitator	Data Deficient	Critically endangered	5
Hylodes glaber	Data Deficient	Endangered	356.8
Hylodes mertensi	Data Deficient	Endangered	532.7
Hyophryne histrio	Data Deficient	Endangered	486.3
Ischnocnema gehrti	Data Deficient	Critically endangered	12.7
Ischnocnema holti	Data Deficient	Endangered	335.5
Ischnocnema nigriventris	Data Deficient	Endangered	226.1
Leptodactylus hylodes	Data Deficient	Critically endangered	39.3
Megaelosia massarti	Data Deficient	Critically endangered	24.8
Melanophryniscus pachyrhynus	Data Deficient	Endangered	123.6
Oreobates heterodactylus	Data Deficient	Endangered	2311.7
Osteocephalus inframaculatus	Data Deficient	Endangered	1098.7
Paratelmatobius gaigeae	Data Deficient	Critically endangered	95.9
Paratelmatobius lutzii	Data Deficient	Endangered	121.2
Phyllodytes wuchereri	Data Deficient	Vulnerable	10,612.1
Phyllomedusa megacephala	Data Deficient	Endangered	2235.3
Physalaemus moreirae	Data Deficient	Endangered	4168.3
Pleurodema fuscomaculatum	Data Deficient	Endangered	494.7
Vitreorana parvula	Data Deficient	Endangered	879.2

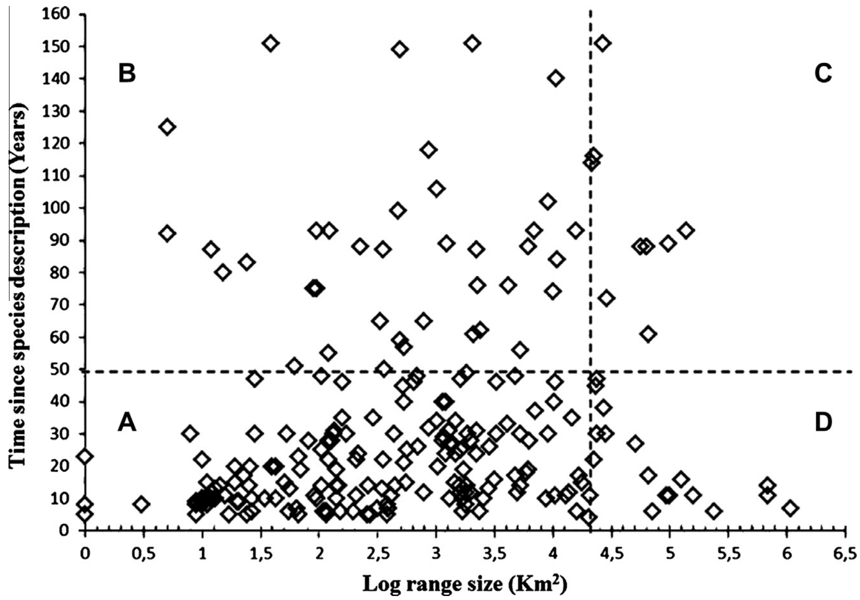

Fig. 2. Distribution of Brazilian anuran species classified as Data Deficient within of the established categories in this study.

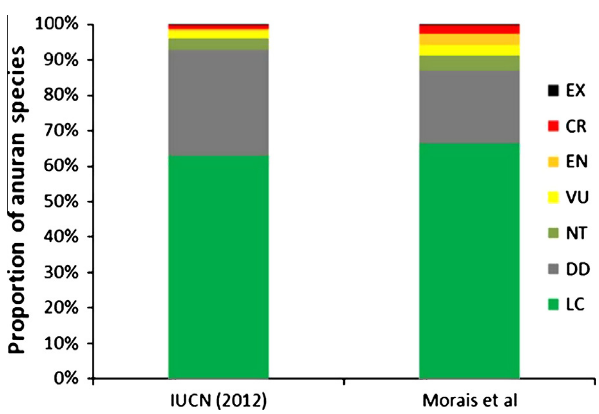

Fig. 3. Proportion of Brazilian anuran species within each IUCN' category.

