Chapter 23
Traffic and Trade in Owl Monkeys

Sam Shanee, A. Patricia Mendoza, Angela M. Maldonado, Lorena Fernández-Hidalgo, and Magdalena S. Svensson

Abstract Trade can have serious implications for primate species. Owl monkeys (*Aotus* spp.) have historically been a principal species traded for biomedical research. Individuals found in the biomedical trade continue to be sourced from captive-bred, wild, and semi-wild populations. The number of legally traded owl monkey body parts or derivatives registered with CITES is increasing, while the only trade of live individuals since 1990 is from Peru. There are estimates that numbers of owl monkeys trafficked illegally for biomedical experiments to Colombia during 1994–2011 are at least as great as the global legal trade. Owl monkeys are commonly found in the illegal pet trade, which is larger and has more serious implications than the legal trade, and trafficking in live animals is the main form of domestic trade. Reported numbers consistently underestimate the true scale of the problem, and current levels of enforcement are insufficient to properly combat trafficking.

Keywords *Aotus* · CITES · Hunting · Illegal primate trade · Night monkey · South America · Wildlife markets

S. Shanee (✉)
Neotropical Primate Conservation, Looe Hill, Seaton, Cornwall, UK

Nocturnal Primate Research Group, School of Social Sciences, Oxford Brookes University, Oxford, UK
e-mail: sam@neoprimate.org

A. P. Mendoza
Wildlife Conservation Society, Lima, Lima, Peru

Asociación Neotropical Primate Conservation Perú, Moyobamba, San Martin, Peru

A. M. Maldonado
Fundación Entropika, Leticia, Amazonas, Colombia

L. Fernández-Hidalgo
Asociación Neotropical Primate Conservation Perú, Moyobamba, San Martin, Peru

M. S. Svensson
Nocturnal Primate Research Group, School of Social Sciences, Oxford Brookes University, Oxford, UK

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23.1 Introduction

While the primary threats to primates worldwide are habitat loss and forest fragmentation, legal and illegal hunting and trade are among the principal threats to many species (Nijman et al. 2011; Estrada et al. 2017). Wildlife trade is defined as the commerce of wild plants/animals, or their derivatives, generally obtained from their natural environment, in a legal, or quasi-legal, form, whereas wildlife trafficking is the illegal commerce of these products, often of threatened or protected species (Rosen and Smith 2010). In practice, there is substantial overlap between legal trade and trafficking, with high levels of corruption, discrepancies in reporting, and lack of enforcement (Broad et al. 2003; Wyatt et al. 2018). Primates, including owl monkeys, are found in local, national, and international trade and traffic (Nekaris et al. 2010; Nijman et al. 2011; Maldonado 2012; Shanee 2012; de Souza Fialho et al. 2016; Svensson et al. 2016; Estrada et al. 2017).

Wildlife trafficking at the international, national, and local scale is a threat to owl monkeys. International traffic is concentrated in the tri-border area of Brazil, Colombia, and Peru and is primarily for biomedical research (Maldonado et al. 2009; Maldonado and Lafon 2017). National and local traffic of owl monkeys for the illegal pet trade exists across Latin America and has been recorded for several species (Lizarralde 2002; Altherr 2007; Svensson 2008; Parathian and Maldonado 2010; Shanee 2012; Tirira 2013; Stafford et al. 2016). Owl monkeys in the local and national trade are rarely traded as meat, as they sometimes feature in local taboos and have pungent subcaudal scent glands (Cormier 2006: Maldonado and Waters 2020). However, owl monkeys are occasionally consumed, and there is at least one report of their use in traditional medicine (Mena et al. 2000; Lizarralde 2002; Altherr 2007; Zapata-Ríos et al. 2009; Parathian and Maldonado 2010; Maldonado 2012; Shanee 2012; Alves et al. 2013).

Owl monkeys are particularly well-suited as models for biomedical research, mainly in the development of antimalarial vaccines, human immunodeficiency virus (HIV) drugs, and ophthalmological research (Collins 1994; Ogden 1994; Hofmann et al. 1999; Herrera et al. 2002). This suitability for biomedical research has led to a great demand internationally, with several species commonly found in the biomedical trade (Svensson et al. 2016). Prior to the signing of the Convention on International Trade in Endangered Species (CITES) agreement in 1975 (CITES 2020), trade in wild-caught animals from South and Central America was uncontrolled (Linder et al. 2013). Subsequent to the signing of CITES, captive breeding programs were set up to compensate for the shortfall in supply (Gozalo and Montoya 1990; Málaga et al. 1997). Even so, trafficking for international biomedical research continues in the tri-border area of Brazil, Colombia, and Peru (Maldonado et al. 2009; Maldonado and Lafon 2017).

