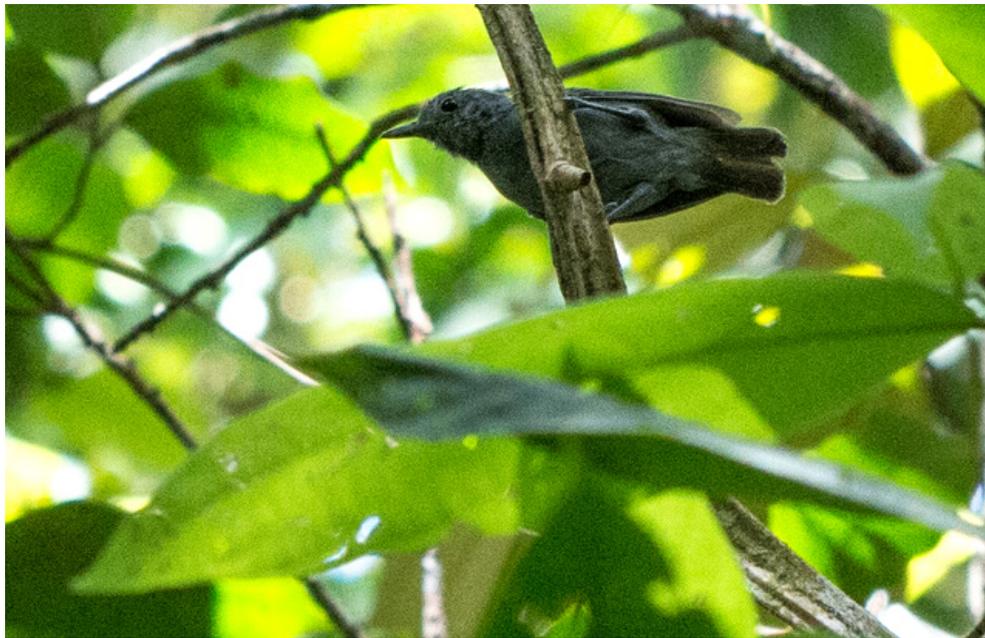


WORKSHOP REPORT AND PROGRESS UPDATE

Conservation planning for Alagoas Antwren *Myrmotherula snowi* and Blue-eyed Ground-dove *Columbina cyanopsis*, with a focus on potential ex situ and intensive management actions

Foz do Iguaçu, Paraná, Brazil. 2021



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Support:



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Conservation planning for Alagoas Antwren *Myrmotherula snowi* and Blue-eyed Ground-dove *Columbina cyanopis*, with a focus on potential ex situ and intensive management actions



Parque das Aves

Report on 2019 workshop and 2021 progress update Foz do Iguaçu, Paraná, Brazil

Organization:

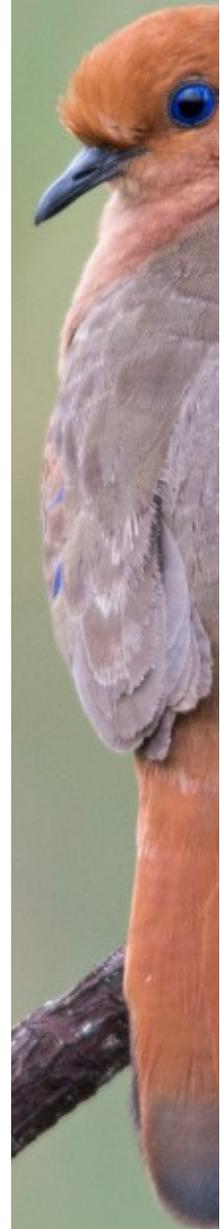


Support:



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ABBREVIATIONS AND ACRONYMS

- apud** Used to refer to an unavailable original source that is cited by an (available) secondary reference
- CEMAVE** National Center for Bird Conservation and Research (*Centro Nacional de Pesquisa e Conservação de Aves Silvestres*), part of ICMBio
- CPSG** Conservation Planning Specialist Group, of IUCN SSC
- ESALQ/USP** Luiz de Queiroz College of Agriculture, part of the University of São Paulo
- ESEC** Strict nature reserve, in IUCN category 1a (*Estação Ecológica*)
- ha** hectare(s)
- IBAMA** Administrative arm of MMA (*Instituto Brasileiro do Meio Ambiente e dos Recursos Naturais Renováveis*)
- ICMBio** The Brazilian government agency for biodiversity conservation (*Instituto Chico Mendes de Conservação da Biodiversidade*)
- IEF** State Forest Institute in Minas Gerais (*Instituto Estadual de Florestas*)
- in litt.** In a letter or other correspondence, such as an email
- IUCN** International Union for Conservation of Nature
- m** metre(s)
- MMA** Brazilian Environment Ministry (*Ministério do Meio Ambiente*)
- PAN** National Action Plan (*Plano de Ação Nacional*)
- pers. obs.** Personal communication
- RPPN** Private protected area (*Reserva Particular do Patrimônio Natural*)
- SAVE Brasil** The BirdLife partner organization in Brazil (*Sociedade para a Conservação das Aves do Brasil*)
- SDM** Species distribution model
- spp.** Species (plural)
- SSC** Species Survival Commission, of IUCN
- SISBIO** System by which collection of biological material and research in federal protected areas are licensed in Brazil (*Sistema de Autorização e Informação em Biodiversidade*)
- UENF** Northern Rio de Janeiro State University (*Universidade Estadual do Norte Fluminense*)
- UFAL** Federal University of Alagoas (*Universidade Federal de Alagoas*)
- UFPB** Federal University of Paraíba (*Universidade Federal da Paraíba*)
- WWF** World Wide Fund for Nature, an international conservation organization
- ZIMS** Zoological Information Management Software, a global online database of animal records, primarily ex situ, curated by the members of the non-profit organization Species360

EXECUTIVE SUMMARY

The purpose of this workshop was to identify priority conservation actions for two Critically Endangered birds endemic to Brazil: Alagoas Antwren *Myrmotherula snowi* and Blue-eyed Ground-dove *Columbina cyanopis*. We focused on identifying whether ex situ management is an appropriate conservation tool for these species, and if so, which ex situ roles should be implemented. These two species were selected in collaboration with SAVE Brasil, as being species of particular concern, each with populations of the order of 20 individuals, and for which ex situ strategies had been identified as potentially important, but not yet evaluated or developed in detail. The two species are included in the National Action Plan for Conservation of Atlantic Forest Birds (ICMBio 2018) and National Action Plan for Conservation of Birds of the Cerrado and Pantanal (ICMBio 2014), respectively.

The workshop was held between 19 and 22 August 2019 in Parque das Aves, in Brazil, and was co-organized with SAVE Brasil, with planning and facilitation by the IUCN SSC Conservation Planning Specialist Group, and support from CEMAVE. Participants included most of the leading specialists in the focal species in Brazil, as well as national and international experts with relevant experience of both ex situ and in situ conservation (for a full list of participants and institutions, see Appendix A; for the workshop agenda, see Appendix B). Additional background information as provided to participants is reproduced in Appendices C–G.

In this workshop, we focused in particular on identifying appropriate ex situ conservation roles and actions for the two species as well as intensive management actions in the wild, to complement existing conservation plans (see Appendix E) and actions in the field by SAVE Brasil and partners. For both species, the need to first develop ex situ methods with model species was identified as important, to minimize any potential risks to the small remaining populations of Alagoas Antwren and Blue-eyed Ground-dove. When effective, reliable husbandry methods are developed, these can then be applied to both species. At the same time, continued research in the wild will be crucial to understanding and addressing threats and informing ex situ work. Fieldwork priorities include finding and monitoring nests, searches for additional populations, identifying key habitat characteristics, and testing intensive population management interventions that could increase reproductive success in the wild.

The recommendations from the workshop overlap to some extent with existing proposed actions of the National Action Plans for birds of the Atlantic Forest and Cerrado. Reports on progress will be integrated into ongoing monitoring of those National Action Plans by CEMAVE/ICMBio. Further recommendations and actions arising from the workshop will be monitored by Parque das Aves and SAVE Brasil, as they are too numerous and detailed to be incorporated in full into the National Action Plans. An initial summary of progress up to September 2021, when this report was finalized, is given in Appendices H (Alagoas Antwren) and I (Blue-eyed Ground-dove).



EX SITU ASSESSMENT WORKSHOP PROCESS

The workshop followed an established process outlined in the IUCN Species Survival Commission Guidelines on the Use of Ex Situ Management for Species Conservation (IUCN/SSC 2014) for identifying and evaluating ways in which ex situ individuals or activities might contribute to species conservation. Here, we define “ex situ” as conditions in which individuals are spatially restricted, removed from many of their natural ecological processes, and are managed on some level by humans. In summary, ex situ refers to individuals or live biological samples that are held in artificial, human-controlled settings, whether these are highly artificial environments or semi-natural conditions, and whether they are held temporarily or long-term. Such settings, in the case of birds, can include zoos, breeding centers, wildlife rescue or rehabilitation centers, and other facilities.

Ex situ conservation has the potential to help reduce or mitigate primary threats, to offset the effects of threats, to restore wild populations, and to prevent species extinction by buying time for threat abatement. Such activities can complement other conservation activities focused on wild (in situ) populations and conditions so that species do not disappear before suitable conditions in the wild are restored. Integration of in situ and ex situ conservation plans is important to assure that, whenever appropriate, ex situ conservation is used to support in situ conservation in the best possible manner.

In some cases, ex situ management will be a critical component of a species conservation strategy, while in others it will have secondary relevance, supporting other primary interventions. In yet other cases it may have no feasible conservation role to play. It is necessary, therefore, to consider how ex situ management can contribute towards the general goals of conservation established for the species, to assess the feasibility of such efforts, and to clearly document this assessment. The involvement of all stakeholders and all populations of a species in developing an integrated conservation strategy is known as the One Plan Approach (Byers et al. 2013).

The IUCN ex situ guidelines outline a five-step decision process to assess the value and appropriateness of ex situ management as a conservation tool, as follows:

1

Step 1. Compile a review of the status and threats of the species

To inform discussion of conservation actions, it is necessary to review and collate all relevant information on the species, both in the wild and ex situ. This information is used to assess the viability of the population and to identify and understand the threats that impact the species.

2

Step 2. Define the role or roles that ex situ management could play in the overall conservation of the species

The potential ex situ management strategies proposed should address one or more specific threats or constraints to the viability and conservation of the species, as identified in the status review and threat analysis, and target improving its conservation status.

3

Step 3. Determine the characteristics and dimensions of the ex situ population or program required to fulfill the identified conservation role(s)

The identified conservation purpose and function of the ex situ program will help determine its required structure, scale and duration.

4

Step 4. Define the resources and expertise needed for the ex situ management program to fulfill its role(s) and assess the feasibility and risks

It is important to evaluate the required resources; the feasibility and likelihood of success in all steps, including, if relevant, any releases to the wild; and any risks, including risks to the species in the wild and to other conservation activities. These factors should be balanced against the risks of not adopting appropriate conservation measures.

5

Step 5. Make a decision that is well informed (using the information gathered above) and transparent (showing how and why the decision was made)

The decision to include ex situ management in the species conservation strategy should be determined by weighing the potential benefit to the species, along with the likelihood of success, against the overall costs and risks. The potential benefits, costs and risks of alternative conservation actions, and of inaction, should also be considered.

If the decision is made to implement an ex situ management program for conservation, then the following considerations are important in the development of this program:

- formulate the actions required for the program to meet its conservation goals;
- develop protocols for data collection and management for adequate monitoring;
- develop the ex situ management program according to existing national and international conservation plans, agreements, and policies;
- consult throughout the process with all stakeholder groups and organizations; and
- establish a timeline with clear and achievable deadlines for implementing the actions.

The IUCN ex situ guidelines suggest regular evaluation of the ex situ program so that its performance can be measured, and so that it can be adjusted and improved whenever necessary. This includes not only evaluation of the program's success but also its role within the overall conservation strategy for the species, which is likely to change over time. Regular reporting on ex situ activities is also important to generate awareness and support, meet any legal requirements, and contribute to knowledge on ex situ management for conservation.

We followed the process described above to develop an ex situ plan for each focal taxon. The ex situ roles considered in this workshop included all of those identified in the IUCN ex situ guidelines and/or Amphibian Ark Conservation Needs Assessment Process (Amphibian Ark 2012). Of these, most were not recommended at this time, until expertise can be developed with model species (by which we mean here closely-related species, similar in ecology and behaviour, with which techniques for management and reproduction can be developed and refined, before being applied to the threatened species). Discussions relevant to each role are summarized in the next two sections on the two species, along with consideration of other intensive management actions. A description of each role, including those identified as not important or appropriate for either species, is provided in Appendix C. Information on prior conservation planning and actions for both species is provided in Appendices D and E.



SUMMARY OF WORKSHOP RECOMMENDATIONS

We provide a brief summary of the recommendations from the workshop, with more details in subsequent sections on each species in turn. The ex situ and intensive management conservation roles that were discussed and rejected or recommended are outlined in Table 1.

For Alagoas Antwren, no ex situ roles were indicated as appropriate for the species at this time, as keeping insectivorous suboscine passerines in controlled conditions is uncommon and adequate expertise does not yet exist. Instead, participants recommended that conservation interventions and research effort continue to focus on the wild population, while at the same time, ex situ methods and protocols are developed with one or more model species. The Plain Antwren *Dysithamnus mentalis* was suggested as an initial model species, while the Unicolored Antwren *Myrmotherula unicolor* was indicated as the most appropriate model species for any further refinement of protocols. Once these protocols have been developed, ex situ roles, in particular the establishment of an insurance population, should be revisited.

For Blue-eyed Ground-dove, there already exists a body of knowledge and expertise on the rearing of small doves, so the challenges for ex situ conservation are less severe. Nevertheless, participants recommended that expertise be refined with model species in advance of initiating an ex situ population. An ex situ population of a foster species such as the Diamond Dove *Geopelia cuneata* may also be needed to facilitate captive breeding. Once the necessary expertise and resources are in place, participants recommended removal of some clutches of eggs from the wild population, which is expected to have minimal impact on the population as nest losses are common and can be soon replaced. These eggs should be reared to initiate an insurance population.

For both species, ongoing searches for additional populations within areas identified as being potentially suitable were recommended, as well as research to understand what habitat requirements or other factors are limiting population growth. Fieldwork to find and monitor nests will be important not just for informing possible ex situ efforts, but also to quantify threats and inform interventions to improve the conservation status of both species in the wild.

Table 1. Identification of potential ex situ and intensive population management roles for the conservation of the Alagoas Antwren *Myrmotherula snowi* and Blue-eyed Ground-dove *Columbina cyanopsis*, recommended by workshop participants after considering potential benefits, risks and feasibility. See species sections for more information on decisions presented in the table, and Appendix C for details of ex situ roles.

Ex situ role	Alagoas Antwren	Blue-eyed Ground-dove
Ark	Not recommended	Not recommended
Insurance population	"On hold" – until feasibility improves	Recommended, once methods refined with model species
Population rescue (temporary or long term)	Not recommended at this time, unless there is an indication of high immediate risk in the wild	Not recommended
Demographic manipulation	Considered under "Intensive population management in the wild"	Considered under "Intensive population management in the wild"
Population restoration: Reintroduction	"On hold" – until ex situ population is established	"On hold" – until ex situ population is established
Population restoration: Reinforcement	"On hold" – until ex situ population is established	"On hold" – until ex situ population is established
Conservation introduction: Ecological replacement	Not recommended – but consider reintroduction of nuclear mixed-flock species	Not recommended
Conservation introduction: Assisted colonization	Not recommended	Not recommended
Ex situ research and/or training	Recommended: development of ex situ methods with model species; genetic analysis	Recommended: development of ex situ methods with model species; genetic analysis
Conservation education	Not recommended	Not recommended
Intensive population management in the wild	Recommended – including demographic manipulation	Recommended – including demographic manipulation



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Ciro Albano



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Alagoas Antwren

Myrmotherula snowi

Global Red List:
Critically Endangered (2018)

National Red List:
Critically Endangered (2014)



STATUS AND ECOLOGY IN THE WILD

Endemic to the Atlantic forest of Alagoas and Pernambuco in the Pernambuco Center of Endemism. Only now known from a single site, Estação Ecológica Murici (ESEC Murici) in the municipality of Murici, Alagoas. Within the ESEC Murici and surrounding fragments, playback surveys have found the species only in the largest fragment, Fazenda Bananeiras, usually in the interior of closed-canopy forest. Studies completed after the workshop indicate that this species is most often found in flatter sites close to streams and with taller trees (Vilela 2020). The Alagoas Antwren feeds on invertebrates taken from live and dead foliage in the middle strata of the forest, and in the past was often observed in association with mixed-species flocks. It is restricted to upland forest at least 400 m above sea level. For further details and references on habitat and ecology, see Appendix F.

The total population is now estimated at fewer than 30 individuals (Pereira et al. 2014, Lees et al. 2014, Vilela 2020). Monthly point counts at Fazenda Bananeiras from October 2018 to March 2019, using playback at 28 points, recorded 12 individuals at seven of the surveyed points (H. Vilela pers. obs.). This gives a lower bound to the population estimate at that time, although further decline has occurred since. It has not been found since 2007 at three sites in Pernambuco at which it formerly occurred (see Appendix F).

THREATS

All of the threats to the species are magnified by the fact that very little of its habitat remains, as a result of past deforestation for pasture, sugarcane, bananas and other crops. Remaining forest is in fragments that have been degraded by logging, fire and other stressors and are vulnerable to edge effects (Ribeiro et al. 2009). Defaunation as a result of years of hunting and trapping has likely changed the dynamics of the ecological communities in the forest. It is unclear what effect improved control of hunting, as has occurred in the past 3–4 years, might have on the Alagoas Antwren.



A rebound in predator populations could have positive effects via trophic cascades as well as direct negative effects. Climate change is a possible threat, as the species has a montane distribution that is close to the maximum altitude within its range. A warmer or drier climate could potentially have both direct and indirect effects on the species and its insect prey, for example by reducing the capacity of the forest to retain humidity and to buffer daytime temperature fluctuations.

The breakdown of species associations is a candidate threat to the species. The Alagoas Antwren was formerly commonly sighted foraging within mixed flocks (Teixeira & Gonzaga 1985, Whitney & Pacheco 1997, Mazar Barnett et al. 2005). However, in recent years these mixed flocks have not been recorded at Murici. Alagoas Antwren is sometimes seen in the company of other species such as White-flanked Antwren *Myrmotherula axillaris*, but larger mixed flocks are no longer observed in the understory and mid-levels. Key nuclear flock-forming birds – such as Cinereous Antshrike *Thamnomanes caesius* and Red-crowned Ant-tanager *Habia rubica* – are now extremely rare within the distribution of Alagoas Antwren. The advantage for small insectivorous birds of joining mixed-species flocks is that they can rely on the vigilance of others to reduce predation risk and increase their foraging rates (Sridhar et al. 2009). The loss of nuclear flock-forming birds might thus have had a negative impact on the foraging success and/or survival rate of the Alagoas Antwren (Develey & Peres 2000, Cestari 2007).

We have insufficient information to understand in detail how these threats affect the population, or on their current relative importance. At the most basic level, we do not have robust estimates of survival rates of eggs, nestlings, juveniles or adults, which could help to identify what factors might be most important in limiting growth of the population. Regarding recruitment, only two active nests have been found, and both failed. Like other tropical forest understory nesters, Alagoas Antwrens likely contend with a high rate of nest predation. The two known nests were 0.9 to 1.9 m above the ground, and vulnerable to a range of predators (M. Efe, H. Vilela, A. Andrade, pers. obs.). Studies of nests of other understory nesters at Murici by M. Efe and his students have recorded predation by South American Coati *Nasua nasua*, small marsupials, snakes and hawks (M. Efe, H. Vilela, A. Andrade, and others, pers. obs.). Other predators of small passerine nests, including bats, toucans and larger passerines have been recorded elsewhere in the Atlantic Forest (Perrella et al. 2020, Zima et al. 2021). Since 2010, 18 individual antwrens have been caught in mist-nets at Fazenda Bananeiras and ringed, including seven young at seven sampling sites, indicating some successful reproduction (M. Efe, pers. obs.). Young stay with the parents in family groups for some time, perhaps until the next breeding attempt. Clutch size is likely two eggs, as with other antwrens.

Regarding adult survival, one marked individual is known to have survived for at least seven years (H. Vilela, pers. obs.). Any attempts to calculate sex ratio are biased by the use of playback in surveys, to which males are more responsive. Untargeted mist-net captures suggest that the sex ratio is approximately 1:1, but based on a small sample size.

Food availability could be a limiting factor for either adult survival or nesting success. The abundance of suitable invertebrate prey could be affected by edge effects, climate change, and possibly the use of pesticides in surrounding agricultural land. Monitoring of invertebrate resources in live and dead leaves at Fazenda Bananeiras has shown a decline in abundance of many groups of invertebrates between the early part of the breeding season, in October to December, and later in the breeding season, in February to March (H. Vilela, in prep.). Other studies from elsewhere in the Atlantic Forest have found that mixed flocks form when invertebrate abundance is low (Develey & Peres 2000). The breakdown of mixed flocks might have a negative effect on food utilization by Alagoas Antwren, even if insect prey continues to be available. The most closely-related species to the Alagoas Antwren, Unicolored Antwren *Myrmotherula unicolor*, is one of the most frequently-encountered members of mixed flocks in the southeast of Brazil (Develey & Peres 2000).

Genetic problems are a potential risk for such a small population. One individual was seen and mist-netted in ESEC Murici with some whitish feathers (H. Vilela, A. Andrade, Figure 1). This leucism might indicate inbreeding (S. Bruslund, pers. comm.). If it were possible to photograph the same individual again, from both sides, we might have more indication as to whether the condition is genetic, or perhaps caused by disease or dietary deficiencies. No other individuals of other species with similar leucism have ever been seen by the team in the area (H. Vilela, A. Andrade, pers. obs) adding to the probability that it may be related to the extremely small population size in this species.



Figure 1. Alagoas Antwren *Myrmotherula snowi* with some white feathers, perhaps indicating genetic or nutritional problem. Photos of the same individual male taken on 11 February 2017 (top, H. Vilela) and 18 January 2018 (bottom left and right, A. Andrade)

EX SITU STATUS

There are no Alagoas Antwrens in captivity, and no evidence of captive specimens in the past.

EX SITU STATUS OF OTHER ANTWRENS

Turning to the family Thamnophilidae, there is no established captive population of any species registered in the ZIMS database (Species360 2020). Some species have been hand-reared, including Barred Antshrike *Thamnophilus doliatus* (E. S. Morton unpublished, apud Kroodsma 1984), Northern Slaty Antshrike *T. punctatus* (Lima et al. 2007) and Spotted Antbird *Hylophylax naevioides* (Touchton et al. 2014). However, these were isolated efforts and they encountered high levels of nestling mortality from malnutrition and/or disease (G. R. Lima pers. comm., J. Tobias in litt.). In Frankfurt Zoo, two Barred Antshrikes hatched in captivity in 1988 and 1994 lived for just two days and two weeks, respectively (S. Stadler in litt.).

