



Science, Policy, and Conservation Management for a Critically Endangered Primate in the Atlantic Forest of Brazil

Karen B. Strier^{1*}, Fabiano R. Melo², Sérgio L. Mendes^{3,4},
Monica M. Valença-Montenegro⁵, Anthony B. Rylands⁶, Russell A. Mittermeier⁶ and
Leandro Jerusalinsky^{5*}

¹ Department of Anthropology, University of Wisconsin-Madison, Madison, WI, United States, ² Departamento de Engenharia Florestal, Universidade Federal de Viçosa, Viçosa, Brazil, ³ Instituto Nacional da Mata Atlântica, Santa Teresa, Brazil, ⁴ Departamento de Ciências Biológicas, Universidade Federal do Espírito Santo, Vitória, Brazil, ⁵ Centro Nacional de Pesquisa e Conservação de Primatas Brasileiros, Instituto Chico Mendes de Conservação da Biodiversidade, Cabedelo, Brazil, ⁶ Re:wild, Austin, TX, United States

OPEN ACCESS

Edited by:

Ronald R. Swaisgood,
San Diego Zoo Wildlife Alliance,
United States

Reviewed by:

Carlos R. Ruiz-Miranda,
State University of the North
Fluminense Darcy Ribeiro, Brazil
Andrés Link,
University of Los Andes,
Colombia, Colombia

*Correspondence:

Karen B. Strier
kbstrier@wisc.edu
Leandro Jerusalinsky
leandro.jerusalinsky@icmbio.gov.br

Specialty section:

This article was submitted to
Animal Conservation,
a section of the journal
Frontiers in Conservation Science

Received: 30 June 2021

Accepted: 07 September 2021

Published: 04 October 2021

Citation:

Strier KB, Melo FR, Mendes SL,
Valença-Montenegro MM,
Rylands AB, Mittermeier RA and
Jerusalinsky L (2021) Science, Policy,
and Conservation Management for a
Critically Endangered Primate in the
Atlantic Forest of Brazil.
Front. Conserv. Sci. 2:734183.
doi: 10.3389/fcosc.2021.734183

Long-standing concerns about the status of the world's endangered primates have stimulated significant international efforts, such as the primate action plans published by the Primate Specialist Group of the International Union for Conservation of Nature's Species Survival Commission. However, national-level action plans that bring together diverse scientific experts, non-governmental organizations, and governmental agencies to focus on improving the status of endangered species are generally rare. Here, we highlight one such plan published a decade ago, the *Brazilian National Action Plan for the Conservation of Muriquis*, which promoted the integration of scientific findings about the behavioral ecology, demography, and genetics of northern muriquis with conservation measures supported by the Brazilian government. This plan provided a holistic framework for the development of an effective national strategy that has contributed to significant advances in research and management applied to the conservation of this Critically Endangered species. We hope that this model for muriquis will stimulate conservationists around the world to pursue integrative national-level sponsorship of action plans on behalf of other endangered species.

Keywords: primate activism, primate action plans, national action plans, Northern muriqui, *Brachyteles hypoxanthus*, threatened species, strategic conservation planning, conservation management

INTRODUCTION

Rising extinction risks for the world's wild primates have stimulated calls for greater activism and advocacy on behalf of endangered species (Mittermeier, 1977; Oates et al., 1982, 1987; Oates, 2013; Estrada et al., 2017; Garber, 2019, 2021). Primatologists and primatological societies are now increasingly being urged to take responsibility for “inspiring, organizing, and mobilizing others to join together to take designed to effect change” (Garber, 2021, p. 6; see also Oates, 2013). Primatologists are often the only people who possess the expert knowledge needed for informed conservation and management for their study species. Yet, there are rarely opportunities for integrating their knowledge with that of other researchers and managers with

diverse expertise, or for the direct transfer of this integrated knowledge to policy makers who hold the political power needed to enact effective and enforceable conservation legislation. It is also the case that engaging in conservation without fully understanding and taking into account local community interests and regional or national political contexts can have negative repercussions for the researchers and primates alike. Compounding these risks and the lack of access to, and influence over, the people and processes that must be mobilized for change, are the challenges of developing practical guidelines for the implementation of conservation, and of deriving measurable criteria for evaluating their success (Betts et al., 2020; Junker et al., 2020).

The International Union for the Conservation of Nature's Species Survival Commission (IUCN SSC) has successfully recruited participation from international stakeholders upon whose expertise their assessments of species extinction risks are based. The IUCN Red List resulting from these assessments has been influential in identifying species conservation priorities and in rallying for funding and other support (Rodrigues et al., 2006). Similarly, the biennial release of the World's 25 Most Endangered Primates, identified by IUCN SSC Primate Specialist Group (PSG) members and other experts during open sessions at the International Primatological Society meetings, has been effective in stimulating increased publications and public awareness over the short term, and could likely extend over longer periods if investment in the visibility of the "top 25" lists were sustained (Acerbi et al., 2020; Reuter et al., 2021). However, translating these assessments and agreed-upon priorities into actionable, sustainable conservation and management for threatened species and their habitats requires additional mechanisms that explicitly integrate a wide range of perspectives, and permit systematic evaluations of the effectiveness of conservation actions at the appropriate local, regional, and national scales (Betts et al., 2020).

Among the few available mechanisms employed for achieving these aims have been the action plans sponsored by the IUCN SSC PSG. A global primate action plan written by Mittermeier (1977) was followed by plans for African (Oates et al., 1982, 1987; Oates, 1986, 1996), Asian (Eudey, 1987), and Mesoamerican primates (Rodríguez-Luna et al., 1996) and for lemurs (Mittermeier et al., 1992; Schwitzer et al., 2013)—all developed via correspondence, with only informal in-person gatherings. More recent action plans have been drawn up following structured workshops. Since 2003, the PSG has produced 11 action plans for all of the African great apes, the most recent being for the western chimpanzee (*Pan troglodytes verus*) (IUCN SSC Primate Specialist Group, 2020). The IUCN SSC Conservation Planning Specialist Group (CPSG; previously, Conservation Breeding Specialist Group, or CBSG), has used a workshop approach to develop Population and Habitat Viability Analyses (PHVAs) (Lacy, 1993/1994) which has been used for primates, including lion tamarins *Leontopithecus* (Seal et al., 1990; Rylands, 1993/1994; Ballou et al., 1998; Holst et al., 2006) and muriquis *Brachyteles* (Strier, 1993/1994; Rylands et al., 1998). The CPSG also developed the Conservation Assessment and Management Plan (CAMP) workshop methodology to provide strategic guidance for intensive management and information

collection techniques for threatened taxa on a regional scale (Ellis and Seal, 1996), used for example for Indonesian (Supriatna et al., 2001) and Mexican primates (Rodríguez-Luna et al., 2009).

The PHVAs and CAMPs are technical working documents for informing, organizing and structuring conservation initiatives on behalf of endangered species and their habitats, focusing on particular taxa or regions. Action plans tend to be more directive in their emphasis on prioritizing conservation measures to promote action and fund-raising, typically including detailed summaries of available information about the distribution and population status of the primates at risk, as well as considerations of past and ongoing anthropogenic pressures, and recommendations for mitigating identified threats. Collating such diverse sources of information is feasible because of the participation and contributions of diverse stakeholders, ranging from researchers to non-governmental conservationists to government officials, representatives of zoos, and often local communities (IUCN/SSC, 2008; IUCN SSC Species Conservation Planning Sub-Committee, 2017).

These international initiatives have been successful in promoting conservation activities (Fuller et al., 2003) in much the same way that the IUCN Red List has proven to be an effective tool in lobbying for global conservation commitments (Betts et al., 2020). However, national-level buy-in from host country governments and engagement with local capacity is also essential for translating global priorities into local action (Collen et al., 2013; Durant, 2013). This national buy-in was consolidated in the Convention on Biological Diversity (<https://www.cbd.int/>) and its Strategic Plans (2002-2010; 2011-2020), with most countries committing to adopt national policies in order to prevent and reduce the loss of biodiversity. The need for national plans to save threatened species was expressed in the Aichi target 12: "By 2020 the extinction of known threatened species has been prevented and their conservation status, particularly of those most in decline, has been improved and sustained."