Interpreting the existing data on trade and traffic is complicated by poor species identification (Svensson et al. 2016) and changes in taxonomy (Fernandez-Duque et al. 2023 this volume). Prior to 1983, all owl monkeys were considered to belong

to a single species, *Aotus trivirgatus*. Hershkovitz (1983) was the first to revise the genus, settling on nine species, and this number has since increased (Fernandez-Duque et al. 2013; IUCN 2021; Fernandez-Duque et al. 2023 this volume). On the International Union for Conservation of Nature (IUCN 2021) Red List of Threatened Species, *A. azarae*, *A. nigriceps*, *A. trivirgatus*, and *A. vociferans* are listed as Least Concern; *A. brumbacki*, *A. griseimembra*, *A. lemurinus*, and *A. nancymaae* as Vulnerable; *A. miconax* as Endangered; *A. zonalis* as Near Threatened; and *A. jorgehernandezi* as Data Deficient, and all species are categorized as Appendix II by CITES (2020). Until the mid-1990s, almost all reports to CITES were classified as *A. trivirgatus*, and even now CITES only considers eight species and identification is often inadequate. All owl monkey range countries are signatories on CITES, and all have laws prohibiting or controlling the capture, trade, or keeping of wildlife (Svensson et al. 2016). Inconsistencies in taxonomies, coupled with the physical similarities between species, also affect measures to control trafficking, meaning that animals are rarely identified correctly making evaluation of the true nature of trade and traffic even more difficult (Shanee and Shanee 2021).

Here we present data on owl monkey traffic and trade using a four-pronged approach. Firstly, we examine official levels of legal international trade using the CITES trade database. We then investigate the illegal online trade through social media searches and web scraping. Thirdly, we examine illegal trafficking in range countries through official government statistics, published data, "gray" literature sources, and personal communications. This aspect of our work is illustrated with a case study from Peru, an example of the best dataset currently available on the illegal wildlife trade in Latin America. Finally, we present a case study on the mixed legal trade and trafficking for biomedical research in the tri-border area of Brazil, Colombia, and Peru.

23.2 Methods

23.2.1 Legal Trade

Building on research by Svensson et al. (2016), we downloaded data from the CITES database (http://trade.cites.org/) for the period 2015–2018 (data from 2019 were not yet available) in May 2020, to investigate legal international trade. We calculated the number of live and dead individuals that were exported from range countries, as well as the number of body parts and derivatives (Fig. 23.1). CITES lists "specimens" in their database as any readily recognizable part of an animal or derivative thereof, which can be anything from hair samples to live animals. However, as there are further specific categories for live animals, dead animals, and whole bodies, specimen rarely refers to these. To minimize this, we excluded exports reported by volume and restricted counting of dead individuals to skins and bodies (a skin and a skull exported on two separate occasions could be derived from

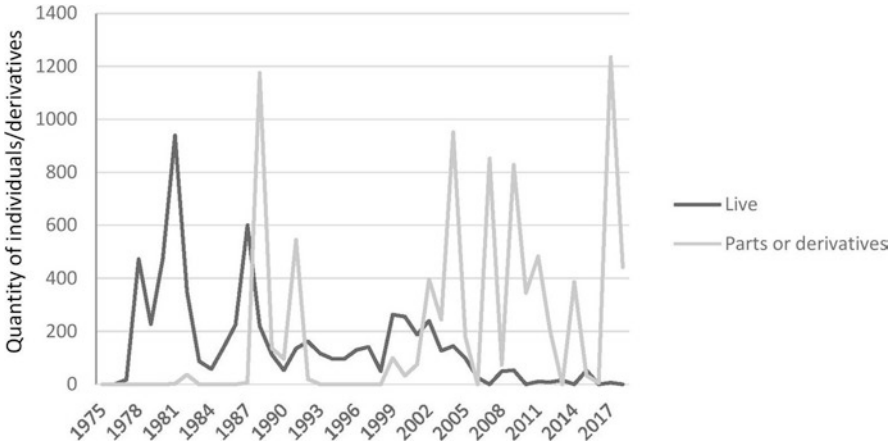

Fig. 23.1 Annual legal export of owl monkeys out of South and Central American range countries (1975–2018)

the same individual); as such our numbers represent a minimum estimate. To better understand the impact of trade on individual species and provide a clearer idea of the possible diversity of species traded legally, we corrected the species name, where possible, to reflect our current understanding of owl monkey taxonomy and geographical distribution, following Fernandez-Duque et al. (2013, 2023 this volume), Shanee et al. (2023 this volume), and the IUCN Red List (IUCN 2021). In doing so, we assumed that the owl monkeys traded were sourced in the exporting country, and we only corrected the species name for countries where only one species occurs. Where we were not able to confidently infer the species involved, we use *Aotus* sp. We are aware that due to (illegal) cross-border trade, it is possible that species in addition to the ones that occur naturally within a country may be reexported. While we expect that in absolute terms this will concern only a small number of individuals, we have no way to verify this. When import and export quantities (reported by the importing and exporting country, respectively) did not match, we cross-checked the data and included the largest overall totals by comparing the reports. We also checked all reexports (when there is an export by one country after it has been imported from another) to prevent double-counting.

