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COMMENTARY

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A call-to-action to assist in efforts to protect owl monkeys (*Aotus* spp.)

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Abstract

The majority of the 11 species of owl monkeys (*Aotus* spp.) have declining populations or are listed as data deficient. Deforestation due to agriculture, development, or logging poses threats to owl monkeys throughout their range. In some areas, *Aotus* are hunted for bushmeat or trapped for the wildlife trade. In Colombia, the country with the greatest number of *Aotus* species, owl monkeys are also threatened by civil unrest. To help combat these challenges, nonprofit organizations and field researchers in habitat countries have successfully implemented a variety of conservation projects such as censusing and monitoring owl monkey populations, establishing protected areas, reforesting degraded areas, filing lawsuits to protect wild populations, helping law enforcement with environmental regulation, and promoting environmental education. We highlight some of the conservation successes and suggest actions people around the world can take to contribute to these important efforts.

KEYWORDS

conservation, environmental education, night monkey, nonprofit organization, threat

1 | IMMINENT THREATS TO *AOTUS*

There are at least 11 species of owl monkeys (*Aotus* spp.) (Defler & Bueno, 2007), possibly 12 (Martins-Junior et al., 2022), ranging from Panama to Northern Argentina. For those species that have been adequately censused, their populations are declining and many face the risk of extinction. Five species are most at risk: *Aotus miconax* is listed as endangered (EN) (Shanee et al., 2020) and *Aotus brumbacki*, *Aotus griseimembra*, *Aotus lemurinus*, and *Aotus nancymaae* are listed as vulnerable (VU) (Carretero et al., 2020; Link et al., 2021a; Link et al., 2021b; Maldonado et al., 2017) by the International Union for Conservation of Nature (IUCN). *Aotus zonalis* is listed as near threatened (Table 1) (Méndez-Carvajal & Link, 2021). With the exception of species with unknown population trends (*Aotus jorgehernandezi*, *Aotus nigriceps*, *Aotus vociferans*, and *A. zonalis*), populations are decreasing (IUCN, 2023). Deforestation is a major threat to *Aotus* as trees in the areas they inhabit are harvested for wood and land is cleared for small-scale and industrialized agriculture, cattle ranching, urbanization and infrastructure, mining operations, and illegal crops (Maldonado & Waters, 2020; Shanee et al., 2015). In many parts of their range, they are hunted (Altherr, 2007; Mena et al., 2000; Méndez-Carvajal, 2019; Méndez-Carvajal et al., 2023; Shanee et al., 2023; Zapata-Ríos et al., 2009).

In addition, owl monkeys are also trapped for the wildlife trade. According to the Convention on International Trade in Endangered

Abbreviations: CITES, Convention on International Trade in Endangered Species; EN, endangered; FCPP, Fundación Pro-Conservación de los Primates Panameños; HIV, human immunodeficiency virus; IAVH, Instituto de Investigación de Recursos Biológicos Alexander von Humboldt Institute; ICGES, Instituto Conmemorativo Gorgas de Estudios de la Salud; IUCN, International Union for Conservation of Nature; NGO, nongovernmental organization; VU, vulnerable.

TABLE 1 Conservation status, distribution, and major threats (proximate human activities that have high or medium impacts on the status of a taxon) to the various species of *Aotus* according to the IUCN Red List (IUCN, 2023). Major threats are proximate human activities that have high or medium impacts on the conservation status of a taxon.

Species	Conservation status	Geographic range	Major threats
Aotus azarae	Least concern	Argentina, Bolivia, Brazil, Paraguay, Peru	HL, D, A, M, H/T
Aotus brumbacki	Vulnerable	Colombia	HL, D, A, L, EP, CU
Aotus griseimembra	Vulnerable	Colombia, Venezuela	HL, D, A, H/T, L, CU
Aotus jorgehernandezi	Data deficient	Colombia	CU, UK
Aotus lemurinus	Vulnerable	Colombia, Ecuador, Venezuela	HL, D, A, M, L, CU
Aotus miconax	Endangered	Peru	HL, D, A, M, RR, H/T, L
Aotus nancymaae	Vulnerable	Brazil, Colombia, Peru	HL, A, H/T, L, CU
Aotus nigriceps	Least concern	Brazil, Bolivia, Peru	HL, D, RR, H/T
Aotus trivirgatus	Least concern	Brazil, Venezuela	HL, A, RR, L
Aotus vociferans	Least concern	Brazil, Colombia, Ecuador, Peru	HL, D, A, H/T, L, CU
Aotus zonalis	Near threatened	Colombia, Panama	HL, D, A, M, RR, L, CU

Abbreviations: A, agriculture; CU, civil unrest; D, development; EP, energy production; HL, habitat loss; H/T, hunting/trapping; L, logging; M, mining; RR, roads and/or railways; UK, unknown.