The Brazilian Environment Ministry's Instituto Chico Mendes de Conservação da Biodiversidade (ICMBio) has sponsored the formation of advisory groups for the development of national action plans for threatened Brazilian species (Brazil, ICMBio, 2018a). Here, we review the contributions of one of these plans to our collaborative national and international actions to save the Critically Endangered northern muriqui (*Brachyteles hypoxanthus*). Muriquis are the largest extant nonhuman primates of the Americas and endemic to the Atlantic Forest of southeastern Brazil. It is important to note that many research and conservation efforts on behalf of the northern muriqui were already underway before the publication of the *Plano de Ação Nacional para a Conservação dos Muriquis*, or *PAN Muriquis*, a decade ago (Jerusalinsky et al., 2011). Nonetheless, many recent advances can be directly attributed to the strategic priorities, decision processes, and policy recommendations that emerged from the plan. These include targeted surveys to confirm the occurrence and numbers of remaining populations and the implementation of integrated conservation and management measures. Thus, our approach for the northern muriqui illustrates the dynamic synergism among basic scientific research and conservation actions involving

diverse public and private stakeholders (e.g., universities, NGOs, environmental agencies, and zoos) in the development of a national action plan. i.e., simultaneously informed by the best available science and aligned with Brazilian national priorities and policy. By sharing our experiences with the northern muriqui, we hope to encourage colleagues around the world to consider the merits of developing national action plans for their endangered and critically endangered primates.

TEMPORAL AND SPATIAL SCALES OF SCIENTIFIC RESEARCH

Concern about the future of muriquis and their Atlantic Forest habitat was raised some 50 years ago, when the first systematic survey revealed alarming declines (Aguirre, 1971). Subsequent excursions to locate and study muriquis were made during the 1970s, initiated by Brazilian and foreign researchers and conservationists (Nishimura, 1979; Valle et al., 1983; Nishimura et al., 1988). It was not until the early 1980s, however, that the first long-term studies were launched. At that time the muriqui was classified as a monotypic species, *Brachyteles arachnoides*, and it was not until the early 2000s that the separation of the genus into two species was widely recognized, with molecular data marking their split at *c.* 2 million years (reviewed by Chaves et al., 2019). The reclassification of the northern muriqui from *B. arachnoides* to *B. hypoxanthus* makes prior literature confusing to non-experts, who may not appreciate that the northern muriqui had been studied for decades before it was given its own species name (Strier, 2018).

The 1,000 or so northern muriquis estimated to survive today are distributed among 12 predominantly small, fragmented populations (**Figure 1**). We have information on the status of nine of these populations that have been surveyed and/or studied to varying degrees (Strier et al., 2017). At one extreme is the small population at Peçanha, MG (#3 on **Figure 1**), where the presence of at least seven muriquis was confirmed in a few hours of effort using infrared imaging and drone technology (Melo, 2021). At the other extreme is the relatively large population (currently *c.* 250 individuals) at the Reserva Particular de Patrimônio Natural-Feliciano Miguel Abdala (RPPN-FMA), a private natural heritage reserve in Caratinga, MG (#6 on **Figure 1**), where continuous, systematic studies on behavioral ecology, reproduction, life histories, and demography have been underway on one group since 1983. Northern muriquis have very distinctive facial and fur markings that make it possible to recognize individuals (Strier and Mendes, 2012).

Research on the behavioral ecology of northern muriquis, including the long-term Muriqui Project of Caratinga, has been based on non-invasive, observational studies of wild, unprovisioned animals, and has focused on evaluating hypotheses derived from comparative theories of primate behavioral ecology and social evolution (Strier, 2019). Indeed, the early discovery that northern muriquis live in unusually peaceful, egalitarian societies in which males are philopatric and females typically disperse from their natal groups prior to the onset of puberty, contributed to a greater appreciation

for primate behavioral diversity in general (Strier, 1994, 2003). Moreover, as these behavioral patterns of female dispersal in the Caratinga muriquis were confirmed in comparative studies of other northern muriquis, they took on even greater significance because of their direct implications for the success of potential translocation, reintroduction, and captive breeding programs (Tabacow et al., 2021; Oliveira et al., in press). Indeed, the strong affiliative relationships that persist among related, patrilocal males (Strier et al., 2002) implied that management efforts would be more effective and less destructive if they focused on moving females of dispersal age instead of philopatric males, consistent with their natural dispersal patterns.

The long-term data from Caratinga and comparative data from eight other populations have been equally valuable in assessing how northern muriquis respond under different ecological and demographic conditions (e.g., Lemos de Sá and Strier, 1992; Silva-Júnior et al., 2011; Strier and Mendes, 2012). For example, tree species evenness and structural traits driven by succession were found to be important factors in determining muriqui abundance patterns across different forests (Silva-Júnior et al., 2009, 2010), with higher densities generally occurring in the more disturbed forests (e.g., Pinto et al., 1993). Similarly, the long-term and comparative data on northern muriquis also show their great behavioral flexibility in response to demographic fluctuations, with high population density associated with fission-fusion grouping patterns and an expansion of their vertical niche to include an increased use of terrestrial substrates. Nonetheless, other behavioral traits, including the muriquis' peaceful intragroup social dynamics and female dispersal with male philopatry, appear to be more conservative and persistent, even under variable ecological and demographic conditions (Strier, 2017).

PROCESS AND POLICY OF THE MURIQUI NATIONAL ACTION PLAN

The muriqui has been present in every official national list of threatened species in Brazil. It was listed as *B. arachnoides* in 1968, 1973 and 1989, and then split into *B. arachnoides* and *B. hypoxanthus* in 2003 and 2014. The IUCN Red List categories and criteria were applied in these last two editions, with the northern muriqui being assessed as Critically Endangered (Mendes et al., 2008; Melo et al., 2018). The first conservation planning for the species was a PHVA (Rylands et al., 1998). Following the recommendations of this PHVA, and the pioneering committee model developed for the conservation of lion tamarins (Kleiman and Mallinson, 1998; Rambaldi et al., 2002), in 2003 the Brazilian federal government created an international committee for conservation and management of the muriquis, linked to IBAMA (Brazil, IBAMA, 2003). This Committee initiated the elaboration of a national action plan for muriquis in 2005. Two other workshops, held in 2008 and 2010, concluded the plan, which ultimately defined the structure that was broadly followed by dozens of subsequent such plans to reverse the extinction risk of other threatened species (Brazil, ICMBio, 2018b), including those

