

Disappearing in the Night: An Overview on Trade and Legislation of Night Monkeys in South and Central America

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Keywords

Aotus · Convention on International Trade in Endangered Species · Douroucoulis · Domestic legislation · Malaria research · Neotropics · Owl monkeys

Abstract

The international trade in night monkeys (*Aotus* spp.), found throughout Central and South America, has been regulated by the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) since 1975. We present a quantitative analysis of this trade from all 9 range countries, over 4 decades, and compare domestic legislation to CITES regulations. Night monkeys were exported from 8 of the 9 habitat

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countries, totalling 5,968 live individuals and 7,098 specimens, with trade of live individuals declining over time. In terms of species, the most commonly traded was *Aotus nancymae* (present in Brazil, Colombia, Peru) followed by *A. vociferans* (Brazil, Colombia, Ecuador, Peru) and *A. zonalis* (Colombia, Panama). There was no significant correlation between levels of trade and species' geographic range size or the number of countries in which a species occurs. Five countries have legislation that meets CITES requirements for implementation, whereas the other 4 countries' legislation showed deficiencies. Research conducted in Colombia, Peru, and Brazil suggests significant cross-border trade not captured in official international trade registers. Although international trade has diminished, current trends suggest that populations of rarer species may be under unsustainable pressure. Further research is needed to quantify real trade numbers occurring between habitat countries.

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Introduction

Primates worldwide are threatened by habitat loss, forest fragmentation and overhunting, as well as legal and illegal trade, including the trade for consumption, medicine and as pets [Duarte-Quiroga and Estrada, 2003; Nekaris and Jaffe, 2007; Ceballos-Mago et al., 2010; Nijman et al., 2011; Strier, 2011; Svensson and Friant, 2014; Nijman and Healy, 2016]. Primates are traded domestically, for instance within a village or from one village to the next [Nekaris et al., 2010], regionally, for instance from one province to the next [Shanee et al., 2015b; Nijman et al., 2016], across international borders from one country to the next [Maldonado et al., 2009], and globally, from one continent to another [Mack and Mittermeier, 1984; Nijman et al., 2011; de Souza Fialho et al., 2016]. This trade occurs within and amongst primate range countries and non-primate range countries [Nijman et al., 2011]. While much of the international primate trade adheres to domestic legislation and international agreements, some of it is illegal [Maldonado et al., 2009; Nijman and Healy, 2016]. Partially due to their cryptic nature, nocturnal species have often been excluded from studies on trade [Nekaris and Nijman, 2013; Svensson and Friant, 2014]. Recent work has, however, found them to be increasingly threatened by both domestic and international trade [Shepherd et al., 2005; Maldonado and Peck, 2014; Nijman and Nekaris, 2014; Svensson and Friant, 2014; Shanee et al., 2015b; Svensson et al., 2015].

In assessing the scale and traceability of the trade, the ever-changing taxonomy of many primate taxa is problematic as outdated taxonomies and synonyms lead to difficulties in identifying which species are traded from where [Mace, 2004]. Again, this is especially prominent in nocturnal primates, which have seen significant taxonomical changes as, until recently, their true diversity in terms of number of species has not been recognized [Hershkovitz, 1983; Groves, 2001; Nekaris and Bearder, 2011]. A case in point are the night monkeys (*Aotus* spp.), also referred to as owl monkeys or douroucoulis. Their range is vast, encompassing the Chaco plains of Argentina in the south to Coclé del Norte in Panama's rain forests in the north (Fig. 1) [Fernandez-Duque et al., 2013]. Since night monkeys were first described in 1802 by Félix de Azara [Goldman, 1914], the taxonomy and suggested arrangements of the number of species and subspecies has been greatly debated [Defler and Bueno, 2007]. Until 1983, when 9 taxa were suggested, they were thought to comprise only 1 species,