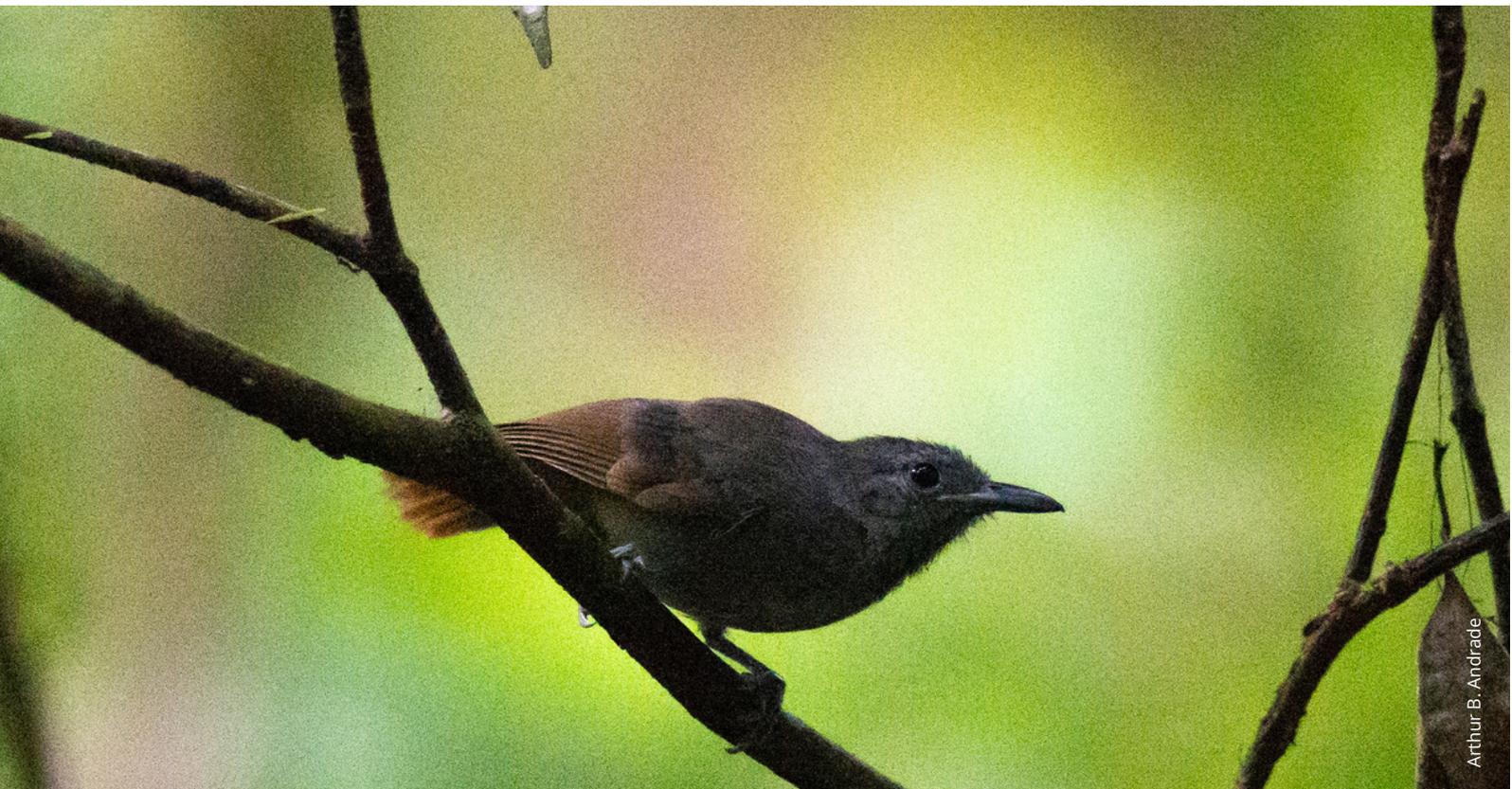
CONSERVATION ACTIONS UNDERWAY

The last remaining site for the species at Murici has been protected since 2001 within an *Estação Ecológica* (ESEC), a federal protected area established with support from SAVE Brasil and managed by ICMBio. The ESEC has still not been fully implemented, and includes areas of private land that continue to be managed as pasture and cropland. However, patrolling effort has improved in recent years, which has reduced hunting and trapping. SAVE Brasil has been working closely with the manager and staff of ESEC Murici to identify the main challenges facing its implementation. In parallel SAVE Brasil had meetings with high-level representatives of the Ministry of Environment to communicate the urgency of effective protection. A new project, with the support of BirdLife International, WWF-Brazil and WWF-Netherlands, has the long term aim of restoring connectivity within the ~100 km between Murici and Serra do Urubu, one of the sites where Alagoas Antwren previously occurred. Bird monitoring suggests that forest condition in SAVE Brasil's 434 ha reserve at Serra do Urubu is improving.

A one-day meeting was held in August 2016 with a range of interested parties, including conservation organizations, researchers and government agencies, to identify priority conservation actions for the species (SAVE Brasil 2016; Appendix E).

Research efforts are ongoing at ESEC Murici, and have been coordinated since 2010 by M. Efe of Universidade Federal de Alagoas. Undergraduate and Master's projects on the Alagoas Antwren, on the natural history of the species, and assessing its population size, habitat selection and insect resource availability, were completed in 2017 and 2020 by H. Vilela (Vilela 2017, Vilela 2020).

A grant from National Geographic was secured by SAVE Brasil to increase monitoring effort, collect more information on breeding success and survival, and explore the potential of different conservation interventions, including captive breeding, from 2019 to 2021. This work is a collaboration with Parque das Aves, Universidade Federal da Bahia and Universidade Federal da Paraíba. For further information on research and conservation efforts, see Appendices D and E.



Arthur B. Andrade

RECOMMENDATIONS

Recommended actions are detailed in Appendix H, with priorities, responsible parties, timeline and budget, and a review of progress as of September 2021.

SEARCHES WITHIN HISTORICAL RANGE

It remains possible that populations of Alagoas Antwren exist outside of Murici, even despite the lack of recent records from other sites. This species can be difficult to detect, so repeated visits may be needed to determine absence with a reasonable level of confidence. K. Ferraz, A. Bovo and C. Ortiz developed a model of potential distribution for the Alagoas Antwren based on recent records of presence, which was further refined during the workshop (see modelling chapter). The model identifies areas of potential occurrence of the species, but does not inform whether the species is present or not. The model should be validated by field surveys and updated and improved frequently as new data becomes available. It was used as the basis for searches conducted after the workshop, in 2020.

A point made in the workshop is that the model may not identify ideal habitat for the Alagoas Antwren, but rather the areas of suitable habitat that remain, which are not necessarily the most optimal areas. We do not have a good understanding of the habitat and micro-habitat features important to this species – a question addressed by the Master's thesis of H. Vilela, completed in 2020, after the workshop (Vilela 2020). It is possible that no ideal habitat for the species remains, because of deforestation and forest degradation. The suggestion was made to put all records in historical perspective and historical ecological context.

INTENSIVE POPULATION MANAGEMENT IN THE WILD

Participants agreed that at present, knowledge is insufficient to safely bring individuals into captivity. Instead, they recommended testing interventions aimed at improving breeding success in the wild (Table 2). These could include actions to (i) protect nests, (ii) remove eggs from nests for protection, (iii) supplementary feeding and (iv) promotion of mixed-species flocks. Data should be collected, for example with nest cameras or other methods, to inform and test these measures, and where risks are considered high, they should ideally be tested with other species first.

(i) Intervene to protect nests

Students of M. Efe are already carrying out experiments on the efficacy of fences of black polythene sheeting placed at a radius of 3 m around old nests of other species with similar nest types, baited with quail eggs. Although fences have been successful in reducing nest predation by mammals (but not snakes) of another insectivorous passerine in another context (Ragheb et al. 2019), results so far indicate a 25% predation rate of nests both with and without fences, suggesting that this intervention may not be effective at Murici (M. Efe, pers. obs.). One suggestion from participants was to review the literature on nest protection of other bird species, including from New Zealand where there is much experience with this issue. Predator control would be difficult because there is a wide range of predators, comprising native and threatened species, and controlling one species might have the unintended consequence of increasing numbers of another. Predators of adults are not known, but might include raptors such as forest-falcons *Micrastur* spp. as well as snakes.

Another possibility would be to have round-the-clock protection of any active nest by the field team, to scare off any potential predators that come close to the nest. Other methods that might be tried include electric wires or fences around nests, cones to prevent predators climbing trees, lights, or faeces/urine from top predators such as jaguars. A major challenge is to even find the nests of this species. The field team has had some success in finding used nests thought to be of Alagoas Antwren, constructed of fungal fibres in the fork of a small sapling, but finding active nests continues to be very difficult.

(ii) Remove eggs from nests for protection

A possibility for consideration is removing eggs from nests and replacing them with dummy eggs, keeping the real eggs in an incubator, and returning the eggs shortly before they hatch. Hatching the eggs and returning hand-reared chicks to the nest would not be advisable, because there is a risk that the adult birds might not recognize the chicks as their own; there are difficulties associated with the hand-rearing of chicks (especially in a remote field context); and there is a risk of the nest being abandoned before chicks can be returned. The need was highlighted to develop a protocol in the case of finding an abandoned or failed nest – what samples should be collected and preserved, and how?

(iii) Provide supplementary food

This could involve developing a feeder to provide mealworms or other prey to the birds or installing light attractants that could concentrate insects. Given the high diversity of

insectivores in tropical forests, there is a need to ensure that supplementary food is received only by Alagoas Antwren. There are risks of instead attracting other dominant species if the method used is insufficiently specific. The ideal is to train birds individually to come for supplemental food, as has been done with other shy forest insectivores, including several species of antpittas *Grallaria* spp. (Greeney 2012). There is also much experience with supplemental feeding from New Zealand and Mauritius. Any interventions should be tested on other species first, and monitored carefully for any negative effects.

(iv) Re-establish or promote focal species from mixed species flocks

Re-establishing or promoting focal species from mixed species flocks could help to create conditions for Alagoas Antwren to thrive. Two nuclear mixed flock species were mentioned during the workshop: Red-crowned Ant-tanager and Cinereous Antshrike. The latter, based on information available during the workshop, had been extirpated from the northeast of Brazil, but in 2020 this species was again recorded at ESEC Murici. The possibility of translocating this species from southern Bahia was mentioned, but it was not clear what other interventions could help to restore mixed flock dynamics. It was noted that even at one of the monitoring sites in Murici with high species richness and presence of Red-crowned Ant-tanager, mixed flocks of insectivorous birds were not observed (A. Andrade, pers. obs.), suggesting that some change in environmental conditions may be behind the loss of mixed flock dynamics.

Table 2. Suggested strategies for intensive population management of Alagoas Antwren *Myrmotherula snowi* in the wild.

Strategy	Detail of actions
Nest protection	<ul style="list-style-type: none"> - Identify Antwren nest predators and quantify their impact - Test predator exclusion, deterrence or control methods (e.g., fencing, repellent lure, trapping) with model bird species - Investigate which nest monitoring strategy causes least disturbance - Risk analysis: measures against one predator might attract or increase the incidence of others (e.g., coatis vs snakes) or have other ecological effects
Removal of eggs for protection	<ul style="list-style-type: none"> - Artificially incubate Alagoas Antwren eggs - Replace them with dummy eggs, so that adults continue to incubate, but without the risk of losing eggs to predation - Return the eggs just before they hatch - Develop a protocol for what to do in the case of nest abandonment, including a protocol for biological samples
Supplemental feeding	<ul style="list-style-type: none"> - Investigate if food shortage is a factor in the area - Test supplemental feeding with model species, away from Murici - Implement rigorous hygiene protocol - Consider feeding at strategic times, such as during breeding season, droughts, in case of additional stressors such as pesticide use in surrounding area, or for reintroduced individuals
Promotion of mixed flocks	<ul style="list-style-type: none"> - Conduct research and monitoring to understand dynamics and importance of mixed flocks to Alagoas Antwren

DEVELOPMENT OF EX SITU METHODS WITH MODEL SPECIES

The need was identified to develop suitable management methods before any attempts at establishing an ex situ population are undertaken. Participants agreed that this should be done with a model species, as similar as possible in its characteristics and difficulties to Alagoas Antwren. The skills developed through ex situ work with the model species – addressing capture and transport, artificial incubation of eggs, husbandry, nutrition and releases – could then be transferred to Alagoas Antwren, with lower risk of unforeseen problems.

Removing eggs from the wild population would be preferable to removing adults in terms of its impact on the wild population, as nest predation rates are high. However, hand-rearing tiny antwren chicks from eggs presents challenges with feeding and handling. There is a risk that hand-reared chicks may not learn alarm and breeding calls, but this risk is probably low because species vocalizations in suboscine passerines are innate, not learned. A foster species could be used to incubate eggs of Alagoas Antwren, but this presents the risk of young imprinting sexually on the wrong species. There could also be a risk of disease transfer between species with fostering. Another option, not discussed in depth in the workshop, would be to take nestlings. However, few nests survive to that stage, so removing them would have a greater impact on the wild population than taking eggs.

Unicolored Antwren would be a good model because it is the sister species to the Alagoas Antwren; they were previously considered conspecific. Its distribution does not overlap with that of Alagoas Antwren, minimising any concerns about sexual imprinting should it be used as a foster species. However, it is uncommon and Near Threatened, and does not occur close to Parque das Aves, making it less suitable for initial work. No species of *Myrmotherula* antwren is found in Foz do Iguaçu, perhaps because they cannot survive the occasional periods of very cold temperatures during the winter. Participants decided that a better model species would be a non-threatened antwren species found in Foz do Iguaçu, where Parque das Aves is based. Additional feasibility considerations are that some funding is already available for this work through a National Geographic grant to SAVE Brasil and that there are existing staff and resources at Parque das Aves to start these efforts.

The recommendations were a series of steps to be initiated in sequence. The steps would likely overlap or run in parallel to some extent:

1

Start ex situ work with a common species found in Foz do Iguaçu, likely Plain Antvireo *Dysithamnus mentalis* (Least Concern, Figure 2), to make use of the facilities and staff available at Parque das Aves;



Figure 2. Plain Antvireo *Dysithamnus mentalis*, selected as the **most appropriate initial model species** for Alagoas Antwren. (Ben Phalan/Parque das Aves)

2

Later, if thought necessary (and this was identified as necessary by some participants), work with Unicolored Antwren in an institution within that species' distribution;

3

Finally, when sufficient ex situ knowledge and skills have been developed with the model species, apply these to Alagoas Antwren in Alagoas.

Among the aspects where knowledge and skills will need to be developed are:

- Mist netting
- Egg collection
- Transport
- Acclimatisation
- Hand-rearing
- Breeding
- Health management
- Diet
- General husbandry
- Behaviour
- Social management
- Release strategies

Each of the three steps would involve taking eggs, nestlings or adults from the wild, transporting them safely, and bringing them into human care. The second stage might be bypassed if the methods used with Plain Antvireo prove sufficiently successful, and if the Alagoas Antwren population continues to decline, creating further urgency. If it is deemed necessary, feasibility of implementing this step in partnership with other institutions should be evaluated, with possible partners including zoos and breeding centers in the states of Paraná, São Paulo and Rio de Janeiro. Licenses will be needed for this work, but a well-designed proposal would be likely to be accepted. A study of nesting birds in Morretes, Paraná, found two nests of Unicolored Antwren in October 2018, and the breeding season is believed to be from September to January (T. Bichinski pers. obs.).

For the third stage, that of ex situ work with Alagoas Antwren, several participants suggested that the facility should ideally be at ESEC Murici or nearby, to lower the risks of transporting, climate adaptation and other issues, as well as to facilitate future reintroduction actions. Another option could be a facility with some degree of climate control, in the lowlands or in

another state. Issues that will need consideration include possible risk of low immunity due to the lack of exposure to natural parasites; possible differences in climate between captive and native range; and nutrition.

RESEARCH IN THE WILD

There are still many unknowns about this species which are important to investigate to provide information on which to base conservation interventions.

Data gaps highlighted during the workshop included:

- Diet of nestlings and adults (relevant to ex situ work)
- Nest materials (also relevant to ex situ work)
- Precise habitat preferences for foraging, nesting, singing, roosting and predator evasion
- General ecology and behaviour of model species, particularly Unicolored Antwren (relevant to ex situ work with model species, and might provide clues to aspects of Alagoas Antwren ecology)
- Benefits to the species of feeding with multispecies flocks
- Predator population densities and trends of predators, and how those might be affected by improved control of hunting, or by changes in land-use surrounding ESEC Murici
- Relative importance of different predators (relevant to interventions to reduce predation; research ongoing with camera traps monitoring nests of understory birds, taking precautions to avoid giving away nest locations to predators or causing nest abandonment)
- Population genetics (information relevant to both ex situ and conservation efforts in the field; need to understand degree of inbreeding and loss of genetic diversity)
- Sex ratio
- Sensitivity at family – and ideally genus – level to disturbance and manipulations near active nests

EX SITU ROLES NOT RECOMMENDED AT THIS TIME

Insurance population, rescue, ark and source for population restoration

After discussion, all roles that involved the formation of an ex situ population were rejected at this time. It was felt that there is far too little knowledge of how to care for this species in captivity to make these options feasible, and the risks to the small wild population would therefore be very high. However, the group recommended that these roles be considered again if feasibility improves. Participants indicated that the priorities at this time are to develop techniques to manage the population in the wild, and to develop ex situ methods with a model species.

In the event of an immediate, critical threat to the population, the group indicated that wild-to-wild translocation would be a preferred option rather than rescue of birds into human care. However, no such imminent threat that would trigger an emergency protocol was identified, beyond the ongoing critical situation of this tiny population. Moreover, substantial research would be required to identify ecologically appropriate areas into which birds could be translocated. Similarly, establishing an Ark population (taking all individuals into human care) was considered too risky, with requisite knowledge to do so safely lacking.

Population restoration via wild-to-wild translocation

Taking into account that some previously-recorded individuals had disappeared by 2018 in the Fazenda Bananeiras area (within the ESEC Murici) it was suggested that wild-to-wild translocation of individuals from the edge of the fragment into the central area could be considered an option. However, this forest is linked via secondary forest to the main block of forest and so it seems unlikely that these individuals could not disperse if they chose to.

Participants suggested that if and when future population reinforcement and reintroduction is implemented, reinforcing the population at Murici should be the first priority, and re-establishing a population at SAVE Brasil's reserve in Serra do Urubu should be the second. Other participants suggested that these actions might both be undertaken in parallel. Serra do Urubu was highlighted as being the foremost of the locations with recent records of the species where the forest is now well-protected, where forest condition is improving, and where SAVE Brasil already has infrastructure and staff that could assist with this effort.

Conservation introduction: ecological replacement and assisted colonization

Conservation introduction is the introduction of the species to areas outside of its native range, either to restore ecological function (as an ecological replacement) or to establish the species in new suitable areas when sufficient habitat is no longer available within its original distribution (assisted colonization). Neither of these actions is appropriate for this species at this time.

Ex situ research and training, and conservation education

Participants agreed that ex situ research and training should focus, at this point, only on the model species. No specific need for an ex situ population for conservation education was identified at this time.





Ciro Albano

Blue-eyed Ground-dove

Columbina cyanopsis

Global Red List:

Critically Endangered (2018)

National Red List:

Critically Endangered (2014)



STATUS AND ECOLOGY IN THE WILD

Endemic to the Cerrado of Brazil, with scattered historical records across a large range extending from Mato Grosso to Goiás and the border between São Paulo and Mato Grosso do Sul, the Blue-eyed Ground-dove is now only known from a single site in the municipality of Botumirim, Minas Gerais. Specimens in Goiás were taken in open grassland, while the currently known population is found in areas with quartzitic rocky outcrops and their associated white-sand ecosystem (*campos rupestres*), with clean flowing surface water, at elevations between 730 m and 950 m. Vegetation in these areas is dominated by grasses, sedges, shrubs and everlasting/strawflower species (see Appendix G for further details). The species likely has a very patchy distribution, if it still occurs elsewhere, but its precise habitat requirements are not well understood. The population known at the time of the workshop was 20 individuals. Since the workshop, surveys have revealed additional birds and the number has increased to 27. The breeding season is believed to extend from December to June.

THREATS

The Blue-eyed Ground-dove has remained a very poorly-known species since its discovery two centuries ago. It is likely that the large-scale conversion of Cerrado to pastures and cropland has had a negative effect on this species. In recent years, the Cerrado has suffered more rapid rates of habitat clearance than other Brazilian biomes, and is poorly covered by protected areas (Strassburg et al. 2017). The dove is probably threatened by habitat loss (caused by mining, cattle ranching, crops, and *Eucalyptus* plantations, among others), dams and water abstraction, and invasive species such as domestic dogs, but little concrete information exists on these threats.

The role of fire in the ecology of the Blue-eyed Ground-dove is not well understood. Fire is an important and necessary element of the Cerrado landscape, and might play a role in creating suitable conditions for this species. Changes in fire regimes (as a result of human-ignited fires, changes in land use, and climate change) could also be a threat to the species.

Camera traps in the area where the species occurs have recorded the presence of more than 20 different domestic dogs from neighbouring settlements, as well as a wide range of potential predators of native species. The birds are relatively confiding and feed on the ground, and so might be vulnerable to non-native predators, but there is no evidence that free-ranging domestic animals in fact pose a threat. There could also be downsides to excluding dogs from the area, if doing so resulted in an increase in activity of other predators, including free-ranging domestic cats which are found in settlements not far away.

EX SITU STATUS

There are no Blue-eyed Ground-doves in captivity, and no historical evidence of any captive birds.

EX SITU STATUS OF RELATED DOVES

There already exists experience in zoos and breeding centers, both in Brazil and around the world, with captive breeding of other species of *Columbina* ground-doves, including Ruddy Ground-dove *C. talpacoti*, Common Ground-dove *C. passerina*, and Croaking Ground-dove *C. cruziana*. Threatened species of Columbidae that have been bred in captivity include Socorro Dove *Zenaida graysoni* (Extinct in the Wild), Santa Cruz Ground-dove *Alopecoenas sanctaecrucis* (Endangered) and Pink Pigeon *Nesoenas mayeri* (Vulnerable). Diamond Dove *Geopelia cuneata*, a widely-kept Australian species, was identified prior to the workshop as a possible foster species.

CONSERVATION ACTIONS UNDERWAY

When this species was rediscovered in 2015, after an interval of 74 years without confirmed records, the first action taken was to secure its habitat. The entire known population is now protected within a private 593 ha reserve managed by SAVE Brasil, and in the surrounding Botumirim State Park (35,682 ha). The Botumirim State Park has still not been implemented, and people (around 20 families) live inside its limits, so there is further work to be done to ensure that potential threats to the Blue-eyed Ground-dove are addressed.

SAVE Brasil has implemented a field program with one full-time field worker (Marcelo Lisita) based in Botumirim. Besides monitoring and research, SAVE Brasil's activities include working to strengthen conservation of the Botumirim State Park, environmental education, eco-tourism and community engagement. A model of potential species distribution has been developed by K. Ferraz, A. Bovo and C. Ortiz (see modeling chapter), and is being used to guide additional surveys with the aim of locating further populations of the species.

A Species Action Plan was developed for the species by a team of 19 ornithologists and bird conservationists in September 2018 (SAVE Brasil 2018).





Ciro Albano

RECOMMENDATIONS

Recommended actions are detailed in Appendix I, with priorities, responsible parties, timeline and budget, and a review of progress as of September 2021.

SEARCHES WITHIN HISTORICAL RANGE

Participants agreed that further search effort for additional populations of the Blue-eyed Ground-dove is an ongoing priority. These should continue both in the Botumirim area, and also in other locations with historical records or where the species distribution model indicates that potentially suitable habitat is present. Autonomous sound recorders are now available at low cost and could be of use in monitoring areas of potentially suitable habitat.

Participants noted that the discovery of additional populations – unless they were very large, which is improbable – would be unlikely to affect the other recommendations from the workshop. Even with knowledge of the bird's vocalizations and visits by experienced observers to other potential sites, no new population outside of Botumirim has been located. In case a new population is found, care must be taken before communicating this information publicly, to minimize any risk to the species.