Species (CITES) trade database (http://trade.cites.org/), an average of 1100 wild-caught live individuals were traded with CITES registration permits per decade since 1974, although since 2005 only captive-bred individuals have been exported through CITES (Shanee et al., 2023). Peru and Brazil have been the main exporting countries, and the United States has received the majority of imports (Shanee et al., 2023). Most of these exports have been for biomedical research (Shanee et al., 2023). In Panama, *A. zonalis* was used for malaria and other blood parasite studies since the 1930s (Thatcher & Porter, 1968). Later, the Instituto Conmemorativo Gorgas de Estudios de la Salud (ICGES) together with the United States used *A. zonalis* for a variety of epidemiological studies (Obaldía et al., 2018). *Aotus* are also used for ophthalmological research (their large eyes and pupils provide clear views of the fundus; Ogden, 1994) and for research into the human immunodeficiency virus (HIV), as they are resistant to HIV-1 (Sayah et al., 2004). The international trade of owl monkeys for biomedical research registered through CITES has declined over the past few decades, and since 2006, the only sources reported are from breeding colonies in Peru (Shanee et al., 2023). In Panama, *A. zonalis* continued to be collected by the United States and ICGES until 2004 (Méndez-Carvajal, 2019). Despite national bans by most habitat countries on primate exports and the initiation of captive breeding programs, illegal trafficking of *Aotus* for biomedical research continues (Svensson et al., 2017). This illegal trade occurs primarily in the tri-border area of Brazil, Colombia, and Peru (Maldonado et al., 2023; Maldonado & Waters, 2017; Shanee et al., 2023).

The Colombian government still permits the capture of *Aotus* for use in malarial research, as well as their subsequent release back into the wild after the research has been completed (Maldonado et al., 2023; Maldonado & Lafon, 2017). For instance, permission was granted for the capture of 400 *A. nancymaae* and *A. vociferans* per year (2020–2022) for use by a single biomedical laboratory (Corpoamazonia, 2020). These permits promote the illegal trade from Peru, as Colombian nationals who reside in Peru are listed as collectors (Maldonado & Lafon, 2017). Given their small size, cute appearance, and docile nature, owl monkeys throughout their range are also trapped for the pet trade (Cornejo et al., 2008; Maldonado et al., 2023; Svensson et al., 2017). Relatively little research and public attention have focused on the trafficking of wild primates in South America (Maldonado & Waters, 2017). Extrapolated data from surveyed markets in wildlife trafficking hotspots such as Belen market in Iquitos, Peru, and confiscations carried out by local police in Leticia, Colombia, suggest that governments are likely to be under-reporting the numbers of *Aotus* trafficked in these regions (Mendoza et al., 2022; Maldonado & Waters, 2017; Shanee et al., 2023).

2 | CONSERVATION EFFORTS THAT NEED SUPPORT

Because owl monkeys are arboreal, live in small groups, and are active at night, they could disappear from forests without notice. In addition to enforcing government regulations and international conventions, there is a need for research, education and conservation-related initiatives to prevent further population declines (Maldonado, 2018). Recent efforts by nonprofit organizations and field researchers aim to protect *Aotus* by helping to census and monitor changes in population size, establish protected areas, promote reforestation, collaborate with authorities in improving capacity building and law enforcement, and facilitate environmental education (Figure 1). Below, we summarize conservation efforts and work with local communities to conduct research and protect owl