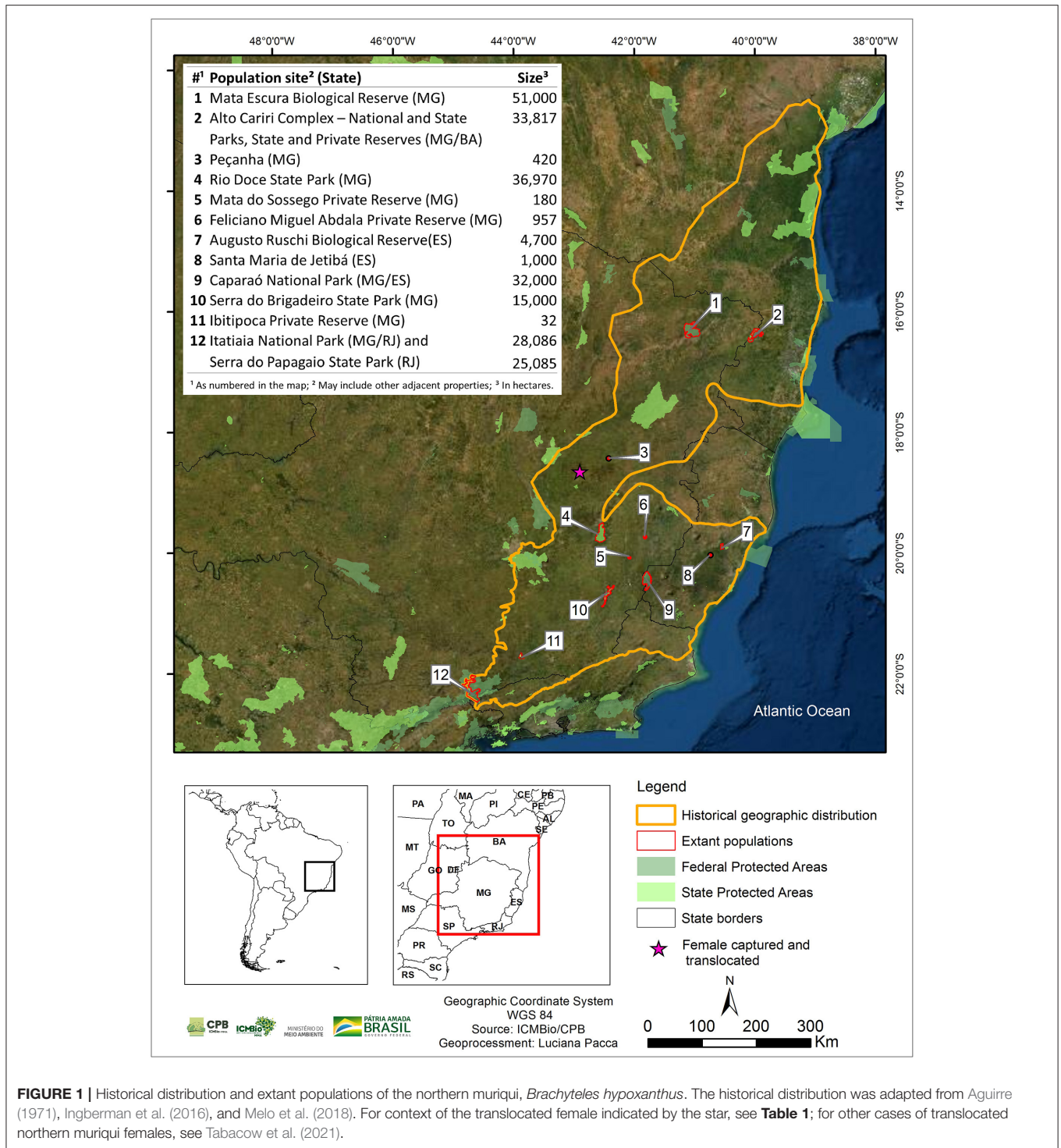


FIGURE 1 | Historical distribution and extant populations of the northern muriqui, *Brachyteles hypoxanthus*. The historical distribution was adapted from Aguirre (1971), Ingberman et al. (2016), and Melo et al. (2018). For context of the translocated female indicated by the star, see **Table 1**; for other cases of translocated northern muriqui females, see Tabacow et al. (2021).

currently covering all of the Brazilian imperiled primates (e.g., Escarlate-Tavares et al., 2016; Jerusalinsky et al., 2017).

The overarching goal of the PAN Muriquis was to downlist both muriqui species by at least one risk category. Ten objectives with 58 actions were set to reach this goal, with responsibilities, timeframes, products, and cost estimates assigned to each

action. Compiling a collective knowledge about the muriqui and incorporating this understanding into conservation and management actions was a collaborative effort that involved more than 30 participants, including 14 members of the federally recognized Technical Advisory Group, or GAT (Brazil, ICMBio, 2014). As such, the PAN Muriquis was broadly participatory, and

the resulting strategic planning reflected the agreements reached between the stakeholders. The final product was submitted to ICMBio's directorate and, after approval, its summary was published as a legal instrument of public policy for the species' conservation (Brazil, ICMBio, 2010). The implementation of the itemized actions was monitored annually, and the progress made in meeting the objectives was analyzed in interim and final evaluations (Table 1).

Overall, 46% of the actions were implemented as planned, while 54% were advanced but not concluded. Although none of the 10 objectives had all planned actions accomplished, for most the quantitative goals were achieved or approximated, including those focusing on counting the remaining populations, creating new public or private protected areas, developing and integrating demographic monitoring and research, promoting habitat connectivity, institutional integration and commitment for the species conservation, and establishing an integrated management program (Table 1).

In parallel, from 2010 to 2017, muriquis were grouped with 26 other taxa in the *National Action Plan for the Conservation of Central Atlantic Forest Mammals* (Escarlate-Tavares et al., 2016). This multi-taxa and geographically broadened approach followed the ICMBio guidelines to increase the number of threatened species benefitting from national action plans. The PAN Muriquis first cycle was concluded in 2017 and, although the GAT recommended a second cycle, the ICMBio directorate decided to instead include both northern and southern muriquis, together with the four lion tamarin species and seven other primate species in a new, scaled-up *National Action Plan for Conservation of the Atlantic Forest Primates and the Maned Sloth* (Brazil, ICMBio, 2018b). The objectives and actions of the PAN Muriquis have, nevertheless, persisted in providing guidelines for organizing conservation efforts for both muriqui species.

CONSERVATION AND MANAGEMENT ACTIONS

The PAN Muriquis has contributed fundamentally to more integrated research and conservation initiatives (Table 1). For example, the workshops that generated the PAN Muriquis were directly responsible for the development of criteria for prioritizing muriqui populations regarding their demographic, genetic, and geographic importance for the species' conservation (Strier et al., 2017). They also facilitated the data sharing that enabled comparative analyses of natural demographic fluctuations (Strier et al., 2019), the impact of management and natural dispersal processes on population size and composition (Tabacow et al., 2021), the genetics that demonstrate the 2 MY split, and insights into population histories that distinguish the northern and southern species (Chaves et al., 2019). The objectives of the PAN Muriquis also called for coordinated assessments and reassessments of the status of all populations of muriquis, to which the most up-to-date technologies, such as arboreal cameras and drones with infrared cameras, have been applied (Melo, 2021; Tabacow et al., in press, a). Although at least some of the long-term and new research and conservation

activities would have likely proceeded without the PAN Muriquis, there is no doubt that it generated greater opportunities and provided a stimulus for the cooperation that was essential for the success of these broader, more collaborative products.

A second important contribution of the PAN Muriquis also grew out of the workshops, which brought together stakeholders from both field and captive settings, collectively representing a wide range of expertise across both *in situ* and *ex situ* contexts. The synergy among participants generated 14 protocols for monitoring and managing muriquis and their habitats that would never have been developed without these exchanges (Valença-Montenegro et al., in press). Among them are criteria for classifying the viability of muriqui populations (Lanna et al., in press), a "Decision Key" for objectively identifying inviable populations and the subsequent steps of assessing the most appropriate forms of management for them (Strier et al., in press), and a procedure for evaluating the compatibility of populations identified as inviable for management purposes (Moreira et al., in press). With these protocols, all northern muriqui populations can now be evaluated as potential sources of females for *in situ* or *ex situ* management purposes, or as receptors of females, depending on their status.

A third contribution from the PAN Muriquis and its associated protocols has been the sequence of steps taken to insure the persistence of the muriqui population in Ibitipoca, Minas Gerais (#11 on Figure 1). There, episodic censusing demonstrated a small and declining population (Nogueira et al., 2010) and by August 2014 only two adult males remained. At the same time, reports of solitary females from two locales elsewhere in the state had been confirmed, and the decision was made to bring both males and the females into an outdoor enclosure, with access to a 2-ha patch of forest. At present writing, one of the males has already sired an infant with one of the translocated females (Tabacow et al., 2021).

Throughout this process, expertise from researchers of both captive (Coimbra-Filho et al., 1993) and wild muriquis has been integrated, distinguishing it from previous female translocations and other management initiatives. In January 2020, ICMBio staff met with a subset of the PAN Muriquis' contributors to determine the key decisions about the management of any northern muriqui individual, not only considering emergency situations (Strier et al., in press) but also cases where the translocation of isolated animals, or even groups of muriquis might be warranted. The PAN Muriquis provided both the motivation for the meeting and the tools to achieve what is now a comprehensive approach for the conservation and management of this species.

A fourth contribution from PAN Muriquis to the conservation of the northern muriqui has been the coordination of efforts to create new protected areas (Objective 3 in Table 1) and an expanding network of forest corridors to increase connectivity among prioritized populations. A first step in these efforts has been the official designation of the Sossego-Caratinga Ecological Corridor (SCEC), recognized by the Minas Gerais State Decree No. 397 on August 1, 2014 (Brazil, Minas Gerais, IEF, 2014). Designation of this important corridor was motivated by the need to protect the northern muriqui populations present in the two fragmented, private reserves 45 km apart (#5 and #6 on Figure 1),

TABLE 1 | Advances following the adoption of the PAN Muriquis concerning ongoing conservation initiatives for the northern muriqui, *Brachyteles hypoxanthus*. Adapted from Brazil, ICMBio/CPB (2017).