INTENSIVE POPULATION MANAGEMENT IN THE WILD

Ten active nests of Blue-eyed Ground-dove were found from 2017 to March 2021, with eggs present as early as late January and nestlings as late as early June. Of these nests, five are believed to have been predated, one was abandoned with eggs, one nestling died likely as a result of chilling after heavy rain, and three nests successfully produced fledglings. A further nest with eggs was found in September 2021, but later predated. The egg predator in one

case was suspected to be a Crab-eating Raccoon *Procyon cancrivorus*, captured on a camera trap nearby. Protecting nests from predators could help the population to grow. It will be necessary to evaluate which potential predators are present, monitor nests to identify predators, and investigate interventions to deter or exclude these predators from nests.

DEVELOPMENT OF EX SITU METHODS WITH MODEL SPECIES

There was overall consensus that to reduce any risks to the tiny Blue-eyed Ground-dove population, ex situ methods should be developed with other model species of small dove before attempting to bring any of this Critically Endangered species into human care. The protocols developed could then be applied to the Blue-eyed Ground-dove. Participants also agreed that cross-species fostering could be an option worth consideration.

The methods that will need to be developed include:

- Collection of eggs (under license) from wild nests
- Transport of eggs
- Incubation
- Hand-rearing of nestlings
- Breeding
- Health management
- Diet
- General husbandry
- Social management of groups and pairs
- Release strategies

Three candidate model species were identified:

- Ruddy Ground-dove – a widespread native species, similar in many respects to Blue-eyed Ground-dove (Figure 3)



Figure 3. Ruddy Ground-dove *Columbina talpacoti*, identified as the most appropriate model species for Blue-eyed Ground-dove (Ben Phalan/Parque das Aves)

- Diamond Dove – an Australian species, widely kept by breeders, and established as a good foster parent
- Zebra Dove *Geopelia striata* – a Southeast Asian species, also widely kept as a cagebird

The Ruddy Ground-dove (Figure 3) was highlighted as the most taxonomically similar species, and thus the first choice as a model species. It was noted that small doves have low survival rates when hand-reared from the egg stage, but that hand-rearing methods have progressed tremendously in recent years. Nevertheless, parent rearing remains the preferred option when it is possible. Many dove species will breed readily in controlled environments, often producing multiple clutches in a year. Threatened species such as Santa Cruz Ground-doves have been successfully bred in this way.

The Diamond Dove was highlighted as a promising foster species for rearing Blue-eyed Ground-dove nestlings. Ruddy Ground-doves could be less suitable for this as they are found naturally in the range of the Blue-eyed Ground-dove, and there would be a risk of sexual imprinting and hybridization if fostered birds were released into the wild. Workshop participant T. Bichinski shared his experience with Diamond Doves as foster parents for Ruddy Ground-doves, Picui Ground-doves *Columbina picui* and Scaled Ground-doves *Columbina squammata*. In his experience, Diamond Doves will re-clutch within 20 days if their eggs are taken. Participants with experience of using foster species recommended having at least five breeding pairs per clutch of eggs to be fostered, to ensure that at least one pair is at the right stage to receive fostered eggs. In the case of Pink Pigeons, a colony of 20 pairs of Barbary Doves *Streptopelia risoria* was used as foster parents, with a similar nestling period of 14 days. There is a need to have stringent health protocols to minimize the risk of disease transmission when working with foster parents.

Ex situ methods can be perfected with model and foster species, starting soon after the workshop and continuing in parallel with a possible pilot to initiate an ex situ population of Blue-eyed Ground-dove in 2021 (this date will depend on progress with ex situ methods). Soon after the workshop, Parque das Aves received 17 Ruddy Ground-doves that had been rescued (mostly injured birds or fledglings brought to environmental police), to perfect the protocols needed for their nutrition, husbandry and hand-rearing. Effective methods for release to maximize survival in the wild will also need to be developed. One important challenge is to prevent trauma in these easily-startled birds. It was noted that some 50% of known causes of ex situ mortality of *Columbina* doves worldwide was from trauma. Plentiful vegetation, appropriately-sized aviaries, and soft mesh screens to reduce the impact of collisions would help to prevent this.

INSURANCE POPULATION

The group reached consensus that it would be desirable to establish an insurance population of Blue-eyed Ground-dove, although some concerns were raised in initial discussions. These concerns were that the wild population is likely underestimated, apparently not in decline, and that there is no imminent threat that would justify taking individuals to start an ex situ population. However, after discussion, participants agreed that the wild population, even if larger than 20 individuals, cannot be very much larger; that there is a credible, if not imminent, risk of a catastrophic event such as fire; and that eggs could be taken with minimal impact on the population – if first clutches are taken early in incubation. Nevertheless, some participants highlighted the importance of re-assessing the need for an insurance population if the situation changes, and not assuming that it must proceed simply because there has been an investment of time and resources in developing appropriate methods.

The group concluded that taking eggs would be the most appropriate way to establish an ex situ population, even if most captive dove populations were founded with adults, and even though it would require dealing with the complexities of fostering or hand-rearing. Taking the first clutch from a pair would likely have a minimal impact on the population, given that predation is frequent and that pairs can nest again. It was thought that birds would be less likely to nest again if nestlings were taken, but further information on this question is desirable. Taking adults from the wild to breed in captivity would be easier, but would have a larger negative impact on this small population, so was opposed. An option that could be considered in the future, if necessary, is a version of head-starting: taking adults from the wild, breeding them in controlled conditions, and then releasing them and their offspring again, but this was not recommended in the first instance.

Tentatively, the group suggested establishing and testing ex situ methods with model species in 2020, and piloting the collection of up to two clutches from Blue-eyed Ground-dove nests in 2021. Based on the results from this pilot, a decision can be made about how to proceed in subsequent years. Flexibility was recommended; if field surveys find new populations, plans will need to be reconsidered and the needs for an ex situ programme might change. Conversely, if additional threats to the wild population, such as fires, emerge, there might be a need to accelerate this work. A population viability analysis (for example using the software Vortex) could help inform decisions about how many eggs should be taken in each year, but many parameters would need to be inferred from other species.

A second possibility to be prepared for, in addition to planned removals of eggs, is opportunistic rescue of individual eggs, chicks or adults, in the event of nest abandonment, death of breeding adults, or injury. This method has been useful in the case of Pink Pigeon, with rescued animals adding to the ex situ population without adding risk to the wild population. The field team should be ready for such an eventuality, with an emergency protocol, capacity and infrastructure (this protocol has now been prepared, see Appendix J). Parque das Aves can provide training to SAVE Brasil staff in the care of rescued eggs or birds, and can be ready to send a staff member to Botumirim if an opportunistic rescue occurs.

RESEARCH ON THE WILD POPULATION

There was agreement that research efforts to understand the natural history of the wild population should continue. Finding and monitoring nests is of particular importance. Nests of this species and of other species nesting in the same habitat should be monitored to identify predators and measure reproductive success. To allay concerns about the potential of cameras to cause disturbance or attract predators, camera traps to monitor nest success should be tested with other species, ideally dove species, in the area before being used with Blue-eyed Ground-dove.

Once used, nests are abandoned and not used again. Therefore they can be collected to identify the materials (plant species) with which they are made, and collect parasites and potentially biological samples such as feathers and droppings. Some of the plant species have already been identified (see Appendix G). Capturing individuals for ringing and collecting samples was not recommended at this time, to minimize any risk of harm. Continued censuses to monitor the size of the wild population are very important so that any decline can be identified.

Understanding the microhabitat requirements of the species was identified as a crucial research question, comparing occupied and unoccupied areas in order to determine possible management strategies to increase the population. Understanding the role of fire and of herbivores in maintaining or degrading suitable conditions will be important for protecting the species in the long term. Fencing off areas to exclude domestic livestock could provide useful data in this regard, but could also have unintended consequences (for example, if it excluded dogs that had suppressed activity of cats or other smaller predators), and so such experiments should not be done within Blue-eyed Ground-dove territories.



EX SITU ROLES NOT RECOMMENDED AT THIS TIME

Rescue and ark

There was consensus that a rescue or ark population would not be appropriate for this species. The small wild population is not in such imminent danger that removal to human care would be justified. Maintaining and protecting the population of this species in its natural environment was agreed by all as an important objective of conservation efforts for this species.

Translocation: reintroduction and reinforcement

No rationale for translocations was identified at this time. Until an ex situ population is established, such translocations would have to be wild-to-wild, and there is insufficient understanding of the species' requirements to identify suitable locations for reintroduction. Local translocations within the Botumirim landscapes would likely fail because birds would be likely to return to their original site. Also, there were concerns that the population is not large enough to sustain removals of adults or juveniles. The possibility of translocating unpaired males that interfere with the reproduction of established pairs was discussed, but strong evidence of such interference would be needed. Once an insurance population has been established, the need for reintroduction or reinforcement can be re-evaluated.

Conservation introduction: ecological replacement and assisted colonization

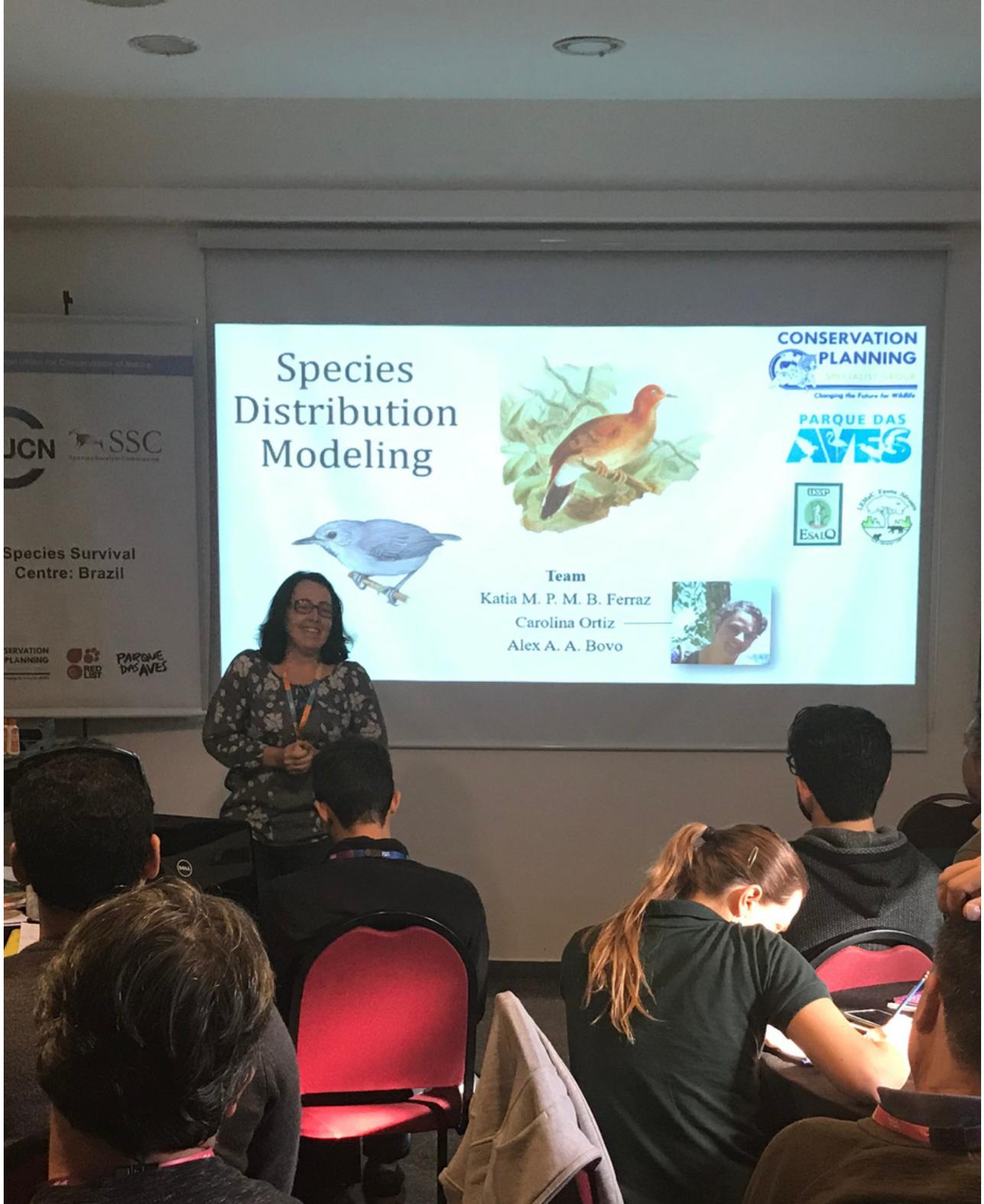
Ecological replacement was rejected as a role. The focus is primarily on preventing the extinction of the species, rather than on any specific ecological role or service that it provides. Assisted colonization might be re-assessed in the future, but at this time we do not have any information to suggest a need for this role, nor to identify suitable sites for colonization.

Demographic manipulation

As indicated above, head-starting (taking adults from the wild, breeding them in controlled conditions, and then releasing them and their offspring again) was not recommended in the first instance. Therefore, demographic manipulation using ex situ management was not recommended at this time (though may be reconsidered in the future). In relation to the wild population, it would likely be beneficial to enhance breeding success and increase the number of juveniles entering the population – see section above on “Intensive population management in the wild.”

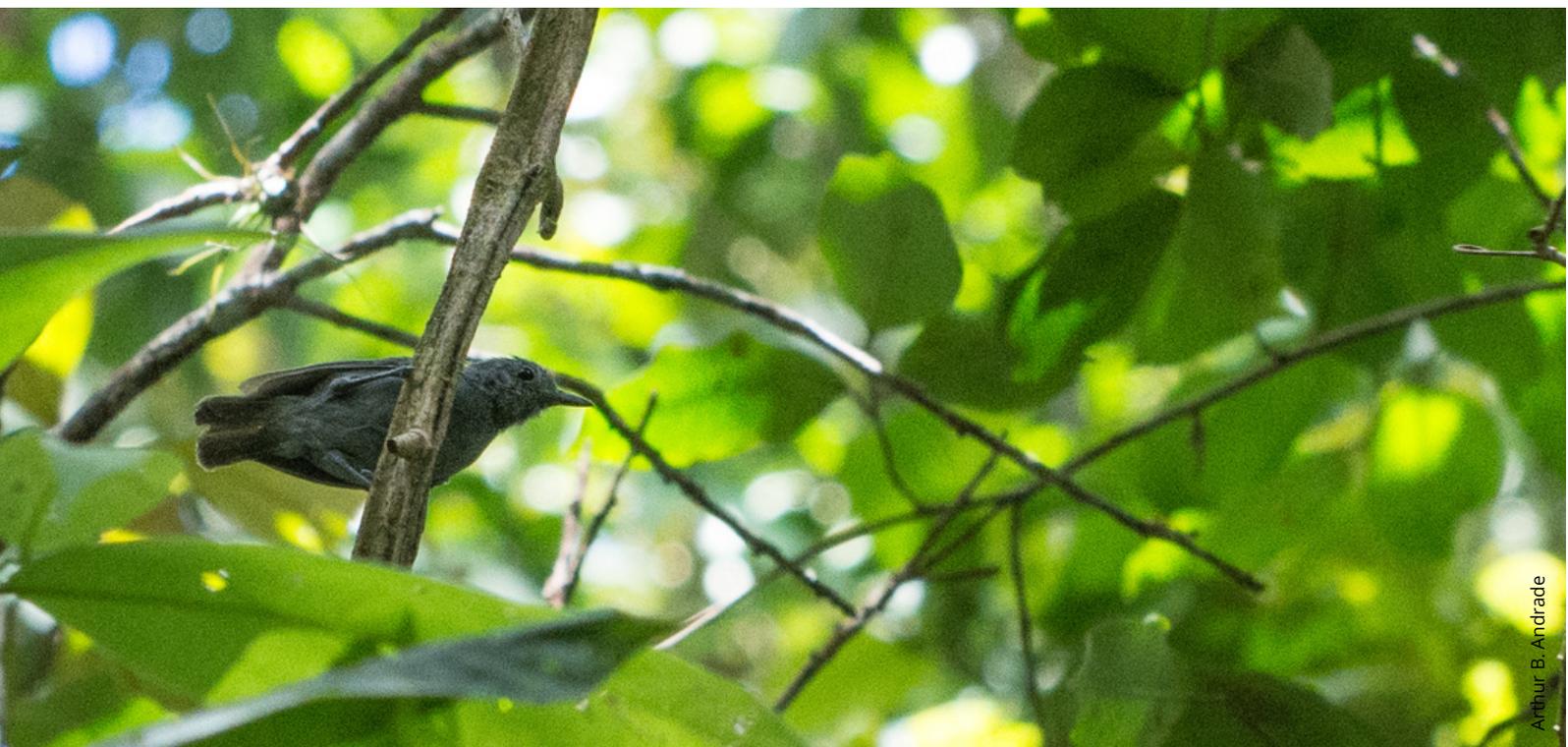
Conservation education

Until such time as an ex situ population is established and security concerns can be addressed, participants agreed that discussion of an education role for ex situ populations should be put on hold.



Species Distribution Modeling





Arthur B. Andrade

ALAGOAS ANTWREN SPECIES DISTRIBUTION MODEL

This section was contributed by Katia Maria P. M. de Barros Ferraz, Alex A. A. Bovo (ESALQ/USP and IUCN SSC CPSG Brasil) and Carolina Ortiz (ESALQ/USP)

A species distribution model (SDM) for the Alagoas Antwren was developed through a participatory modeling process involving meetings in collaboration with species experts in advance of the workshop to select the models to be presented at the workshop. At the workshop the models were presented, discussed again, and one of the models was accepted by all experts in plenary.

The presence database compiled for the species contained 229 species presence points provided by SAVE Brasil (from 2014 to the present), of which 228 were unique (Figure 4). These points were subjected to the rarefaction procedure in order to eliminate spatial dependence between them using the “thin.algorithm” function of the *SpThin* package (Aiello-Lammens et al. 2019) in the software R version 3.6.1 (R Core Team 2019). The minimum distance defined between the points was 1 km, considering the home range of approximately 3 ha (SAVE Brasil unpublished data), since this is a safe distance to consider two records as being from different territories, resulting in six geographically independent points in space to be used in modeling.

The modeled geographic space (85,559 km²) was defined from the WWF ecoregion map (Olson et al. 2001). The “Pernambuco coastal forest” and “Pernambuco interior forest” ecoregions present in the Pernambuco Endemism Center were selected, within which historical and recent records of the species are present. From these formations, a 50 km buffer was generated to include marginal areas (Figure 4).

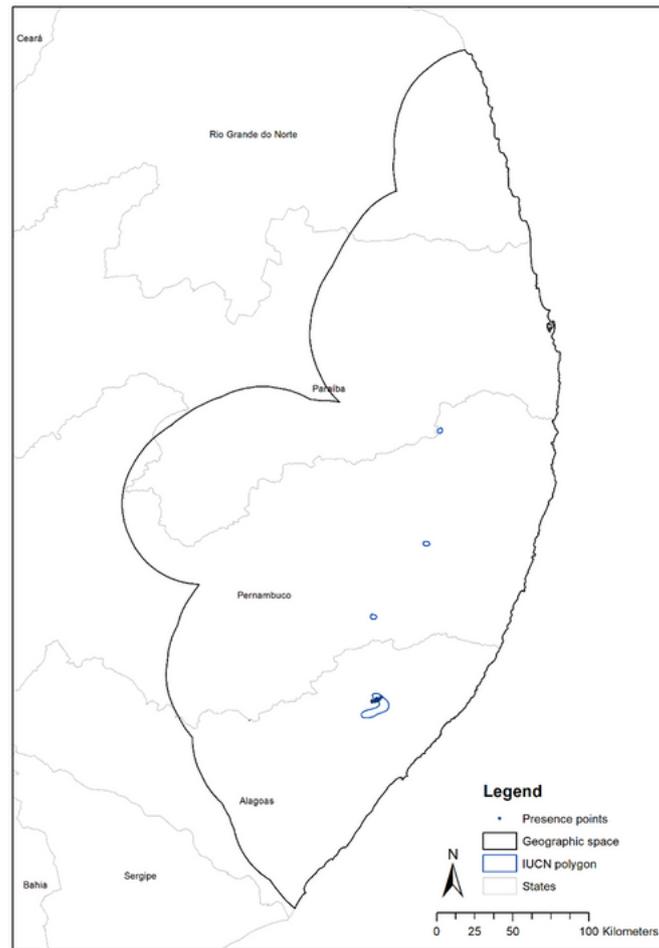


Figure 4. Modelled geographic space used to develop SDM for *Myrmotherula snowi*, with recent records of presence and IUCN range polygon.

The environmental variables available for modeling included landscape, topographic, edaphological and drainage information, of which four were used in the final model (Table 3). Variables were subjected to Pearson's correlation analysis, considering as autocorrelated the variables with a value equal to or greater than 0.7 and equal to or less than -0.7. The spatial resolution adopted for modeling was 250 m. A maximum of five variables were used for each model, due to the reduced number of points of presence.

Table 3. Environmental variables selected for modeling.

Name	Description	Spatial Resolution	Year	Source
Altitude	Altitude above sea level	30 m	2009	www.webmapit.com.br/inpe/topodata/ (Valeriano et al. 2012)
Clay	Soil clay content mass fraction in %	250 m	2017	soilgrids.org (Hengl et al. 2017).
Aspect	Identify the downslope direction of the terrain (derived from the Digital Elevation Model)	30 m	2009	www.webmapit.com.br/inpe/topodata/ (Valeriano et al. 2012).
Forest edge distance	Distance of a forest pixel until the forest edge (derived from the class "forest formation", MapBiomias v3.1)	30 m	2018	mapbiomas.org (MapBiomias 2018).

The models were generated from a set of four algorithms: Bioclim (Loiselle et al. 2003), Domain (Hirzel et al. 2002), RandomForest (Breiman 2001) and Maxent (Phillips et al. 2006) using the *dismo* (Hijmans et al., 2017), *randomForest* (Liaw and Wiener, 2002) and *maxnet* (Phillips 2017) packages in the software R (R Core Team 2019). The choice of algorithms was based on the following approaches: presence data – Bioclim and Domain; and presence and pseudo-absence data – RandomForest and Maxent. Resulting models of each algorithm were combined by arithmetic mean to generate a single consensus model (Marmion et al. 2009). Model performance was assessed by AUC and TSS values. Area Under Curve (AUC) is the probability of randomly choosing randomized point-presence presence data (Fielding and Bell, 1997) and True Skill Statistic (TSS) weights the model's ability to discriminate between presence and absence (Allouche et al. 2006). Predictions of the algorithms that presented AUC and TSS smaller than 0.7 were not considered in the final consensus models.

The accepted SDM of *M. snowi* was considered satisfactory (AUC and TSS = 1.0) indicating potential distribution areas of the species, mostly located in Área de Proteção Ambiental Murici and ESEC Murici (Figure 5). 89.9% of the points of presence were predicted in areas of medium to high suitability (≥ 0.41) (Figure 6). The area predicted as suitable (greater than 50% suitability) for the species was 22.9 km² (0.03% of the total modeled area) (Figure 7). The division of the model into four equal classes of environmental suitability showed most areas with low suitability (99.74%) (Figure 5c; Table 4). The variable that contributed the most to the model was forest edge distance (47.37%), then, altitude (34.17%), aspect (15.36%) and soil clay content (3.07%). Presence points of the species are at least 40 m from the forest edge and at altitudes from 415 to 580 m, confined to the nuclear areas of the remaining fragments of the Pernambuco Center of Endemism.