When investigating purpose of export, we pooled certain categories. For example, we combined medical and scientific, as the term medical was not used in the earlier days of CITES and can be categorized under scientific purposes. Our data were not normally distributed, and we used nonparametric statistics (Spearman rank correlation coefficient), conducted in R, to test for statistical significance, with significance accepted when $p < 0.05$ in a two-tailed test.

23.2.2 Illegal Trafficking

To investigate the online trafficking of owl monkeys, we examined evidence from social media. We monitored 30 active Brazilian Facebook groups with primates for sale between January 2017 and May 2020. To avoid duplication, we did not record any advertisement from the same profile for a 6-month interval. We also surveyed 14 open Facebook groups and pages from the rest of South America through a process of manual "scraping" (Batrinca and Treleaven 2015). We used a selection of 36 key search words and terms for identifying possible groups and pages and used the same selection of key words and terms to search publications and activity within the open groups and pages. For each search, we considered the first 50 results for likely sources of trade, excluding pages that did not sell animals (those of NGOs, conservation groups, scientific societies, and miscellaneous others). This was repeated for each key word and term separately and in combination. We noted the name and number of members of each group and page and any activity involving the sale or keeping of owl monkeys.

To investigate trafficking, and the authorities' responses within habitat countries, we contacted national environmental agencies, national primatological associations, NGOs, and individual researchers in Argentina, Brazil, Colombia, Ecuador, Panama, Peru, and Venezuela. We also contacted a researcher in Trinidad and Tobago for data on international wildlife trafficking originating in Venezuela and Guyana. We carried out an extensive literature search of scientific publications, reports, government statistics, and other gray literature. In Peru, we used data on confiscations carried out by government agencies between 2001 and 2019, reported yearly by the different agencies, and shared with our team by regional and national authorities. These reports were collated into a single database for analyses and filtered for data corresponding to primates, and specifically owl monkeys, confiscated alive or dead (but complete, i.e., skins, taxidermized animals) and quantified by individual units. Our results represent a minimum estimate as they exclude confiscations that were not documented or entered into government databases. Similarly, for some years, data were not available for some regions. Nevertheless, this represents the historic record of confiscations in the country for the last 20 years. Species identifications where given here are those in the official records, meaning that some will be erroneous; however, they still provide an idea of which species are traded.

23.2.3 Case Study 1: An Assessment of Trafficking in Peruvian Markets

As part of a general study of wildlife trafficking in Peru, we collected data in markets in the cities of Iquitos, Pucallpa (Amazon), Tumbes, Piura, Chiclayo, Trujillo and Ica (northern and central coast), and the capital, Lima, between 2010 and 2012. To register trafficking events in city markets, we conducted surveys on randomized

dates to identify and count wildlife and wildlife derivatives sold at market stalls and by ambulatory vendors within a 300 m radius of the market. In markets where we detected wildlife sales, we continued surveys with variable frequency and with voluntary verbal consent of vendors, without payments or economic incentive. We performed species identification to genus level because of the difficulty in identifying species by nonspecialists solely through visual observation. We also conducted an additional "complete" survey in the Bellavista market in Pucallpa, Ucayali. Here we trained a local market stallholder to record the identity of every wild animal displayed and sold at all surrounding market stalls for a 20-month period between August 2010 and March 2012, except 6 weeks when data were not collected (Shanee et al. 2017). The overall results of this assessment are given in Shanee et al. (2017). Here we present an in-depth review of results specific to *Aotus* spp.

In an effort to examine the efficiency and reliability of the response to and reporting of actions against illegal wildlife trafficking in Peru on the part of wildlife authorities, we compared our data from market counts and rescues with official numbers given by the authorities for regions where we had data from both sources.

23.2.4 Case Study 2: Trafficking of Owl Monkeys in the Tri-border Area of Brazil, Colombia, and Peru

The *Fundación Instituto de Inmunologia de Colombia* (FIDIC) has been using owl monkeys as models for biomedical research toward developing a malaria vaccine since 1987 (Corpoamazonia 1999; Patarroyo et al. 2006; Maldonado and Waters 2017). Based in Leticia, Colombia, FIDIC has permissions for capture, and later release, of animals from Indigenous territories surrounding the city (Corpoamazonia 2010). Based on extensive field investigations and legal action, it was found that many more animals were being used than allowed under the permits (Maldonado 2011). These investigations also revealed large-scale, international trafficking of *A. nancymaae*, *A. nigriceps*, and *A. vociferans* from Brazil and Peru into Colombia for use at the laboratory (Ruiz-García et al. 2013).