Specific objectives	Advances attributed to PAN Muriquis
1. Quantify the remaining populations of muriquis.	<ul style="list-style-type: none"> • Increased information about areas of occurrence of northern muriquis and their population sizes. New information includes: <ul style="list-style-type: none"> ◦ Confirmation of the presence of <i>Brachyteles hypoxanthus</i> in Itatiaia National Park and Serra do Papagaio State Park [#12 on Figure 1; Aximoff (2015) and Carvalho et al. (2015)]. ◦ Confirmation of the decline in Ibitipoca population (#11 on Figure 1) to only two adult males as of 2015 (and targeted as priority for management with translocated females). ◦ Confirmation of an isolated female in a forest near the area of Esmeralda de Ferros, Ferros, Minas Gerais (star on Figure 1—see Objective 10). ◦ Confirmation of the occurrence of a small group in Peçanha, Minas Gerais (#3 in Figure 1). • Population estimates obtained for 9 of the 12 areas (75%) where northern muriquis occur, with the total confirmed number being 1,213 individuals. • Completion of the protocol for quantifying muriqui populations [Tabacow et al. (in press, a)]. • Increased monitoring of hunting in various locations in Minas Gerais [Brazil, ICMBio/CPB (2017)].
2. Increase enforcement measures to effectively reduce hunting pressure on muriqui populations in and around protected areas.	<ul style="list-style-type: none"> • Creation of new private reserves (RPPNs): <ul style="list-style-type: none"> ◦ Two private reserves (RPPNs) near Caparaó National Park (#9 on Figure 1): “Dois Irmãos: Cláudio Murilo Belletti Rodrigues,” 57.25 ha [Brazil, Minas Gerais, IEF (2016)] and “Dois Irmãos: Emílio Sérgio Belletti Rodrigues,” 50.31 ha [Brazil, Minas Gerais, IEF (2017)]. ◦ Private reserve of 339.48 ha continuous with that of Sossego (#5 on Figure 1): RPPN Sossego do Muriqui, created by Curimbaba Mining Company (with help from the Muriqui Instituto de Biodiversidade (MIB) and the Fundação Grupo Boticário de Proteção à Natureza) [Brazil, Minas Gerais, IEF (2018)].
4. Implement mechanisms to finance muriqui research and conservation activities.	<ul style="list-style-type: none"> • Although a specific fund has yet to be created, the PAN Muriquis enhanced the capture of financial resources to support projects and actions related to these objectives. For example: <ul style="list-style-type: none"> ◦ The “Programa de Conservação Muriquis de Minas (PCMM)” financed for 4 years by the Fundação Grupo Boticário de Proteção à Natureza; ◦ The “Casa do Muriqui” project funded by the Comuna da Ibitipoca, New World Primate Taxon Advisory Group of the Association of Zoos & Aquariums, and Mohamed bin Zayed Species Conservation Fund; ◦ Thirteen grants, totaling \$93,499, awarded by the Primate Action Fund of Re:wild (formerly Global Wildlife Conservation) and the Margot Marsh Biodiversity Foundation (2011–2020).
5. Establish an integrated program for the demographic monitoring of muriqui populations in priority areas.	<ul style="list-style-type: none"> • Completion of analyses for prioritizing populations and for monitoring population demography [Strier et al. (2017)]. • The demographic monitoring of three populations ongoing (Caratinga, Santa Maria do Jetibá, and Ibitipoca; #6, 8, and 11, respectively, on Figure 1). • Initiation of monitoring of two additional populations (Mata do Sossego and Caparaó National Park; #5 and 9, respectively, on Figure 1).
6. Implement an integrated long-term research program applied to the conservation of muriquis	<ul style="list-style-type: none"> • Increase in integration and synergy among long-term and new research programs, specifically with relevance for conservation, e.g., <ul style="list-style-type: none"> ◦ Demographic fluctuations: Strier et al. (2017, 2019); Tabacow et al. (2021). ◦ Genetics: Chaves et al. (2019).
7. Develop state projects to ensure and increase connectivity in at least 50% of the areas where potentially viable muriqui populations occur.	<ul style="list-style-type: none"> • Maps of areas of occurrence and land use, with a protocol for identifying priorities for connectivity [Tabacow et al. (in press, b)]. <ul style="list-style-type: none"> ◦ Minas Gerais: The official designation of the Sossego-Caratinga Ecological Corridor [Brazil, Minas Gerais, IEF (2014)]. ◦ Espírito Santo: Project approved to promote connectivity among forest fragments in Santa Maria de Jetibá, Santa Teresa, and Santa Leopoldina.
8. Establish strategies for Environmental Education, scientific dissemination, communication and income generation aimed at the conservation of muriquis.	<ul style="list-style-type: none"> • Popular books for children [Moreira (2009)] and the general public, including “O Muriqui” [Mendes et al. (2014) and Leitão et al. (2017)]. • Educational videos, such as, “Entre Montanhas e Muriquis” and “Resgate de Esmeralda: Salva o Muriqui” (https://mib.org.br/videos/). • Citizen Science for monitoring primates in the Brazilian Atlantic Forest [Nery et al. (2021)].
9. Have strategic institutions working in coordination for the conservation of muriquis.	<ul style="list-style-type: none"> • Annual meetings of the Technical Advisory Group of PAN Muriquis • Post PAN Muriquis meetings, including: <ul style="list-style-type: none"> ◦ 1st meeting for Research and Conservation of the Northern Muriqui, held at the Instituto Nacional para a Mata Atlântica (INMA), Vitória, ES, September 2018. ◦ 2nd meeting for Research and Conservation of the Northern Muriqui, sponsored by the Comuna da Ibitipoca, Ibitipoca, MG, January 2020. • At least 60 participants from at least 40 institutions and organizations collaborated on research and conservation activities through 2017.

(Continued)

TABLE 1 | Continued

Specific objectives	Advances attributed to PAN Muriquis
10. Implement a management program for known muriqui populations that are not potentially viable.	<ul style="list-style-type: none"> • A new non-governmental organization, the Muriqui Instituto de Biodiversidade (MIB), was created to provide logistical and technical support for research and conservation projects for muriquis. • Protocols booklet that includes the classification of all known muriqui populations using criteria of their viability, and protocols for evaluating the need for emergency management of muriquis <i>in situ</i> and <i>ex situ</i> [Valença-Montenegro et al. (in press)]. • Translocation of isolated females, following protocols and recommendations of the Technical Advisory Group of the PAN Muriquis [listed in Tabacow et al. (2021)].

both of which are recognized as priority populations for this species (Strier et al., 2017). The value of ecological corridors is particularly high for the Atlantic Forest (Rezende et al., 2018), and one of the protocols resulting from the PAN Muriquis is focused on developing connectivity of areas prioritized for their muriqui populations (Tabacow et al., in press, b). Once established, the SCEC will cover an area of 66,424.56 ha in the Atlantic Forest, spanning seven municipalities in the state (Brazil, Minas Gerais, IEF, 2017). The hope is that the corridor will permit these currently isolated muriqui populations to expand into suitable habitat where gene flow can occur through female dispersal.

CONCLUSIONS

Our experience with these national level and species-specific action plans is that they are effective, especially in integrating the diverse experiences and perspectives of scientists with different areas of expertise, non-governmental organizations, and the appropriate government agencies. National Action Plans serve a vital role in channeling global biodiversity priorities into actionable conservation commitments implemented directly by the countries where the species occur. National Action Plans can also simultaneously provide a platform and a stimulus for the development of even more focused regional and state-level plans, as has occurred with the *Plano Estadual de Ação para a Conservação dos Muriquis*, which is being implemented in the state of Espírito Santo (Brazil, Espírito Santo, SEAMA/IEMA, 2014).

With many of the conservation and management actions identified in the PAN Muriquis already underway for *B. hypoxanthus*, there is now a solid, resilient network that makes us optimistic about the potential to increase the viability of northern muriqui populations that have been badly affected by anthropogenic activities in the past and will experience increasing pressures from climate change and ongoing human impact in the future. We urge everyone with a commitment to the conservation of endangered species to work with local stakeholders representing diverse organizations to explore existing mechanisms or establish new ones for developing national action plans. We also recommend that these national action plans be established as public policies, as is the case in Brazil, so that their chances for success are enhanced.