Table 4. Quantity and percentage of area in four different suitability classes

Classes	Area (km ²)	Area (%)
Very low (0–25%)	85289.12	99.74%
Low (25–50%)	178.84	0.21%
Medium (50–75%)	37.49	0.04%
High (75–100%)	6.92	0.01%

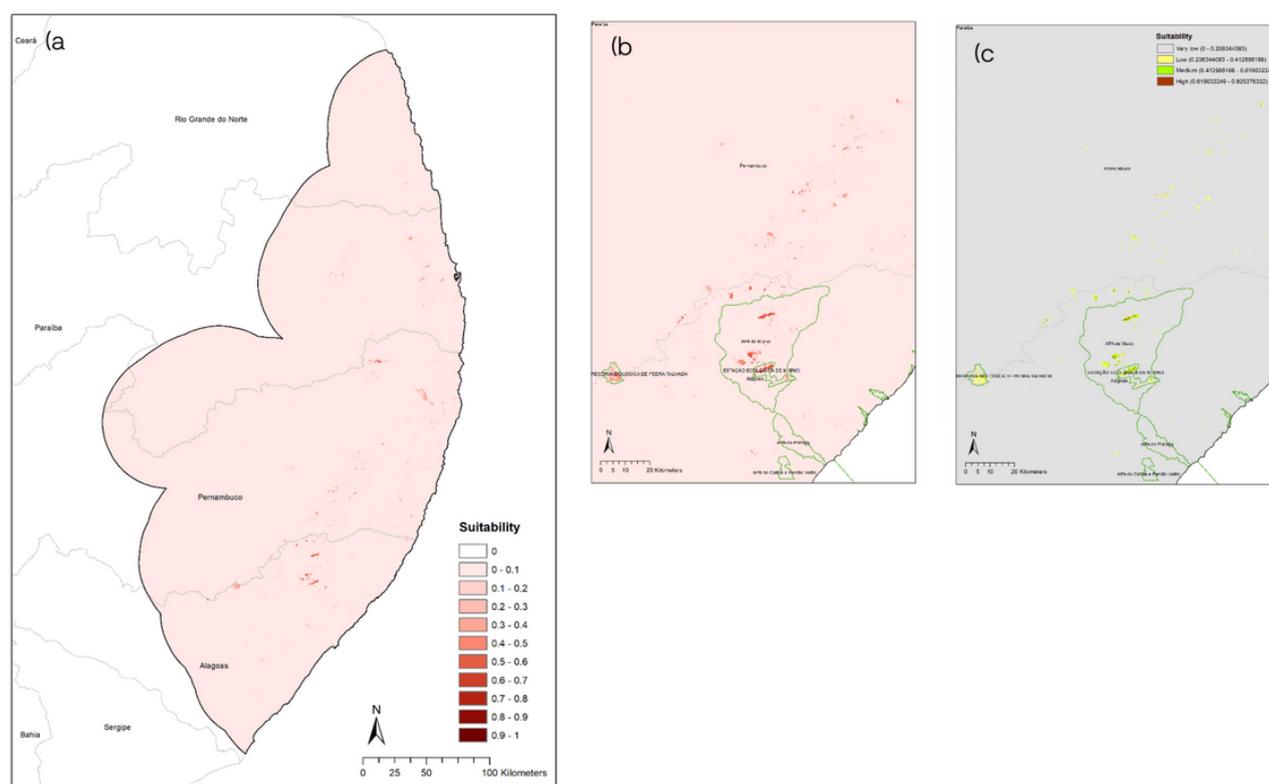


Figure 5. (a) Species distribution model of *Myrmotherula snowi*, with (b) areas of highest suitability enlarged, and (c) classified into four suitability classes.

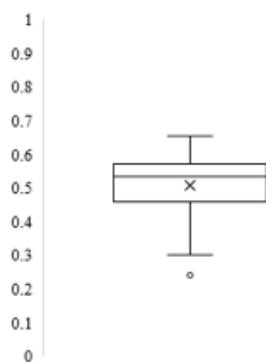


Figure 6. Boxplot showing the environmental suitability values of unique occurrence points of *Myrmotherula snowi*.

New areas suitable for searches for new populations can be seen in Figure 8. Three potential areas are allocated within the Área de Proteção Ambiental Murici but outside the ESEC Murici. Of these, only Serra Grande (northernmost portion of the Área de Proteção Ambiental) has been previously sampled, without records of the species. Another potentially suitable area is located near the Mata do Estado in Pernambuco, where there is a historical record of the species.

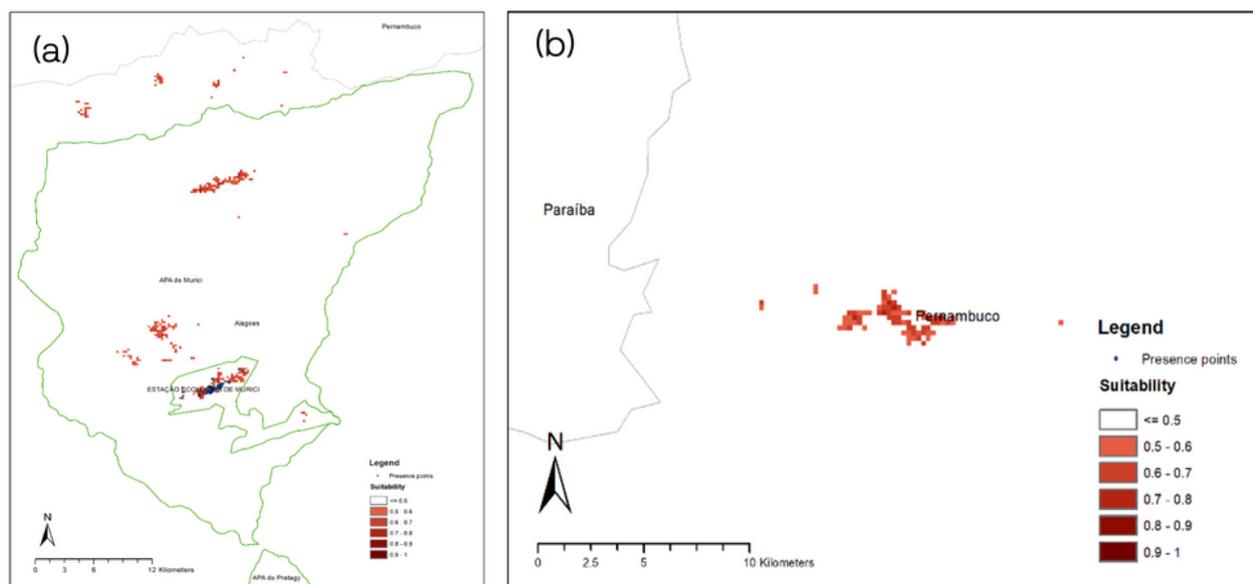


Figure 7. Species distribution model of *Myrmotherula snowi* with suitability values of at least 50%: (a) Área de Proteção Ambiental Murici; (b) area close to Mata do Estado.





Figure 8. Suitable areas with suitability values equal to or greater than 50%, indicating potential sites to search for new populations. Insets as in Figure 7.

FINAL CONSIDERATIONS

The SDM of *M. snowi* indicated few areas suitable for the occurrence of the species, strictly related to the larger fragments present in the modeled space. The distribution of the points of presence at distances greater than 40 m from the forest edge confirms the information that the edge effect limits its presence. The same can be confirmed by the variable “distance from the forest edge”, which was the predictor with the greatest contribution to the final model result.

Appropriate areas near the northern boundary of ESEC Murici should be prioritized for further exploration, as well as the Mata do Estado fragment, mainly because they have not been the subject of a recent search effort for this species.

It is noteworthy that the estimates must be redone with each new record of presence of the species in order to improve its predictive power. New absence records should also be used to validate the accepted model, confirming or not the estimates of the accepted model.

NEXT STEPS

The search for the species in suitable areas for its occurrence will result in absences and confirmed presences, which will be used to validate and possibly update the model.



Silvia Linhares

BLUE-EYED GROUND-DOVE SPECIES DISTRIBUTION MODEL

This section was modified from a full report written by Katia Maria P. M. de Barros Ferraz, Alex A. A. Bovo (ESALQ/USP and IUCN SSC CPSG Brasil) and Carolina Ortiz (ESALQ/USP)

A species distribution model for the Blue-eyed Ground-dove was developed through a participatory modeling process involving meetings in collaboration with species experts in advance of the workshop to select the models to be presented at the workshop. At the workshop the models were presented, discussed again, and one of the models was accepted by all experts in plenary.

The presence database compiled for the species resulted in 168 species presence points provided by SAVE Brasil (from 2015 to the present), with only 29 unique points (Figure 9). These points were subjected to the rarefaction procedure to eliminate spatial dependence between them using the “thin.algorithm” function of the *SpThin* package (Aiello-Lammens et al. 2019) in the software R version 3.6.1 (R Core Team 2019). The minimum distance defined between the points was 1 km, considering a home range of approximately 3 ha (Pedro Develey pers. obs.), since this is a safe distance to consider two records as being from different territories, resulting in six independent points in geographic space that were used in the modeling process.

The modeled geographic space (~40,454 km²) was defined from the WWF ecoregion map (Olson et al. 2001), where a Cerrado patch with recent records of the species was selected (Figure 9). Procedures similar to those used for the Alagoas Antwren were followed, and 27 consensus models at a resolution of 250 m were generated, resulting in the selection of a model indicating the probability of presence of the species. The division of the model into four equal suitability classes showed most areas with very low suitability (95.05%) (Table 5).

Further details of the model are redacted from this report to minimize any potential risk to the species, but it will be used to guide search efforts in the field, and refined as new presence and absence data are collected.

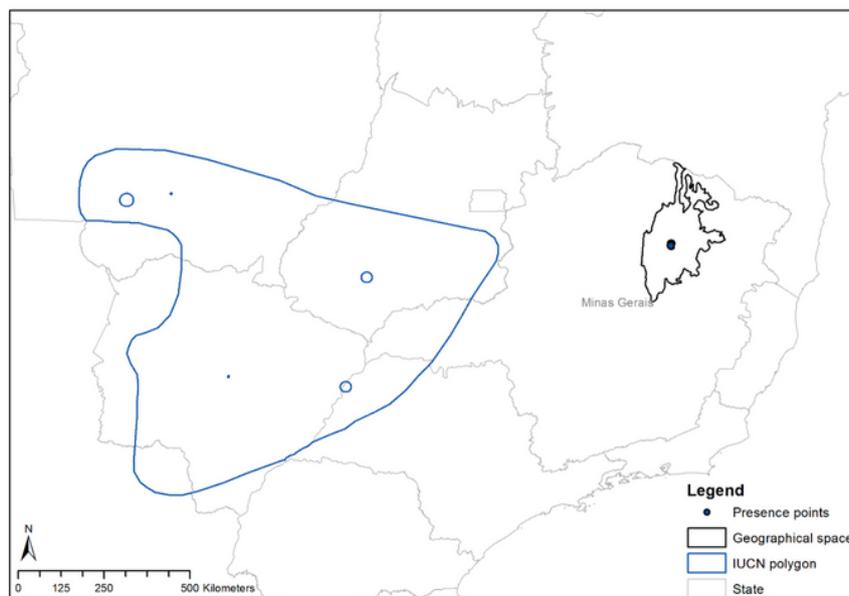
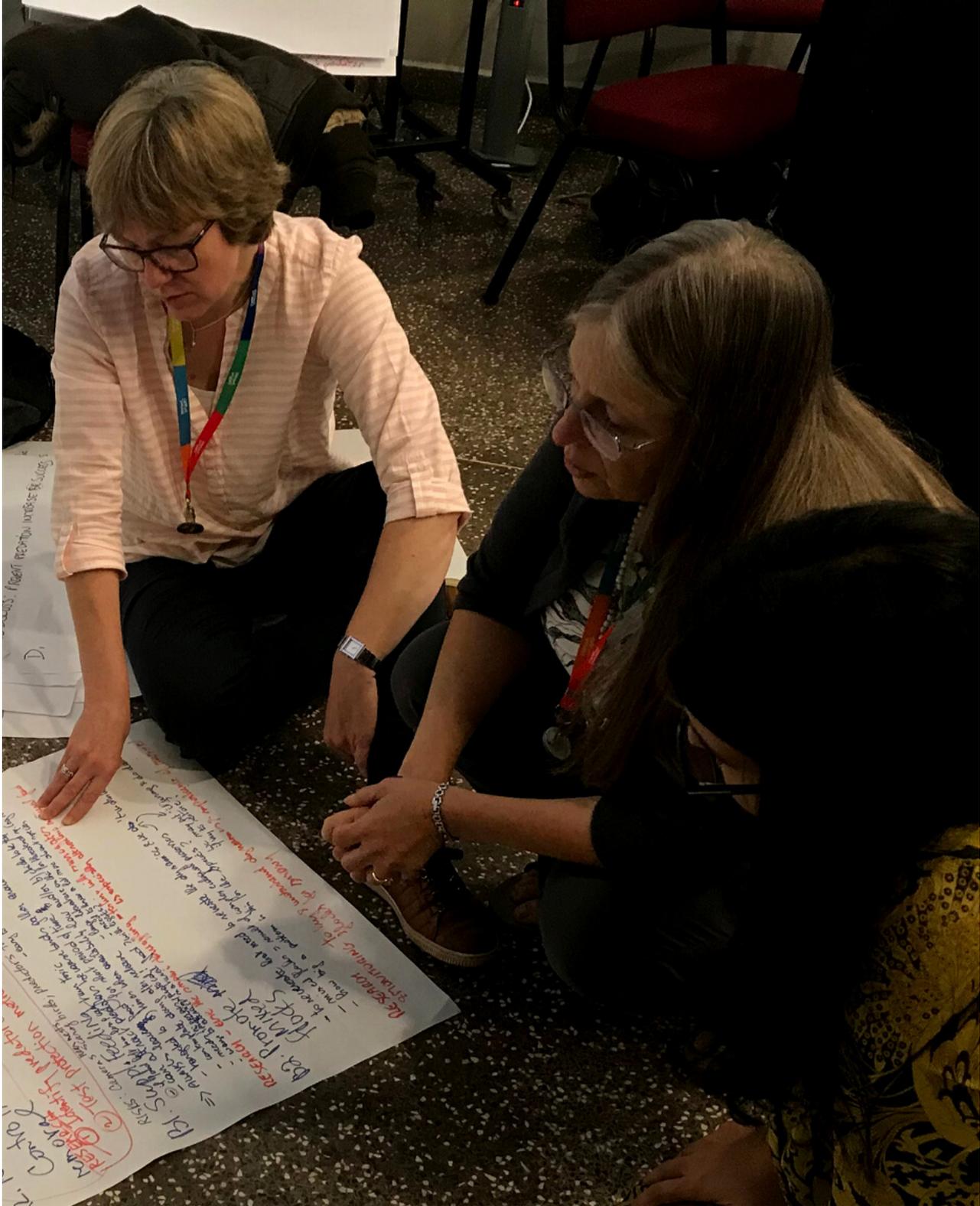


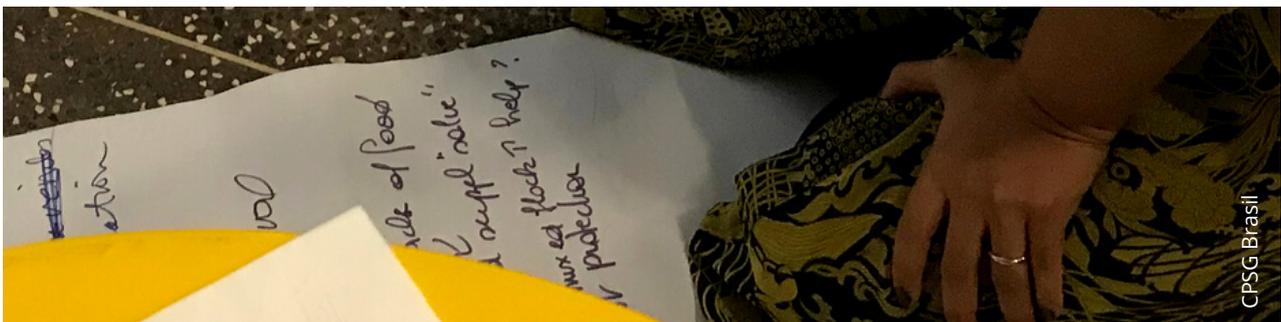
Figure 9. Modeled geographic space (black outline) used to develop species distribution model for *Columbina cyanopsis*, with recent records of presence (filled points) and IUCN range polygon (blue outline).

Table 5. Quantity and percentage of area in four different suitability classes.

Classes	Area (km ²)	Area (%)
Very low (0–25%)	38,340	95.05%
Low (25–50%)	1,299	3.22%
Medium (50–75%)	597	1.48%
High (75–100%)	99	0.24%



Update on progress since workshop



We provide an update on progress up to September 2021, when this report was finalized. Further information on progress of each action is given in Appendix H (Alagoas Antwren) and I (Blue-eyed Ground-dove). Action numbers (e.g., 1.1) refer to the tables in those appendices. Many actions were delayed or postponed because of the effect of the COVID-19 pandemic, which resulted in shortfalls of funding and personnel, reallocation of staff time to other activities, and restrictions on movement of researchers.

PROGRESS WITH ALAGOAS ANTWREN



Arthur B. Andrade

- Action 1.1** **Obtain research permit to take birds and eggs of model species *Dysithamnus mentalis* from the wild**
 – Applied for, and granted in November 2019 (SISBIO number 72145). Renewed in 2021.
- Action 1.2** **Develop and evaluate capture and transport methods with adult or juvenile birds**
 – So far, only local transport of captured birds (*Dysithamnus mentalis*) in cloth bags from capture site to aviary.
- Action 1.3** **Develop and evaluate husbandry and other ex situ techniques for adult birds**
 – Two individuals of Plain Antwren were captured by Karlla Barbosa of SAVE Brasil and Ben Phalan of Parque das Aves, of which one, a juvenile female, died of a bacterial infection after two days. The other, an adult male, survived in human care for over six months (192 days) in Parque das Aves, until succumbing to pneumonia during a cold period at the end of June. Diet was primarily mealworms and crickets, with the former offered ad libitum and replenished three times daily. Various prepared foods, and black soldierfly larvae, were offered but not consumed. Diet was supplemented with calcium sprinkled onto insects, and occasionally with wild-caught orthoptera, and with other insects foraged inside the aviary. We are now testing a light attractant to introduce more diversity. Feeders used included earthenware plates to offer mealworms and water; small plastic cagebird feeders for mealworms, and a large, open-topped plastic box with twig perches, and with the rim coated in fluon, in which crickets were placed for the antwren to catch. The aviary was modified to improve protection from rain, and will be further modified to provide better protection from cold periods in winter.

- Action 1.4 Identify staff who have a talent for management of these species, building on experience we already have with passerines**
 – Several Parque das Aves keepers have shown aptitude in providing care and tracking food consumption, while staff from both conservation and welfare divisions developed and implemented an ethogram to record behaviour.
- Action 3.1 Investigate feasibility for in-range field site for ex situ management**
 – A spreadsheet was prepared with the different options. After discussion, the preferred options were Serra do Urubu in Pernambuco, and the sugarcane research station (*Estação de Floração e Cruzamento*) in Serra do Ouro, within the ESEC Murici. M. Efe and B. Phalan had an initial conversation with the managers of Serra do Ouro, who are open to supporting this work, but after further discussion Serra do Urubu was selected as the most practical site for ex situ management.
- Action 3.2 Develop ex situ facilities in Alagoas (might be best to have multiple sites)**
 – SAVE Brasil has produced plans for aviaries at Serra do Urubu and is in the process of obtaining the relevant licenses.
- Action 4.1 Use nest cameras to identify nest predators, starting with other species in Murici**
 – Camera traps have been used to monitor nests of various understory birds at Murici. In 2020-2021, 37 active nests were monitored, of which six were successful, 20 failed, and the rest had an unknown outcome: a failure rate of 77% of known outcomes, mostly lost to predation (H. Vilela). Predators identified during this period and previously were snakes (including *Epicrates cenchria* and *Spilotes sulphureus*), hawks, small mammals, unidentified invertebrates, and possibly bats and Margay *Leopardus wiedii*.
- Action 4.2 Determine least risky method to monitor nests of *M. snowi*, including work with model species**
 – Camera traps have been used with success, but we are also investigating use of a nest camera connected by cable to a power supply and memory bank, for continuous recording and real-time monitoring from a distance.
- Action 4.3 Literature review of methods to deter, exclude or control likely nest predators**
 – Initiated but not completed.
- Action 4.4 Design and test methods for deterring or excluding predators at Murici, using nests of other species and/or artificial nests**
 – Tests with exclosures around artificial nests using black plastic sheeting resulted in similar rates of predation between test and control nests, although these tests were not continued in the absence of an interested student (M. Efe). Other methods remain to be tested.

- Action 4.7 Analyse food abundance through the season to address whether it is actually a problem**
 – Monitoring of invertebrates in live and dead leaves at Fazenda Bananeiras has shown declines in abundance of the main groups of prey species during the breeding season (from October to March), not only where Alagoas Antwrens occur but throughout the forest (H. Vilela, in prep.).
- Action 4.8 Test effectiveness of light traps or other methods to create local concentrations of potential food for antwrens**
 – We are testing a light attractant at Parque das Aves to provide additional food for captive birds in the first instance.
- Action 4.9 Quantify breeding trajectories and success of *M. snowi* and *M. unicolor* and identify causes of loss**
 – Most nests found have been inactive. One active nest of *M. snowi* found in January 2021, with a small nestling. It disappeared after two days, probably predated by a snake as the camera trap was not triggered.
- Action 4.12 Collecting and storing genetic material from wild population**
 – Feather samples taken from 3–4 mist-netted individuals are already available, but have not been analysed (action 4.13).
- Action 4.14 Validate Species Distribution Modeling by surveying potential new sites in field**
 – Six sites in Pernambuco and one in Alagoas, with historical records and/or highlighted by the model as having most potential to support *M. snowi*, were visited in late 2020 and early 2021 by H. Vilela and A. Andrade. No Alagoas Antwrens were found, although other threatened and endemic birds were recorded, including *Terenura sicki* and *Phylloscartes ceciliae*.
- Action 4.16 Quantify survival estimates through playback with photography and trapping ringed birds**
 – During the period December 2019 to January 2020, two expeditions were conducted in which two points (#39 and #50) and their adjacent quadrats were sampled. In each expedition 45 point counts were carried out, totalling 90 counts. No vocalizations of Alagoas Antwrens were detected in the two locations sampled. After this period, fieldwork using playback was interrupted by the COVID-19 pandemic. Mist-netting effort was also interrupted by the pandemic, although it was restarted in December 2020. As yet, no more Alagoas Antwrens have been captured or recaptured, and it is suspected that the two points sampled by playback were not occupied (M. Efe).