Until recently, the only species of *Aotus* reported in the Colombian Amazon was *A. vociferans* (Defler 2003, 2004). More recently, molecular evidence has suggested the presence of *A. nancymaae* in Colombia (Bloor et al. 2012); it remains uncertain as to whether *A. nancymaae* populations in Colombia are natural or the result of animals released by FIDIC after being used in tests (Maldonado and Lafon 2017). There is also evidence that some of the animals used by the lab are hunted in Peru and smuggled through the border using permits granted for Colombia only. The negative impact of this cross-border traffic has been shown through surveys at sites in Peru where *A. nancymaae* are captured for FIDIC. At these sites, population densities of *A. nancymaae* are lower than at other comparable sites (Maldonado and Peck 2014).

Since evidence of this trafficking and its effects on local owl monkey populations came to light, a long litigation has taken place, which has included the revocation, and later reinstatement, of capture permits for FIDIC (Maldonado and Lafon 2017). Here we present an update to previous publications based on legal documents and permits issued for the period 2016–2020.

23.3 Results

23.3.1 Legal Trade

Peru and Brazil were the first countries with wild owl monkey populations to become parties to CITES in 1975, and by 1981 all range countries had joined. Venezuela is the only range country that has not reported any exports. Argentina, Brazil, and Ecuador reported exports of parts or derivatives, but no live animals. Across all range countries, exports of 5,893 live individuals and 8,871 parts or derivatives have been reported since 1975 (Fig. 23.1).

Trade in live individuals accounted for 66% of the total from range countries for the period 1975–2018. The majority were exported before 1990; afterward, only Peru continued to export live individuals, all to the USA, where 76% of these exports were for scientific/medical purposes. Since 1975, the USA has been the main importer with 75% of the total import records (parts or derivatives $n = 59$ and live individuals $n = 94$) followed by Germany (4%). There was a statistically significant decrease in the reported number of live individuals exported over time (Spearman rank correlation coefficient, $r_s = -0.488$, $n = 44$, $p < 0.001$), whereas reports of exported parts or derivatives have significantly increased ($\rho = 0.562$, $n = 44$, $p < 0.001$) and have remained high from many countries over the last two decades (Fig. 23.1).

CITES has information on the source of traded owl monkeys for a subset of exports, as they only started to report this consistently from 1994 onward. Thirty percent of all exported live individuals were wild-caught, all from Peru (*A. vociferans* and *A. nancymaae*), and these were mainly traded for commercial or scientific purposes. CITES reports the last wild-caught individual in 2005 and from 2006 onward reported sources for live individuals are only captive-bred second-generation (56%) and first-generation offspring (44%).

From the subset of reports with owl monkey species that we could identify (123 of 204), CITES only reported *A. vociferans* and *A. nancymaae* to be traded live after 1994. Looking at the total trade from range countries (including dead animals, parts or derivatives), *A. nancymaae* was the most common (40%), followed by *A. vociferans* (24%), *A. zonalis* (16%), *A. azarae* (13%), *A. nigriceps* (4%), *A. miconax* (2%), and *A. trivirgatus* (1%).

In the 1970s, the purpose of trade was rarely reported. CITES only reported owl monkeys a couple of times as traded for personal or educational purposes.

Throughout the 44-year period, the most commonly reported purpose for trade has been scientific/medical (63% of all reported exports). In the 1970s through to 1990s, exports for commercial purpose were also common but have since declined, being 28% of the total trade purposes, followed by zoological purpose (7%).

23.3.2 Illegal Trafficking

We did not find any owl monkeys for sale in any of the 30 Brazilian Facebook groups that regularly sell primates online over the >3-year period. The average number of group members was 8,269 (SD 13,724), ranging from 510 to 44,396 members. Through manual scraping of 14 open English and Spanish language Facebook groups and pages that specialize in exotic pet keeping and sales, we found details of three monkeys for sale, including one *Aotus* spp. The average number of members/followers of these open groups and pages was 10,365 (SD 13,439), ranging from 394 to 45,924. The owl monkey found for sale was not identified to species level.