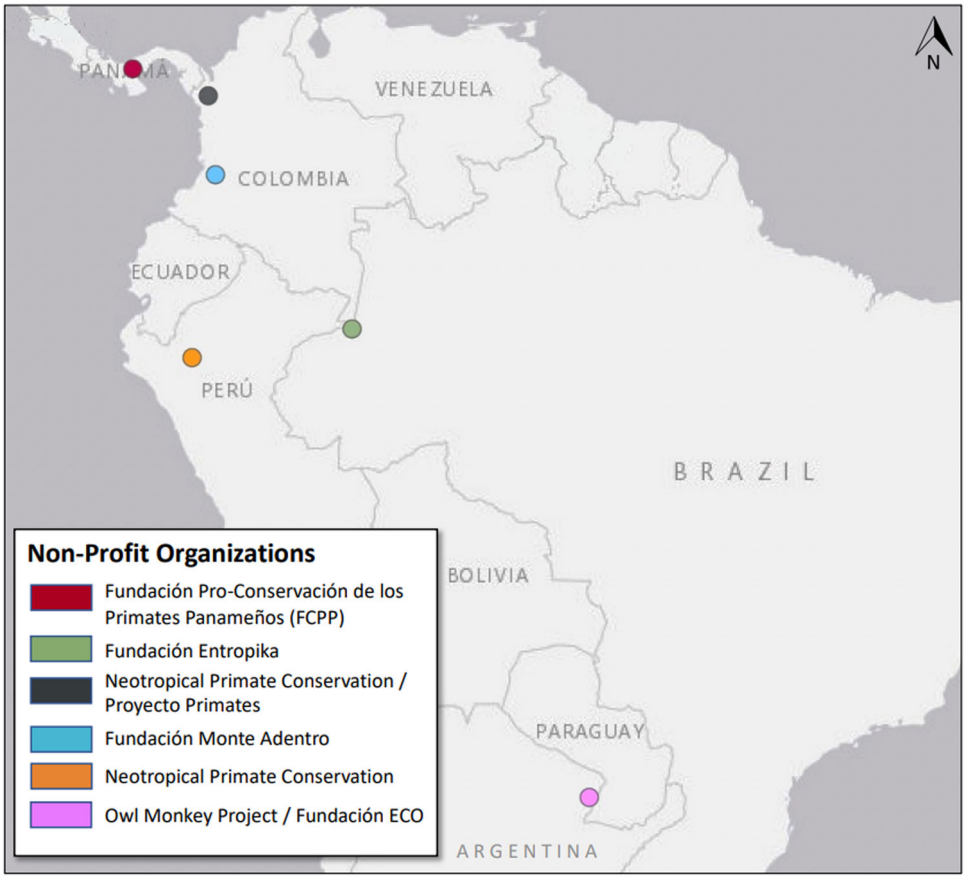

FIGURE 1 Map highlighting several nonprofit organizations in habitat countries engaged in research and conservation projects aimed to protect *Aotus*, © Gabrielle Risko.

monkey populations. Although *Aotus* populations have been studied in Brazil (Helenbrook & Valdez, 2021) and there are limited investigations of *Aotus* behavior elsewhere (e.g., Ecuador, Fernandez-Duque et al., 2008), we chose to highlight efforts in Peru, Colombia, Panama, and Argentina as researchers have studied owl monkeys in these regions for an extended period of time and conservation initiatives are established.

2.1 | Peru

Over the past 15 years, the nonprofit organization *Neotropical Primate Conservation* (https://www.neoprimate.org) has successfully created private and communally protected areas in Peru, helped local communities with financing, and actively trained local people in relevant technical skills (creating surveys, mapping, administration) necessary in obtaining official protected status for these areas. These efforts led to the creation of 11 officially recognized reserves totaling some 60,000 ha that contain populations of *Aotus*. The majority of these protected areas are in montane and premontane forests in the eastern Andes of northern Peru, home of the EN *A. miconax*. In lower elevation reserves, *A. nancymaae* and *A. nigriceps* are also protected (Shanee, 2013).