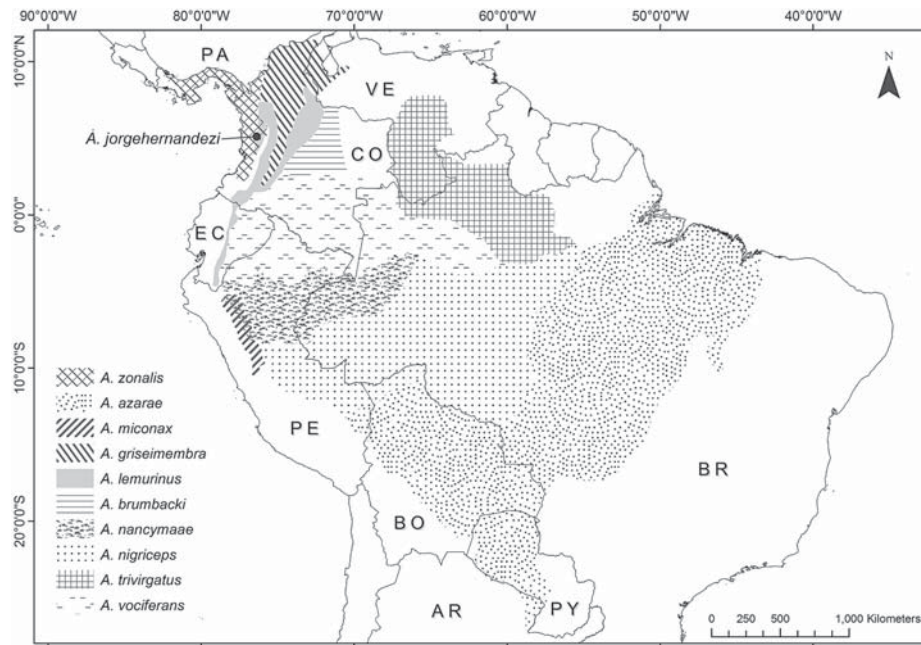


Fig. 1. Distribution of *Aotus* species. AR, Argentina; BO, Bolivia; BR, Brazil; CO, Colombia; EC, Ecuador; PA, Panama; PE, Peru; PY, Paraguay; VE, Venezuela. Map created using IUCN shape files [IUCN, 2008].

Aotus trivirgatus [Hershkovitz, 1983]. Here we follow the taxonomy used by Fernandez-Duque et al. [2013], recognizing 11 species, which also coincides with the International Union for Conservation of Nature's (IUCN) Red List. Five of these are listed as Least Concern on the 2008 assessment (*A. azarae*, *A. nancymaae*, *A. nigriceps*, *A. trivirgatus* and *A. vociferans*), 4 as Vulnerable (*A. brumbacki*, *A. griseimembra*, *A. lemurinus* and *A. miconax*) and 2 as Data Deficient (*A. zonalis* and *A. jorgehernandezi*) [IUCN, 2008]. The population trends for all species are given as either decreasing or unknown in the IUCN Red List; none is listed as having stable or increasing population trends [IUCN, 2008].

Like many other primate species, most night monkey species are threatened by varying levels of habitat loss throughout their range, mainly caused by expansion of the agricultural frontier, cattle ranching, logging, armed conflict, and mining operations [Butchart et al., 1995; Strier, 2011; Shanee et al., 2015a]. Additionally to these threats, night monkeys have been, and continue to be, traded domestically, regionally, and internationally [Mittermeier et al., 1994; Maldonado et al., 2009; Shanee, 2012; Ruiz-García et al., 2013; Shanee et al., 2015b].

In this study, we first provide an overview of the trade in night monkeys from the 1960s onwards, and secondly, we present the results of a quantitative analysis of the international trade in night monkeys from all 9 South and Central American range countries. In this analysis we take into account, and explore relationships between, trade volumes, origins and destinations, proportions of live trade, species

identity, and species' geographic range size. Finally we provide an overview of the relevant domestic legislation and how well this complies with the rules and regulations of CITES, and how this compares to recorded levels of international trade. We hypothesize that the combined effect of legal and illegal trade is a real and emerging threat even for cryptic primate species, and we intend this overview document to be available for conservation planning.

Methods

We downloaded data in October 2016 on the export of night monkeys from the CITES trade database (<http://trade.cites.org/>) for the period 1975–2014 (data from 2015 were not yet available). For four 10-year periods (Table 1), we established the number of live and dead individuals that were exported from range countries as well as the number of specimens. It is possible to overestimate the number of individuals when counting specimens in the CITES database as specimens are defined as any readily recognizable part or derivative of the animal (we use the definition of specimen as described by www.CITES.org). To avoid this we excluded specimens where it was specified that the export was in metric volume units or as shipments. We restricted dead individuals to bodies and skins to avoid possible double counting (a skin and a skull exported on two separate occasions could be derived from the same individual); as such our numbers represent a minimum estimate.

The reliability of the records in the CITES database is entirely dependent on the accuracy at which CITES parties report data. Importing and exporting parties can legitimately report differences in associated information attached to individual transactions (e.g., purpose). It has been documented that there can be large discrepancies between officially reported import and export figures and the actual import or export figures [Blundell and Mascia, 2005; Nijman and Shepherd, 2010]. Indeed, we found that some of the reported quantities differed significantly between what was reported by the importing and the exporting party, and reporting rates for certain countries were suspected to be lower than what was actually traded internationally. Unfortunately it was not possible to assess to what extent these discrepancies are intentional. As import data (reported by the importing country) and export data (reported by the night monkey range country) did not always coincide, we cross-checked the data and included the largest overall totals by comparing data from importing and exporting countries. We checked all re-exports (when an individual is exported by one country after it has been imported from another) to prevent double-counting. By its very nature, the CITES trade database only holds records of international trade, trade that is reported (either by the importing party and/or the exporting party), and, to a lesser degree, seizure data. It does not hold information on domestic trade or the illicit trade. Reports of exports or imports in the CITES trade database are conservative in the taxonomy employed, with the majority of the entries being labelled as *A. trivirgatus* or simply as *Aotus* spp. [de Souza Fialho et al., 2016]. We corrected the species name where possible so as to reflect our current understanding of night monkey taxonomy and geographical distribution and to better understand the impact of trade on each individual species. Where we were not able to identify or infer the species involved, we use *Aotus* spp. We are aware that due to (illegal) cross-border trade, it is possible that species additional to the ones that occur naturally within a country may be re-exported; we expect that in absolute terms this will concern a small number of individuals but we have no way to verify this.