- Action 4.17 Identify microhabitat variables important for *M. snowi***
 – H. Vilela completed his Master’s thesis on habitat selection (Vilela 2020). Alagoas Antwrens were most likely to be found in flatter sites close to streams and with taller trees. Black-throated Trogon *Trogon rufus* (now split as Alagoas Black-throated Trogon *T. muriciensis*) was identified as a potential indicator species, being often found at the same sites.
- Action 4.18 Literature review of other small populations of passerines (recovery potential)**
 – Literature searches carried out but results not compiled systematically yet.
- Action 4.19 Carry out PVA analysis**
 – Models in Vortex were constructed by B. Phalan, based on vital rates from other *Myrmotherula* antwrens, and show that the declines observed in the last three years could be explained solely by very low reproductive success, and are not necessarily indicative of increased adult mortality. However, both factors could be involved. We do not have good estimates of vital rates for Alagoas Antwren, but the observed population size (now perhaps fewer than 10 individuals) and rate of decline (around 20% per year over the past three years) indicate that without intervention the species will likely be extinct within 5–10 years.
- Action 4.20 Collect abandoned nests to identify parasites and understand nest construction and materials**
 – One nest, which was dislodged by a falling bromeliad, has been collected and will be lodged in the museum in UFAL. Nests are also rephotographed at intervals to understand disintegration rates. The main nest materials are aerial marasmioid rhizomorphs of fungi from the suborder Marasmiineae.
- Action 4.21 Determine where collected nests can be archived**
 – They will be archived in the UFAL museum.
- Action 5.1 Establish project advisory committee, including Coordinator from Mata Atlantica PAN**
 – Advisory committee proposed as: A. Owen, A. Eduardo Barbosa, B. Hennessey, M. Efe, N. Collar, S. Bruslund and T. Bichinski.
- Action 5.2 Define leadership of project**
 – Research efforts at ESEC Murici will continue to be led by UFAL (M. Efe) and by UFPB/Save Brasil (H. Vilela, A. Andrade). In situ conservation efforts are led by SAVE Brasil (A. Andrade, B. Cavalcante, reporting to A. Reisfeld and P. Develey) who have signed a partnership agreement with ICMBio/management of ESEC Murici. Ex situ conservation efforts, including work with model species, are led by Parque das Aves (B. Phalan, reporting to P. Bosso and C. Croukamp).

- Action 5.3 Identify fundraising possibilities and communicate to advisory group**
 – Resources are still available for conservation work on this species from the National Geographic grant as well as from the Aage V. Jensen Charity Foundation (via BirdLife International), and WWF-Brazil. Additional funds were provided by ABC in 2021.
- Action 6.1 Establish MOU on publicity with partners: use learning from ground-dove project**
 – Model Memorandum of Understanding received from J. Wood, but not yet developed further.
- Action 6.2 Establish clear message from workshop**
 – Press release sent out after workshop, and publicity received by various of the organizations involved.
- Action 6.3 Make presentations and action plan, table available to workshop participants**
 – Presentations and other documents made available to participants via Google Drive after the workshop.

Actions not yet initiated (as of September 2021):

1.5, 1.6, 1.7, 1.8, 2.1, 2.2, 2.3, 4.5, 4.6, 4.10, 4.11, 4.13, 4.15, 4.22.

ADDITIONAL UPDATE:

Repeated surveys at ESEC Murici found 12 individuals of Alagoas Antwren in the 2018/2019 season (October-March), 10 in 2019/2020 (October-February), and 8 in 2020/2021 (October-January). In January 2021 a juvenile male (with mix of brown and grey feathers so likely less than two months old) and an adult male were found at a site that had been without records of the species since October 2019 (H. Vilela, A. Andrade).

PROGRESS WITH BLUE-EYED GROUND-DOVE



Action 1.1 Recruit and train local person(s) in nest finding and monitoring and intensive observation/resighting of adults

– Osmane, from the local community, has been trained as a field assistant and ranger, and assists with monitoring adults; but he has not been trained yet in finding and monitoring nests.

Action 1.2 Train Parque das Aves staff in ex situ management and hand rearing

– Ongoing. Staff continue to develop experience with hand-rearing Ruddy Ground-dove chicks, with advice from workshop specialists. Eight eggs successfully hatched after artificial incubation, but no chicks survived more than 48 hours. Adenovirus and *Klebsiella* were detected after autopsies. Two broods (total three chicks) successfully reared by parents. Modifications made to protocols, with help from workshop specialists. Further attempts at hand-rearing continued in 2021, starting with two-day old squabs, with success. However, rearing from the egg has not yet been achieved, hampered by the unavailability of commercial crop milk replacer in Brazil, and difficulties in importing the same.

Action 1.3 Develop/synthesize protocols on dove hand-rearing

– Hand-rearing methods still in refinement phase, with input from expert group.

Action 1.5 Develop task profile of extra/volunteer zoo staff to help with ex situ management and recruit if deemed necessary

– In development.

Action 1.6 Define and develop emergency facilities for receiving eggs/chicks/adults in 2020

– Plans for facilities have been drawn up and are in the construction schedule, but construction has not yet started. See Appendix J.

Action 1.7 Identify and rent/buy house

– Options have been identified, but funds for rent have not yet been secured.

Action 1.8 Secure permits to take eggs/young (ICMBio)

– SISBIO license obtained for emergency rescue.

- Action 1.10 Construct/adapt ex situ facilities for model species**
 – Four aviaries at Parque das Aves repurposed for Ruddy Ground-dove, with three pairs established in breeding aviaries.
- Action 1.11 Construct/adapt ex situ facilities for *C. cyanopis***
 – plans were developed for these facilities, but construction was delayed because of the COVID-19 pandemic.
- Action 1.13 Develop an emergency protocol for rescuing eggs/nestlings/adults**
 – Protocol produced and revised with input from specialists, see Appendix J.
- Action 2.5 Validate Species Distribution Modeling by surveying potential new sites in field, both in Botumirim State Park and more widely in Cerrado**
 – Thirty-nine areas were visited in Botumirim State Park, one of which had confirmed the presence of the species, with two individuals; in total, seven new individuals were found in new territories inside Botumirim State Park, bringing the known population to 27 individuals. An expedition to Serra das Araras in Mato Grosso, in December 2019, by Albert Aguiar and Marcelo Lisita, did not find any evidence of the species, nor even habitat similar to that in Botumirim. Serra das Araras was not highlighted by the model, but the species was reported from there in the 1980s (see Appendix G).
- Action 2.6 Use autonomous sound recorders to survey potentially suitable sites**
 – Twenty-nine autonomous AudioMoth recorders were installed in two locations in Botumirim State Park, generating 974 Blue-eyed Ground-dove records in 70,284 recordings.
- Action 2.7 Intensive study of nests to quantify all stages of reproductive success for Population Viability Analysis**
 – Searches for nests continue. Ten active nests have been found since the beginning of the project. Of these, chicks fledged successfully from three. The ideal period for studies on the reproductive biology of the species begins in December and probably lasts until May or June, the end of the rainy season. Nest construction appears to depend on the flowering of at least three everlasting/strawflower species (*Xyris trachyphylla*, *Leiothrix spergula* and *Comanthera dealbata*) that bloom after the onset of rains in the region (Bichinski 2020).

- Action 2.13 Study of other species in area with similar nests to identify nest predators, using nest cameras**
 – Seven camera traps installed inside SAVE Brasil's Reserve and Botumirim State Park (but not at nests of other species), revealing presence of potential predators of nests or birds, including opossums *Didelphis* sp., marmosets *Callithrix* sp., small felids *Leopardus pardalis* and *L. tigrinus*, foxes *Cerdocyon thous* and *Lycalopex vetulus*, Tayra *Eira barbara* and Crab-eating Raccoon *Procyon cancrivorus*. Other potential nest predators are likely to include raptors and snakes.
- Action 2.17 Develop a system to maintain and analyse data, including who will maintain data and security considerations, and data archiving with ICMBio**
 – Nest data maintained in a spreadsheet by A. Aguiar.
- Action 3.1 Establish project advisory committee, including Coordinator from Cerrado PAN**
 – Advisory committee proposed as: A. Owen, A. Eduardo Barbosa, B. Hennessey, C. Jones, C. Ruiz-Miranda, C. Cerbini, J. Wood, N. Collar, S. Bruslund and T. Bichinski. We propose to include Elivan Arantes de Souza from ICMBio and Monica Blackwell from Toledo Zoo in the advisory committee.
- Action 3.2 Define leadership of project**
 – The species conservation project is led by SAVE Brasil, in partnership with Parque das Aves. Parque das Aves will lead on off-site ex situ components, in partnership with SAVE Brasil. Project actions will be implemented by M. Lisita, A. Reisfeld, A. Aguiar, B. Phalan and B. Fernandes (with help from other SAVE Brasil and Parque das Aves staff where necessary), reporting to P. Develey, P. Bosso and C. Croukamp.
- Action 3.3 Identify fundraising possibilities and communicate to advisory group**
 – Funding applications were made to the EDGE of Existence, Anglo-American and European Outdoor Conservation Association, without success, and to National Geographic (awaiting decision). Funds were approved from American Bird Conservancy (Latin American Reserve Stewardship Initiative) and Marshall-Reynolds Foundation, to support management of the reserve, habitat protection, and searches for the species.
- Action 4.1 Establish MOU on publicity with partners**
 – Model Memorandum of Understanding received from J. Wood, but not yet developed further.

Action 4.2 Establish clear message from workshop

– Press release sent out after workshop, and publicity received by various of the organizations involved.

Action 4.3 Define how to communicate report

– Make sensitive information available only as supplement not publicly available
– Removal of sensitive information (species distribution model) from public version of report.

Actions not yet initiated (as of September 2021):

1.4, 1.8, 1.9, 1.11, 1.12, 2.1, 2.2, 2.3, 2.4, 2.8, 2.9, 2.10, 2.11, 2.12, 2.14, 2.15, 2.16, 2.18

ADDITIONAL UPDATE:

Support from SAVE Brasil/American Bird Conservancy to the fire brigade of the Botumirim State Park, by providing protective and fire-fighting equipment. Occurrence of four fires since the workshop – none inside SAVE Brasil's Reserve, all inside the State Park, including one fire at a site used by the doves for breeding.

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Marco Silva



Ciro Albano



Fabiana Rocha

Appendices



Albert Aguiar

APPENDIX A

Participant list

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Remote participation and modelling

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Workshop participation as observers

Name	Organization (contribution)
Fernanda Bento da Cunha	Parque das Aves (logistics, translation)
Henrique Tavares	Parque das Aves (nutrition)
Renato Yabiku	Parque das Aves (husbandry)
Yuri G. G. Ribeiro	Universidade de São Paulo (CPSG - facilitation training)



APPENDIX B

Agenda

Long-term conservation of the Blue-eyed Ground-dove (*Columbina cyanopis*) and Alagoas Antwren (*Myrmotherula snowi*): A decision model to evaluate and plan ex situ conservation actions, including captive breeding

Aim of workshop:

To define detailed protocols of specific ex-situ actions that can be implemented immediately to promote the conservation of the Blue-eyed Ground-dove and Alagoas Antwren.

In-situ conservation measures are already in place and underway for both species, but their respective Emergency Action Plans also call for ex situ measures to be implemented in support of their overall conservation strategies. This workshop will focus primarily on making decisions and specific plans for the ex-situ actions needed and will use IUCN SSC's Guidelines on the Use of Ex situ Management for Species Conservation and Guidelines for Reintroductions and Other Conservation Translocations to guide this process.

19 August, Monday: Introduction to participants and process

Participant arrival and introductions. Guided visit to Parque das Aves in afternoon.

18.00 Welcome on behalf of Parque das Aves, SAVE Brasil, CPSG, ICMBio (PAN)
Participant introductions

Introductory presentations:

- Overview of workshop aims and process (SAVE Brasil, Parque das Aves, CPSG)
- Introduction to the extinction vortex, the One Plan Approach and relevant IUCN SSC guidelines on ex-situ management and on conservation translocations (CPSG)

20 August, Tuesday: Potential ex-situ roles and strategies

08.00 Review of current knowledge on in-situ status and threats

- Overview of status and threats to Blue-eyed Ground-dove (Marcelo Lisita)
- Current and planned in-situ conservation actions for Blue-eyed Ground-dove (Albert Aguiar)
- Overview of status and threats to Alagoas Antwren (Hermínio Vilela, Ben Phalan)
- Current and planned in-situ conservation actions for Alagoas Antwren (Alice Reisfeld)
- Potential distribution and sites for reintroduction of Alagoas Antwren and Blue-eyed Ground-dove: Maxent modeling results (Katia Ferraz)

09.30 General overview of ex-situ expertise for related and comparable species (Ben Phalan)

10.00 BREAK (including group photo)

10.30 Review of definitions for potential roles for ex-situ management and for different conservation translocations

Plenary discussion – for each species:

- What are potential roles for ex-situ management and/or types of conservation translocations for each of the species, and what are the goals of these in terms of addressing threats and population viability?
- For each role, identify the different potential strategies to establish ex-situ populations or activities to fulfil the role.

13.30 Discussions to identify, for each ex-situ role:

- the characteristics of the program, including:
 - management methodology (what would you be doing)
 - demographic and genetic goals
 - important program timelines
 - physical setup/facilities
- rate/evaluate the relative conservation benefit
- identify any challenges/information gaps (and potential fixes)
- identify important risks (and potential fixes)
- evaluate feasibility and likelihood of success
- triggers (criteria) for initiating or ending specific actions

Once all potential strategies for a role have been discussed, determine which strategies to recommend for further development and discussion

Once all roles and their strategies have been analyzed, determine how the strategies under consideration might relate to each other and combine to form a comprehensive ex-situ program

18.00 End of workshop for the day

21 August, Wednesday: Recommended roles and strategies

08.00 Complete evaluation of roles and strategies

16.45 Finalize decisions and make revisions to recommended roles and strategies

18.00 End of workshop for the day

22 August, Thursday: Actions and next steps

08.00 For each of the selected strategies, identify actions, including:

- Description of action (including next steps)
- Responsible people
- Budget estimate and timeline

15.00 Final discussion/next steps

17.00 Close of workshop

APPENDIX C

Descriptions of ex situ roles

The roles listed below are based on a combination of the role descriptions in the IUCN SSC *Guidelines on the Use of Ex Situ Management for Species Conservation* (IUCN/SSC 2014) the IUCN SSC *Guidelines for Reintroductions and Other Conservation Translocations* (IUCN/SSC 2013), and those in Appendix I of the *Amphibian Ark Conservation Needs Assessment* (Amphibian Ark 2012).

Ark

Maintain a long-term ex situ population after extinction of all known wild populations and as a preparation for reintroduction or assisted colonization if and when feasible.

Insurance population

Maintain a long-term viable ex situ population of the species to prevent predicted local, regional or global species extinction and preserve options for future conservation strategies. These are typically species that are threatened and/or declining and for which it is unsure whether in situ threat mitigation will have the sufficient effect in a sufficient timeframe to prevent the extinction of the species or to prevent a dramatic decline in the numbers, populations and/or genetic diversity of the species. An ex situ population may be desired as an insurance population from which individuals can be taken for genetic and/or demographic supplementation or other conservation translocations as required, but these are not yet actively planned the foreseeable future.

Rescue population (temporary or long term)

Establish an ex situ population for a species that is in imminent danger of extinction (locally or globally) and requires ex situ management, as part of an integrated program, to ensure its survival. The species may be in imminent danger because the threats cannot/will not be reversed in time to prevent likely species extinction, or the threats have no current remedy. The rescue may need to be long term or temporary (for example, to protect from catastrophes or predicted imminent threats that are limited in time, e.g. extreme weather, disease, oil spill).

Demographic manipulation

Improve a demographic rate (survival or reproduction) or status (e.g. skewed sex ratio) in the wild, often of a particular age, sex, or life stage. An example is a head-start program that removes individuals from the wild to reduce high mortality during a specific life stage and then subsequently returns them to the wild.

Population restoration: Reintroduction

Serve as a source of individuals for population restoration to re-establish the species to part of its former range from which it has been extirpated.

Population restoration: Reinforcement

Serve as a source of individuals for population restoration to supplement an existing population (e.g. for demographic, behavioral or genetic purposes).

Conservation introduction: Ecological replacement

Introduce the species outside of its indigenous range to re-establish a lost ecological function and/or modify habitats. This may involve species that are not themselves threatened but that contribute to the conservation of other taxa through their ecological role.

Conservation introduction: Assisted colonization

Introduce the species outside of its indigenous range to avoid extinction of populations of the species.

Ex situ research and/or training

Use an ex situ population for research and/or training that will directly benefit conservation of the species, or a similar species, in the wild (e.g. develop monitoring methods; address data gaps in disease transmission or treatment). The research or training must address specific questions essential for success of the overall conservation strategy for the species. This can include non-threatened species serving as a model for threatened species or establishing ex situ populations of a threatened species to gain important species-specific husbandry and breeding expertise that is likely to be needed in the future to conserve the species.

Conservation education

Forms the basis for an education and awareness program that addresses specific threats or constraints to the conservation of the species or its habitat. Education should address specific human behavioral changes that are essential for the success, and an integral part of, the overall conservation strategy for the species. This primarily involves ex situ locations visited by the intended human audience.

APPENDIX D

Summary of previous in situ conservation actions

This document presents a brief background of in situ actions that have been carried out for the conservation of Alagoas Antwren (*Myrmotherula snowi*) and Blue-eyed Ground-dove (*Columbina cyanopis*). The antwren has been one of SAVE Brasil's conservation priorities since the beginning of the organisation as the Brazil Programme of BirdLife International in 2000. Actions for the dove are more recent, following its rediscovery in 2015. Detailed information about these on-the-ground actions was presented during the introductory part of the workshop.

Alagoas Antwren (*Myrmotherula snowi*)

The Alagoas Antwren is currently found only in Murici Ecological Station (ESEC Murici), a single fragment of Atlantic rainforest in the northeast of Brazil (state of Alagoas). SAVE Brasil has been working for the conservation of Murici since its beginning, in 2000, as the BirdLife International Brazil Programme. Over these 18 years, SAVE Brasil has worked with partners to guarantee the protection and conservation of this priority area that houses 14 threatened bird species, including the Alagoas Antwren. SAVE Brasil's efforts contributed to the establishment of Murici Ecological Station by the federal environment agency in 2001, covering 6,131 hectares of the 7,000 hectare Alliance for Zero Extinction site/Important Bird and Biodiversity Area (IBA). However, even as a legally protected area, the Ecological Station still lacks proper implementation.

Concerned about this scenario, SAVE Brasil is now back working at Murici through a new four year project that aims to restore the connectivity between Serra do Urubu and Murici, which are about 100 kilometers apart, and form one of the priority corridors for conservation in the Atlantic Forest. SAVE Brasil is working closely with the manager and staff of the Murici Ecological Station to identify the main challenges facing its implementation. In parallel SAVE Brasil had meetings with high-level representatives of the Ministry of Environment to communicate the urgency of effective protection. At local level, we are investigating the willingness of landowners to manage land for forest restoration. Suitable areas are those that adjoin the main block of forest at Fazenda Bananeira (Murici), and which are >500 m above sea level with enough soil to support forest restoration. SAVE Brasil is creating a database and map of properties, owners, local communities, conservation status, present state and willingness to restore.

Another key site for the species and for the project is Serra do Urubu (state of Pernambuco), which is a 1400-hectare forest fragment. It is also an IBA which until 2007 housed the Alagoas Antwren, and is now a potential site for translocation or reintroduction. In 2004, SAVE Brasil purchased a property and created a 360-ha private reserve in Serra do Urubu and started a conservation project. The total area of the reserve now totals 434 hectares, as a new property has just been incorporated. For the past 14 years, the project's conservation model allying surveillance, community engagement, restoration, bird monitoring and ecotourism has been successful in preserving this forest. In addition to halting charcoal exploitation and timber extraction, the project restored 40 ha of degraded forest. Bird monitoring shows that the forest has regenerated successfully – at the beginning of the

project, only three bird species were recorded in the restoration areas, and now this number has gone up to 40. Besides surveillance, community engagement has had a significant contribution in ceasing illegal practices. Adding to this conservation model, the project has been promoting tourism as a way to engage the community in forest conservation and as a source of income to contribute to the reserve's financial sustainability.

Regarding research focused on the Alagoas Antwren, Hermínio Vilela (Universidade Federal de Paraíba, previously Universidade Federal de Alagoas) has been studying the species focusing on population size, habitat, prey abundance, foraging behavior, food resource availability and color banding as part of his undergraduate and Master's projects (Vilela 2017, Vilela 2020).

Blue-eyed Ground-dove (*Columbina cyanopsis*)

Following the Blue-eyed Ground-dove's [rediscovery in 2015](#) by ornithologist Rafael Bessa in Botumirim (state of Minas Gerais), SAVE Brasil started fundraising with the support from BirdLife International and began a conservation project to protect this species in 2016.

In December 2017, SAVE Brasil purchased a 600-hectare reserve in Botumirim with support from Rainforest Trust. The boundaries were fenced and identified with signs, and daily patrols are carried out inside and around the reserve to monitor the area and the doves. In addition, eight camera traps are recording the presence of wildlife and domestic animals such as dogs, cats and horses, inside the reserve and State Park. The main objective is to monitor the presence of domestic dogs and cats inside the reserve as potential predators of the doves.

Since February 2018, the reserve has been receiving birdwatchers from all around the world and members of local community who come to see this rare species and its unique habitat. The visits of birdwatchers from abroad is also helping the local community, who is benefiting from tourism. Visits have to be previously scheduled and visitors need to be escorted by the project field assistant. Since its opening, the reserve has received 313 visitors.

In addition, the project also has a community engagement component. Up to July 2019, 373 students from eight schools had participated in educational and recreational activities. The residents of Botumirim are now using the dove as a symbol of the town in its local events and handicraft. Media coverage has been also important to reinforce their pride. Birdwatchers from the region have created the first bird club in Montes Claros, which is increasing the activity in the Espinhaço Range, while in Botumirim a small group of beginner birdwatchers is receiving training in the practice.

In parallel with its work on the private reserve, SAVE Brasil worked with the State government in a proposal to create a large public Protected Area in the region. In July 2018, the 36,000 hectare Botumirim State Park was established, overlapping with SAVE Brasil's reserve. Although the State Park is still in the early stages of implementation, its establishment was a milestone. Local NGO Instituto Grande Sertão had been advocating for its creation with the State Environmental Agency since 1999 and after being on hold for a long time, the rediscovery of the Blue-eyed Ground-dove and SAVE Brasil participation was able to accelerate the process.

Regarding research, the SAVE Brasil field team has been studying aspects of the Blue-eyed Ground-dove's natural history. Their objectives include estimates of population size and home range, descriptions of foraging and breeding behavior, characterisation of habitat, and searches for new areas of occurrence. Please see some of the results of this study in the species fact sheet (Appendix G of this report).

APPENDIX E

Summary of ex situ conservation actions defined in prior plans

This document presents the history of meetings held to create Emergency Action Plans for the conservation of two Critically Endangered species: the Blue-eyed Ground-dove (*Columbina cyanopsis*) and the Alagoas Antwren (*Myrmotherula snowi*). Both only have one known population and a small number of individuals. In light of this alarming situation, ex situ strategies were considered crucial for the survival of these species in their respective Action Plans. The objective is to establish viable populations in captivity for future reintroductions and population reinforcement in their historical ranges.

A summary of the strategies regarding ex situ conservation defined in these Emergency Plans is presented below.