Neotropical Primate Conservation's research in Peru led to the updated IUCN status of *A. miconax* (from VU to EN based on the first range-wide field evaluation), as well as new information about their ecology and behavior. *Neotropical Primate Conservation* works to identify new populations of *Aotus*, evaluate current threats, estimate population densities, and determine the effects of habitat degradation and fragmentation on parasite load and animal health (Campbell et al., 2019; Larrañaga & Shanee, 2012; Shanee, 2016; Shanee et al., 2015). Researchers from this nongovernmental organization (NGO) are actively involved in restoration efforts and environmental education in local communities (Shanee et al., 2018). Another focus of the organization is the continued fight against illegal wildlife trafficking. Their teams work closely with local authorities in the confiscation, handling, care, and rehoming of rescued animals (Mendoza et al., 2022; Shanee & Shanee, 2021). The government of Peru has now placed greater emphasis on *Aotus* conservation with the creation of new protected areas such as the Zona Reservada Rio Nieva, which lists the conservation of *A. miconax* as one of its priorities (Zona Reservada Rio Nieva, 2019). Similarly, the number and size of civil society reserves (nongovernment, i.e., private people or communities), particularly in the north of Peru have increased significantly in recent years (Shanee et al., 2020). The majority of these reserves provide protection for *Aotus*. For example, the

Huiquilla Private Conservation Area in Amazonas uses *A. miconax* as its flagship species and a regional action plan to protect this species was developed (https://www.facebook.com/huiquilla.amazonas.peru/).

2.2 | Colombia

Unfortunately, promoting social and environmental justice comes at a high cost in Colombia. During the past 10 years, over 320 environmental leaders have been murdered and this number continues to rise (Hines, 2022). Even a global pandemic was unable to stop this trend; Gonzalo Cardona Molina from the environmental NGO, *ProAves Colombia*, was murdered on January 8, 2021 (Janetsky & Faiola, 2021).

Many continue to work toward conserving Colombia's fauna and flora, despite the risk to themselves. Researchers from *Fundación Entropika* (https://www.entropika.org/, @fentropika—Instagram) have worked tirelessly for Amazonian owl monkey conservation. Their efforts have resulted in hunting bans implemented by Amazonian communities and investigations into the illegal trade of *Aotus* in Colombia. In addition, they completed the first population assessment of *Aotus* in the Colombian–Peruvian border region. Genetic analyses confirmed that *A. nancymaae* (Figure 2) is present in the highly deforested area of Loreto, Peru, and provided evidence that these monkeys had been released in Peruvian territory by a Colombian biomedical facility (Maldonado et al., 2023; Maldonado & Lafon, 2017; Ruiz-García et al., 2013). Owing to the long-term pressure that *Fundación Entropika* has placed on the regional environmental authority Corpoamazonia (Corporation for the Sustainable Development of the Southern Amazon, responsible for issuing research permits) to investigate irregularities with trapping permits, Corpoamazonia opened an environmental penalty process against the biomedical facility (PS-06-91-LAR-010-2021) and new captures of owl monkeys have been suspended (Corpoamazonia, DTA 0004, January 7, 2022). Also in 2022, the Instituto de Investigación de Recursos Biológicos Alexander von Humboldt Institute (IAVH), the IUCN, and The Colombian Primatological Association raised the conservation status of *A. nancymaae*, from VU to EN. Once the new Colombian list of threatened species is published, it is likely that trapping permits will no longer be granted. Entropika's work underlines the importance of using an interdisciplinary approach as well as the need to defend of fundamental rights of local people (Sollund & Wyatt, 2022). Indigenous communities overlapping the Amacayacu National Park have implemented a hunting ban for owl monkeys and woolly monkeys (Maldonado & Waters, 2020). Entropika also helped develop sustainable economic alternatives, such as low-impact wildlife tourism, for key communities previously involved in illegal natural resource extraction (Maldonado & Waters, 2020).

Neotropical Primate Conservation and *Proyecto Primates* (an NGO devoted to promoting primate research and conservation) have conducted population surveys of *A. zonalis* on the Pacific coast and Darién regions of Colombia. As a result of these efforts, *A. zonalis* was recently listed as near threatened by the IUCN (changed from data deficient). Although *A. zonalis* has a relatively widespread distribution, there are increasing threats to these populations from development, logging, mining, and civil unrest (Méndez-Carvajal & Link, 2021). In addition, *Neotropical Primate Conservation* and *Proyecto Primates* carry out educational activities in schools and provide seminars and capacity building for local communities, with the goal of creating locally protected areas for *Aotus* and other wildlife. Initiatives for community-based reforestation and additional field sites for longer-term ecological studies have begun, but need additional financial support.