Using annual totals of individuals exported, we explored whether or not there has been an increase or decline in the number of night monkeys traded over the 40-year period. All other things being equal, species with larger range sizes, and possibly species occurring in a larger number of countries, have larger population sizes [Gaston, 2003]. In the absence of data on actual population sizes, we checked whether or not species with an overall larger geographic range or species that occurred in multiple countries were exported in larger numbers (Fig. 1) [IUCN, 2008]. Geographic range sizes were converted to ranks prior to analysis.

All range countries provide some level of legal protection for night monkeys, although in varying degrees according to the CITES National Legislation Project (NLP) (Table 2) [Vasquez,

Table 1. Export of night monkeys out of South and Central American range countries (1975–2014)

Country/ species	1975–1984			1985–1994			1995–2004			2005–2014		
	live	dead	spec.	live	dead	spec.	live	dead	spec.	live	dead	spec.
Argentina												
<i>A. azarae</i>	0	0	0	0	0	0	0	0	932	0	0	576
Bolivia												
<i>A. azarae</i>	0	0	0	0	0	0	0	0	0	0	0	8
<i>Aotus</i> spp.	1,351	0	0	20	1	0	0	0	0	0	0	0
Brazil												
<i>Aotus</i> spp.	0	0	2	0	0	2	0	0	0	0	0	0
Colombia												
<i>Aotus</i> spp.	109	0	13	0	0	1,270	0	0	0	0	0	18
Ecuador												
<i>A. vociferans</i>	0	0	0	0	0	0	0	0	0	0	0	6
Panama												
<i>A. zonalis</i>	301	0	0	0	1	641	0	0	0	0	0	2,061
Paraguay												
<i>A. azarae</i>	174	0	0	0	0	0	0	0	0	0	0	0
Peru												
<i>A. miconax</i>	0	0	0	0	0	0	0	0	0	0	0	1
<i>A. nancymaeae</i>	0	0	0	70	0	0	1,321	0	840	216	0	640
<i>A. nigriceps</i>	0	0	0	0	0	0	0	0	0	0	0	15
<i>A. vociferans</i>	0	0	0	25	0	0	400	0	0	38	0	0
<i>Aotus</i> spp.	197	23	24	1,741	0	24	0	1	4	5	0	21
Venezuela												
<i>Aotus</i> spp.	0	0	0	0	0	0	0	0	0	0	0	0
Total	2,132	23	39	1,856	2	1,937	1,721	1	1,776	259	0	3,346

For each range country, we show the number of live/dead individuals and specimens (spec.) exported per decade, from 1975 at the inception of CITES to 2014, the last year for which records were available. Note that real levels of international trade may be considerably higher, and domestic trade is not taken into account.

2003; CITES, 2016a]. CITES NLP is the mechanism for assisting and encouraging the CITES parties' legislative efforts, and places the parties in 3 different categories according to how well domestic legislation matches CITES legislation. These categories are (1) legislation that is believed generally to meet the requirements for implementation of CITES, (2) legislation that is believed generally to meet only some of the requirements for the implementation of CITES, and (3) legislation that is believed generally not to meet the requirements for the implementation of CITES [Vasquez, 2003; CITES, 2016a]. We gathered information on country-specific legislation relating to CITES and wildlife trade using searchable legislative and policy databases such as Bagheera's Endangered Species Legislation Compendium (<http://www.bagheera.com/endangered-species-laws-i>), the Food and Agriculture Organization of the United Nations' FAOLEX database (<http://faolex.fao.org/>) as well as from our own extensive knowledge of working in many night monkey range countries (Argentina, Bolivia, Brazil, Colombia, Ecuador, Panama, and Peru). We tested whether or not countries that had legislation that agreed with CITES regulations exported more or less night monkeys compared to those countries that had deficiencies in their primary legislation (i.e., legislation embracing main laws passed by the legislative bodies of the respective governments, thus excluding secondary or subordinate legislation, passed by lower levels of government).

