Disappearing in the night: an overview on trade and legislation of night monkeys in South and Central America

Magdalena S. Svensson[1,2], Sam Shanee[1,3,4], Noga Shanee[3,4], Flavia B. Bannister[1], Laura Cervera[5,6], Giuseppe Donati[1], Maren Huck[7,8], Leandro Jerusalinsky[9], Cecilia P. Juarez[8,10], Angela M. Maldonado[11], Jesus Martinez Mollinedo[12], Pedro G. Méndez-Carvajal[13], Miguel A. Molina Argandoña[14], Antonietta D. Mollo Vino[14], KAI Nekaris[1,2], Mika Peck[15], Jennifer Rey-Goyeneche[1], Denise Spaan[16], Vincent Nijman[1,2]

[1]Nocturnal Primate Research Group, Oxford Brookes University, Oxford, UK
[2]Oxford Wildlife Trade Research Group, Oxford Brookes University, Oxford, UK
[3]Neotropical Primate Conservation, Manchester, UK
[4]Asociacion Neotropical Primate Conservation Peru, Yambrasbamba, Peru
[5]Asociacion Ecuatoriana de Mastozoologia, Quito, Ecuador
[6]Grupo de Estudio de Primates del Ecuador, Quito, Ecuador
[7]Environmental Sustainability Research Centre, University of Derby, Derby, UK
[8]Owl Monkey Project, Formosa, Argentina
[9]Centro Nacional de Pesquisa e Conservação de Primatas Brasileiros, Instituto Chico Mendes de Conservação da Biodiversidade, Brasília, Brazil.
[10]Universidad Nacional de Formosa, Formosa, Argentina.
[11]Fundacion Entropika, Leticia, Colombia
[12]Wildlife Conservation Society, La Paz, Bolivia
[13]Fundación Pro-Conservación de los Primates Panameños, Panama City, Panama
[14]Dirección General de Biodiversidad y Áreas Protegidas, Viceministerio de Medio Ambiente, Biodiversidad, Cambios Climáticos y de Gestión y Desarrollo Forestal. La Paz, Bolivia
[15]University of Sussex, Brighton, UK
[16]Instituto de Neurología, Universidad Veracruzana, Xalapa, México

Svensson, M.S. (Oxford), Shanee, S., Shanee, N. (Manchester/Yambrasbamba), Bannister, F.B. (Oxford), Cervera, L. (Quito), Donati, G. (Oxford), Huck, M. (Derby/Formosa), Jerusalinsky, L. (Brasília), Juarez, C.P. (Formosa), Maldonado, A.M. (Leticia), Martinez Mollinedo, J. (La Paz), Méndez-Carvajal, P.G. (Panama City), Molina Argandoña, M.A., Mollo Vino, A.D. (La Paz), Nekaris, K.A.I. (Oxford), Peck, M. (Brighton), Rey-Goyeneche, J. (Oxford), Spaan, D. (Xalapa), Nijman, V. (Oxford)

Short title: Trade in Night Monkeys

Corresponding author: Magdalena Svensson, Oxford Brookes University, Nocturnal Primate Research Group, Oxford OX3 0BP, UK.

ABSTRACT

International trade in night monkeys (*Aotus* spp.), found throughout Central and South America, has been regulated through the Convention on International Trade in Endangered Species of Wild Fauna and Flora since 1975. We present a quantitative analysis of this trade from all nine range countries, over four decades, and compare domestic legislation to CITES regulations. Night monkeys were exported from eight of the nine habitat 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 nancymaae* (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 meet CITES' requirements for implementation, whereas the other four 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 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.

KEY WORDS: *Aotus; CITES; douroucoulis; domestic legislation; malaria research; Neotropics; owl monkeys*

INTRODUCTION

Primates worldwide are threatened through habitat loss, forest fragmentation, overhunting as well as legal and illegal trade, including the trade for consumption, medicine and as pets [Duarte-Quiroga et al., 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 follows 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 rainforests 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 nine taxa were suggested, they were thought to comprise only one species, *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 (*Aotus azarae, A. nancymaae, A. nigriceps, A. trivirgatus* and *A. vociferans*), 4 as Vulnerable (A. *brumbacki, A. griseimembra, A. lemurinus* and *A. miconax*) and two as Data Deficient (*A. zonalis and A. jorgehernandezi*) [IUCN, 2008]. The population trends for all species are either considered decreasing or unknown by the IUCN Red List; none is listed as having stable or increasing population trends [IUCN, 2008]. The population trends for all species are either considered decreasing or unknown by the IUCN Red List, none is listed as having stable or increasing population trends [C. Schwitzer, pers. comm].