In Pance, a small town within a highly biodiverse region of Colombia (Farallones, West Andes), young community leaders are working to protect *A. lemurinus* (Figure 3). *Fundación Monte Adentro* (@colectivo_monteadentro) is a youth organization mentored by environmentalists from the region (Figure 4). The group monitors and manages resources destined for the conservation of biodiversity in this region. The group's members provide continuous monitoring of

FIGURE 2 Two *Aotus nancymaae* active at night, Yavari River, Brazilian–Peruvian border, ©B. Wittemann, Fundación Entropika.

FIGURE 3 An adult Andean owl monkey (*Aotus lemurinus*) gazes at the photographer at dusk in the commune of Pance, Department of Valle del Cauca, Colombia ©S. Tabares, Fundación Monte Adentro.

FIGURE 4 Left: The Collectivo Monte Adentro Team on top of the Farallones Mountains, Colombia; center: artistic collective @Alpajaguar, commemorating owl monkeys for the yearly Andean spectacled bear festival organized by Collectivo Monte Adentro; right: successful expedition by Team Aotus (DuMond Conservancy) and Collectivo Monte Adentro ©A. Garcia.

mammals in Farallones National Park and have sighted species such as puma (*Puma concolor*), spectacled bear (*Tremarctos ornatus*), and little red brocket deer (*Mazama rufina*) that had not been observed locally for decades. *Fundación Monte Adentro* educates local people about the value of biodiversity and the importance of respecting and conserving it. Their conservationists organized an annual festival to celebrate the presence of owl monkeys, spectacled bears, ocelots (*Leopardus pardalis*), ring-tailed coatis (*Nasua nasua*), and other local species in an effort to foster a greater local commitment to protecting wildlife. To create a space for conservation and environmental education, a field station is planned in this region, but the global pandemic slowed the process.

Population surveys in periurban forests have also been conducted by another new local NGO (*Fundación Ambiental Mohanes*) together with the University of Quindío, Colombia. *A. lemurinus* was confirmed present in Valle del Cauca Department, 76 years after the last scientific observations, prompting community conservation activities in the area (Grajales-Suaza et al., 2021).

2.3 | Panama

To better understand the conservation status, ecology, and distribution of *A. zonalis* (Figure 5), which is listed as near threatened, researchers from *Fundación Pro-Conservación de los Primates Panameños* (FCPP) recently estimated population densities of *A. zonalis* across several sites in Panama (Méndez-Carvajal, 2019). Using camera traps, direct observations, and informal interviews, *A. zonalis* were confirmed near gallery forests where much of the land is in the process of being transformed and degraded (Méndez-Carvajal, 2014, 2019). Although *A. zonalis* in Panama is not typically consumed as bushmeat, it is occasionally found in the pet trade (Méndez-Carvajal, 2019). In areas such as La Vieja, Churuquita, Donoso and Penonomé, Coclé province, owl monkeys are killed due to the false belief by local people that their presence brings "bad luck," death, or "mysterious powers"; similar beliefs surround other nocturnal fauna in Panama (e.g., *Nyctibius griseus*). To combat these negative attitudes toward *Aotus*, *FCPP* gives informative talks and distributes t-shirts and posters to elementary schools (Méndez-Carvajal et al., 2013). These efforts are reinforced through a collaboration with the Grupo de Investigación de Primatología of the Universidad de Panamá (GIP-UP), in which undergraduate students conduct research on primates including *A. zonalis* (González-Hernández et al., 2020). In addition, new challenges have arisen as tourists visiting Panama are visiting owl monkey nests and knocking on the trees to wake them up and view them (P. Méndez-Carvajal, observation, June 30, 2017). This behavior interrupts their

FIGURE 5 *Aotus zonalis*, near the Gaillard-Madden road, inside the old Panama Canal Zone, Panama. An owl monkey emerges from a tree hole during the daytime after being disturbed by visitors. The photographer took advantage of the opportunity to capture its striking colors. Owl monkeys may abandon their sleep sites after several disturbances. ©Eduardo Estrada.

circadian activity and eventually causes owl monkeys to leave their sleeping site (Méndez-Carvajal, unpublished data). In response, *FCPP* has embarked on a conservation campaign distributing educational materials, collaborating on environmental TV shows (e.g., https://www.tvn-2.com/videos/noticias/mono-nocturno-video_8_1411801.html), and providing talks to local people and tour guides in an effort to combat these problems.