Our call for information from primary sources active in range countries yielded results from Colombia, Ecuador, Panama, Peru, and Venezuela. We also received information from Trinidad and Tobago, where trafficked wildlife mainly comes from Venezuela and possibly Guyana (Table 23.1). Literature searches resulted in only five publications that attempted to quantify national-level trafficking in primates, including owl monkeys, two from Peru (Shanee 2012; Shanee et al. 2017), one from Brazil (Levacov et al. 2011), one from Ecuador (Tirira 2013), and one from Venezuela (Asmüssen et al. 2019). Likewise, we were able to get official government statistics from Colombia, Ecuador, and Peru and further unpublished data from primatologists working in Argentina and Panama. Data from the various sources were given at different geographic and temporal scales and generally represented official government confiscation records or NGO studies (Table 23.1).

Data from Colombia were from government sources and the Wildlife Conservation Society. In Colombia, 10% (191) of all primate confiscations between 2010 and 2018 were of owl monkeys (WCS In Prep); however, these figures do not include at least one confiscation, where police records show the confiscation of 24 *A. nancymaae* from a Peruvian trafficker transporting the animals to FIDIC (DEAMA-COMAN 2013). There was a general trend of decreasing confiscations of primates over this period, from 331 in 2010 to 46 in 2018, which was also seen in owl monkey confiscations, from 65 in 2010 to just 3 in 2018 (WCS In Prep). In neither case was this a steady decline, with numbers varying between years, and the reasons for this reduction are not clear. Individuals from at least six species were confiscated in Colombia; *A. lemurinus* was the most common, followed by *A. vociferans*, although most were recorded as *Aotus* sp. (Table 23.1).

Data from Ecuador came from one publication (Tirira 2013) and unpublished internal reports from the Ministry of the Environment. There were records of only 12 owl monkeys confiscated over a 27-year period (1989 to 2017), excluding 2016

Table 23.1 Official confiscation records of owl monkeys

	A. azarae	*A. brumbacki*	*A. griseimembra*	*A. jorgehernandezi*	*A. lemurinus*	*A. miconax*	*A. nancymaae*	*A. nigriceps*	*A. trivirgatus*	*A. vociferans*	*A. zonalis*	*Aotus* sp.	Years	Source
Argentina	–	–	–	–	–	–	–	–	–	–	–	1	2013–2020	Oklander pers. comm.
Brazil	–	–	–	–	–	–	–	–	–	–	–	31	1999–2006	Levacov et al. (2011)
Colombia	–	1	6	–	35	–	5	–	3	16	–	125	2010–2018	WCS In Prep
Ecuador	–	–	–	–	3	–	–	–	–	9	–	–	1989–2017	Tirira (2013), Tirira pers. comm.
Panama	–	–	–	–	–	–	–	–	–	–	4	–	2014–2020	Mendez-Carvajal pers. comm.
Peru	–	–	–	–	–	5	11	19	–	–	–	18	2000–2019	Fernandez-Hidalgo, S. Shanee, P. Mendoza unpublished data
Venezuela	–	–	–	–	–	–	–	–	70	–	–	–	2000–2009	Asmüssen et al. (2019)

for which no information was available. We only recorded two species (*A. lemurinus* and *A. vociferans*).

Official data on confiscations in Peru came from internal reports of the National Forestry Service and various regional environmental authorities. We obtained records of 10,410 operations between 2001 and 2019. Records included 69 owl monkeys, representing 3% of the total number of primates (2,281, excluding derivatives and unspecified records). Sixty-two (91%) of the confiscated individuals were live, and six (9%) were unspecified. We found no records of dead owl monkeys. The individuals included 5 *A. miconax* (7%), 19 *A. nancymaae* (28%), 22 *A. nigriceps* (32%), 1 *A. vociferans* (2%), and 21 *Aotus* sp. (31%). There was no discernible trend in confiscations over the period, but this may be because the datasets were so uneven between regions.

Fewer data were available from the remaining countries (Table 23.1). These included an animal seized in Argentina and four seized in Panama, which were all live individuals kept as pets (Mendez-Carvajal pers. com.). In Brazil, only information from rescue centers was available, which included 31 owl monkeys (Levacov et al. 2011). From the Orinoco basin in Venezuela, we received reports of trafficking four primate species, none of which was an owl monkey (Gibson pers. com.). One publication based on official confiscation records noted 70 *A. trivirgatus* confiscated in Venezuela between 2000 and 2009 (Asmüssen et al. 2019). Government data on primates seized, or, in news reports, entering Trinidad and Tobago from Venezuela and possibly Guyana, showed that none were owl monkeys (Gibson, pers. com.).