Table 2. Country-specific legislation regarding wildlife trade, years when range countries entered CITES, and the category each country falls into according to the CITES National Legislation Project

Countries	<i>Aotus</i> spp.	Legislation	CITES	Category	Source
Argentina	<i>azarae</i>	Law No. 22344 (1981) adheres to CITES, and Decree 522/97 regulates permits for export/import of <i>A. azarae</i> , as the species is included under CITES Appendix II. Formosa Province Law No. 1582 (2012) declared <i>A. azarae</i> a “provincial monument,” prohibiting hunting, pet ownership, marketing, and intra- and interprovincial transit of the species. This is also supported by Law No. 1060 (1993, Provincial Ecological and Environmental Law of Formosa)	1981	1	a, b
Bolivia	<i>nigriceps</i> , <i>azarae</i>	Law No. 1333 (1992) and Decree No. 22641 (1990) prohibit the capture and collection of wild animals and their derivatives. Decree No. 25458 allows sustainable use of some wildlife species for research, approval is needed from the Ministry of Sustainable Development and Planning. The Environment and Water Ministry works to implement CITES regulation (administrative resolution: 32/2015 VMABCCGDF) to reinforce actions against illegal wildlife trafficking	1979	2	c, d
Brazil	<i>azarae</i> , <i>nigriceps</i> , <i>nancymaae</i> , <i>vociferans</i> , <i>trivirgatus</i>	Law No. 5.197 (1967) – Fauna Protection Law – prohibited the illegal commercialization, hunting, export and keeping as pets of all native species. Law No. 9.605 (1998) – Environmental Crimes Law – defined the activities cited above as crimes, with penalties more severe if threatened species are involved or in protected areas. Both laws are still valid. Decree No. 3.607 (2000) refers to the implementation of CITES. Chapter 1 defines the Brazilian Institute of Environment and Renewable-Natural Resources (IBAMA) as the CITES administrative authority and the Chico Mendes Institute for Biodiversity Conservation (ICMBio) as the scientific authority for fauna species. Both IBAMA and ICMBio are linked to the Ministry of Environment. Chapter 2 of the Decree defines the procedures needed for the international trade of species. It declares that for the export/import of species included in their appendixes, a license issued by IBAMA is necessary. For species included in Appendixes I and II, a declaration is needed from ICMBio, attesting that the exportation/importation of the species will not affect its survival	1975	1	e, f, g
Colombia	<i>jorgehernandezii</i> , <i>griseimembra</i> , <i>zonalis</i> , <i>trivirgatus</i> , <i>vociferans</i> , <i>brumbacki</i> , <i>lemurinus</i> , <i>nancymaae</i>	Article IV (1981) of Law No. 17 states that commercial exploitation of wildlife listed in CITES Appendix II requires an export/import permit to be granted by the Environmental Ministry. Law No. 1608 (1978) states that the environmental authority must conduct population studies prior to the exercise of any permit that allows the extraction of wild fauna and flora. Recently, new laws to increase penalties for environmental crime have been implemented (e.g., Law No. 1333, 2009). In addition, the Resolution 0192 (2014) updates the list of threatened species, including as vulnerable <i>A. griseimembra</i> , <i>A. brumbacki</i> , and <i>A. lemurinus</i>	1981	1	h, i
Ecuador	<i>vociferans</i> , <i>lemurinus</i>	Article 15 of Law No. 3.339, Amendment No. 2.274 (2004), states that the trading of specimens of wildlife and their derivatives is only allowed for scientific and taxonomic identification purposes, and requires authorization from the Ministry of Environment. Sanctions for perpetrators include the confiscation of the animals as well as fines or imprisonment	1975	2	j
Panama	<i>zonalis</i>	Article 40 of Law No. 43 (2004), Chapter 3, states that the use and transport of wildlife and their derivatives, without the prior authorization by the Environmental Ministry, is prohibited. Article 38 of Law No. 24 (1995), Chapter 4, also establishes that it is prohibited in the entire national territory to collect, capture, or submit to any transportation and commercial activities any wildlife species, its products, or its derivative parts, unless the Environmental Ministry technically considers the contrary in accordance with any previous study about that particular species	1978	1	k, l
Paraguay	<i>azarae</i>	Law No. 583 (1976) and Decree No. 9701 (2012) regulate any activities relating to CITES-listed species regarding import/export, and authorization is needed, the CITES authority being the General Directorate of Biodiversity Protection and Conservation	1976	2	m, n

Table 2 (continued)

Countries	<i>Aotus</i> spp.	Legislation	CITES	Category	Source
Peru	<i>nigriceps</i> , <i>nancymaae</i> , <i>vociferans</i> , <i>miconax</i>	Law No. 29763 (2015) states that all wildlife is protected and its use must be authorized, and with regard to any import/export of primates the National Forest and Wildlife Service (SERFOR) or the regional wildlife authorities are in charge of issuing permits depending on the species' threat category. Supreme Decree No. 004-2014-MINAGRI (2014) approved the list of Threatened species by Peruvian law. Of all night monkeys, the decree considers only <i>A. miconax</i> as a threatened species, that is as Vulnerable. Species that are not included in Supreme Decree 004-2014-MINAGRI can be collected from the wild provided SERFOR approves the research proposal that requires the species' collection for scientific purposes. Specimens of <i>A. miconax</i> can only be exported if derived from captive breeding centres. To collect the breeding stock, the applicant needs to justify the necessity of the collection and prove that specimens of the species do not exist in captivity and that collection will not negatively affect wild populations	1975	1	o, p
Venezuela	<i>trivirgatus</i> , <i>griseimembra</i> , <i>lemurinus</i>	Law No. 29.289 (1970) states that all matters relating to the import/export of wild animals and their by-products is subject to the provisions of this Act. Law No. 39.913 (2012) states that trafficking of wild animals and/or products should be reported to the Environmental Ministry (Unidad de Control de Tráfico Ilicito de Especies – MINAMB)	1977	2	q, r