2.4 | Argentina

Much of our understanding of *Aotus* ecology and behavior stems from research conducted as part of the Owl Monkey Project of Fundación ECO in Formosa, Argentina. After 25 years, and with a focus on research and conservation, the Owl Monkey Project is established as a national and international collaborative field project both for the study of *Aotus* and for understanding the flora and fauna that constitute the biodiverse ecosystems of the Humid Gran Chaco. By employing diverse biological and ecological methods, the team has taken a multidisciplinary approach and combined studies of population biology, demography, behavior, genetics, endocrinology, and ecology (Babb et al., 2011; Corley et al., 2023; Fernandez-Duque et al., 2023; García de la Chica et al., 2023; van der Heide et al., 2023; Huck & Fernandez-Duque, 2023; Juárez et al., 2017).

The Owl Monkey project has employed various technologies to understand the role of Azara's owl monkeys (*A. azarae*) in contributing to ecosystem services. In 2000, the Owl Monkey Project began capturing and fitting individuals with collars. Monkeys were fitted either with bead collars or with radio collars, which allowed researchers to consistently identify them and to locate and monitor groups using telemetry (Figure 6). Current research includes an analysis of fruiting and flowering phenophases via remote sensing with drones and assessing *Aotus* trophic interactions via arboreal camera traps (Fernandez-Duque et al., 2023). With support from a National Science Foundation award, researchers examined *Aotus* population genetics to gain a better understanding of the mating system and dispersal patterns of the species (Corley et al., 2023; Huck et al., 2014). Additional research examined reproductive competition between "floaters" (unpaired adults) and group residents using portable acoustic monitoring stations to passively record naturally occurring vocalizations (Garcia de la Chica et al., 2021). Collectively, these data will help determine the effects of ecology and habitat fragmentation on mate choice and ultimately, gene flow in *A. azarae*.

The Owl Monkey Project also promotes research and conservation within the biological corridors of the Humid Gran Chaco, a highly biodiverse region that spans parts of Paraguay, Argentina, and Brazil. Studies have included bird and mammal surveys (Huck et al., 2017) and a health assessment of the owl monkey population (Acardi et al., 2013; Perea-Rodriguez et al., 2010). As part of ecological restoration efforts in collaboration with the Centro de Biodiversidad del Chaco Argentino, researchers evaluated the growth rates of digested native seeds to assess the potential of owl monkeys as seed dispersers and their role in forest regeneration. The team also provided the information required to update the IUCN status of

FIGURE 6 *Aotus azarae*, from Estancia Guaycolec, Formosa Province, Argentina. Top image: A radio-collared Azara's owl monkey, ©M. Corley, Owl Monkey Project. Bottom: Wild Azara's owl monkeys resting in their social group. Two adults are sitting on the sides with one subadult and one juvenile in between them, a typical arrangement for owl monkeys at this site, ©E. White, Owl Monkey Project.

A. azarae (Fernandez-Duque et al., 2008), as well as new information on their ecology and behavior as part of a recent categorization of mammal conservation in the country (Briggs et al., 2019). In Argentina, the Owl Monkey Project has contributed to the National Plan for Primate Conservation, which was approved by the governmental resolution in 2021. The team has continued to work closely with local authorities and has collaborated in the promotion of *A. azarae* as a legislated regional monument through the Law 1582/2012, which prohibits the hunting, commercialization, and intra- and interprovincial transit of the species (Juárez et al., 2017). As part of the continuous work of the Owl Monkey Project, efforts are now focused on educational activities to teach students and members of the local community about the natural habitat of owl monkeys.