23.3.3 Case Study 1: Trafficking of Owl Monkeys in Peru

For our study in Peru, we surveyed markets in six of the main wildlife trafficking hotspots periodically between 2010 and 2012 (Shanee et al. 2017). We identified 741 primates for sale, of which 33 (4.5%) of these were owl monkeys, all recorded as *Aotus* sp. During the "complete" survey at the Bellavista market, 4,063 primates were offered for sale across 14 stalls, including 63 (1.6%) owl monkeys, of which 41 were sold during the survey period. On average, three owl monkeys were offered, and a minimum of two sold, per month at this market. We found a large difference when comparing these levels of traffic to official confiscation numbers. Our complete survey in Bellavista market documented 6 owl monkeys trafficked between August and December 2010, 34 during 2011, and 1 in the first quarter of 2012. Confiscation records from Ucayali show only two owl monkeys seized in 2010, and none in the following 2 years.

We also found large differences when we compared our data with official confiscation records from Amazonas and San Martin. We participated in the confiscation of eight *A. miconax* seized by the regional wildlife authorities from the traffic in these regions between 2007 and 2011. On the other hand, official records include only one owl monkey confiscation in Amazonas and none for San Martin. In other

words, the official records of the regional wildlife authorities severely underreport the actual number of confiscations.

23.3.4 Case Study 2: Illegal Trafficking of Owl Monkeys in the Tri-border Area of Brazil, Colombia, and Peru

Corpoamazonia, the regional environmental authority of Amazonas, Colombia, authorized the FIDIC biomedical facility to capture a total 11,600 *Aotus* spp. between 1999 and 2020, in quotas that ranged from 400 to 800 animals per year (Corpoamazonia 2020a). These authorizations were originally issued to trap *A. vociferans* only, but publications from FIDIC included results of experiments with both *A. nancymaae* and *A. nigriceps* (considered exotic to the country) (Baquero et al. 2006; Spirig et al. 2005). In 2014, a court course brought against the FIDIC laboratory ruled in favor of stopping further capture of owl monkeys. However, a later trial reinstated these permits in 2015, and in 2016, Corpoamazonia allowed the inclusion of *A. nancymaae* for trapping, despite the fact that the species had been uplisted from Least Concern (LC) to Vulnerable (VU) (Maldonado et al. 2017). The Colombian Ministry of Environment (MADS) did not include *A. nancymaae* in the latest List of Endangered Species for Colombia (Resolution 1912, 2017), arguing that a national assessment of the species conservation status is needed. In November 2017, MADS and the National University finished assessing the status of *A. nancymaae* in Colombia following the IUCN guidelines (Convenio 518 de 2017). The results would place the species in the Vulnerable category, but these results have not yet been made public. Corpoamazonia continues granting trapping permits for *A. nancymaae*, arguing that MADS is in charge of including species on the list of threatened species for Colombia and that *A. nancymaae* is not yet included (Corpoamazonia 2020b). These captures place the current, small, Colombian population of *A. nancymaae* at risk and provide opportunity to launder animals illegally sourced from Brazil or Peru.

Indigenous collectors have continued capturing animals for FIDIC, contravening legal rulings. In October 2020, the police from Puerto Nariño, Amazonas, confiscated and released approximately 20 owl monkeys found on a boat awaiting collection by FIDIC. The Indigenous people who had the animals did not have permits and did not belong to communities included in Corpoamazonia permits, and some were Peruvian citizens. Owing to the inobservance of stipulations in recent resolutions issued by Corpoamazonia, civil society agencies petitioned for an investigation of the environmental authorities to the Comptroller General, as well as to the Attorney General of Colombia. In October 2019, the Comptroller General for the Environment found the Colombian Ministry of Environment and Corpoamazonia guilty of impacting natural resources through their negligence in granting and supervising FIDIC's permit (Contraloría General de la República de Colombia 2019). They ordered disciplinary and penal investigations against both authorities, marking the

first time that criminal investigations will be carried out regarding trafficking in owl monkeys of Colombia.

The legal actions taken to curb the trade and expose governmental irregularities in the issuing of permits by A. Maldonado and her team have resulted in legal and popular media campaigns against them. Following threats related to these campaigns, Green Party senators in Colombia requested government protection for A. Maldonado. Especially worrying in this context is that Colombia was recently ranked as having the highest number of killings of environmental leaders globally, with 64 killed in 2019, and the highest record in 8 years (Global Witness 2020). Currently, the Colombian National Protection Union provides a personal security detail to A. Maldonado to ensure her safety.

23.4 Discussion

We found that both legal trade and illegal trafficking of many species of owl monkey still occur throughout their range countries. The legal trade occurs in eight of the range countries, with most trade originating in Peru since 1990, and although it is decreasing, this is not reflected in national-level trafficking. The existence of breeding centers in the USA to fulfill demands for biomedical research has probably contributed to this decrease, but owl monkeys are still traded internationally and could be reexported from the USA. It is also evident that whereas trade in other species is increasingly moving online along with globalized access to the Internet (Lavorgna 2015; Demeau et al. 2019), this is not the case for owl monkeys; the trade of these primates seems to be mainly occurring offline.