a, Argentina [1982]; b, Provincia de Formosa [2012]; c, MMAyA [2016]; d, Bolivia [1992]; e, Brazil [1967]; f, Brazil [1998]; g, Brazil [2000]; h, Maldonado et al. [2009]; i, MADS [2012]; j, Ministerio del Ambiente [2011]; k, Panama [1995]; l, Panama [2004]; m, Paraguay [1976]; n, Paraguay [2012]; o, Gómez [2015]; p, Shanee et al. [2015b]; q, Venezuela [1970]; r, Venezuela [2012].

Data were not normally distributed and we used non-parametric statistics (Spearman rank correlation coefficient and Mann-Whitney U test), implemented in R, to test for statistical significance, with significance accepted when $p < 0.05$ in a 2-tailed test [Siegel, 1956].

Results

Historic Overview of Night Monkey Trade

In the 1960s, night monkeys were found to be the best-suited primate model for medical research into malarial vaccines and for tests of antimalarial drugs [Young et al., 1966; Collins, 1994]. Several species have since commonly occurred in the biomedical trade, such as *A. vociferans*, *A. nigriceps*, and *A. nancymaae* [Mittermeier et al., 1994; Maldonado et al., 2009; Galinski and Barnwell, 2012] due to the similarity of their immune system with that of humans and their high susceptibility to several forms of malaria-causing *Plasmodium* parasites [Herrera et al., 2002]. Different species of night monkeys have different susceptibilities to malarial parasites, and not all are suited as animal models [Groves, 2005]. Nowadays night monkeys are also used as animal models in biomedical research regarding the human immunodeficiency virus (HIV) as they are the only New World primate that is resistant to HIV-1 [Hofmann et al., 1999], as well as in ophthalmologic research due to the easily viewed retina [Ogden, 1994]. In the decades prior to 1975, when CITES was established, the trade in night monkeys and other primates for biomedical research was vast and uncontrolled, especially from the Amazon Basin [Linder et al., 2013]. Exports of wild-caught night monkeys were principally to the USA and Europe. Trade of night monkeys and other primates from South and Central America occurred at an alarming rate, leading to national bans being implemented on exports of primates in the mid-



Color version available online

Fig. 2. Trade in night monkeys in South America. **a** *Aotus nancymaae* trapped for malarial research in Gamboa, Peru (photo by L. Pelaez). **b** Infant *Aotus miconax* confiscated by authorities in Peru (photo by N. Shanee). **c** *Aotus cf. nigriceps* in the Bellavista wildlife market, Peru (photo by N. Shanee).

1960s and 1970s in Brazil, Colombia, Peru, Paraguay, and Panama, with official licenses being issued for limited numbers of night monkeys allowed to be exported in any given year [Brazil, 1967; Mack and Mittermeier, 1984; Maldonado and Peck, 2014]. When trade became regulated, captive breeding programmes were started in the 1970s and 1980s, particularly in the USA, Peru, Panama, and Germany [Gozalo and Montoya, 1990; Rappold and Erkert, 1994; Málaga et al., 1997; Obaldía, 2001]. Despite the availability of captive-bred animals, several researchers have found evidence that the international trade of night monkeys for biomedical research is continuing illegally from at least part of their range [Maldonado et al., 2009; Rojas Briñez, 2011; Ruiz-García et al., 2013; Maldonado and Peck, 2014].

Relying on information from the literature, the domestic trade of night monkeys appears to be low and rarely quantified in publications when mentioned (but for examples from Colombia, Brazil, and Peru, see Maldonado et al. [2009], Levacov et al. [2011], and Shanee [2012]). Due to their small body size they are not a preferred meat source, and domestic trade for meat appears limited. Furthermore, Cormier [2006] found night monkeys to occur commonly in taboos and food avoidance throughout Amazonia, and in parts of their range night monkey meat is considered distasteful due to their pungent subcaudal scent glands [Cornejo et al., 2008; Aquino et al., 2009; Shanee et al., 2015a]. There are however reports of night monkeys being hunted for consumption in Venezuela (*A. griseimembra*) [Lizarralde, 2002], Colombia (*Aotus* spp.) [Parathian and Maldonado, 2010; Maldonado, 2012], Ecuador (*A. vociferans*) [Mena et al., 2000; Zapata-Rios et al., 2009], and Peru (*A. miconax*) [Altherr, 2007; Shanee, 2012]. Alves et al. [2010] report on *A. azarae* being used in traditional medicine in Bolivia where it is believed to cure dribbling in babies.