Elaboração do Plano para a Conservação da Choquinha-de-Alaça (*Myrmotherula snowi*)

Data: 05 de agosto de 2016

Horário: 09:00 – 17:00

Local: Pousada dos Pirineus Resort - Chácara Mata do Sobrado, 80, Bairro do Ca Paraisópolis (GO)

Objetivo da reunião: Discutir um plano de conservação para *Myrmotherula snowi* medidas de curto, médio e longo prazo

Programação:

09:00 – Abertura, apresentação dos participantes, objetivos e dinâmica da reunião
Dr. Pedro F. Develley - SAVE Brasil

09:15 – A estratégia da American Bird Conservancy (ABC) para conservação da brasileira: Dr. Bennett Hennessey – ABC

09:45 – Monitoramento da Choquinha-de-Alagoas (*Myrmotherula snowi*) na Esta Ecológica de Maricá: Dr. Mircio Efe – UFAL

10:10 – A situação atual da Estação Ecológica de Maricá : Sra. Nelma Toledo ICA Gestora da ESEC Maricá

10:40 – Exemplos bem sucedidos de manejo de espécies de aves ameaçadas: Dr. J Olmos (Perman Global)

11:30 – Apresentação da planilha base para elaboração do plano (matriz lógica)

12:00 – 13:30 – Intervalo para almoço (servido no próprio local)

13:30 – Elaboração do Plano de Conservação

17:00 – Próximos Passos e Encerramento

SAVE Brasil (2016) Elaboration of plan for conservation of Alagoas Antwren (*Myrmotherula snowi*)



2019 - 2020
PLANO DE AÇÃO
PARA A CONSERVAÇÃO DA ROLINHA-DO-PLANALTO

SAVE Brasil (2018) Action plan for conservation of Blue-eyed Ground-dove

2016: Emergency Action Plan for Alagoas Antwren

A workshop to develop an Emergency Action Plan for Alagoas Antwren was held on 5 August 2016, in Pirenópolis, Goiás, Brazil, with 19 participants. The Plan defined five strategies, including “Species/habitat management”, which includes among its actions “Experiments for rearing *M. unicolor* in captivity” (Table E1). Besides, during the last revision of the National Action Plan (PAN) for the Conservation of Atlantic Forest Birds, one of the proposed objectives (Specific Objective 7) was the promotion of in situ and/or ex situ management of the species contemplated by the Plan, aiming for reintroduction and/or population reinforcement. Among the Actions, number 7.3 specifies the implementation of projects for reinforcement and/or reintroduction of target species, including *Myrmotherula snowi* (Table E2). Thus, the 2019 workshop organised by SAVE Brasil and Parque das Aves and summarised in this report aims to create a protocol for the captive breeding of *M. snowi* and *M. unicolor*, helping to accomplish this National Action Plan objective.

Table E1. Proposed Actions for Strategy 1 of the 2016 plan for Alagoas Antwren

Conservation Strategy	Action	Description
Strategy 1. Species/habitat management	1	Installation of feeders in known <i>M. snowi</i> territories
	2	Controlling nest predators of <i>M. snowi</i> and other <i>Thamnophilidae</i>
	3	Restoration of ecological relations through reintroduction of mixed flocks
	4	Translocation of <i>M. snowi</i> from Murici Ecological Station to Serra do Urubu
	5	Request SISBIO license for harvesting eggs in situ for establishing an ex situ population
	6	Experiment for rearing <i>M. unicolor</i> in captivity

Table E2. Proposed Actions for Objective 7 of National Action Plan for the Conservation of Atlantic Forest Birds

Objective	Action	Description
Objective 7. Promote in situ and/or ex situ management of the species contemplated by the National Plan (PAN) aiming for reintroduction and/or population reinforcement	7.1	Identify among the taxa listed in the PAN those that require Captive Breeding Programmes, and propose the creation of these programmes
	7.2	Identify among the taxa listed in the PAN those that require population reinforcement and/or reintroduction, as well as priority areas to release them
	7.3	Implement management programmes for reinforcement and/or reintroduction of the species contemplated by this PAN, in particular: <i>Myrmotherula snowi</i> , <i>Formicivora paludicola</i> , <i>Formicivora acutirostris</i> , <i>F. erythronotus</i> , <i>F. litorallis</i> , <i>Pauxi mitu</i> , <i>Crax blumembachii</i> , <i>Aburria jacutinga</i>

2018: Emergency Action Plan for Blue-eyed Ground-dove

A workshop to develop an Emergency Action Plan for the Blue-eyed Ground-dove was held on 1 September 2018, in João Pessoa, Paraíba, at the headquarters of CEMAVE (National Center for Bird Conservation) with 19 participants. The Plan defined 6 strategies, including “Species Management and Protection”, which the objective of “Implementing a programme for ex situ management of *Columbina cyanopsis*”. Thus, the 2019 workshop held by Parque das Aves and SAVE Brasil and summarised in this report aims to fulfill the actions identified in this objective (Create a protocol for captive breeding), and also to contribute to planning for other proposed actions (Table E3).

Table E3. Proposed Actions for Objective 4.1 of Strategy 4 (Species Management and Protection) of the 2018 plan for Blue-eyed Ground-dove

Objective	Action	Description
Objective 4.1. Implement ex situ programme for managing <i>Columbina cyanopsis</i>	4.1.1	Create advisory group to monitor the actions regarding reproductive management
	4.1.2	Search for partners and technical guidance for Blue-eyed Ground-dove captive breeding based on harvesting eggs from the wild
	4.1.3	Hold a workshop to plan ex situ management with the advisory group and partners
	4.1.4	Create a protocol for the species' captive breeding programme with support from the advisory group and partners after the workshop
	4.1.5	Request SISBIO license for harvesting eggs in situ for establishing an ex situ population
	4.1.6	Start the implementation of in situ management of the Blue-eyed Ground-dove

APPENDIX F

Species factsheet for Alagoas Antwren

Alagoas Antwren – *Myrmotherula snowi*

Status In Situ

1. Threat category

IUCN: Critically Endangered (2018); Lista Nacional: Critically Endangered (2014).

2. Population information

a. Distribution

The Alagoas Antwren *Myrmotherula snowi* is an endemic antbird from the Atlantic forest north of the São Francisco River. As far as we know it is now restricted to a single site, Estação Ecológica Murici (ESEC Murici) in the municipality of Murici (Alagoas), specifically in the Fazenda Bananeiras area. This is the site from which the species was described, and where the largest area of suitable habitat persists (Teixeira; Gonzaga, 1985; Pereira et al., 2014). ESEC Murici covers an area of 6,116 ha, but the forest is fragmented and with its irregular shape, heavily subject to edge effects.

There have been records of the species in only three other localities, all in the state of Pernambuco. However, despite multiple visits to each of these sites by experienced birders, Alagoas Antwren has not been recorded in Pernambuco since 2007. The most recent observations and subsequent observer effort at each of these localities in Pernambuco are summarised as follows:

- Mata do Estado, municipality of São Vicente Férrer: two males (adult and immature) and a female trapped in October 1999 at 515 m altitude (Roda et al., 2003). The species was not observed in mixed flocks. These observations extended the range of the species by 500 km to the north. There have been visits to this site by birders since then, in March 2009 and September 2014 but the species has not been recorded again since (e.g. <https://en.wikiaves.com/midias.php?tm=s&t=c&c=2613800&s=10903>).
- RPPN Frei Caneca, municipality of Jaqueira: there were multiple sightings of pairs or individuals of Alagoas Antwren on several dates in February, September and October 2003 (Mazar Barnett et al., 2005) and of a single female by Ciro Albano in December 2007 (see: <https://en.wikiaves.com/midias.php?tm=s&t=c&s=10871&c=2607950>). According to notes from Ciro Albano, the 2007 bird was the first and last time he recorded the species at Frei Caneca. According to eBird data, this area has received many visits from birders (including Ciro) since then especially since SAVE acquired a reserve, Serra do Urubu, in the area. Thus, its loss from this site is likely genuine. RPPN Frei Caneca covers 630 ha, but there are also additional forest fragments beyond the RPPN (Mazar Barnett et al., 2005).

- Mata do Benedito, Engenho Jussará, municipality of Gravatá: a single male was attracted by playback on 22 April 2005, and two sound recordings of the species were made in 2006. Ciro Albano wrote of one of these (translated from Portuguese) “Last documentation of this very rare species in the region. It’s necessary to return to know if it still persists but the fragment is very small.” (<https://en.wikiaves.com/midias.php?tm=s&t=c&s=10871&c=2606408>). According to Roda et al. (2009), the area has several fragments of mostly secondary semi-deciduous seasonal forest, totalling 400 ha. The fragment referred to as Mata do Benedito is “within a steep narrow valley that has a small creek in its bottom and a dense understory of lianas” (Roda et al. 2009). Ciro Albano returned at least once to the site, in June 2014 (<https://ebird.org/view/checklist/S22097905>) but did not record the species there again. Pereira et al. (2014) report searching Engenho Jussará and Gravatá without success.

Other sites. Extensive effort has failed to locate any further sites for the species at any of the following: Serra Grande and Serra dos Mascarenhas (Engenho Água Azul) (Roda et al., 2009); and Bonito, Maraial and Brejo dos Cavalos (Pereira et al., 2014). On the basis of this evidence, it seems reasonable to conclude that most or all of the remaining population exists at Murici.

b. Population size

From recent data from research on the species based on 56 Points Counts in ESEC Murici, it is estimated that the population is no more than 50 individuals and probably less than 30 individuals (in preparation, Vilela, 2019). However, see the topic *Population Trend* below.

c. Habitat and home range

Most often found in the interior of tall primary or mature forests, but has also been observed in secondary forest and near edges (Barnett; Carlos; Roda, 2005). The species has only been found in upland forest, at elevations described as being above 500 m (Roda et al. 2003), or between 400 and 550 m (BirdLife International 2019), and not in the coastal lowlands (Teixeira & Gonzaga 1985). Roda et al. (2003) describe trapping birds along two small streams in the interior of the forest. Descriptions of habitat from Mazar Barnett et al. (2005) include: “mature mossy-laden hilltop forest”, “tall and structured montane forest” and the understory of “low, secondary forest”. The Alagoas Antwren forages in the middle or lower strata of the forest, between about 1.5 and 9 m (mostly 5-8 m) above the ground (Whitney & Pacheco 1997). The species often associates with White-flanked Antwren *Myrmotherula axillaris* and other species in mixed flocks.

The typical habitat of the Alagoas Antwren was described by Roda et al. (2009) as “wet forests commonly clouded in mist, usually near small creeks where the undergrowth is rich in lianas”. The species has also been documented in two semideciduous seasonal forests – at Engenho Jussará, Gravatá-PE and Mata do Estado, São Vicente Férrer-PE (Roda; Carlos, 2003; Roda; Pereira; De Melo Dantas, 2009).

A provisional estimate of average territory size with minimum convex polygon method was 1.33 ha (n =3, minimum 0.75 ha and maximum 1.92 ha). However, these estimates did not stabilize over the period of observation, suggesting that with more time to follow and resight banded individuals, territory/home range size might be larger (Vilela, 2017).

d. Population trend

In conversation with Dante Teixeira (who described the species), he said that *M. snowi* was a commonly-encountered species in Murici in 1979. We have few systematic data on the species' natural history. In 2013 a colleague of Hermínio Vilela (Lahert William Lobo de Araújo, 2013) did a Master's project in the fragments of the APA of Murici, using tape playback in fragments of several different sizes. During this work, Alagoas Antwrens were only recorded in the main fragment (Fazenda Bananeiras). Subsequently to this there was the undergraduate project of Hermínio Vilela, where he surveyed as much as possible of the main fragment using playback in the period from May 2016 to March 2017 and made 22 visual or auditory records in different places (some of these records may have referred to the same individuals, since not all individuals were marked). During Hermínio's project he also refers to a total of 17 individuals captured between 2010 and 2017 in mistnets and marked with colour rings. Between Oct-2017 and May-2018, surveys including areas not previously visited found no new records of the species. This was part of research overseen by Márcio Efe. In 2019-20, students of Márcio Efe will return to retrap or resight as many of these individuals as possible to estimate survival rates. The most recent fieldwork conducted by Hermínio Vilela (Oct. 2018-Mar. 2019) recorded just 12 individuals at the site. This information may indicate a population reduction, but it is just a preliminary analyses and factors as detectability success should be considered for the population estimative.

3. Main threats

The primary threat to the species is loss of habitat. In the whole of the Atlantic Forest, the portion located to the north of the São Francisco River is among those that suffered most severe deforestation after European colonization, due to the exploitation of Brazil wood and sugarcane (Ministério do Meio Ambiente, 2006; Campanili; Prochnow, 2006; Ranta et al., 1998). Estimates of remaining forest cover depend on definitions and resolution of analyses, and for the northeast range from 2% (Alagoan Atlantic Slope) to 12% (Pernambuco Centre) of the original cover (Brooks & Balmford 1996; Ribeiro et al. 2009). Most of what remains is in small fragments which have been degraded by logging, fire and other stressors and are vulnerable to edge effects (Ribeiro et al., 2009). Livestock farming is now the most prevalent activity in the immediate vicinity of Murici, while other production systems including bananas (and other fruit) and tree plantations play a smaller role.

Hunting activity, although it is believed to have reduced somewhat compared to past levels, is still an activity that must be tackled at ESEC Murici, since it directly affects the dynamics of the community – for example, perhaps by suppressing larger mammals that might control the numbers of mesopredators (nest predators such as coatis) through trophic cascades.

A further potential threat mentioned in the BirdLife account is climate change, as the species has a montane distribution that is close to the maximum altitude within its range. A warmer or drier climate could potentially have both direct and indirect effects on the species, for example by reducing the capacity of the forest to retain humidity and to buffer daytime temperature fluctuations.

The breakdown of species associations is a candidate threat to the species. The Alagoas Antwren was commonly sighted foraging within mixed flocks (Barnett; Carlos; Roda, 2005; Whitney, Pacheco 1997; Teixeira; Gonzaga, 1985). However, the presence of nuclear flock-forming birds – such as Cinereous Antshrike *Thamnomanes caesius* and Red-crowned Ant-tanager *Habia rubica* – is now extremely rare in the places where *M. snowi* is observed. The former species may already have been extirpated in the northeast, with few individuals (n=8) of Red-crowned Ant-tanager recorded in the area, but the formation of mixed flocks was not observed (see: <https://www.wikiaves.com.br/midias.php?tm=s&t=b&o=dp&desc=1#>). The advantage for small insectivorous birds of joining mixed-species flocks is that they can rely on the vigilance of others to reduce predation risk and increase their foraging rates (Sridhar et al. 2009). The loss of nuclear flock-forming birds may thus have had a negative impact on the foraging success and/or survival rate of the Alagoas Antwren (Cestari, 2007; Develey; Peres, 2000).

4. Conservation actions

a. Existing activities

Currently a Master's project entitled Selection of habitat and resource availability of *Myrmotherula snowi* Teixeira & Gonzaga, 1985 (Aves, Thamnophilidae), a critically endangered species is underway (Hermínio Vilela), which intends to identify which are the most important factors involved in habitat selection by the bird at the Murici Ecological Station. We have also secured a grant from National Geographic to increase monitoring effort, collect more information on breeding success and survival, and explore the potential of different conservation interventions, including captive breeding. This work is a collaboration between SAVE Brasil, Parque das Aves, Universidade Federal da Bahia and Universidade Federal da Paraíba. A document with a history of all conservation efforts at the ESEC Murici and the other remaining forest in the region will be provided to workshop participants.

b. Key knowledge gaps

Data are needed to understand the population trend at Murici. Is the population stable or declining? For this, at least annual comprehensive counts throughout the area of suitable habitat are needed. A baseline for this was established in 2018-19.

We also need demographic data to understand the possible consequences of removing eggs or adults for captive breeding or translocation. This includes the number of nesting attempts per year, reproductive success, pre-reproductive survival and adult survival.

Information on breeding biology will be useful if captive breeding is attempted, particularly details of the diet fed to nestlings. Information on predators could help with in situ management, while information on habitat quality and food availability will be helpful when evaluating possible translocation sites (e.g. at Serra do Urubu).

Systematic searches of the species in other forest fragments should be done, in order to find new populations or to provide stronger evidence that species has been lost from these other sites.

c. Priority actions

A list of actions was defined at a workshop on this species in 2016, with 19 participants from the bird conservation community in Brazil (SAVE Brasil, 2016). This defined the following actions as important for the conservation of the species:

I. Management of the species and its habitat

- Install supplementary feeders
- Control nest predators
- Reintroduce nuclear mixed-flock dynamics
- Translocate individuals of *M. snowi* from Murici to Serra do Urubu
- Trial captive breeding of *M. unicolor*

II. Scientific research

- Model potential areas of occurrence of *M. snowi* in Alagoas and Pernambuco
- Expeditions to search for the species in other fragments
- Find individuals in small fragments outside the ESEC Murici and translocate
- Study the natural history of *M. snowi*
- Experiment with translocation of closely-related species
- Census of *M. snowi* in ESEC Murici
- Establish a protocol for collection of biological samples

III. Protected areas

- Internal articulation within ICMBio of the importance of intensifying implementation of conservation and management actions

IV. Landscape management

- Establish a program to restore forests and connectivity between fragments

V. Public policy

Articulate with leadership of ICMBio and MMA (the national environmental agency and ministry) a strategy to conserve Fazenda Bananeiras and Angelim (principal areas of forest at Murici) and others, with Renan Calheiros and family.¹

Some of these actions have been implemented to some extent, some are in the process of being implemented, while others have not yet been attempted. This list remains a useful guide to the most important actions needed for the conservation of the species.

5. Reproductive biology

a. Age of first breeding

Unknown. Mean age at first breeding in the genus *Myrmotherula* is estimated at one year in the BirdLife International World Bird Database (unpublished), extrapolated from mean values for other genera in Passeriformes of similar size and ecology. In another antbird species, *Thamnophilus atrinucha*, in Panama, individuals did not breed until the second year after fledging (Tarwater et al. 2011).

¹ Renan Calheiros is a prominent politician and he and his family own much of the land within and around the ESEC Murici

b. Mating system

Presumably monogamous and pairs for life, like almost all antbirds where this has been studied (Del Hoyo et al. 2003). Most antbirds also defend territories year-round.

c. Clutch size

As with other species of *Thamnophilidae*, as well as *M. axillaris* of the region, the normal clutch size is expected to be two eggs. The incubation period is unknown. In other antbirds it is usually 14–16 days, but up to 20 days in some species (Del Hoyo et al. 2003). Nestlings remain in the nest for 8–9 days in the closely-related White-flanked Antwren (Del Hoyo et al. 2003).

d. Breeding season and nesting interval

We tentatively estimate that the breeding season of the Alagoas Antwren runs from October until March. A female with an egg in the oviduct was collected on 9 February (Teixeira & Gonzaga 1985), and juveniles in the company of their presumed parents were observed in January and February (H. Vilela personal observation) and in May (Teixeira & Gonzaga 1985). Eggs possibly hatch in November and December, because the observation of juveniles are since December. Juveniles of other antbird species begin moulting from juvenile to adult plumage within a month of leaving the nest, but can remain with their parents for up to three or four months, even after the adults have started to nest again (Del Hoyo et al. 2003). It is not known if this applies to the Alagoas Antwren. It seems very likely that a pair is capable of more than one nesting attempt each year, but we do not have any data to show that. The only suggestive evidence for multiple breeding attempts is that old nests which were identified in 2018 as pertaining to this species are among the most commonly-observed type of nests at Murici (M. Efe, T. Bichinski, personal observation).

e. Rate of breeding success

There is no available information for the Alagoas Antwren and very few information for other species, however during the period from September 2014 to January 2016 the field team working at Murici Ecological Station encountered 19 active nests of the following species: *Conopophaga melanops* (n=3), *Chiroxiphia pareola* (n=2), *Ramphocaenus melanurus* (n=1), *Manacus manacus* (n=1), *Nyctidromus albicollis* (n=1), *Thamnophilus aethiops* (n=1), *Florisuga fusca* (n=1), *Dysithamnus mentalis* (n=1), *Myrmotherula axillaris* (n=1) and seven other unidentified nests. Through the camera traps monitoring the follow predators were identified: South America coati (*Nasua nasua*) (n=3), one marsupial or rodent, one hawk (*Pseudastur polionotus*), one snake and one Argentine giant tegu (*Salvator merianae*).

6. Natural history

a. Longevity and survival rate

No data available. There is an individual followed by Hermínio Vilela during his undergraduate studies that was marked in 2010, and 2017 was the last time it was observed, so the species can live to at least seven years. Although searches have continued in the territory and areas close to where that individual was captured, until today he has not been rediscovered, except for a day when H. Vilela found a male without a color ring in the same place, but the same has not appeared since. According to the BirdLife International World Bird Database (unpublished), “maximum longevity” in *Myrmotherula* species is 5 years.

However, this is based on four recaptures of a single individual of Star-throated Antwren *M. gularis* (Lopes et al. 1980), and is likely both an underestimate of potential longevity in *Myrmotherula*, and unrepresentative of *M. snowi*.

Estimated annual adult survival rates in other “grey” *Myrmotherula* species are 0.57 in *M. longipennis* and 0.60 to 0.87 in *M. axillaris* (Jullien and Clobert 2000). A mean annual survival rate of 0.759 for the genus *Myrmotherula* is reported in the BirdLife International World Bird Database (unpublished).

b. Generation length

Estimated at 5.1 years (BirdLife International 2019). Generation length is calculated based on extrapolated mean age at first breeding and extrapolated mean annual survival (BirdLife International World Bird Database, unpublished).

c. Body size

10.5 cm. The male is predominantly gray in color, but with a black macula on the throat, very similar to *M. unicolor*, whereas in the female a rufous brown predominates (Teixeira; Gonzaga, 1985). As pointed out by Teixeira and Gonzaga (1985), young have a coloration similar to that of adult females.

d. Social organization

Usually they live in pairs, except for young (newly adult) males, which can be seen wandering among territories.

e. Daily movements

Few data available. H. Vilela and A. Andrade have collected some data from colour banded individuals and the maximum distance observed is approximate 700 m, based on an adult male captured on 10th December 2018 and recaptured some days after on 17th December 2018. According to the BirdLife International World Bird Database (unpublished), mean and maximum dispersal distance can be estimated at 1–9 km (extrapolated from mean values for other genera in Passeriformes of similar size and ecology).

f. Diet

Arthropods gleaned from live and dead leaves. The stomachs of specimens collected contained the remains of spiders and insects, including beetles, cockroaches and ants (Teixeira and Gonzaga 1985). Other prey items include orthopterans (Tettigoniidae) and caterpillars (Lepidoptera) (Del Hoyo et al. 2003). In terms of feeding rates, there is no information, but with other antbird species, nestlings are fed 1-5 times per hour, which would imply 0.5–2.5 feeds per nestling per hour (Del Hoyo et al. 2003).

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APPENDIX G

Species factsheet for Blue-eyed Ground-dove

Blue-eyed Ground-dove – *Columbina cyanopsis* (Pelzeln, 1870)

Status In Situ

1. Threat category

Columbina cyanopsis is considered Critically Endangered, following an amended version of the 2016 assessment (BirdLife/IUCN, 2018) where it was classified according to the criterion **C2a(i)**. Criterion **C2** refers to an observed, estimated, projected or inferred continuing decline in the population, and **a(i)** means the number of mature individuals in each subpopulation is less or equal to 50 (IUCN, 2012). At the national level, it was listed as possibly extinct in the assessment made in 2016 (ICMBio/IBAMA, 2018), aside from being attested as regionally extinct in the state of São Paulo (São Paulo, 2018).

IUCN: Critically Endangered (2016); **Brazilian national list:** Critically Endangered (2018); São Paulo: Regionally Extinct (2008).