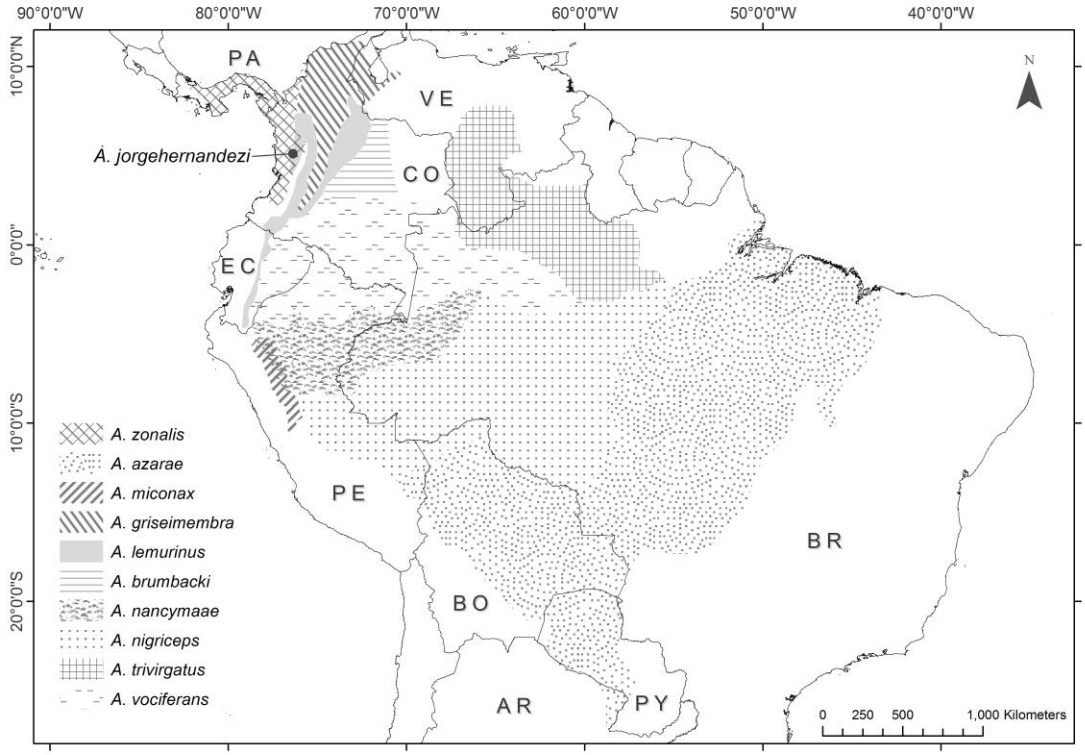

Figure 1. Distribution of Aotus species. AR) Argentina, BO) Bolivia, BR) Brazil, CO) Colombia, EC) Ecuador, PA) Panama, PE) Peru, PY) Paraguay, VE) Venezuela. Map created using IUCN shape files [IUCN, 2008].

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 firstly 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 nine South and Central American range countries. In this analysis we take into account, and explore relationships between, trade

128 volumes, origins and destinations, proportions of live trade, species identity and
129 species' geographic range size. Finally we provide an overview of the relevant domestic
130 legislation and how well this complies with the rules and regulations of the Convention
131 on International Trade in Endangered Species of Wild Fauna and Flora (CITES), and
132 how this compares to recorded levels of international trade. We hypothesize that the
133 combined effect of legal and illegal trade is a real and emerging threat even for cryptic
134 primate species and we intend this overview document to be available for conservation
135 planning.
136