All primate families within South and Central America are represented in the illegal pet trade, regardless of body size [Linder et al., 2013], and night monkeys are no exception having been observed in the pet trade throughout their range (Fig. 2): *A. miconax*, *A. nancymaae*, and *A. nigriceps* in Peru [Shanee, 2012; Shanee et al., 2015b], *A. zonalis* in Panama [Altherr, 2007; Svensson, 2008], *A. vociferans* in Colombia

[Parathian and Maldonado, 2010], *A. griseimembra* in Venezuela [Lizarralde, 2002], *A. azarae* in Brazil [Altherr, 2007], and *A. lemurinus* and *A. vociferans* in Ecuador [Tirira, 2013; Stafford et al., 2016].

Quantitative Analysis of International Trade

Over the 40 years prior to 2014 we found international trade reported from 8 range countries, with only Venezuela not reporting trade in night monkeys. We found reports of a total of 5,968 live individuals and 7,098 specimens of night monkeys exported by range countries (Table 1). There has been a significant decrease in the number of live individuals exported over time (Spearman rank correlation coefficient, $\rho = -0.619$, $n = 40$, $p < 0.001$) whereas the trade in specimens has seen a significant increase ($\rho = 0.509$, $n = 40$, $p = 0.001$). The majority of night monkeys were exported before 1994, after this year only Peru continued to export live individuals. The live trade out of Peru did not show an increase or a decrease over time when considering the entire 40-year data set ($\rho = -0.043$, $n = 40$, $p = 0.799$) but there was a significant increase in the period prior to the year 2000 ($\rho = 0.597$, $n = 25$, $p = 0.003$) which changed to a significant decrease in the years up to 2014 ($\rho = -0.853$, $n = 15$, $p < 0.001$). Argentina, Brazil, and Ecuador reported the export of specimens but no live night monkeys. Exports of specimens comprised 54% of the total trade, mainly *A. zonalis* from Panama ($n = 2,702$), *A. azarae* from Argentina ($n = 1,508$) and *Aotus* spp. from Colombia ($n = 1,301$). Trade in live individuals accounted for 45% of the total trade. The USA was the main importer with 78% of import records ($n = 152$). We found no difference in the levels of export between countries that had legislation that met the requirements of CITES and ones that showed deficiencies (Mann-Whitney U test, $N_1 = 5$, $N_2 = 4$, $U = 3$, $p > 0.10$).

For a subset of the exports, mostly from the 1990s onwards, we have information on the origin of the night monkeys traded. Focussing on the live trade, just over half (52%) is reported as being wild-caught (W in CITES terminology), with smaller numbers being declared as captive-bred second-generation offspring (C, 32%), captive-born first-generation offspring (F, 10%), and ranch-reared offspring (R, 6%).

Of the reported exports from night monkey range countries where it was possible to determine the species (119 reports out of 197), *A. nancymaae* was the most commonly reported (40%), followed by *A. vociferans* (28%), *A. zonalis* (16%), *A. azarae* (13%), *A. nigriceps* (2%), and *A. miconax* (1%). We found no significant correlation between the number of individuals traded and the species' geographic range size ($\rho = -0.086$, $n = 6$, $p = 0.919$) or the number of countries in which a species occurred ($\rho = -0.463$, $n = 6$, $p = 0.355$). *A. nancymaae* were all from Peru and almost all exported alive to the USA, mainly for scientific or commercial trade purposes.

Overview of Legislation

All countries where night monkeys occur are parties to CITES, with Peru, Ecuador, and Brazil joining the Convention at the time of its inception in 1975 and Argentina and Colombia joining last in 1981 (Table 2). All night monkey species are listed under CITES Appendix II, meaning that international trade requires official permission and evidence that extraction does not negatively impact wild populations [CITES, 2016b].

All countries had at least some primary legislation in place (thus no country falling under NLP category 3), with some specifically addressing night monkeys and oth-

ers providing general wildlife protection regulations (Table 2). Five of the range countries have legislation that generally met the requirements for implementation of CITES, thus falling under NLP category 1 (i.e., Argentina, Brazil, Colombia, Panama, and Peru), whereas the other 4 countries' legislation showed deficiencies for implementing CITES, falling under NLP category 2 (i.e., Bolivia, Ecuador, Paraguay, and Venezuela).