2. Population information

a. Distribution

The Blue-eyed Ground-dove (*Columbina cyanopsis*) is an extremely rare Columbiforme (Sick 1965, Sick 1985) endemic to the Cerrado formations in Central Brazil (Sick 1997). This species is historically rare and known from just eight specimens collected in more than one century, between 1823 and 1941 (Baptista, Trail, and Horblit 1997). Due to its historical rarity, *C. cyanopsis* is considered one of the greatest mysteries of ornithology (Collar et al. 1992). Until the 1950s, extensive areas of potential habitat included in their known occurrence range still presented a reasonable level of conservation (Conservation International 1999, Cavalcanti 1999) and even so, there is no known documentation after the 1940s. Between the 19th and 20th centuries, only eight specimens were collected in three distinct localities (Baptista, Trail, and Horblit 1997), and these represented the only documented records until 2015. The Blue-eyed Ground-dove was described by von Pelzeln (1868-1971) from a series formed by five individuals collected by Johann Natterer from 1824 to 1825 near the city of Cuiabá, Mato Grosso (MT), mid-western Brazil (von Pelzeln 1868-1971). This area remained as the only known location for the occurrence of *C. cyanopsis* until 1901, when Ernst Garbe, a travelling naturalist from the Museu Paulista de Zoologia obtained a male specimen in the town of Itapura, alongside the margins of Paraná River, on the border between São Paulo and Mato Grosso do Sul (von Ihering and von Ihering 1907, Pinto 1937, Pinto 1945). Despite searches throughout many regions of Brazil, the species was only observed again between 1939 and 1941, when Walter Garbe obtained one male and one female individual in Fazenda Transvaal, in Claro River's valley, municipality Cachoeira Alta, South of Goiás (Pinto 1945, Pinto 1949). Since the last time it was collected, only non-documented records were reported. However, considering its natural rarity (Collar et al. 1992), the total unfamiliarity regarding its habitat needs, as well as its similarity with *C. talpacoti* (Sick 1997, Batista et al. 2015) and other congeners, such records should be interpreted with extreme caution, once they can represent possible identification misconceptions. This suspicion is strengthened by

the great variety of environments and situations in which such records were reported. One of these records reports *C. cyanopis* in the vicinity of Cuiabá-MT in the 1980s in a “rice field after harvest” (D.M. Teixeira in litt. 1987 *apud* Collar et al. 1992). In February 1986, a “small population” was reported in Serra das Araras Ecological Station (E.E.S.A) in an area of grassland Cerrado in the state of Mato Grosso (Silva and Oniki 1988), although the species was not reencountered on the following year in a search conducted in the area (J.M.C. da Silva in litt. 1987 *apud* Collar et al. 1992). In October 1992, Parker and Willis (1997) reported what they believed to be *C. cyanopis* in a gallery forest border along with *C. talpacoti* individuals in Campo Grande, Mato Grosso do Sul. Once again, the species was not found in the same place after a new search conducted in November 1993 (Parker and Willis, 1997). In March 2007, the Blue-eyed Ground-dove was reported again in E.E.S.A, when an individual was supposedly observed in a rocky outcrop (*cerrado rupestre*) site drinking water from a puddle, along with three *C. talpacoti* individuals (Valadão 2012). Despite the collected individuals and the non-documented observations, the species’ natural history, including vocalization, breeding, habitat, and feeding remained a complete mystery until recently. The few available information is contradictory in many times, not allowing a more precise definition of its habitat needs. The long period without unquestionable evidence regarding its permanence in nature, associated to the high anthropogenic pressures on the cerrado’s vegetation since half of the 20th century (Parker and Willis 1997, Conservation International 1999, Cavalcanti 1999) has led some authors to consider the possibility of *C. cyanopis* already being extinct in the wild. This scenario only came to change in April 2015 when ornithologist Rafael Bessa came across a small population of this species in Botumirim, Minas Gerais, in the central portion of the Espinhaço Ridge. In 2017, SAVE Brasil established the Blue-eyed Ground-dove Nature Reserve, a plot of land where the species’ core population was rediscovered. The project to protect the species held by SAVE Brasil has helped to create the Botumirim State Park, which encompasses the private reserve totalling 36,000 hectares where 5 subpopulations of *C. cyanopis* had confirmed occurrence (until July 2019). In addition, the Espinhaço Range Biosphere Reserve has grown in its second phase, approved on July 2019, strengthened also by the species presence. The current knowledge indicates that the species is patchily distributed and strongly associated with a quartzitic rocky outcrop and its related white-sand ecosystem. According to Silva (2008), this kind of ecosystem is dominated by Poaceae, Cyperaceae and Eriocaulaceae families (Silva 2008).

b. Population size

The current population size (N=20) refers to the known individuals recorded in Botumirim since 2015. Until now, there is a consensus among Brazilian researchers related to the species conservation project to not band any individual from *C. cyanopis*, which turns the complete count harder to achieve, even using census methods in the portions of the study area with higher probability to find the species. The fieldwork has been focused on the monitoring of the known sites where the species is recorded. In addition, in January 2018, a team with five experienced ornithologists undertook searches in the known sites of *C. cyanopis*, using transects and radio-communication to record the species population size. Fifteen individuals were recorded in three different sites in a two-day simultaneous search. In February 4 individuals were found in a hitherto unknown site, which we have considered to be additions to those 15 individuals, considering its small movements through the

landscape. Finally, a fledgling was found in May 2019 adding a new individual in the known population. Eight nests were found until now in two territories since 2017, two eggs were naturally predated in May 2018 and a hatchling have died on February 2018, probably caused by heavy rains, a day after we have installed a trail camera to record it.

Year	Individuals recorded in Botumirim
2015	11
2016	11
2017	12
2018	15
2019	20

c. Habitat and home range

The species has been recorded at altitudes from 729 m to 944 m, with an average of 788 m. The 20 currently known individuals are divided into five subpopulations inside the limits of the Botumirim State Park. The current occurrence data shows an EOO of 28,000 km² (the real EOO is 21,014 km², and thus, changed to make it equal of AOO, as suggested by IUCN) and an AOO of 28,000 km² following IUCN default for this statistic, analyzed with GeoCAT software. Accurate information about the *C. cyanopsis* home range was not analyzed yet due to the absence of banding, but measurements from two couple indicate an area of three hectares each, approximately.

d. Population trend

Since 2015, when the species was recorded in Botumirim for the first time, eleven individuals were usually found in two subpopulations, about 7 km distant in a straight line. Inside the species' reserve, three individuals are recorded almost every day, but a number as high as 6 individuals were recorded there, showing, probably, movements across patches of habitat or lower detectability, which is less likely following our experience. The new additions from 2017 until now refer, basically to a fledgling and new areas of species detection. Once the entire area is now protected by a State Park, the species may have fewer threats. Although the species might be restricted to the white sand ecosystems, several expeditions in similar areas were executed in the Espinhaço Range, without new occurrence areas outside Botumirim.

3. Main threats

The Blue-eyed Ground-dove is a naturally rare species and its associated knowledge is scarce. However, the best knowledge available indicates that *C. cyanopsis* is patchily distributed in the matrix and it might impose survival challenges. The species occupies restricted portions of the Cerrado, best known as rocky outcrops, a quartzitic formation in with smaller patches are covered by white-sand soil sites. Cerrado is proclaimed to be the most threatened biome in Brazil today, after losing half of its original vegetation cover, mainly in the last five decades (Tollefson, 2018). A spillover effect from conservation measures in Amazon may have helped to increase the Cerrado vegetation loss (Dou 2018).

The rocky outcrops formations from Cerrado are being explored in the last centuries by mining, cattle ranching (Silva 2008) and ultimately by silviculture/eucalyptus plantations (Espírito-Santo 2016). Fire is a natural component of the Cerrado, but the species is threatened by human-caused fires for clearing the land for small crops. Besides these broader threats, this tame species might also be impacted by collisions with motor vehicles, children shooting with slingshots and invasive exotic species like domestic cats and dogs. Rock formations seem to limit domestic hoofed animals in the species' habitat and, thus, does not appear to be a major threat. There are, however, areas with potential habitat for the species that have been degraded by small cattle farms. Another limitation that may threaten the Blue-eyed Ground-dove is water pumping and/or damming, limiting the naturally intermittent water flow in small courses through the species' habitat, since it seems to preferentially occupy sites near water bodies.

4. Conservation actions

a. Existing activities

Currently, a Master's project entitled "Biology and Conservation of the Blue-eyed Ground-dove, *Columbina cyanopis* Pelzeln, 1870 (Aves, Columbidae), a critically endangered species" is underway (Bruno Rennó), which intends to identify species' reproductive and foraging behavior, its home range and current distribution. SAVE Brasil has an ongoing project which is also allowing the species monitoring and data collection for the master's thesis. Besides the species monitoring and research, SAVE Brasil carries out activities for area protection (public policy), habitat protection, environmental education, tourism and community engagement (see the in-situ conservation activities document).

b. Key knowledge gaps

Data are needed to understand the population trend at Botumirim. Is the population stable or declining? For this, at least annual comprehensive counts throughout the area of suitable habitat are needed. We also need demographic data to understand the possible consequences of removing eggs or adults for captive breeding or translocation. This includes the number of nesting attempts per year, reproductive success, pre-reproductive survival and adult survival. Information on breeding biology will be useful if captive breeding is attempted, particularly details of the diet fed to nestlings. Information on predators could help with in situ management, while information on habitat quality and food availability will be helpful when evaluating possible translocation sites (e.g. at the unoccupied site in Botumirim State Park). Systematic searches for the species in other cerrado fragments should be done, in order to find new populations or to provide stronger evidence that species are currently occupying only the Botumirim State Park area.

c. Priority actions

The Blue-eyed Ground-dove has a Species Action Plan, created by a team of 19 professionals from the bird conservation/ornithology community in Brazil on September 2018, listing several needed actions to protect the species:

- i. Public policy
 - Incorporate actions from the Action Plan for the Conservation of the Blue-eyed Ground-dove into the National Action Plan (PAN) for the Conservation of Birds from the Cerrado and Pantanal;
 - Include compatible actions resulting from the Action Plan for the Conservation of the Blue-eyed Ground-dove in PAN Birds from the Cerrado and Pantanal, following ICMBio's scope and criteria;
 - Encourage policies for controlling the populations of cats and dogs (spaying and neutering), and promoting educational campaigns regarding responsible pet ownership in Botumirim;
 - Evaluate the implementation of Brazilian Law n. 13.426/2017 (regards spaying and neutering of cats and dogs) in Botumirim, by contacting the town's Secretariat of Health;
 - Create a responsible pet ownership campaign in Botumirim.
- ii. Habitat management
 - Implement an Emergency Response Plan for dealing with threats resulting from fire at the Blue-eyed Ground-dove Nature Reserve;
 - Establish a partnership with Plantar/Diflor to integrate actions from the company's fire surveillance and control system, to include the Blue-eyed Ground-dove Nature Reserve and Botumirim State Park inside their area of influence;
 - Seek support from Botumirim's local government and the State's Forest Institute (IEF - Instituto Estadual de Florestas) for the implementation of the emergency plan;
 - Create firebreaks surrounding the Blue-eyed Ground-dove's range inside the Reserve (17 ha).
- iii. Landscape and protected areas management
 - Contribute to the implementation of Botumirim State Park, focusing in the correct definition of priority areas for the Conservation of the Blue-eyed Ground-dove;
 - Assess the State Parks's necessities that could be either facilitated or executed by SAVE Brasil, along with the IEF's department responsible for implementing and managing protected areas;
 - Create Risk Analysis and Emergency Management Plan against fires in the Blue-eyed Ground-dove Nature Reserve, in accordance with PMI (Project Management Institute);
 - Implement interpretative trails at the Blue-eyed Ground-dove Nature Reserve;
 - Integrate pre-existing trails, firebreaks and new trails for the creation of interpretative trails for tourism and research at the Reserve.
- iv. Species management and protection
 - Implement a programme for ex situ management of *Columbina cyanopis*;
 - Create an advisory group to monitor the actions regarding reproductive management;
 - Search for partners and technical guidance for Blue-eyed Ground-dove captive breeding based on harvesting eggs from the wild;
 - Hold a workshop to plan ex situ management with the advisory group and partners;
 - Create a protocol for the species' captive breeding programme with support from the advisory group and partners after the workshop;
 - Request SISBIO license for harvesting eggs in situ for establishing an ex situ population;
 - Start the implementation of in situ management of the Blue-eyed Ground-dove.

v. Research and monitoring

- Understand the limiting factors for survival of the Blue-eyed Ground-dove;
- Identify threats to the Blue-eyed Ground-dove by using camera traps and monitor the use of the Reserve by dogs;
- Build fences to contain the entrance of cats and dogs inside the major breeding area for the Blue-eyed Ground-dove, in case Action 5.1.1 shows this necessity;
- Increase knowledge about *C. cyanopis* population size, demography and aspects of its natural history;
- Implement continuous monitoring of *C. cyanopis* by conducting census (point counts and autonomous recorders);
- Describe habitat/micro-habitat of the species by selection analysis (models);
- Investigate phenological aspects of the vegetation used by Blue-eyed Ground-dove;
- Monitor nests using inspection and/or action cameras;
- Use data from the cameras and census to determine the home range of the individuals;
- Continuous collection of biological material found in the field;
- Conduct genetic analysis of the biological material found in the field;
- Consolidate a search programme for new areas of occurrence of the Blue-eyed Ground-dove;
- Conduct searches in protected areas of the region (northern Serra do Espinhaço) and investigate sites indicated by people from the local community;
- Create a minimum protocol for searching the species in new areas by birdwatchers using a simple questionnaire with effort and negative data, integrating information from eBird;
- Coordinate continuous participatory searches for the species involving birdwatchers lead by SAVE Brasil;
- Identify potential areas for releasing individuals from captivity.

vi. Communication and publicity

- Intensify communication actions about the Conservation of the Blue-eyed Ground-dove;
- Create a campaign to disseminate the Blue-eyed Ground-dove as one of the flagship species for the Conservation of the Cerrado and the importance of searches in potential areas for the species' occurrence;
- Create a website/landing page with interactive media about the species (history, conservation actions, and searches for new areas);
- Publish two papers in scientific journals with the results of research about the Blue-eyed Ground-dove;
- Reunite co-authors and create a plan for publishing the research;
- Submit papers to scientific journals according to the plan;

5. Reproductive biology

a. Age of first breeding

Unknown for the Blue-eyed Ground-dove. Cintra (1988) reported that a Ruddy Ground-dove male banded as a nestling was seen incubating eggs in a nest at the age of three months, suggesting sexual maturity. Baptista et al. (2019) emphasize that most pigeons do not breed until a year-old, however, they say, it is common among some species as in Common Ground-dove, Ruddy Ground-dove, American Mourning Dove and Eared Dove to breed around 3 months old.

b. Mating system

Unknown, presumably monogamous. Baptista et al. (2019) show that the general pattern for other pigeons and doves, at least during the breeding season is the same. A couple of *C. cyanopsis* has been observed defending its territory inside the private reserve from another male since 2018. It is difficult to attest, yet, that the same individuals form this couple, always seen in the area. The male performs aerial displays associated with territory defense but also other displays during courtship, similar to other Columbidae. In another observed courtship behavior, the male fanned his tail raising the body and tilting the trunk down while performing the "trill" voice. Both sexes build the nest together. It seems that the male has greater responsibility for choosing and collecting material for nest building, but female collects also. The female seems to have more responsibility in building the nest, receiving from male the material and then braiding the material. The male was observed feeding the female while it was incubating the eggs. Both sexes take care for the nestlings, which hatch bared-skin and with eyes closed.

c. Eggs and nest

The general rule for Columbiformes is a clutch size containing two eggs (Pinto 1949), usually one in *Patagioenas* genus, according to (Sick 1997). *Columbina cyanopsis* follows the pattern, given that we have observed two nests filled with two white and immaculate eggs. The shape and size resemble those from *C. talpacoti*, that according to Marini et al. (2010) are ellipsoid-shaped. The eggs from *C. talpacoti* have a length of 20–24.5 mm in length and 15.2 to 18.5 mm in width, according to Hart (2011), which may be similar to *C. cyanopsis* due to its similar size (15.5 cm). Eggs from *C. talpacoti* weigh 2 to 4.2 g following Cintra (1988) an approximate value for *C. cyanopsis* could be extrapolated from it. The Blue-eyed Ground-dove builds its nest usually 1–2.5 m above the ground inside the dense foliage formed by the rounded crown from *Humiria balsamifera* (Aubl.) A.St.-Hil (Humiriaceae) and sometimes of *Macairea radula* (Bonpl.) DC. (Melastomataceae). The nest is a shallowish cup made of sticks, roots and pedicels of everlasting plants (semper-vivas), besides *Panicum* cf. *poliophyllum* (Poaceae) and *Comanthera dealbata* (Eriocaulaceae).

d. Breeding season and nesting interval

Unknown. Although *C. cyanopsis* might breed all year-round as other ground-doves, the nesting season seems to be more intense during the wet season. In the northern portion of Espinhaço Range, the annual precipitation follows a cycle divided between dry and wet seasons, being the rains accumulated from October to April, December is the wettest month with precipitation of 220 mm, 23% from the annual rainfall. We have observed that after some days of rainfall the species become more active, which includes territory defense, sexual displays and copula. One of the two nests observed with eggs was registered in May (dry season). The hatchling that died on the nest occurred in February 2018, whereas the twentieth individual, a fledgling was recorded in April 2019. *C. talpacoti* has an incubation period of 12 to 13 days, sometimes with consecutive clutches.

e. Rate of breeding success

Unknown. Although the Blue-eyed Ground-dove was observed in sexual behavior year-round, just two active nests were recorded, with 100% loss due to predation (N=4 eggs). A hatchling has died in a third nest and just one nestling was recorded until now. According to Cintra (1988), 67.3% of 422 eggs laid by Ruddy Ground-dove have hatched. Cintra (1988) have shown also that from the 32.7% eggs lost, predation was responsible in 70.1% of the time, while 13.9% were abandoned, 13.1% were infertile, 0.7% caused by flushed parents after human interference and the remaining 2.2% were lost for unknown reasons.

6. Natural history

a. Longevity and survival rate

No data available for the Blue-eyed Ground-dove. Cintra (1988), however, reported rates of survival for *C. talpacoti* of 58% for hatchling and 63.3% for a nestling to achieve a fledgling age.

b. Generation length

No data available. Marini et al. (2010) found an incubation period of 14 days, followed by 12.9 days of development for the hatchling of Ruddy Ground-dove. Cintra (1988) found that *C. talpacoti* have incubated the eggs for 12 days and hatchlings remaining in the nest for 9 to 15 days. Fledgling individuals of *C. talpacoti* remained near the parents for 25 days (Cintra 1988).

c. Body size

15.5 cm (Pinto 1949, Sick 1997). Wings 6.9 cm ♂, 6.7 cm ♀ and tail 6.7 cm ♂, 6.4 cm ♀ (Pinto 1949). *C. talpacoti*, comparing with, has a body size measuring from 15 to 18 cm (Baptista et al. 2019), its wings measure an average of 9 cm and its tail 6.9 on average (Pinto 1949). The congener *C. minuta* has a body size of 15 cm, whereas the wings are, on average, 7.6 cm and the tail 5.7 cm. It seems, thus, that *C. cyanopsis* has the smallest wing proportion relative to its size compared with its congeners. The Blue-eyed Ground-dove seems like to have a wing loading (mass related to total wing area) higher than other *Columbina*, which could indicate that this dove has less lift (flight capacity) than its congeners. We have observed an adult of *C. cyanopsis* flying in a straight line for 60 meters approximately, it was the maximum already recorded. Our experience shows that the species have low movements in the landscape, which can be influenced by its flight capacity.

d. Social organization

Few data available shows that the species usually live in pairs, a strong pair bond may exist. Small groups seen in other ground-doves were not recorded for *C. cyanopsis* yet. We have not seen the species with its congeners as well, even though *C. talpacoti* and *C. minuta* occur in the area with less regularity. Historical non-documented observations before 2015 usually have presented this interaction, another reason that those observations should be interpreted with caution.

e. Daily movements

No data available. Walk on the ground, use rocks while foraging and to hide. Small flights

observed inside its territory. Three individuals of the Blue-eyed Ground-dove often disappear from SAVE Brasil's reserve which could indicate movements across the matrix.

f. Population size

20 individuals divided into five subpopulations.

g. Diet

The species capture seeds by pecking it in the ground as well as walking in puddles while capturing seeds and small insects in the water surface, also seeking below leaves, as Leaf-tossers do. We have observed *C. cyanopis* capturing small seeds while perched in a stalk. The species seems to prefer the seeds of *Panicum* cf. *poliophyllum* (Poaceae) and *Lagenocarpus rigidus* (Cyperaceae).

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APPENDIX H

Table of prioritized actions for Alagoas Antwren

The following table was developed immediately after the workshop with a small set of participants, and identifies conservation actions for Alagoas Antwren, with a focus on ex situ and intensive population management actions. Responsible parties, funding sources, timelines and assessment of priority are included. Actions listed as “Critical” are those we consider need to happen; “High” are important but might depend on results of other actions; and “Medium” are desirable but not essential to the survival of the species. Actions are further colour-coded by their status as of September 2021 when this report was prepared, as shown in the following summary:

Status	Critical	High	Medium
Completed	4	0	3
Underway	5	4	2
Underway but with delays or problems	2	2	3
Action not yet initiated	7	5	4

Progress on these actions was affected by the covid-19 pandemic during 2020, which interfered with fieldwork and also had a severe effect on the staffing and financial situation of the main organisations involved.