137 **METHODS**

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

150 The reliability of the records in the CITES database is entirely dependent on the
151 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 documented that there can be large discrepancies between officially reported import and export figures and the actual imports 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. [cf. de Souza Fialho et al. 2016]. We corrected the species name where possible 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. *Ceteris paribus*, 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 (Table 2), although in varying degrees according to the CITES National Legislation Project (NLP) (Table 2) [Vasquez, 2003; CITES, 2016a]. CITES' NLP is the mechanism for assisting and encouraging the CITES Parties' legislative efforts, and places the Parties in three different categories according to how well domestic legislation matches CITES legislation. These categories are: Category 1) legislation that is believed generally to meet the requirements for implementation of CITES; Category 2) legislation that is believed generally to meet only some of the requirements for the implementation of CITES; Category 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

199 (http://faolex.fao.org/) as well as from our own extensive knowledge of working in
200 many night monkey range countries (Argentina, Bolivia, Brazil, Colombia, Ecuador,
201 Panama, and Peru). We tested whether or not countries that had legislation that agreed
202 with CITES regulations exported more or less night monkeys compared to those
203 countries that had deficiencies in their primary legislation (i.e. legislation embracing
204 main laws passed by the legislative bodies of the respective governments, thus
205 excluding secondary or subordinate legislation, passed by lower levels of government).
206 Data were not normally distributed and we used non-parametric statistics
207 (Spearman Rank Correlation Coefficient and Mann-Whitney U test), implemented in R,
208 to test for statistical significance, with significance accepted when $P<0.05$ in a two-
209 tailed test [Siegel, 1956].
210
211 **RESULTS**
212 ***Historic overview of night monkey trade***
213 In the 1960s night monkeys were found to be the best suited primate model for medical
214 research into malarial vaccines and for tests of anti-malarial drugs [Young et al., 1966;
215 Collins, 1994]. Several species have since commonly occurred in the biomedical trade,
216 such as *A. vociferans, A. nigriceps* and *A. nancymaae* [Mittermeier et al., 1994;
217 Maldonado et al., 2009; Galinski and Barnwell, 2012] due to the similarity of their
218 immune system with that of humans and their high susceptibility to several forms of
219 malaria-causing *Plasmodium* parasites [Herrera et al., 2002]. Different species of night
220 monkeys have different susceptibility to malarial parasites, and not all are suited as
221 animal models [Groves, 2005]. Nowadays night monkeys are also used as animal
222 models in biomedical research regarding the human immunodeficiency virus (HIV) as

223 they are the only New World primate that is resistant to HIV-1 [Hofmann et al., 1999],
224 as well as ophthalmologic research due to the easily viewed retina [Ogden, 1994]. In the
225 decades prior to 1975, when CITES was established, the trade in night monkeys and
226 other primates for biomedical research was vast and uncontrolled, especially from the
227 Amazon basin [Linder et al., 2013]. Exports of wild caught night monkeys were
228 principally to the United States of America (USA) and Europe. Trade of night monkeys
229 and other primates from South and Central America occurred at an alarming rate,
230 leading to national bans being implemented on exports of primates in the mid-1960s and
231 1970s in Brazil, Colombia, Peru, Paraguay and Panama, with official licenses being
232 issued for limited numbers of night monkeys allowed to be exported in any given year
233 [Brasil, 1967; Mack and Mittermeier, 1984; Maldonado and Peck, 2014]. When trade
234 became regulated, captive breeding programs were started in the 1970s and 1980s,
235 particularly in the USA, Peru, Panama and Germany [Gozalo and Montoya, 1990;
236 Rappold and Eckert, 1994; Málaga et al., 1997; Obaldía III, 2001]. Despite the
237 availability of captive bred animals, several researchers have found evidence that the
238 international trade of night monkeys for biomedical research is continuing illegally from
239 at least part of their range [Maldonado et al., 2009; Rojas Briñez, 2011; Ruiz-García et
240 al., 2013; Maldonado and Peck, 2014].

241 Relying on information from the literature, the domestic trade of night monkeys
242 appears to be low, and rarely quantified in publications when mentioned [but see
243 Maldonado et al., 2009, Levacov et al., 2011 and Shanee, 2012 for examples from
244 Colombia, Brazil and Peru]. Due to their small body size they are not a preferred meat
245 source, and domestic trade for meat appears limited. Furthermore, Cormier [2006]
246 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 sub-caudal 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] as well as *A. lemurinus* and *A. vociferans* in Ecuador [Tirira, 2013; Stafford et al., 2016].

Figure 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).