When investigating the legal trade, it is important to consider the reliability of the CITES database, which is dependent on the accuracy of data reported. Exporting and importing parties can legitimately report different information, and therefore large discrepancies in the actual number of traded animals result (Blundell and Mascia 2005; Nijman and Shepherd 2010). Reports in the CITES trade database are conservative in the taxonomy employed, with the majority of the entries being labeled as *A. trivirgatus* or simply as *Aotus* spp. In our examination of the CITES data, we corrected the species name where possible export countries have only one naturally occurring owl monkey species. We are aware that illegal cross-border trade makes it possible that additional species may be reexported, and although we suspect that this may concern only a small number of individuals, we have no way to verify this. We chose to include this correction of species names to provide at least an estimate of the species being affected by the trade. It is imperative that the location of origin and, when possible, the species are identified as accurately as possible so that traceability and assessment of the scale and impact of the trade is possible. This is complicated by the difficulties in accurately identifying owl monkey species through visual inspection (Fernandez Duque et al. 2023 this volume; Di Fiore et al. 2023 this volume), and border personnel and wildlife authorities generally lack training. Under the current system, it is possible to confuse

or even launder owl monkey species. The use of pedigree studies and parentage analyses are options for confirming the origin of imported animals and for species identification (Mucci et al. 2014; Oklander et al. 2020), but genetic methods are not currently employed. The verification process could engage research facilities in reducing their impact on species, as biomedical facilities presumably have the necessary infrastructure for the genetic assessments. We suggest that these, and other control measures, be substantially increased at arrival ports and destination countries. The mismatch between import and export reports shows a potential breach in the control of these reports, which contravenes CITES goals and the commitments of the parties (Challender et al. 2015).

Brazil, Ecuador, and Venezuela reported low levels of international trade to CITES, with importing countries also reporting low levels from these countries, suggesting that trade is minimal in these cases. We also found evidence of low levels of illegal trafficking in Argentina, Ecuador, Panama, and Venezuela, although this is probably due to low levels of enforcement and/or lack of reporting.

Contrary to other general trends, we did not find evidence that online trade has replaced physical markets, even when 85% of the Latin American countries are active users of social media, with Facebook being one of the most popular platforms (Navarro 2020). Still, this does not mean that owl monkeys are not sold online. During preliminary general Internet searches outside of social media sites, we found several individuals for sale from online exotic pet stores. However, we could not determine the source of these animals (i.e., illegal or legally captive bred).

There was a general paucity of available data of confiscations from range countries. The low numbers or absence of records suggests that owl monkeys are either not being detected or not properly reported. Encouragingly, recent confiscation records were more readily available and more complete than older data, suggesting that enforcement is improving. Recently, more attention is being focused on wildlife trafficking in general, including the publication of national strategies in Colombia, Ecuador, and Peru (Ministerio del Ambiente y Agua 2001; Ministerio de Medio Ambiente y Desarrollo Sostenible 2012; Ministerio de Agricultura y Riego 2017). These actions need to be replicated across the region and could lead to real improvements against wildlife trafficking.

In all countries for which we could get data, almost all individuals seized by authorities were live, suggesting that owl monkeys are predominantly trafficked for the pet trade and biomedical research. Unfortunately, there is no way of knowing the exact purpose or destination of the seized animals, such as whether end consumers are national or international. What we did find is that the majority of owl monkey confiscations in Peru and Colombia were at Amazonian sites, near the locations from where the animals were presumably extracted. This suggests that the local pet trade is the principal market.

The relatively high number of confiscations in Colombia, and the trend of decreasing numbers of confiscated owl monkeys and primates in general, may reflect better enforcement and/or higher levels of traffic than in Peru. By far the largest number of owl monkey confiscations in Colombia was from Amazonas region, which is the center of trade for biomedical research and includes illegal

trafficking from Peru and Brazil (Maldonado 2011). The need for transnational strategies to counter wildlife trafficking is particularly relevant in this area, due to high demand, porous borders, and an established network of trappers, transporters, and buyers (Maldonado 2011). Similarly, the existence of in situ breeding facilities and laboratories makes the area ideal for "laundering" illegally sourced animals (Gozalo and Montoya 1990; Maldonado and Lafon 2017). Confiscations in this area are difficult as none of the countries involved have nearby rescue centers nor legal facilities to hold the animals. For instance, in Leticia, the regional environmental authority confiscates animals and gives them to local tourist attractions where they are further exploited economically (Maldonado and Waters 2017), even though this form of use is illegal (Law 1333, 2009) and has led to investigation of Corpoamazonia. Similar actions occur in Peru where, due to the lack of rescue centers and reticence to euthanize animals, authorities leave animals under inadequate care and, in some cases, return animals to their former "owners" even though this is prohibited (Shanee and Shanee 2021).