Collaboration amongst South American CITES management authorities does exist. In 1978 the Amazon Cooperation Treaty Organization (ACTO) was instituted between Bolivia, Brazil, Colombia, Ecuador, Guyana, Peru, Suriname, and Venezuela as a legal instrument recognizing the transboundary nature of the Amazon region [CITES, 2012, 2014]. In 2010 ACTO established the Amazonian Strategic Cooperation Agenda, including a subtopic (A.3) with the objective to strengthen the institutional and technical capacity of member countries from a regional perspective to manage, monitor, and control the trade of endangered wildlife [Dorfler and Aragón, 2011]. ACTO is collaborating with CITES to reduce illegal and unsustainable wildlife trade more effectively, for example by developing an electronic CITES permit system for the traceability of specimens of CITES-listed species. This collaboration was set up during the Rio+20 United Nations Conference on Sustainable Development in 2012 [CITES, 2014]. This and the sharing of expertise are believed to improve the ability of member countries of ACTO to reduce the illegal international wildlife trade.

National Level Trade Mitigation Initiatives

There have been a number of initiatives to curb the domestic and international trade in night monkeys; we here focus on Bolivia and Colombia, as they represent opposite ends of the night monkey trade. While official statistics (Table 1) suggest that the number of night monkeys exported from Bolivia has declined, this is thought to be caused mainly by a reduction of monitoring activities resulting in incomplete information [A.D. Mollo Vino, pers. observation]. Recognizing this, the Bolivian government has been working over the last 5 years on increasing the implementation of CITES regulation and improving monitoring of wildlife trafficking. In practice, this has led to an increase in enforcement efforts at international borders and airports, targeting a wide range of species. Its General Directorate of Biodiversity and Protected Areas has created national guidelines and actions for wildlife conservation such as the Action Plan for the Conservation of Bolivian Threatened Mammals 2014–2018 by the Ministerio de Medio Ambiente y Agua [MMAyA, 2013] and the Action Plan for the Conservation of Threatened Vertebrate Species in the National Protected Areas System [MMAyA, 2015].

Until 2015, permits for malarial research in Colombia allowed the capture of *A. vociferans* [Maldonado and Peck, 2014]. However, due to overextraction it became hard to source the species, which led to the biomedical laboratory Fundación Instituto de Inmunología de Colombia (FIDIC) requesting permits to capture *A. nancy-maae* as well [FIDIC, 2015]. *A. nancy-maae* has recently been reported to be present in Colombia, with a small distribution at the southern part of the Colombian Amazon; therefore extraction of individuals could be detrimental for the population's survival [Bloor et al., 2012]. Initiatives such as the agreement between the Colombian Ministry of the Environment, the National Police, and the Institute of Genetics at the National University of Colombia have enabled the creation of tools for tracing wildlife trade and attempts to improve decision-making, research, sanctioning, and postconfiscation

management [MADS, 2012]. Despite these efforts, in August 2016 the regional environmental authority Corporación para el Desarrollo Sostenible del Sur de la Amazonía (Corpoamazonia) permitted the capture of *A. nancymaae* for malarial research [Corpoamazonia, 2016]. This new permit lacks information on the population status of this species, and the decision obeys the political and economic influence of the FIDIC. In addition, Colombian indigenous collectors resident in Peru were allowed to be part of the team of trappers [Corpoamazonia, 2016], promoting the illegal trade of *A. nancymaae* from Peru [A. Maldonado, pers. observation], thus hampering the implementation, compliance, and enforcement of CITES regulations at the border between Colombia and Peru, inhabited mainly by indigenous people. In Colombia, as indeed in other night monkey range countries, ethnic groups have been recognized as autonomous communities, with the authority to manage their natural resources. These local regulations are not necessarily framed within international legislation, thus weakening community management capacity [MADS, 2012].

Discussion

We have demonstrated that over the last 4 decades trade has affected at least 8 of the 11 currently recognized species of night monkeys, and that, with respect to the legal international trade, night monkeys, or their derivatives, have been exported from 8 of the 9 range countries. The level of legal international trade of live individuals continues to decline. Only 5 countries have legislation that meets CITES requirements for implementation, whereas the remaining 4 countries' legislation showed deficiencies. However, it is important to consider that just because legislation exists it does not mean that sufficient law enforcement is in place or that governance is high. Whilst the ACTO collaboration amongst some of the South American CITES management authorities is a step in the right direction, it is vital to increase management of the international night monkey trade. Improvements in legislation in Bolivia, Ecuador, Paraguay, and Venezuela are imperative to meet the requirements for implementation of CITES.

Investigative research conducted in countries such as Colombia, Peru, and Brazil suggests significant cross-border trade that is not captured in the official international trade registers [Maldonado et al., 2009; Rojas Briñez, 2011; Ruiz-García et al., 2013; Maldonado and Peck, 2014]. This illegal trade is not easily captured under CITES, and it is imperative that domestic legislation extends to address and strengthen illegal in-country activities more efficiently, as well as implement cross-border cooperative efforts involving border officials and environmental authorities.