Quantitative analysis of international trade

Over the 40 years prior to 2014 we found international trade reported from eight 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 dataset (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 only 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, $N_1 = 5$, $N_2 = 4$, U = 3, $p > 0.10$).

Table 1. Export of night monkeys out of South and Central American range countries (1975-2014). For each range country we show the number of live / dead individuals and specimens 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 considerable higher and domestic trade is not taken into account.

		1975-1984			1985-1994			1995-2004			2005-2014		
Country	**Species**	**Live**	**Dead**	**Spec**	**Live**	**Dead**	**Spec**	**Live**	**Dead**	**Spec**	**Live**	**Dead**	**Spec**
Argentina	*A. azarae*	0	0	0	0	0	0	0	0	932	0	0	576
Bolivia	*A. azarae*	0	0	0	0	0	0	0	0	0	0	0	8
	Aotus spp.	1,351	0	0	20	1	0	0	0	0	0	0	0
Brazil	*Aotus* spp.	0	0	2	0	0	2	0	0	0	0	0	0
Colombia	*Aotus* spp.	109	0	13	0	0	1,270	0	0	0	0	0	18
Ecuador	*A. vociferans*	0	0	0	0	0	0	0	0	0	0	0	6
Panama	*A. zonalis*	301	0	0	0	1	641	0	0	0	0	0	2,061
Paraguay	*A. azarae*	174	0	0	0	0	0	0	0	0	0	0	0
Peru	*A. miconax*	0	0	0	0	0	0	0	0	0	0	0	1
	A. nancymaae	0	0	0	70	0	0	1,321	0	840	216	0	640
	A. nigriceps	0	0	0	0	0	0	0	0	0	0	0	15
	A. vociferans	0	0	0	25	0	0	400	0	0	38	0	0
	Aotus spp.	197	23	24	1,741	0	24	0	1	4	5	0	21
Venezuela	*Aotus* spp.	0	0	0	0	0	0	0	0	0	0	0	0
TOTALS		**2,132**	**23**	**39**	**1,856**	**2**	**1,937**	**1,721**	**1**	**1,776**	**259**	**0**	**3,346**

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) *Aotus 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). *Aotus nancymaae* were all from Peru and

305 almost all exported alive to the USA, mainly for scientific or commercial trade
306 purposes.
307
308 ***Overview of legislation***
309 All countries where night monkeys occur are Parties to CITES, with Peru, Ecuador and
310 Brazil joining the Convention at the time of its inception in 1975 and Argentina and
311 Colombia joining last in 1981 (Table 2). All night monkey species are listed under
312 CITES Appendix II, meaning that international trade requires official permission and
313 evidence that extraction does not negatively impact wild populations [CITES, 2016b].
314 All countries had at least some primary legislation in place (thus no country
315 falling under NLP's Category 3), with some specifically addressing night monkeys and
316 others providing general wildlife protection regulations (Table 2). Five of the range
317 countries have legislation that generally met the requirements for implementation of
318 CITES and thus falling under NLP's Category 1 (viz. Argentina, Brazil, Colombia,
319 Panama and Peru), whereas the other four countries' legislation showed deficiencies for
320 implementing CITES, falling under NLP's Category 2 (viz. Bolivia, Ecuador, Paraguay
321 and Venezuela).
322 Collaboration amongst South American CITES management authorities does
323 exist. In 1978 the Amazon Cooperation Treaty Organization (ACTO) was signed
324 between Bolivia, Brazil, Colombia, Ecuador, Guyana, Peru, Suriname and Venezuela,
325 as a legal instrument recognizing the transboundary nature of the Amazon region
326 [CITES 2014]. In 2010 ACTO established the Amazonian Strategic Cooperation
327 Agenda, including a Subtopic (A.3) with the objective to strengthen institutional and
328 technical capacity of member countries from a regional perspective to manage, monitor