DATA AVAILABILITY STATEMENT

The original contributions presented in the study are included in the article/supplementary material, further inquiries can be directed to the corresponding author/s.

AUTHOR CONTRIBUTIONS

KS, FM, SM, MV-M, AR, RM, and LJ contributed to the conception and design of the study. MV-M and LJ organized the results presented in **Table 1**. LJ and FM organized the data shown in **Figure 1**. KS wrote the first draft of the manuscript. FM, AR, and LJ wrote sections of the manuscript. All authors contributed to the article, and approved the submitted version.

FUNDING

Instituto Chico Mendes de Conservação da Biodiversidade (ICMBio), Instituto Brasileiro do Meio Ambiente e dos Recursos Naturais Renováveis (IBAMA), Instituto Estadual de Florestas/Secretaria de Estado de Meio-Ambiente e Desenvolvimento Sustentável-Minas Gerais (IEF/SEMAD-MG), and Comuna do Ibitipoca financed the workshops that resulted in the PAN Muriquis.

ACKNOWLEDGMENTS

We are grateful to Marcelo Marcelino de Oliveira and Juliana G. Ferreira for their leadership during the initial meetings that led to the PAN Muriquis. We also thank our colleagues and fellow GAT members (Alcides Pissinatti, Beto Mesquita, Cecília Pessutti, Fernanda P. Tabacow, Leandro S. Moreira, Marcello S. Nery, Marcelo C. Amarante, Maurício Talebi, Paula M. S. Breves, and Tereza C. C. Margarido), and the many other colleagues who collaborated on various aspects of the PAN Muriquis and its products to date (Adriana Milagres, Adriano P. Paglia, Alexandre Bastos, Anderson I. G. Ferreira, André A. Cunha, André M. Lanna, Anthony Di Fiore, Brittany Berger, Carla B. Possamai, Daniel A. R. Vilela, Daniel S. Ferraz, Danilo Simonini, Erika Procópio, Eutálio L. M. Pimenta, Felipe B. M. Eurico, Juciara Pelles, Luana D'Avilla Centoducatte, Luiz Gustavo Dias, Marcelo L. Reis, Mariana Y. G. Fialho, Mariane Kaizer, Mikaelly F. Testa, Paulo B. Chaves, Plautino de O. Laroque, Priscila M. Pereira, Priscila Oliveira, Robson O. E. Hack, Rodrigo H. F. Teixeira, Rodrigo R. Valle, Rogério R. Santos, Sandro L.

Bonato, Suzan Mo, Tielli Magnus, Valéria Fagundes, Valéria Pereira, and Vivian T. Fraiha). We thank Dan Blumstein for his invitation to contribute to *Frontiers in Conservation Science* –

Animal Conservation. Luciana G. Pacca (ICMBio/CPB) kindly updated the historical distribution limits and created the map in **Figure 1**.