Action	Responsible parties	Funding	Timeline	Priority
<i>1. Build staff capacity and physical structures for ex situ management and better understanding of biology of antbirds (using model species)</i>				
1.1 Obtain research permit to take birds and eggs [of model species] from the wild (SISBIO)	SAVE Brasil & Parque das Aves & Iguacu National Park supported by CEMAVE/ICMBio	-	End Oct 2019	Critical
1.2 Develop and evaluate capture and transport methods with adult or juvenile birds (family groups? Inside/outside breeding season?)	SAVE Brasil & Parque das Aves & UFAL, UFPB supported by expert facilities (advisory group)	SAVE Brasil/National Geographic	Start when permits are available	Critical
1.3 Develop and evaluate husbandry and other ex situ techniques for adult birds (including temperature variation; disease screening, prevention & treatment; diet)	Parque das Aves & SAVE Brasil supported by expert facilities (advisory group)	Parque das Aves/National Geographic	Start when permits are available	Critical
1.4 Identify staff who have a talent for management of these species, building on experience we already have with passerines	Parque das Aves	Parque das Aves	Ongoing	Critical

1.5 Develop and evaluate methods for nest finding and collection, handling, transport of eggs	SAVE Brasil, Tony Bichinski, UFAL, UFPB, Parque das Aves, supported by expert facilities (advisory group)	Parque das Aves/National Geographic	Depends on progress with adults	Critical
1.6 Develop and evaluate methods for incubation and hand-rearing from eggs	Parque das Aves, Tony Bichinski & SAVE Brasil, supported by expert facilities (advisory group)	Parque das Aves/National Geographic	Depends on progress with adults	Critical
1.7 Produce best practice guidelines for application to Alagoas Antwren, considering field experience from Murici	Parque das Aves, Tony Bichinski, SAVE Brasil, UFAL & UFPB, supported by expert facilities (advisory group)	To be secured	By Aug 2021	Critical
1.8 Develop an exit strategy for the model species – what to do with ex situ birds? (Education? etc)	Parque das Aves & SAVE Brasil	-	By end 2022	High
2. Build staff capacity and physical structures for ex situ management of <i>M. unicolor</i>				
2.1 Establish if work on <i>M. unicoloris</i> needed	Parque das Aves & SAVE Brasil	-	By Aug 2021 (preferably earlier)	High
2.2 Identify suitable partner within <i>M. unicolor</i> range	Parque das Aves & SAVE Brasil	-	By Aug 2021	High
2.3 Adapt and transfer methods from initial work with model species	Parque das Aves & SAVE Brasil	To be defined	Depends on decision	High
3. Develop ex situ program for Alagoas Antwren				
3.1 Investigate feasibility for in-range field site for ex situ management (UFAL Sugarcane Research Centre? CETAS? Alagoas curassow project/Fernando Pinto?/CESMAC?/Serra do Urubu?)	UFAL (Marcio Efe), supported by Parque das Aves & SAVE Brasil	-	Start initial conversations soon (end Nov 2019)	Critical
3.2 Develop ex situ facilities in Alagoas (might be best to have multiple sites)	Parque das Aves & SAVE Brasil, with support of UFAL and expert advisory group	Need to be secured	Action plan to be developed	Critical
4. Research on antbirds, <i>M. unicolor</i> and <i>M. snowi</i>				
4.1 Use nest cameras to identify nest predators, starting with other species in Murici	UFAL (Marcio Efe, Arthur Andrade), UFPB (Herminio Vilela), Tony Bichinski, with support from SAVE Brasil, Parque das Aves, CPSG (Fabiana Rocha) and expert group	National Geographic	Ongoing	High
4.2 Determine least risky method to monitor nests of <i>M. snowi</i> , including work with model species	UFAL (Marcio Efe, Arthur Andrade), UFPB (Herminio Vilela), Tony Bichinski, with support from SAVE Brasil, Parque das Aves, and expert group	National Geographic	Initial assessment end Mar 2020	Critical
4.3 Literature review of methods to deter, exclude or control likely nest predators	Parque das Aves (Ben), UFAL (Marcio, Arthur), UFPB (Herminio), CPSG (Fabiana) with input from advisory group	-	By end Dec 2019	High

4.4 Design and test methods for deterring or excluding predators at Murici, using nests of other species and/or artificial nests (including possible trophic cascades) – jaquar poo, lure, fences...	Parque das Aves (Ben), UFAL (Marcio, Arthur), UFPB (Herminio), CPSG (Fabiana) with input from advisory group	National Geographic &?	Start Oct 2019	High
4.5 Investigate feasibility and effectiveness of predator control methods	Parque das Aves (Ben), UFAL (Marcio, Arthur), UFPB (Herminio), CPSG (Fabiana) with input from advisory group	National Geographic & additional source to be determined	2020	Medium
4.6 Encourage research by others to quantify predator abundance and distribution at Murici	Local universities?	To be determined	-	Medium
4.7 Analyse food abundance through the season to address whether it is actually a problem	UFPB (Herminio Vilela) with support from rest of group	UFPB	Ongoing	High
4.8 Test effectiveness of light traps or other methods to create local concentrations of potential food for antwrens (test on <i>M. unicolor</i> ?)	To be determined	To be determined	To be determined	Medium
4.9 Quantify breeding trajectories and success of <i>M. snowi</i> and <i>M. unicolor</i> (in areas with high density of <i>unicolor</i>) and identify causes of loss e.g. fertility and predation	UFAL (Marcio Efe, Arthur Andrade), UFPB (Herminio Vilela), Tony Bichinski, with support from SAVE Brasil, Parque das Aves, and expert group – collaboration with universities?	To be determined	To be determined	Critical
4.10 Quantify feeding rates of <i>M. snowi</i> and <i>M. unicolor</i> (in areas with high density of <i>unicolor</i>)	UFAL (Marcio Efe, Arthur Andrade), UFPB (Herminio Vilela), Tony Bichinski, with support from SAVE Brasil, Parque das Aves, and expert group – collaboration with universities?	To be determined	To be determined	High
4.11 Assess evidence for problem with mixed flocks and options for researching and restoring the dynamic	Parque das Aves, SAVE Brasil and others	To be determined	To be determined	Medium
4.12 Collect and bank genetic material from wild population (samples from 3-4 individuals are already available)	UFAL with support from others	-	Ongoing	Critical
4.13 Investigate genetics of wild population	SAVE Brasil to connect with USP (Cristina Miyaki)	To check	Ongoing	Critical
4.14 Validate Species Distribution Modelling by surveying potential new sites in field	SAVE Brasil supported by USP (Katia Ferraz, Alex Bovo)	To be secured for fieldwork	Ongoing – the most promising sites to be visited by 1 Mar 2021	High
4.15 Re-photograph bird with white feathers over time to assess any change in plumage, and survival	UFAL (Marcio, Arthur), UFPB (Herminio) with support from Marlow (Simon)	-	Opportunistic	Critical

4.16 Quantify survival estimates through playback with photography and trapping ringed birds (and sample genetics) – if decided as necessary	UFAL (Marcio, Arthur), UFPB (Herminio)	Secured	Ongoing	Critical
4.17 Identify microhabitat variables important for <i>M. snowi</i>	UFPB (Herminio) & SAVE Brasil	Secured	Ongoing	Critical
4.18 Literature review of other small populations of passerines (recovery potential)	To be defined	-	To be defined	Medium
4.19 Carry out PVA analysis	Parque das Aves/CPSG/ researcher (to be defined)	-	Jul 2020	High
4.20 Collect abandoned nests to identify parasites and understand nest construction and materials	Tony Bichinski to advise	-	Ongoing	Medium
4.21 Determine where collected nests can be archived	UFAL with support from others	-	Ongoing	Medium
4.22 Develop a system to maintain and analyse data, including who will maintain data and security considerations, and data archiving with ICMBio	UFAL, UFPB, SAVE Brasil, Parque das Aves, with advice from Associação Mico-leão Dourado/CPSG/ICMBio	-	By 1 Dec 2019	Critical
4.23 Develop an agreement on data ownership and publication ethics, using existing agreements as model	UFAL, UFPB, Parque das Aves/SAVE Brasil with advice from ABC (Bennett)	-	By 1 Aug 2020	Medium
5. Project management				
5.1 Establish project advisory committee, including Coordinator from Mata Atlantica PAN	SAVE Brasil & Parque das Aves	-	Ongoing, formalise by 1 Dec 2019	Critical
5.2 Define leadership of project	SAVE Brasil & UFAL & Parque das Aves	-	Done	Critical
5.3 Identify fundraising possibilities and communicate to advisory group	All	-	Ongoing	Medium
6. Communication				
6.1 Establish MOU on publicity with partners – use learning from ground-dove project	Parque das Aves/SAVE Brasil with advice from others – Toledo (Joe Wood)			Medium
6.2 Establish clear message from workshop	ABC, Parque das Aves, SAVE Brasil	-	After lunch	Medium
6.3 Make presentations and action plan, table available to workshop participants (Google Drive)	CPSG (Fabiana Rocha)	-	End Aug 2019	Medium

APPENDIX I

Table of prioritized actions for Blue-eyed Ground-dove

The following table identifies conservation actions for Blue-eyed Ground-dove, with a focus on ex situ and intensive population management actions. Responsible parties, funding sources, timelines and assessment of priority are included. Actions listed as “Critical” are those we consider need to happen; “High” are important but might depend on results of other actions; and “Medium” are desirable but not essential to the survival of the species. Actions are further colour-coded by their status as of September 2021 when this report was prepared, as shown in the following summary:

Status	Critical	High	Medium	Undefined
Completed	4	1	2	0
Underway	4	1	2	0
Underway but with delays or problems	3	4	2	0
Action not yet initiated	7	1	8	1

Progress on these actions was affected by the covid-19 pandemic during 2020, which interfered with fieldwork and also had a severe effect on the staffing and financial situation of the main organisations involved.

Action	Responsible parties	Funding	Timeline	Priority
<i>1. Build staff capacity and physical structures in preparation for egg collection in 2021</i>				
1.1 Recruit and train local person(s) in nest finding and monitoring and intensive observation/resighting of adults	SAVE Brasil (Marcelo), with support of Tony Bichinski	To be secured	Jan 2020	Critical
1.2 Train Parque das Aves staff in ex situ management and hand rearing	Parque das Aves, with guidance and visit from experts	Parque das Aves	Jan-Aug 2020	Critical
1.3 Develop/synthesize protocols on dove hand-rearing	Parque das Aves, with guidance from experts	Parque das Aves	Starting now	Critical
1.4 Develop task profile of extra seasonal fieldworkers/volunteers (nest monitoring, other fieldwork) and recruit if deemed necessary	SAVE Brasil	To be secured	By 1 Dec 2019	High
1.5 Develop task profile of extra/volunteer zoo staff to help with ex situ management and recruit if deemed necessary	Parque das Aves	Parque das Aves	By 1 Dec 2019	Medium
1.6 Define and develop emergency facilities for receiving eggs/chicks/adults in 2020	Parque das Aves, with guidance from experts	Parque das Aves	By 1 Dec 2019	High
1.7 Identify and rent/buy house	Parque das Aves and SAVE Brasil	To be secured	Start immediately	Medium now, High 2020, Critical 2021
1.8 Secure permits to take eggs/young (ICMBio)	Parque das Aves and SAVE Brasil	-	Start immediately v. apply by 1 Oct 2019	Critical
1.9 Secure permits for ex situ facility (state level)	Parque das Aves and SAVE Brasil	-	Start immediately v. apply by 1 Oct 2019	Critical

1.10 Construct/adapt ex situ facilities for model species	Parque das Aves	To be defined	Ongoing	Critical
1.11 Construct/adapt ex situ facilities for cyanopis	Parque das Aves	To be defined	Ongoing	Critical
1.12 Develop training and emergency protocol with local veterinarians/rescue centre (CETAS Montes Claros)	Parque das Aves and SAVE Brasil	-	Ongoing	High
1.13 Develop emergency protocol for rescuing eggs/nestlings/adults	Parque das Aves, with guidance from experts	-	By 31 Dec 2019	High
2. Research				
2.1 Habitat selection research (and habitat change)	BirdLife (Nigel Collar) in consultation with UENF (Carlos Ruiz), USP (Katia Ferraz), all to be alert for possible students	To be secured (State or federal MSc/PhD scholarship)	Project proposal by mid-Nov (Selection at beginning of Dec)	Critical
2.2 Find a vegetation ecologist/land use historian who knows about Cerrado	Student (literature review)	-	If/when student starts research	Medium
2.3 Collect and bank genetic material from wild population using non-invasive/opportunistic sampling (faeces – including from nests, egg membranes, dropped feathers)	SAVE Brasil	-	Ongoing	Critical
2.4 Investigate genetics of wild population	Universidade de Brasilia (Renato Caparroz)	To check	Ongoing	Critical
2.5 Validate Species Distribution Modelling by surveying potential new sites in field, both in Botumirim State Park and more widely in Cerrado	SAVE Brasil supported by USP (Katia Ferraz, Alex Bovo)	To be secured for fieldwork	Ongoing – the most promising sites to be visited by 1 Aug 2020	Critical
2.6 Use autonomous sound recorders (Audiomoth) to survey potentially suitable sites	SAVE Brasil (maybe with Christian Andretti)	ABC	Ongoing – the most promising sites to be visited by 1 Aug 2020	High
2.7 Intensive study of nests to quantify all stages of reproductive success for Population Viability Analysis	SAVE Brasil (data collection), CPSG Brazil (advice on data needed)	Not needed?	Ongoing	Critical
2.8 Develop protocols for catching small <i>Columbinas</i> and sampling them – literature research on Brazilian researchers working on these species	Parque das Aves	-	End 2020	Critical
2.9 Quantify survival estimates through individual ringing and resighting (and sample genetics) – if decided as necessary	Experienced team coordinated by SAVE Brasil, analysis UENF (Carlos Ruiz)	-	Delay until advisory committee determines low risk to wild population	Not defined (on hold)
2.10 Investigate use of photos to identify individuals	Birder to be identified by SAVE Brasil	-	By 1 Dec 2019	Medium
2.11 Carry out PVA analysis	Parque das Aves/CPSG/researcher (to be defined)	-	When field data available (end 2021)	Medium

2.12 Artificial nest study to identify nest predators (not in immediate area of nesting ground-doves)	-	To be secured	-	Medium
2.13 Study of other species in area with similar nests to identify nest predators, using nest cameras	SAVE Brasil field team	To be secured	Start Jan 2021 (collect opportunistic data before then)	Medium
2.14 Analyse existing behavioral data	Identify researcher in consultation with Carlos Gussoni, BirdLife (Nigel Collar), UENF (Carlos Ruiz)	Determine if needed?	Identify researcher by 1 Dec 2019	Critical
2.15 Collect abandoned nests to identify parasites and understanding nest construction and materials	Tony Bichinski to advise	-	Ongoing	Critical
2.16 Determine where collected nests can be archived	SAVE Brasil with input from others	-	Ongoing	Medium
2.17 Develop a system to maintain and analyse data, including who will maintain data and security considerations, and data archiving with ICMBio	SAVE Brasil, Parque das Aves, with advice from Associacao Mico-leão Dourado/CPSG/ICMBio	-	By 1 Dec 2019	Critical
2.18 Develop an agreement on data ownership and publication ethics, using existing agreements as model	Parque das Aves/SAVE Brasil with advice from ABC (Bennett)	-	By 1 Aug 2020	Medium
3. Project Management				
3.1 Establish project advisory committee, including Coordinator from Cerrado PAN	SAVE Brasil & Parque das Aves	-	Ongoing, formalise by 1 Dec 2019	Critical
3.2 Define leadership of project	SAVE Brasil & Parque das Aves	-	Done	Critical
3.3 Identify fundraising possibilities and communicate to advisory group	All	-	Ongoing	Medium
4. Communication				
4.1 Establish MOU on publicity with partners	Parque das Aves/SAVE Brasil with advice from others – Toledo (Joe Wood)	-	-	Medium
4.2 Establish clear message from workshop	ABC, Parque das Aves, SAVE Brasil	-	After lunch	Medium
4.3 Define how to communicate report – make sensitive information available only as supplement not publicly available	Draft to approved by advisory group	-	Draft distributed by 1 Nov 2019	High
4.4 Make presentations and action plan, table available to workshop participants (Google Drive)	CPSG (Fabiana Rocha)	-	End Aug 2019	Medium
4.5 Define how to communicate new locations – disclose discovery but not location & raise awareness of risk	Advisory committee	-	Ongoing	Medium
4.6 Pursue CITES listing for the species	BirdLife (Nigel Collar)	-	By end 2019	Medium

APPENDIX J

Emergency rescue protocol for Blue-eyed Ground-dove

This protocol was developed after the workshop by B. Phalan, with input from other participants, to guide actions in the field should the need arise to rescue eggs, squabs or injured adults. The guiding principle of such rescue is that it should be undertaken as a last resort, after efforts to ensure the safety of individuals in the wild have been exhausted, and when there is a clear and imminent risk of death unless a rescue is initiated.

Facilities and equipment will need to be prepared in anticipation of a possible rescue. These are detailed further below. In the event of a rescue, it is anticipated that the field team will be assisted by experienced personnel from Parque das Aves. Within the Parque das Aves team, it is a priority to develop and maintain routines that can be implemented with a high level of confidence.

Rescue of eggs

Eggs should be rescued if it is clear that they have been abandoned by the adults. This might occur after a traumatic event, such as one of the adults being killed by a predator. If a nest appears to have been abandoned, but there is no evidence of such an event, eggs could be rescued and replaced with dummies, and returned to the nest if the adults later return. Even eggs that have been cold for some hours may still be viable, so if in doubt, persist with rescue efforts.

Eggs should be placed for local transport in a rigid container thickly lined with soft material, and cushioned individually to prevent breakage. They should be incubated at 37.5 °C and 50–55% humidity. The recommended incubator is the INCA 100 model, or similar, with opportunity for automated turns above 12 times a day. A reliable electricity supply is needed to avoid unwanted temperature fluctuations. Ideally, eggs should be candled to examine their development, and weighed on a balance with at least 0.01 g precision to track and document loss of mass. Viable eggs are expected to lose 13–18% of their mass over the course of incubation. Fostering eggs is also an option (see next section on nestlings).

Rescue of squabs

Squabs should be rescued if it is clear that their survival in the wild is unlikely. This could be because they have been abandoned, are seriously unwell, are at immediate risk from a predator that cannot be scared away from the nest, or if one of the adults suffers a mortality while the nestlings are still less than a week old. Bearing in mind that successful hand-rearing of nestlings is very challenging, if there is doubt it is better not to intervene.

Squabs should be transported in a cardboard box or other container thickly lined with soft material, with sufficient ventilation to avoid any risk of suffocation.

Whether squabs are fostered or hand-reared will depend on the prior establishment and intensive management of a colony of foster doves, and on field staff experience with both methods. A foster colony should include multiple pairs in established pairs, conditioned to using stable nest platforms and managed to have disjunct breeding cycles. The most receptive pairs should be identified in advance by exchanging squabs with those of other pairs.

Emergency treatment of abandoned or ill nestlings may be needed, if they are dehydrated or detrimentally affected by opportunistic parasites such as flies, mites or ticks. Dehydration is best addressed with subcutaneous injections in an emergency situation or with a non-responsive chick. For treatment one of the research targets of the Parque das Aves team and others should be to determine *Columbina* spp. nestlings' sensitivity to common and easily applied anti-parasite drugs such as ivermectin for emergency cases.

Hand-rearing small doves, especially in the first few days after hatching, is challenging, but possible with experience. Feeding is with a commercial crop milk formula. The preferred method is to use a disposable pipette with the end snipped off to leave a hole c.4 mm in diameter. The squab's bill can then be inserted into this, allowing it to feed in much the same way as it would from a parent bird. Crop-tubing might be appropriate with older squabs which refuse to feed voluntarily. Nestlings should be kept at a temperature of 37 °C, which can be gradually reduced as they grow older.

It is important that intake at the first few feeds is sufficient to cause the crop to expand. Newly-hatched nestlings should not be fed for the first 12 hours after hatching or until they have defecated outside the shell. The crop should be kept full during the day and allowed to empty completely overnight.

Fostering can be done with a broody pair of Ruddy Ground-doves or Diamond Doves. The pair will need to have eggs or chicks at a very similar stage to those fostered, or they may not be producing the right sort of crop milk (or any). Any birds in a foster colony will need to be rigorously screened for parasites or diseases.

If nestlings require veterinary care, please consult immediately with the Parque das Aves team. When fledged, it will be necessary for nestlings to socialise with others of their species before being released. Ideally, any such nestlings should be reared with their siblings so they can socialise. Birds that are hand-reared or fostered, therefore, might not be suitable for release, although this should not be ruled out for these individuals based on individual assessments. Later birds should be given the opportunity to socialise in an aviary with conspecifics, and pairs that form can be separated to a breeding aviary.

Rescue of fully-grown adults/juveniles

Fully-grown individuals should be rescued if they are injured or obviously unwell, unless the temperature is very high (35 °C) or above, in which case birds should not be handled for risk of overheating. They should be transported in a cardboard box or similar container, with sufficient ventilation to avoid suffocation, and protected from direct sun. Obvious dehydration may need immediate treatment with subcutaneous injections of Ringer's lactate fluids. Any unwell individual will require a prompt examination by a veterinarian. Inquiries should be made to find an appropriate veterinarian in Botumirim if possible, who could receive specific training at Parque das Aves. Photos, videos and explanation of what has happened should also be sent immediately to Parque das Aves, and a veterinarian with experience of treating wild birds will be dispatched to Minas Gerais if appropriate.

Any such bird should be kept in a cage indoors initially to facilitate treatment and examination, with adequate ventilation, several perches, and temperature maintained at 26–28 °C. It should be provided with water and a mix of small seeds, and newspaper changed twice daily to remove droppings. The interior of the roof of the cage should be lined with soft material to prevent injuries from the bird flying up and hitting its head. Material from a foam mattress or yoga mat are suitable. A low-roof cage design will also help. The cage should be taken outside each morning for 1–2 hours so that the bird has an opportunity to experience natural sunlight (with the option of also perching in the shade if it wishes).

To the extent possible, the bird should be protected from loud noises, sudden movements, and very bright lights. If there is a risk of dehydration, some water can be given at the time of rescue from a syringe, but otherwise, handling should be minimised until the bird can be seen by a veterinarian. When recovered, the bird can be moved to an outdoor aviary, preferably also with soft side panels to prevent injury.

Facilities and equipment required

An incubation room will be needed, which can also serve as a space for caring for nestlings or fully-grown birds. It needs an electricity supply, temperature control (air conditioning), and access to clean water. An incubator, brooder and/or cage can be installed on a bench or table, with space for food preparation. Temperature and humidity should be monitored with a digital thermometer. If foster birds are to be used, indoor or outdoor aviaries or large cages will be required, and, daily care will need to be guaranteed.

In terms of staff, one person (full-time) will be needed to care for eggs for up to two weeks until hatching. For hand-rearing nestlings, two people (full-time) will be needed to care for and feed them for two weeks until they fledge. For fully-grown birds (or fostered nestlings) one person (full time) will be needed to provide care and make observations. For a foster colony, two people will be needed to ensure daily care.

Equipment for rescuing eggs:

- Dummy eggs
- Rigid container with soft material for egg transport
- Incubator INCA 100 (two units)
- Light for candling (LED penlight)
- Electronic balance (precision at least 0.01 g)
- Calipers

Equipment for rescuing nestlings:

- Rigid ventilated container with soft material for nestling transport
- Brooder (if hand-rearing)
- Feather duster (if hand-rearing)
- A heating lamp (with replacement bulbs)
- Kitchen towels
- Towels
- Plastic containers
- Feeding syringes
- Commercial crop milk mix
- Electronic balance (precision at least 0.01 g)
- Refrigerator
- Electric kettle, or other means to heat water
- Thermometer (minimum 3 units)
- Hygrometer
- Latex gloves
- Remote camera for monitoring

Equipment for rescuing fully-grown birds:

- Cardboard box or other container for transport
- Bowls for food and water
- Bird seed mix (composition to be determined)
- Cage with padded ceiling
- Supply of newspaper

Biosecurity

Rigorous biosecurity protocols will be essential to minimise the risks of disease transmission to the wild population. Cages and aviaries should be cleaned on a regular schedule to avoid buildup of uneaten food or faeces, and to reduce the risk of attracting pests (and especially, wild doves or other birds). Foster birds should undergo screening for diseases that could be transferred to the Blue-eyed Ground-dove. We do not recommend treating Blue-eyed Ground-doves with broad-spectrum antibiotics or anti-parasite treatments unless absolutely necessary, as they might support unique parasite species. Access or proximity to domestic poultry such as chicken or ducks must be prevented.

Potential diseases to screen for to prevent entry to wild:

- *Chlamydophila* spp. (Ornithosis, Psittacosis)
- *Salmonella*
- Trichomoniasis
- Toxoplasmosis
- Coccidiosis
- Paramyxovirus (e.g., Newcastle disease)
- Avian Circovirus
- Avian Polyoma virus
- Flavoviridae (e.g., West Nile)
- Adenovirus

Biological samples

Biological samples should be retained from each individual taken into human care, whether egg, nestling or fully-grown bird. Eggs that fail to hatch should be measured, and blown to examine and preserve the contents while preserving the shell dry. The membrane and shell from eggs that hatch can be preserved dry. Tissue samples should be stored in ethanol (at least 70%, and preferably 100%) for later genetic analysis. Samples of blood and muscle should be taken from any birds that die or are found dead and stored in ethanol. If there is no other option, samples should be stored dry, and never discarded. Dead birds should be measured, weighed, and stored in a freezer in a sealed plastic bag, with the digestive tract closed off with plugs of damp cotton wool, for later autopsy and permanent preservation. Feathers, swabs and faeces can be collected from birds that require veterinary care. Parasites detected including flies, lice, mites and ticks should be collected and preserved in ethanol as they may represent threatened or undescribed species. All samples should be carefully and immediately labelled with permanent marker with date, species, and individual identification number.

WORKSHOP REPORT AND PROGRESS UPDATE