329 and control trade of endangered wildlife [Dorfler and Aragón, 2011]. ACTO is
330 collaborating with CITES to reduce illegal and unsustainable wildlife trade more
331 effectively, for example by developing an electronic CITES permit system for the
332 traceability of specimens of CITES-listed species. This collaboration was set up during
333 the Rio+20 United Nations Conference on Sustainable Development in 2012 [CITES,
334 2014]. This method and the sharing of expertise are believed to improve the ability of
335 member countries of ACTO to reduce illegal international wildlife trade.
336
337 ***National level trade mitigation initiatives***
338 There have been a number of initiatives to curb the domestic and international trade in
339 night monkeys; we here focus on Bolivia and Colombia representing opposite ends of
340 the night monkey trade. While official statistics (Table 1) suggest that the number of
341 night monkeys exported from Bolivia has declined, this is thought to be caused mainly
342 by a reduction of monitoring activities resulting in incomplete information (A.D. Mollo
343 Vino, pers. obs.). Recognizing this, the Bolivian government has been working over the
344 last five years on increasing the implementation of CITES regulation and improving
345 monitoring of wildlife trafficking. Practically this has led to an increase in enforcement
346 efforts at international borders and airports, targeting a wide range of species.

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

Countries	*Aotus* Species	Legislation	CITES	Category	Source
Argentina	*azarae*	Law n° 22344 (1981) adheres to CITES, and Decree 522/97 regulates permits for export / import of *A. azarae*, as the species is included under CITES Appendix II. Formosa Province Law n° 1582 (2012) declared *A. azarae* a 'Provincial Monument', prohibiting hunting, pet ownership, marketing and intra and interprovincial transit of the species. This is also supported by Law n° 1060 (1993, Provincial Ecological and Environmental Law of Formosa).	1981	1	a; b
Bolivia	*nigriceps* *azarae*	Law n° 1333 (1992) and Decree n° 22641 (1990) prohibits 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. 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	*azarae; nigriceps; nancymaae; vociferans; trivirgatus*	Law n° 5.197 (1967) - Fauna Protection Law –prohibited the illegal commercialization, hunting, exportation and keeping as pets of all native species. Law n° 9.605 (1998) – Environmental Crimes Law – defined the above cited activities as crimes, with penalties more severe if regarding threatened species or in protected areas. Both laws are still valid. Decree n° 3.607 (2000) refers to the implementation of CITES. Chapter 1 defines Brazilian Institute of Environment and Renewable-Natural Resources (IBAMA) as the CITES Administrative Authority and Chico Mendes Institute for Biodiversity Conservation (ICMBio) as Scientific Authority for fauna species. Both IBAMA and ICMBio are linked to Ministry of Environment. Chapter 2 of the Decree defines the procedures needed for international trade of species. It declares that for the export/import of species included in their appendixes license emitted 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	*jorgehernandezi; griseimembra; zonalis; trivirgatus; vociferans; brumbacki; lemurinus; nancymaae*	Article IV (1981) of Law n° 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 n° 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 n° 1333, 2009). In addition, the Resolution 0192 (2014) updates the list of threatened species, including as vulnerable *A. griseimembra; brumbacki; lemurinus.*	1981	1	h; i
Ecuador	*vociferans; lemurinus*	Article 15 of Law n° 3.339, Amendment n° 2.274 (2004) states that the trading of specimens of wildlife and its 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	*zonalis*	Article 40 of Law n° 43 (2004), Chapter 3, submit to any commercial activities and transportation of any wildlife species, without the prior authorization by the Environmental Ministry, is prohibited. Article 38 of Law n° 24 (1995), Chapter 4 also establish that it is prohibited in the entire national territory, to collect, capture, or any transportation and commercial activities of wildlife species, its products, or its derivate parts, unless the Environmental Ministry technically consider the contrary in accordance with any previous study about that particular species.	1978	1	k; l
Paraguay	*azarae*	Law n° 583 (1976) and Decree n° 9701 (2012) regulates any activities relating to CITES listed species regarding import/export and authorization is needed. CITES authority being the General Directorate of Biodiversity Protection and Conservation.	1976	2	m; n
Peru	*nigriceps; nancymaae; vociferans; miconax*	Law n° 29763 (2015) states that all wildlife is protected and its use must be authorized, and in regards to any import/export of primates the National Forest and Wildlife Service (SERFOR) or the regional wildlife authorities are the entities in charge of issuing permits depends on species´ threat category. Supreme Decree n° 004-2014-MINAGRI (2014), approved the list of Threatened species by Peruvian law. Of all night monkeys, the decree considers only *A. miconax* as a threatened species, as Vulnerable. Species that are not included in Supreme Decree 004-2014-MINAGRI can be collected from the wild after approval of research proposal by SERFOR soliciting collection for scientific purposes. Specimens of *A. miconax* 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	*trivirgatus; griseimembra; lemurinus*	Law n° 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 n° 39.913 (2012) states that trafficking of wild animals and / or products should be reported to the Environmental Ministry (Unidad de Control de Tráfico Ilícito de Especies - MINAMB).	1977	2	q; r

a) Argentina., 1982; **b)** Provincia de Formosa, 2012; **c)** Ministerio de Medio Ambiente y Agua, 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