3 | DUMOND CONSERVANCY FOR PRIMATES AND TROPICAL FORESTS

The *DuMond Conservancy for Primates and Tropical Forests* (Miami, FL) is a nonprofit organization devoted to engaging scientists, students, and the public in the understanding and stewardship of nonhuman

primates and their tropical forest habitats. The Conservancy houses a colony of owl monkeys (20–25 pairs or families; predominantly *A. nancymaae*), which has provided a unique opportunity to study their biology. The owl monkeys live in outdoor enclosures surrounded by a subtropical forest; thus, they experience naturally fluctuating light and temperature levels, and actively forage for insects. These seminatural conditions enabled the first observations of food sharing and social anointing in the genus, which consequently informed and promoted similar studies in nature (Evans & Wolovich, 2023). The Conservancy has formed partnerships with NGOs dedicated to the long-term conservation of biodiversity. For example, they worked with *Fundación Entropika* to help combat the illegal trafficking of owl monkeys across international borders (Shanee et al., 2023). These efforts involved undergraduate students collecting petitions that were subsequently hand-delivered to the Colombian Department of Natural Resources. Furthermore, student volunteers and researchers that worked at the Conservancy have become inspired to participate in conservation-related research and education in habitat countries around the world (Evans & Wolovich, 2023).

4 | TAKE ACTION! THE TIME TO ACT IS NOW!

In summary, 5 of the 11 species of owl monkeys are threatened with extinction. Below we provide a set of actions that scientists, concerned citizens, and government officials can take to conserve tropical forests and protect threatened populations of owl monkeys.

- Support the actions of *Neotropical Primate Conservation* by making a donation. Nearly 100% of the donations assist with field-based projects. Donations can be made through the website, and US donors wishing to make their donation tax-deductible can contribute by visiting (https://conservationallies.org/neotropical-primate-conservation/). *Neotropical Primate Conservation* accepts volunteers and interns year round (both in the field and office). Additional details can be found on the website (https://www.neoprimate.org) or by writing to info@neoprimate.org.
- Support primate conservation in Colombia by donating to *Fundación Monte Adentro* by contacting Sebastian Tabares at funmonteadentro@gmail.com.
- *Fundación Entropika* created an educational book about the biology and ecology of *Aotus* to be distributed to children on the Colombian–Peruvian Amazonian border. This region is the heart of illegal *Aotus* trafficking. They continue to collect funds that will cover the costs of printing and distributing books. Please email Angela Maldonado, *Fundación Entropika* (amaldonado@entropika.org) to help.
- Support primate conservation efforts in Panama by donating to the FCPP (https://www.fcprimatespanama.org/ayuda-donacion-ong/). Donations help purchase equipment and create educational materials. *FCPP* is distributing bookmarks and posters about *Aotus* biology and distribution that inform local people as to how they can help protect these threatened primates. Contact Pedro Méndez-Carvajal (mendezp@fcprimatespanama.org) to discover how else to help.
- Donations can be made to the *Owl Monkey Project* bank account in the USA or *Fundación ECO* in Argentina (https://www.owlmonkeyproject.com/). Please, contact Alba Garcia de la Chica (alba.delachica@gmail.com) if you would like to help.
- Support continued care of owl monkeys at the *DuMond Conservancy* as well as educational and research training opportunities for students to study *Aotus* by donating to the *DuMond Conservancy* (https://dumondconservancy.org/donate/).

AUTHOR CONTRIBUTIONS

Christy K. Wolovich: Conceptualization (equal); investigation (equal); project administration (equal); writing—original draft (lead); writing—review and editing (lead). **Sam Shanee**: Funding acquisition (equal); investigation (equal); methodology (equal); project administration (equal); writing—original draft (lead); writing—review and editing (equal). **Angela M. Maldonado**: Conceptualization (equal); data curation (equal); investigation (equal); methodology (equal); project administration (equal); writing—original draft (equal); writing—review and editing (equal). **Pedro G. Méndez-Carvajal**: Methodology (equal); project administration (equal); writing—original draft (supporting); writing—review and editing (supporting). **Juan P. Perea-Rodriguez**: Project administration (equal); writing—original draft (supporting); writing—review and editing (supporting). **Sebastian Tabares**: Data curation (equal); methodology (equal); project administration (equal); writing—original draft (supporting); writing—review and editing (supporting). **Alba Garcia de la Chica**: Project administration (equal); writing—original draft (supporting); writing—review and editing (supporting). **Siân Evans**: Project administration (equal); writing—original draft (supporting); writing—review and editing (supporting).

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CONFLICT OF INTEREST STATEMENT

The authors declare no conflicts of interest.

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