The numbers we report here for legal trade agree largely with those reported by Maldonado et al. [2009] and, more recently, de Souza Fialho et al. [2016]. The study by Maldonado et al. [2009] covered a shorter time period, and differences between their study and ours are thus attributable to the 6 years of additional data we had at our disposal. With respect to the numbers of night monkeys exported out of Peru, our data show significantly lower levels of international trade than reported by Maldonado and Peck [2014] but markedly higher ones than found by de Souza Fialho et al. [2016]. Maldonado and Peck [2014] reported 3,258 animals exported from Peru, over the period from 1994 to 2011, whereas we recorded a maximum of 1,925 animals, both dead and alive, being exported over this period. The discrepancy stems

from the inclusion of specimens and derivatives, which cannot be attributed to individual animals, in their total. De Souza Fialho et al. [2016] reported almost 700 fewer live animals, possibly because they adopted a more conservative approach when including trade records.

Further research is needed to verify whether the very low levels of international trade reported to the CITES Secretariat by Brazil, Ecuador, and Venezuela are representative of the current situation regarding cross-border night monkey trade from these countries. While it is possible that underreporting from range countries masks higher levels of trade, it is worth noting that similar low levels of trade from Brazil, Ecuador, and Venezuela were reported from importing countries, thus suggesting genuinely low levels of trade. A lack of taxonomic identification ability in the relevant authorities, institutional deficiencies with respect to recording and reporting trade, or corruption could also be the cause of the apparent low levels of international trade.

While the large-scale international trade in night monkeys for biomedical research has diminished, probably due to the proliferation of breeding centres in the USA, considerable numbers of night monkeys are still traded internationally, both legally and illegally. *A. nancymae* was most commonly reported as traded and is among the most commonly used night monkeys in malarial research [Maldonado et al., 2009; Ruiz-García et al., 2013]. Concerns have been raised regarding the ethical issues and the viability of using primates as biomedical research models [Pound et al., 2004; Bailey, 2005; Knight, 2008]. However, studies of avian malarial parasites, using birds and less invasive testing methods, have shown promise in research on malarial vaccines [Marzal, 2012].

At a global level, the legal trade in night monkeys is still very high compared to most other primate taxa. Estrada et al. [2017] provided a global overview of the international trade in primates (live and dead) for the period from 2005 to 2014, tabulating levels of trade at the genus level. From these data it is clear that while 2 genera show comparable levels of trade to that seen in night monkeys (chimpanzees and bonobos, genus *Pan*, and patas monkeys, genus *Erythrocebus*), only 8 taxa showed higher levels of trade (often significantly so, as in the case of macaques, genus *Macaca*), whereas 47 genera were traded in smaller numbers.

It is possible that the most heavily traded night monkey populations (such as *A. nancymae* and *A. vociferans*) and some of the rarer species (e.g., *A. miconax*) are under excessive pressure from the current international legal and illegal trade [Maldonado et al., 2009; Shanee, 2012; Ruiz-García et al., 2013; Maldonado and Peck, 2014; Shanee et al., 2015b]. It is noteworthy that in countries like Colombia, Peru, and Brazil that have domestic legislation in place that meets the requirements for the implementation of CITES and that have regulatory bodies at provincial and national levels, night monkeys are evidently still subject to illegal cross-border trade. This illegal cross-border trade has been ongoing for decades, with Mittermeier et al. [1994] warning that trade in the northern Colombian night monkeys (*A. griseimembra* and *A. zonalis*) could be detrimental at population levels. The effectiveness of CITES enforcement in these countries in particular is in great need of evaluation and improvement.

It is vital that night monkeys in trade are accurately and consistently identified to species level; if the taxonomy used by, for example, CITES does not reflect our current understanding of the richness in species number of night monkeys, it hampers

the traceability and assessment of the scale and impact of the trade. Furthermore, wildlife authorities and border personnel do not use genetic methods to determine species and are often not trained in identifying species [Shanee et al., 2015b]. The morphological similarity between night monkey species suggests the possibility of confusion or even laundering of rarer species under the guise of commoner ones. It would be beneficial to implement protocols for rapid genetic testing throughout night monkey range countries. To reduce the problematic policing of borders, a more practical approach might be to control biomedical facilities.

Regulating international trade requires the cooperation of importing, exporting, and re-exporting countries. With respect to the trade in night monkeys in some range countries, good progress has been made to regulate this trade and to curb the illegal domestic and international trade; other countries still lag behind in this respect. We feel that at present a greater involvement by importing countries in ensuring that the international trade in night monkeys abides by the rules and intentions of CITES and other multinational agreements may result in the greatest benefits for night monkey populations. In more general terms, the trade in night monkeys clearly illustrates that changes in primate taxonomy need to be reflected in conservation assessments of these new taxa. For small or cryptic species occurring in trade, including night monkeys but also taxa such as galagos, slow lorises and (nocturnal) lemurs, the extent of (international and domestic) trade is often poorly documented [Nekaris et al., 2010; Svensson et al., 2015; Reuter and Schaefer, 2016], and true levels of trade may well be a significant impediment to their conservation.

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