347

348 Its General Directorate of Biodiversity and Protected Areas has created national
349 guidelines and actions for wildlife conservation such as the Action Plan for the
350 Conservation of Bolivian Threatened Mammals 2014-2018 [MMAyA, 2013] and the
351 Action Plan for the Conservation of Threatened Vertebrate Species in the National
352 Protected Areas System [MMAyA, 2015].

353 Until 2015, permits for malarial research in Colombia allowed the capture of *A.*
354 *vociferans* [Maldonado and Peck, 2014]. However, due to over-extraction it became
355 hard to source the species, which led to the biomedical laboratory Fundación Instituto
356 de Inmunología de Colombia (FIDIC) requesting permits to capture *A. nancymaae* as
357 well [FIDIC, 2015]. *Aotus nancymaae* was recently described to be present in
358 Colombia, with a small distribution at the southern part of the Colombian Amazon,
359 therefore extraction of individuals could be detrimental for the population's survival
360 [Bloor et al., 2012]. Initiatives such as the agreement between the Colombian Ministry
361 of the Environment, the National Police, and the Institute of Genetics at the National
362 University of Colombia have enabled the creation of tools for tracing wildlife trade and
363 attempt to improve decision making, research, sanctioning, and post-confiscation
364 management [MADS, 2012]. Despite these efforts, in August 2016 the regional
365 environmental authority Corporación para el Desarrollo Sostenible del Sur de la
366 Amazonía (Corpoamazonia) permitted the capture of *A. nancymaae* for malarial
367 research [Corpoamazonia, 2016]. This new permit lacks information on population
368 status of this species, and the decision obeys the political and economic influence of
369 FIDIC. In addition, Colombian indigenous collectors resident in Peru, were allowed to
370 be part of the team of trappers [Corpoamazonia, 2016], promoting the illegal trade of *A.*
371 *nancymaae* from Peru [A. Maldonado, pers. obs.], thus hampering the implementation,

372 compliance, and enforcement of CITES regulations at the border between Colombia and
373 Peru, inhabited mainly by indigenous people. In Colombia, as indeed in other night
374 monkey range countries, ethnic groups have been recognized as autonomous
375 communities, with the authority to manage their natural resources. These local
376 regulations are not necessarily framed within international legislation thus weakening
377 community management capacity [MADS, 2012].
378
379 **DISCUSSION**
380 We have demonstrated that over the last four decades trade has affected at least eight of
381 the 11 currently recognized species of night monkeys, and that, with respect to the legal
382 international trade, night monkey, or their derivatives, have been exported from eight of
383 the nine range countries. The level of legal international trade of live individuals
384 continues to decline. Only five countries have legislation that meet CITES'
385 requirements for implementation, whereas the remaining four countries' legislation
386 showed deficiencies. However, it is important to consider that just because legislation
387 exists it does not mean that sufficient law enforcement is in place or that governance is
388 high. Whilst the ACTO collaboration amongst some of the South American CITES
389 management authorities is a step in the right direction, it is vital to increase management
390 of the international night monkey trade. Improvements in legislation in Bolivia,
391 Ecuador, Paraguay and Venezuela are imperative to meet the requirements for
392 implementation of CITES.
393 Investigative research conducted in countries such as Colombia, Peru and Brazil
394 suggests significant cross-border trade that is not captured in the official international
395 trade registers [Maldonado et al., 2009; Rojas Briñez, 2011; Ruiz-García et al., 2013;

396 Maldonado and Peck, 2014]. This illegal trade is not easily captured under CITES and it
397 is imperative that domestic legislation extends to address and strengthen illegal in-
398 country activities more efficiently, as well as implement cross-border cooperative
399 efforts involving border officials and environmental authorities.