REFERENCES

- Acerbi, A., Kerhoas, D., Webber, A. D., McCabe, G., Mittermeier, R. A., and Schwitzer, C. (2020). The impact of the “World’s 25 Most Endangered Primates” list on scientific publications and media. *J. Nat. Conserv.* 54:125794. doi: 10.1016/j.jnc.2020.125794
- Aguirre, A. C. (1971). *O Mono*, *Brachyteles arachnoides* (É. Geoffroy) – *Situação atual da espécie no Brasil*. Rio de Janeiro, RJ: Academia Brasileira de Ciências.
- Aximoff, I. (2015). Confirmação da ocorrência do muriqui-do-norte (Primates: Atelidae) no Parque Nacional do Itatiaia, Estado do Rio de Janeiro, Sudeste do Brasil. *Oecol. Australis* 18, 1–5. doi: 10.4257/oeco.2014.1801.01
- Ballou, J. D., Lacy, R. C., Kleiman, D. G., Rylands, A. B., and Ellis, S. (eds.). (1998). *Leontopithecus II: Final Report. The Second Population and Habitat Viability Assessment for Lion Tamarins, Belo Horizonte, Brazil, 20–22 May 1997*. Apple Valley, MN: Conservation Breeding Specialist Group (CBSG) SSC/IUCN.
- Betts, J., Young, R. P., Hilton-Taylor, C., Hoffmann, M., Rodríguez, J. P., Stuart, S. N., et al. (2020). A framework for evaluating the impact of the IUCN Red List of threatened species. *Conserv. Biol.* 34, 632–643. doi: 10.1111/cobi.13454
- Brazil, Espírito Santo, SEAMA/IEMA (2014). *Portaria conjunta N.º. 02-S, de 6 de junho de 2014 – Institui o Plano de Ação Estadual para a Conservação do Muriqui* (*Brachyteles hypoxanthus*) no *Espirito Santo – PAE Muriqui*. Vitória: Governo do Estado do Espírito Santo, Secretaria do Meio Ambiente e Recursos Hídricos (SEAMA), Instituto Estadual do Meio Ambiente e Recursos Hídricos (IEMA).
- Brazil, IBAMA (2003). *Portaria N.º. 432, de 26 de maio de 2003 – Institui o Comitê para Conservação e Manejo do Muriqui* (*B. arachnoides* e *B. hypoxanthus*). Brasília: Instituto Brasileiro do Meio Ambiente e dos Recursos Naturais Renováveis (IBAMA). Diário Oficial da União – N.º. 100, Seção 2, 41.
- Brazil, ICMBio (2010). *Portaria N.º. 87, de 27 de agosto de 2010 – Aprova o Plano de Ação Nacional para a Conservação dos Muriquis*. Brasília: Instituto Chico Mendes de Conservação da Biodiversidade (ICMBio). Diário Oficial da União – N.º. 169, Seção 1, 100.
- Brazil, ICMBio (2014). *Portaria N.º. 265, de 24 de junho de 2014 – Institui o Grupo de Assessoramento Técnico para acompanhar a implementação do Plano de Ação Nacional para Conservação dos Muriquis* (*Brachyteles hypoxanthus* e *Brachyteles arachnoides*) – PAN Muriquis. Brasília: Instituto Chico Mendes de Conservação da Biodiversidade (ICMBio). Diário Oficial da União – N.º. 119, Seção 2, 51.
- Brazil, ICMBio (2018a). *Guia para Gestão de Planos de Ação Nacional para a Conservação das Espécies Ameaçadas de Extinção: PAN – Elabore - Monitore - Avalie*. Brasília: Instituto Chico Mendes de Conservação da Biodiversidade (ICMBio). Available online at: https://www.gov.br/icmbio/pt-br/assuntos/biodiversidade/pan/saiba-mais/documentos-e-downloads/PAN_elabore_monitore_avalie_2018v2.pdf (accessed September 14, 2021).
- Brazil, ICMBio (2018b). *Portaria N.º. 702, de 7 de agosto de 2018 – Aprova o Plano de Ação Nacional para a Conservação dos Primatas da Mata Atlântica e da Preguiça-de-Coleira – PAN PPMA*. Brasília: Instituto Chico Mendes de Conservação da Biodiversidade (ICMBio). Diário Oficial da União – N.º. 153, Seção 1, 57.
- Brazil, ICMBio/CPB (2017). *Plano de Ação Nacional para a Conservação dos Muriquis: Relatório de Avaliação Final*. Centro Nacional de Pesquisas e Conservação de Primatas Brasileiros (CPB), Instituto Chico Mendes de Conservação da Biodiversidade (ICMBio), João Pessoa, Brazil.
- Brazil, Minas Gerais, IEF (2014). *Decreto Estadual N.º. 397 de 1 de agosto de 2014 – Cria o Corredor Ecológico Sossego-Caratinga nos Municípios de Caratinga, Simonésia, Manhuaçu, Ipanema, Santa Bárbara do Leste, Santa Rita de Minas e Piedade de Caratinga, e dá outras providências*. Belo Horizonte: Instituto Estadual de Florestas (IEF).
- Brazil, Minas Gerais, IEF (2016). *Portaria N.º. 61, de 16 de setembro de 2016 – Reconhece como Reserva Particular do Patrimônio Natural, a RPPN “Dois Irmãos: Claudio Murilo Belletti Rodrigue.s”*. Belo Horizonte: Instituto Estadual de Florestas (IEF).
- Brazil, Minas Gerais, IEF (2017). *Portaria N.º. 71, de 18 de julho de 2017 – Reconhece como Reserva Particular do Patrimônio Natural, a RPPN “Dois Irmãos: Emilio Sérgio Belletti Rodrigues”*. Belo Horizonte: Instituto Estadual de Florestas (IEF).
- Brazil, Minas Gerais, IEF (2018). *Portaria N.º. 63, de 13 de setembro de 2018 – Reconhece como Reserva Particular do Patrimônio Natural, a RPPN “Sossego do Muriqui”*. Belo Horizonte: Instituto Estadual de Florestas (IEF).
- Carvalho, W. D., Xavier, B. S., and Esbérard, C. E. L. (2015). Primatas do Parque Estadual da Serra do Papagaio e RPPNs adjacentes, estado de Minas Gerais. *Neotrop. Primates* 22, 25–31. Available online at: http://www.primate-sg.org/storage/pdf/NP_22.1_Carvalho_et_al_pp.25-31.pdf
- Chaves, P. B., Magnus, T., Jerusalinsky, L., Talebi, M., Strier, K. B., Breves, P., et al. (2019). Phylogeographic evidence for two species of muriqui (genus *Brachyteles*). *Am. J. Primatol.* 81:e23066. doi: 10.1002/ajp.23066
- Coimbra-Filho, A. F., Pissinatti, A., and Rylands, A. B. (1993). Breeding muriquis (*Brachyteles arachnoides*) in captivity: the experience of the Rio de Janeiro Primate Centre (CPRJ/FEEMA). *Dodo, J. Wildl. Preserv. Trusts* 29, 66–77.
- Collen, B. P., Pettorelli, N., Baillie, J. E. M., and Durant, S. M. (2013). “Biodiversity monitoring and conservation: bridging the gaps between global commitment and local action,” in *Biodiversity Monitoring and Conservation: Bridging the Gap between Global Commitment and Local Action*, eds B. Collen, N. Pettorelli, J. E. M. Baillie, and S. M. Durant (New York, NY: John Wiley & Sons), 1–16. doi: 10.1002/9781118490747.ch1
- Durant, S. M. (2013). “Building sustainable national monitoring networks,” in *Biodiversity Monitoring and Conservation: Bridging the Gap between Global Commitment and Local Action*, eds B. Collen, N. Pettorelli, N., J. E. M. Baillie, and S. M. Durant (New York, NY: John Wiley & Sons), 313–334. doi: 10.1002/9781118490747.ch14
- Ellis, S., and Seal, U. S. (eds.). (1996). *Conservation Assessment and Management Plan (CAMP) Process Reference Manual*. Apple Valley, MN: IUCN/SSC Conservation Breeding Specialist Group (CBSG).
- Escarlate-Tavares, F., Valença-Montenegro, M. M., and Jerusalinsky, L. (eds.). (2016). *Plano de Ação Nacional para Conservação dos Mamíferos da Mata Atlântica Central*. Brasília: Instituto Chico Mendes de Conservação da Biodiversidade (ICMBio), Série Espécies Ameaçadas, 23.
- Estrada, A., Garber, P. A., Rylands, A. B., Roos, C., Fernandez-Duque, E., Di Fiore, A., et al. (2017). Impending extinction crisis of the world’s primates: Why primates matter. *Sci. Adv.* 3:e1600946. doi: 10.1126/sciadv.1600946
- Eudey, A. A. (1987). *Action Plan for Asian Primate Conservation: 1987-1991*. Gland: IUCN/SSC Primate Specialist Group.
- Fuller, R. A., McGowan, P. J. K., Carroll, J. P., Dekker, R. W. R. J., and Garson, P. J. (2003). What does IUCN species action planning contribute to the conservation process? *Biol. Conserv.* 112, 343–349. doi: 10.1016/S0006-3207(02)00331-2
- Garber, P. A. (2019). Moving from advocacy to activism: changing views of primate field research and conservation over the past 40 years. *Am. J. Primatol.* 81:e23052. doi: 10.1002/ajp.23052
- Garber, P. A. (2021). Advocacy and activism as essential tools in primate conservation. *Int. J. Primatol.* 1–17. doi: 10.1007/s10764-021-00201-x
- Holst, B., Medici, E. P., Marinho-Filho, O. J., Kleiman, D. G., Leus, K., Pissinatti, A., et al. (2006). *Lion Tamarin Population and Habitat Viability Assessment Workshop 2005, Final Report*. Apple Valley, MN: IUCN/SSC Conservation Breeding Specialist Group (CBSG).
- Ingberman, B., Fusco-Costa, R., and Monteiro-Filho, E. L. A. (2016). A current perspective on the historical geographic distribution of the endangered muriquis (*Brachyteles* spp.): Implications for conservation. *PLoS ONE* 11:e0150906. doi: 10.1371/journal.pone.0150906
- IUCN SSC Primate Specialist Group (2020). *Regional Action Plan for the Conservation of Western Chimpanzees* (*Pan troglodytes verus*) 2020-2030. Gland: IUCN SSC Primate Specialist Group. Available online at: <http://www>