as Data Deficient has been largely neglected by conservation agenda worldwide (e.g. Gascon et al., 2007) is cause of serious concern, this trend is not different in Brazil (Verdade et al., 2012). Amphibian species listed as threatened have been at the forefront of conservation literature and management actions (Stuart et al., 2004, 2005; Pimenta et al., 2005; Morais et al., 2012), whereas Data Deficient species have received sparse attention so far (e.g., Brito, 2010; Isaac et al., 2012; Trindade-Filho et al., 2012). This pattern is worrisome since both IUCN (IUCN, 2011) and Brazilian herpetologists (Haddad, 2008) stress that the issue of Data Deficient amphibians needs to be urgently addressed by researchers, managers and policy-makers.

Part of the problem may be attributable to differences between the group's high diversity and intrinsic heterogeneity in a relatively small, but growing, scientific community (Rodrigues et al., 2010; Verdade et al., 2012). Additionally, many regions in Brazil are poorly represented in inventories (e.g. north and northeatern Brazil), this may be a problem in conservation issues, because could reflect a lack of uniformity in the data collection effort. Thus, until recently, this scientific community did not plan herpetological research in a coordinated and strategic way (e.g. Brito, 2010; Rodrigues et al., 2010; Verdade et al., 2012). The recent creation of the Amphibian Conservation Action Plan (ACAP) (Gascon et al., 2007) represents an important step towards a more effective amphibian conservation and research. Unfortunately, focusing research on Data Deficient species is not listed among the proposed goals neither for the ACAP (Gascon et al., 2007) nor for the Brazilian Amphibian Conservation Action Plan (BACAP) (Verdade et al., 2012). One of the consequences of such lack of knowledge, besides the large number of Data Deficient species, is that the majority of species are categorized according to criteria B (range distribution size) (Stuart et al., 2004; Haddad, 2008; IUCN, 2012). The BACAP highlights monitoring population fluctuations as a goal (Verdade et al., 2012). Such studies may help clarify the status of some Data Deficient species through the use of criteria A, C and/or D. Even though the production of demographic data may be logistically difficult and time-consuming, amphibian conservation and ecology urgently needs more robust quantitative estimates of population sizes and trends, both at the regional and global levels.

The rate of Data Deficient species for amphibian is higher than the rate observed in other taxonomic groups, such as birds and mammals (Hoffmann et al., 2010; IUCN, 2012). Besides the reasons discussed above, these discrepancies may also be at least partially explained for factors such as differing attitudes of assessors towards data uncertainty during the assessment process (Butchart and Bird, 2010). Besides that, intrinsic biological traits of the group might induce to a true higher level of data deficiency, such as small body size, number of cryptic species, fossorial habits, and nocturnal activity, for example (Butchart and Bird, 2010). Additionally, actual monitoring programs for birds, repeated line censuses, and satellite transmission monitoring allow to obtain more accurate information about bird species, therefore it could explain the differences in the rate of Data Deficient species among such taxonomic groups.

5. Conclusion

Conservation science and policy should join efforts to urgently elucidate the status of Data Deficient species (Butchart and Bird, 2010). Recently, Isaac et al. (2012) suggested that a large number of Data Deficient species are likely to be high priorities for conservation due to their contribution to evolutionary history. Therefore, our methodology contributes to this goal using data available for almost all species. Of course the thresholds used, particularly the time since species description, may be adapted according to a taxonomic group particularities. Such framework not only helps elucidate the status of Data Deficient species, but also contributes to a more efficient allocation of conservation funds and more efficient development of conservation strategies.

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Appendix A. Supplementary material

Supplementary data associated with this article can be found, in the online version, at http://dx.doi.org/10.1016/j.biocon.2013.06.010.

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