400 The numbers we report here for legal trade agree largely with those reported by
401 Maldonado et al. [2009] and, more recently, de Souza Fialho et al. [2016]. Maldonado
402 et al. [2009] covered a shorter time period and differences are thus attributable to the six
403 years of additional data we had at our disposal. With respect to the numbers of night
404 monkeys exported out of Peru our data show significantly lower levels of international
405 trade than reported by Maldonado and Peck [2014] but markedly higher than de Souza
406 Fialho et al. [2016]. Maldonado and Peck [2014] reported 3,258 animals exported from
407 Peru, over the period 1994 to 2011, whereas we recorded a maximum of 1,925 animals,
408 both dead and alive, being exported over this period. The discrepancy stems from the
409 inclusion of specimens and derivatives, which cannot be attributed to individual
410 animals, in their total. De Souza Fialho et al. [2016] reported almost 700 fewer live
411 animals possibly by having adopted a more conservative approach when including trade
412 records.

413 Further research is needed to verify if the very low levels of international trade
414 reported to the CITES Secretariat by Brazil, Ecuador and Venezuela is representative of
415 the current situation regarding cross-border night monkey trade from these countries.
416 While it is possible that underreporting from range countries masks higher levels of
417 trade, it is worth noting that similar low levels of trade from Brazil, Ecuador and
418 Venezuela were reported from importing countries thus suggesting genuinely low levels
419 of trade. A lack of taxonomic identification ability in the relevant authorities,

420 institutional deficiencies with respect to recording and reporting trade, or corruption
421 could also be the cause of the apparent low levels of international trade.

422 While the large-scale international trade in night monkeys for biomedical
423 research has diminished, probably due to the proliferation of breeding centres in the
424 USA, considerable numbers of night monkeys are still traded internationally, both
425 legally and illegally. *Aotus nancymaae* was most commonly reported as traded, and is
426 among the most commonly used night monkey in malarial research [Maldonado et al.,
427 2009; Ruiz-García et al., 2013]. Concerns have been raised regarding the ethical issues
428 and the viability of using primates as biomedical research models [Pound et al., 2004;
429 Bailey, 2005; Knight, 2008]. Further, studies of avian malarial parasites have shown to
430 be efficient and show promise in research on malarial vaccines [Marzal, 2012].

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

439 It is possible that the most heavily traded populations (such as *A. nancymaae*
440 and *A. vociferans*) and some of the rarer species (e.g. *A. miconax*), are under excessive
441 pressure from the current international legal and illegal trade [Maldonado et al., 2009;
442 Shanee, 2012; Ruiz-García et al., 2013; Maldonado and Peck, 2014; Shanee et al.,
443 2015b]. It is noteworthy that in countries like Colombia, Peru and Brazil that have

444 domestic legislation in place that meets the requirements for implementation of CITES
445 and that have regulatory bodies at provincial and national levels, night monkeys are
446 evidently still subject to illegal cross border trade. This ongoing illegal cross border
447 trade has been ongoing for decades, with Mittermeier et al. [1994] warning that trade in
448 the northern Colombian night monkeys (*A. griseimembra* and *A. zonalis*) could be
449 detrimental to population levels. The effectiveness of CITES enforcement in these
450 countries in particular are in great need of evaluation and improvement.

451 It is vital that night monkeys in trade are accurately and consistently identified to
452 species level; if the taxonomy used by, for example, CITES does not reflect our current
453 understanding of the richness in species number of night monkeys it hampers the
454 traceability and assessment of the scale and impact of the trade. Furthermore, wildlife
455 authorities and border personnel do not use genetic methods to determine species and
456 are often not trained in identifying species [Shanee et al., 2015b]. The morphological
457 similarity between night monkey species suggests the possibility of confusion or even
458 laundering of rarer species under the guise of commoner ones. It would be beneficial to
459 implement protocols for rapid genetic testing throughout night monkey range countries.
460 To reduce the problematic policing of borders a more practical approach might be to
461 control biomedical facilities.

462 Regulating international trade requires the cooperation of importing, exporting
463 and re-exporting countries. With respect to the trade in night monkeys in selected range
464 countries good progress has been made to regulate this trade and to curb the illegal
465 domestic and international trade; other countries still lag behind in this respect. We feel
466 that at present a greater involvement by importing countries in ensuring that the
467 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 illustrate 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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