- primate-sg.org/storage/pdf/IUCN_Western_Chimpanzee_Action_Plan_2020.pdf
- IUCN SSC Species Conservation Planning Sub-Committee (2017). *Guidelines for Species Conservation Planning. Version 1.0*. Gland, Switzerland: IUCN
- IUCN/SSC (2008). *Strategic Planning for Species Conservation: A Handbook. Version 1.0*. Gland: IUCN SSC. Available online at: https://www.iucn.org/downloads/scshandbook_2_12_08_compressed.pdf (accessed September 14, 2021).
- Jerusalinsky, L., Azevedo, R. B., and Gordo, M. (eds.). (2017). *Plano de Ação Nacional para a Conservação do Sauim-de-Coleira*. Brasília: Instituto Chico Mendes de Conservação da Biodiversidade (ICMBio), Série Espécies Ameaçadas, 29.
- Jerusalinsky, L., Talebi, M., and Melo, F. R. (eds.). (2011). *Plano de Ação Nacional para a Conservação dos Muriquis*. Brasília: Instituto Chico Mendes de Conservação da Biodiversidade (ICMBio), Série Espécies Ameaçadas, 11.
- Junker, J., Petrovan, S. O., Arroyo-Rodríguez, V., Boonratana, R., Byler, D., Chapman, C. A., et al. (2020). A severe lack of evidence limits effective conservation of the world's primates. *BioScience* 70, 794–803. doi: 10.1093/biosci/biaa082
- Kleiman, D. G., and Mallinson, J. J. C. (1998). Recovery and management committees for lion tamarins: partnerships in conservation planning and implementation. *Conserv. Biol.* 12, 27–38. doi: 10.1046/j.1523-1739.1998.96287.x
- Lacy, R. C. (1993/1994). What is population (and habitat) viability analysis? *Primate Conserv.* 14–15, 27–33.
- Lanna, A. M., Moreira, L. S., Tabacow, F. P., Santos, R. R., Mendes, S. L., Possamai, C. B., et al. (in press). “Critérios para classificação das populações de *Brachyteles* spp. quanto à viabilidade populacional,” in *Protocolos para Pesquisa e Manejo de Muriquis – Gênero Brachyteles*, eds M. M. Valença-Montenegro, F. R. Melo, and L. Jerusalinsky (Brasília: Instituto Chico Mendes de Conservação da Biodiversidade [ICMBio]), 26–27.
- Leitão, M., Strier, K. B., Mittermeier, R. A., and Abranches, S. (2017). *Muriqui – Reis da Mata*. São Paulo: Film Festival, São Paulo.
- Lemos de Sá, R. M., and Strier, K. B. (1992). Comparative forest structure and habitat choice in muriquis. *Biotropica* 24, 455–459. doi: 10.2307/2388617
- Melo, F. R. (2021). Drones for conservation: new techniques to monitor muriquis. *Oryx* 55, 171–171. doi: 10.1017/S0030605321000028
- Melo, F. R., Jerusalinsky, L., Tabacow, F. P., and Ferraz, D. S. (2018). “*Brachyteles hypoxanthus* (Kuhl, 1820)” in *Livro Vermelho da Fauna Brasileira Ameaçada de Extinção. Vol. 2 – Mamíferos, org.* Instituto Chico Mendes de Conservação da Biodiversidade (Brasília: Instituto Chico Mendes de Conservação da Biodiversidade, Ministério do Meio Ambiente), 191–196.
- Mendes, S. L., Silva, M. P., Oliveira, M. Z. T., and Strier, K. B. (2014). *O Muriqui: Símbolo da Mata Atlântica. 2nd Edn*. Vitória: Instituto de Pesquisas da Mata Atlântica (IPEMA), Programa Difusão da Biodiversidade, Projeto Muriqui, Espírito Santo.
- Mendes, S. L., Strier, K. B., and Melo, F. R. (2008). “*Brachyteles hypoxanthus* (Kuhl, 1820)” in *Livro Vermelho da Fauna Brasileira Ameaçada de Extinção*, eds A. B. M. Machado, G. M. Drummond, and A.P. Paglia (Brasília: Ministério do Meio Ambiente and Fundação Biodiversitas, Série Biodiversidade 19), 907.
- Mittermeier, R. A. (1977). *A Global Strategy for Primate Conservation*. Unpublished Report. Washington, DC: World Wildlife Fund-US. 325.
- Mittermeier, R. A., Konstant, W. R., Nicoll, M. E., and Langrand, O. (1992). *Lemurs of Madagascar: An Action Plan for their Conservation 1993–1999*. Gland: IUCN/SSC Primate Specialist Group. doi: 10.2305/IUCN.CH.1992.SSC-AP.5.en
- Moreira, L. S. (2009). *As Aventuras de Lanna: Em Busca do Paraíso Natural*. Carangola, MG: Centro de Estudos e Educação Ambiental – CECO. 92.
- Moreira, L. S., Lanna, A. M., Tabacow, F. P., Melo, F. R., Possamai, C. B., Strier, K. B., and Jerusalinsky, L. (in press). “Protocolo para avaliação de compatibilidade entre populações inviáveis de muriqui-do-norte (*Brachyteles hypoxanthus*),” in *Protocolos para Pesquisa e Manejo de Muriquis – Gênero Brachyteles*, eds M. M. Valença-Montenegro, F. R. Melo, and L. Jerusalinsky (Brasília, DF: Instituto Chico Mendes de Conservação da Biodiversidade [ICMBio]), 33–34.
- Nery, M. S., Pereira, R. P., Tabacow, F. P., Melo, F. R., Mendes, S. L., and Strier, K. B. (2021). Citizen science for monitoring primates in the Brazilian Atlantic Forest: preliminary results from a critical conservation tool. *Primate Conserv.* 35, 107–119.
- Nishimura, A. (1979). In Search of Woolly Spider Monkey. *Reports of New World Monkeys*. Inuyama: Kyoto University, Primate Research Institute. 1, 21–37.
- Nishimura, A., Fonseca, G. A. B., Young, A. L., Strier, K. B., Mittermeier, R. A., and Valle, C. (1988). “The muriqui, genus *Brachyteles*,” in *Ecology and Behavior of Neotropical Primates, Vol. 2*, eds R. A. Mittermeier, A. B. Rylands, A. F. Coimbra-Filho, and G. A. B. da Fonseca (Washington, DC: World Wildlife Fund-US), 577–610.
- Nogueira, D. F., Ferraz, D. S., Oliveira, A. F., Tabacow, F. P., Souza Amâncio, S. M., and Melo, F. R. (2010). Ocorrência de primatas no Parque Estadual do Ibitipoca e entorno, estado de Minas Gerais, Brasil. *Neotrop. Primates* 17, 67–70. doi: 10.1896/044.017.0204
- Oates, J. F. (1986). *Action Plan for African Primate Conservation 1986–1990*. Gland: IUCN/SSC Primate Specialist Group.
- Oates, J. F. (1996). *African Primates: Status Survey and Conservation Action Plan*. Gland, Switzerland: IUCN/SSC Primate Specialist Group. doi: 10.2305/IUCN.CH.1996.SSC-AP.4.en
- Oates, J. F. (2013). Primate conservation: unmet challenges and the role of the International primatological society. *Int. J. Primatol.* 34, 235–245. doi: 10.1007/s10764-013-9664-1
- Oates, J. F., Gartlan, S. J., and Struhsaker, T. T. (1982). A framework for planning rain-forest conservation. *Int. Primatol. Soc. News* 4–9.
- Oates, J. F., Gartlan, S. J., and Struhsaker, T. T. (1987). “A framework for African rain forest primate conservation,” in *Primate Conservation in the Tropical Rain Forest*, eds C. W. Marsh and R. A. Mittermeier (New York, NY: Alan R. Liss), 321–327.
- Oliveira, P. C., Tabacow, F. P., Gasparotto, V. P. O., Teixeira, E. P., Testa, M. F., Teixeira, D. S., et al. (in press). Relato de caso envolvendo a translocação de uma fêmea de *Brachyteles hypoxanthus* (Primates, Atelidae) para um recinto semi-natural, como estratégia de conservação da espécie em Minas Gerais, Brasil. *Neotrop. Primates*
- Pinto, L. P. S., Costa, C. M. R., Strier, K. B., and Fonseca, G. A. B. (1993). Habitats, density, and group size of primates in the Reserva Biológica Augusto Ruschi (Nova Lombardia), Santa Teresa, Brazil. *Folia Primatol.* 61, 135–143. doi: 10.1159/000156740
- Rambaldi, D. M., Kleiman, D. G., Mallinson, J. J. C., Dietz, L. A., and Padua, S. M. (2002). “The role of nongovernmental organizations and the international committee for the conservation and management of *Leontopithecus* in lion tamarin conservation,” in *Lion Tamarins: Biology and Conservation*, eds D. G. Kleiman and A. B. Rylands (Washington, DC: Smithsonian Institution Press), 71–94.
- Reuter, K. E., Mittermeier, R. A., Schwitzer, C., McCabe, G., Rylands, A. B., Jerusalinsky, L., et al. (2021). “The 25 most endangered primates list: impact on conservation fundraising and policy,” in *Communicating Endangered Species: Extinction, News and Public Policy*, eds E. Freedman, S. Shipley Hiles, and D. B. Sachsman (London: Routledge), 101–115. doi: 10.4324/9781003041955-9
- Rezende, C. L., Scarano, F. R., Assad, E. D., Joly, C. A., Metzger, J. P., Strassburg, B. B. N., et al. (2018). From hotspot to hopespot: an opportunity for the Brazilian Atlantic Forest. *Perspect. Ecol. Conserv.* 16, 208–214. doi: 10.1016/j.pecon.2018.10.002
- Rodrigues, A. S., Pilgrim, J. D., Lamoreux, J. F., Hoffmann, M., and Brooks, T. M. (2006). The value of the IUCN Red List for conservation. *Trends Ecol. Evol.* 21, 71–76. doi: 10.1016/j.tree.2005.10.010
- Rodríguez-Luna, E., Cortés-Ortiz, L., Mittermeier, R. A., Rylands, A. B., Wong-Reyes, G., et al. (1996). Hacia un Plan de Acción para los Primates Mesoamericanos. *Neotrop. Primates* 4, 9–23.
- Rodríguez-Luna, E., Solórzano-García, B., Shedden, A., Rangel-Negrín, A., Díaz, P. A. D., Cristóbal-Azkarate, J., et al. (2009). *Taller de Conservación, Análisis y Manejo Planificado para los Primates Mexicanos*. (Veracruz: Apple Valley, MN: Universidad Veracruzana and Conservation Breeding Specialist Group (CBSG),
- Rylands, A. B. (1993/1994). Population viability analyses and the conservation of the lion tamarins, *Leontopithecus*, of south-east Brazil. *Primate Conserv.* 14–15, 34–42.
- Rylands, A. B., Strier, K. B., Mittermeier, R. A., Borovansky, J., and Seal, U. S. (eds.). (1998). *Conserving Brazil's Muriqui: Population and Habitat Viability Assessment (PHVA) for Brachyteles arachnoides*. Apple Valley, MN: IUCN/SSC Conservation Breeding Specialist Group (CBSG).