Owl monkeys were fairly uncommon in the confiscation records we obtained for Peru. Importantly for conservation strategies, the majority of owl monkeys were identified to species level. There was only one recorded confiscation of *A. vociferans*, which is unexpected as it is trafficked in high volumes to Colombia (Maldonado 2011). The form in which owl monkeys are trafficked in Peru also differed from that of other small bodied primate species, in that they are trafficked in small numbers, whereas primate such as *Saimiri* spp. and *Cebuella* spp. are trafficked in medium to large batches (Shanee et al. 2017). This may possibly reduce their detectability during market counts and control activities. However, trafficking in owl monkeys has been constant and widespread among villages and city markets in the Amazon for many years. Thus, low numbers, but a consistent presence on the open market, may serve to advertise their availability within trafficking networks. A 9-month market survey carried out by WCS-Peru in 2017 in Iquitos, Pucallpa, Chiclayo, Tumbes, Puno, and Lima failed to find any owl monkey for sale (Murillo, pers. comm). This probably reflects increased caution on the part of vendors, rather than a true reduction in traffic, as records of confiscations have increased. In Peru, owl monkey confiscations occurred in 12 of its 24 administrative regions. We found several instances where confiscations were not included in official records. Authorities in Peru seldom treat the illegal possession of wildlife as a serious offence and often do not apply the stiff minimum legal penalties (Shanee and Shanee 2021). Our "complete" survey in Pucallpa documented nearly double the quantity reported through other market surveys (Shanee et al. 2017) and many times the number confiscated in the area during the same period. Thus, although confiscations do occur, they are not a good indicator of the true volume of traffic.

Of all regions, South America has been the focus of the least research and public attention on wildlife trafficking (Reuter and O'Regan 2017). We have, however, found owl monkeys to be commonly trafficked, both domestically and internationally, mirroring previous research (Svensson et al. 2016; Estrada et al. 2017). Only incomplete data are available, leaving substantial gaps in our knowledge, which hinders planning and implementation of control. It is possible that the most heavily traded owl monkey populations and some of the rarer species are more threatened

than previously thought. Recorded levels of trade and traffic represent a minimum, with the majority of animals not being confiscated or controlled by authorities.

Wildlife trafficking is tolerated by the public in range countries. This is especially true in the Amazon, the main point of origin of animals entering the traffic stream, where wildlife hunting and pet keeping are a long-standing habit (Bodmer and Lozano 2001; Maldonado and Waters 2020). The current globalized economy makes it necessary to work toward changing attitudes with respect to hunting and the keeping of wildlife as pets in these areas. Organized criminal networks easily launder and traffic animals that originate in subsistence economies (Maldonado and Waters 2017). Communities and local leaders can be effective in the fight against traffic at its origin if they are motivated and not disincentivized by corrupt authorities and overcomplicated legislation (Shanee 2013). Owl monkeys are vulnerable to hunting due to their general immobility during the day and use of regular nesting sites (Aquino and Encarnación 1986; Garcia and Braza 1993), which makes them relatively easy to capture either by slingshot from open vine tangle nests (Shanee 2012) or through the clearance of vegetation surrounding tree hole nests and subsequent trapping in nets (Maldonado and Peck 2014). Trade and traffic in owl monkeys represent a real threat to some species, and with the continued destruction of natural habitats (Maldonado et al. 2023 this volume; Mendez-Carvajal et al. 2023 this volume; Shanee 2023 this volume), this threat will only increase if legislation is not properly enforced. There is still a dearth of documentation in traffic and trade of primates in general, and nocturnal and cryptic species in particular, not knowing the true levels of trade may well be a substantial impediment to conservation efforts (Nekaris et al. 2010).

Trade and traffic in owl monkeys are little studied threats and are largely dependent on differences in hunting and commercialization activities, with some species and populations being more threatened than others. Data available on trafficking of species is scarce and often unreliably reported. We suggest that the results presented here are taken as general best minimum estimates and recommend a substantial increase in in-depth studies and the application of control measures. Trade for biomedical research continues to occur and is inextricably linked to illegal trafficking activities in the Brazil-Colombia-Peru tri-border area (Maldonado 2011; Maldonado and Waters 2020). Similarly, illegal local- and national-level domestic trade is common throughout owl monkey range countries, while official records consistently underestimate its true scale, with problems in reporting of confiscated animals and a further lack of interventions in relation to the number of animals offered for sale in markets. Until adequate control measures are consistently employed, owl monkeys will continue to be threatened by both legal trade and trafficking.

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