- Schwitzer, C., Mittermeier, R. A., Davies, N., Johnson, S., Ratsimbazafy, J., Razafindramanana, J., et al. (2013). *Lemurs of Madagascar: A Strategy for their Conservation 2013–2016*. Bristol: IUCN SSC Primate Specialist Group (PSG), Bristol Conservation and Science Foundation, Conservation International. Available online at: http://www.primates-sg.org/storage/pdf/Lemurs_of_Madagascar_Strategy_for_Their_Conservation_20132016_low_res.pdf
- Seal, U. S., Ballou, J. D., and Valladares-Padua, C. (eds.). (1990). *Leontopithecus—Population Viability Analysis Workshop Report*. Apple Valley, MN: IUCN/SSC Captive Breeding Specialist Group (CBSG).
- Silva-Júnior, W. M., Carmo, F. M. S., Melo, F. R., and Meira-Neto, J. A. A. (2011). “Estimating food sources for woolly spider monkeys (*Brachyteles* spp.) using the forest structure,” in *Animal Diversity, Natural History and Conservation, Vol. 1*, eds V. K. Gupta, and A. K. Verma (New Delhi: Daya Publishing House Ed.), 27–76.
- Silva-Júnior, W. M., Meira-Neto, J. A. A., Melo, F. R., Moreira, L. S., Barbosa, E. F., Dias, L. G. et al. (2009). Habitat quality and the ranging ecology of the woolly spider monkey (*Brachyteles hypoxanthus*). *Folia Primatol.* 80, 295–308. doi: 10.1159/000255651
- Silva-Júnior, W. M., Melo, F. R., Meira-Neto, J. A. A., Barbosa, E. F., and Moreira, L. S. (2010). Structure of Brazilian Atlantic forests with occurrence of the woolly spider monkey (*Brachyteles hypoxanthus*). *Ecol. Res.*, 25, 25–32. doi: 10.1007/s11284-009-0626-1
- Strier, K. B. (1993/1994). Viability analysis of an isolated population of muriqui monkeys (*Brachyteles arachnoides*): implications for primate conservation and demography. *Primate Conserv.* 14–15, 45–32.
- Strier, K. B. (1994). Myth of the typical primate. *Yearb. Phys. Anthropol.* 37, 233–271. doi: 10.1002/ajpa.1330370609
- Strier, K. B. (2003). Primatology comes of age: 2002. *Yearb. Phys. Anthropol.* 122, 2–13. doi: 10.1002/ajpa.10383
- Strier, K. B. (2017). What does variation in primate behavior mean? *Yearb. Phys. Anthropol.* 162, 4–14. doi: 10.1002/ajpa.23143
- Strier, K. B. (2018). Primate social behavior. Centennial Perspective. *Am. J. Phys. Anthropol.* 165, 801–812. doi: 10.1002/ajpa.23369
- Strier, K. B. (2019). Everything for the muriquis: Reflections from a long-term field study of a critically endangered primate. Invited essay for “*As Mulheres da Mastozoologia*.” *Bol. Soc. Brasil. Mastozool.* 85, 117–127.
- Strier, K. B., Dib, L. T., and Figueira, J. E. C. (2002). Social dynamics of male muriquis (*Brachyteles arachnoides hypoxanthus*). *Behaviour* 139, 315–342. doi: 10.1163/156853902760102690
- Strier, K. B., and Mendes, S. L. (2012). “The northern muriqui (*Brachyteles hypoxanthus*): Lessons on behavioral plasticity and population dynamics from a critically endangered primate,” in *Long-Term Field Studies of Primates*, eds P. M. Kappeler, and D. P. Watts (Heidelberg: Springer-Verlag), 125–140. doi: 10.1007/978-3-642-22514-7_6
- Strier, K. B., Possamai, C. B., Moreira, L. S., Lanna, A. M., Tabacow, F. P., Melo, F. R., et al. (in press). “Chave de decisão para manejo das populações inviáveis de *Brachyteles* spp.,” in *Protocolos para Pesquisa e Manejo de Muriquis – Gênero Brachyteles*, eds M. M. Valença-Montenegro, F. R. Melo, and L. Jerusalinsky (Brasília, DF: Instituto Chico Mendes de Conservação da Biodiversidade [ICMBio]), 28–30.
- Strier, K. B., Possamai, C. B., Tabacow, F. P., Pissinatti, A., Lanna, A. M., Melo, F. R., et al. (2017). Demographic monitoring of wild muriqui populations: Criteria for defining priority areas and monitoring intensity. *PLoS ONE* 12:e0188922. doi: 10.1371/journal.pone.0188922
- Strier, K. B., Tabacow, F. P., Possamai, C. B., Ferreira, A. I. G., Nery, M., de Melo, F. R., et al. (2019). Status of the northern muriqui in the time of yellow fever. *Primates* 60, 21–28. doi: 10.1007/s10329-018-0701-8
- Supriatna, J., Mananseng, J., Tumbelaka, L., Andayani, N., Indrawan, M., Darmawan, L., et al. (eds.). (2001). *Conservation Assessment and Management Plan for the Primates of Indonesia: Final Report*. Apple Valley, MN: IUCN/SSC Conservation Breeding Specialist Group (CBSG).
- Tabacow, F. P., Moreira, L. S., Melo, F. R., Strier, K. B., and Jerusalinsky, L. (in press, a). “Protocolo para contagem de indivíduos de *Brachyteles* spp.,” in *Protocolos para Pesquisa e Manejo de Muriquis – Gênero Brachyteles*, eds M. M. Valença-Montenegro, F. R. Melo, and L. Jerusalinsky (Brasília, DF: Instituto Chico Mendes de Conservação da Biodiversidade [ICMBio]), 13–19.
- Tabacow, F. P., Nery, M. S., Centoducatte, L. D., Breves, P., Talebi, M., and Melo, F. R. (in press, b). “Protocolo de conectividade e áreas prioritárias para a formação de corredores ecológicos em localidades de ocorrência de *Brachyteles* spp.,” in *Protocolos para Pesquisa e Manejo de Muriquis (Gênero Brachyteles)*, eds M. M. Valença-Montenegro, F. R. Melo, and L. Jerusalinsky (Brasília: Instituto Chico Mendes de Conservação da Biodiversidade [ICMBio]), 21–25.
- Tabacow, F. P., Nery, M. S., Melo, F. R., Ferreira, A. I. G., Lessa, G., and Strier, K. B. (2021). Demographic effects of the translocation of a female northern muriqui (*Brachyteles hypoxanthus*). *Primate Conserv.* 35, 21–35. Available online at: http://www.primates-sg.org/storage/pdf/PC35_Tabacow_et_al_muriqui_translocation.pdf
- Valença-Montenegro, M. M., Melo, F. R., and Jerusalinsky, L. (eds.). (in press). *Protocolos para Pesquisa e Manejo de Muriquis (Gênero Brachyteles)*. Brasília: Instituto Chico Mendes de Conservação da Biodiversidade (ICMBio), 72.
- Valle, C. M. C., Santos, I. B., Alves, M. C., Pinto, C. A., and Mittermeier, R. A. (1983). “Algumas observações preliminares sobre o comportamento do mono (*Brachyteles arachnoides*) em ambiente natural (Fazenda Montes Claros, município de Caratinga, Minas Gerais, Brasil),” in *A Primatologia no Brasil*, 1st Edn., ed M. Thiago de Mello (Brasília, DF: Sociedade Brasileira de Primatologia), 271–283.

Conflict of Interest: The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Publisher’s Note: All claims expressed in this article are solely those of the authors and do not necessarily represent those of their affiliated organizations, or those of the publisher, the editors and the reviewers. Any product that may be evaluated in this article, or claim that may be made by its manufacturer, is not guaranteed or endorsed by the publisher.

Copyright © 2021 Strier, Melo, Mendes, Valença-Montenegro, Rylands, Mittermeier and Jerusalinsky. This is an open-access article distributed under the terms of the Creative Commons Attribution License (CC BY). The use, distribution or reproduction in other forums is permitted, provided the original author(s) and the copyright owner(s) are credited and that the original publication in this journal is cited, in accordance with accepted academic practice. No use, distribution or reproduction is permitted which does not comply with these terms.