

Wildlife Trade in Morocco: Use, Conservation, Laws and Welfare



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This thesis is the result of my own work and includes nothing which is the outcome of work done in collaboration except where specifically stated in the text.

Title photograph: shops in Moroccan markets. All photographs reproduced here are my own work.

This PhD is dedicated to my mum, Ceara, who would have loved to see it come to fruition.

Abstract

Official records on the numbers of animals being removed from the wild for commercial purposes are often patchy, incomplete or absent entirely. Available data from the legal trade combined with surveys of legal and illegal trade can give an insight into the species that are being targeted, the numbers in which they are being removed from the wild, the reasons for which they are traded and can highlight conservation, legal and welfare issues relating to this trade. Morocco, situated on the north-west coast of the African continent as little as eight miles from the Spanish mainland, is a hub for tourism in the region and a focal point for trade between Africa and Europe. Although some work had been conducted on specific areas and species in Morocco, a comprehensive account of the wildlife trade was lacking, and little was known about the effects of wildlife trade in the country. Morocco updated its wildlife trade laws in 2015 and for the first time has the ability to effectively combat illegal and unsustainable trade, provided sufficient resources are allocated to the law's implementation. This law is comprehensive and clear and Morocco therefore provides an interesting case study to explore the effectiveness of wildlife trade laws. My publications included in this PhD by Published Work document the results of market and online surveys carried out between April 2013 and April 2018 over the course of six study-periods. I investigated the use, conservation, laws and welfare relating to the sale and keeping of birds, mammals and reptiles in markets in 27 Moroccan cities and two Spanish cities within Morocco's borders. My research has provided detailed, robust data on the trade of over 11,000 animals of 47 species, sold as pets, decoration, photo props, clothing, and medicine. This trade represents a significant conservation concern for many of these species and the majority of animals are being kept in consistently poor welfare conditions. The majority of wild animal trade in Morocco is illegal according to new law. Through my research and publications, I have documented a baseline for Moroccan wildlife trade and provided NGOs and the Moroccan government with much-needed data to inform policy and conservation initiatives. These data have been given to conservation organisations operating in Morocco and to the Moroccan government, in both paper and summary form and disseminated to the wider conservation community. They provide these stakeholders with a detailed account of hotspots, species vulnerable to overexploitation and causes of the wildlife trade, with the aim of helping conservation efforts to become more targeted and therefore more effective in situations with limited resources.

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Abbreviations

CITES - the Convention on International Trade in Endangered Species of Wild Fauna and Flora

CPT - The Corruption Perception Index

Eaux et Forêts - le Haut Commissariat aux Eaux et Forêts et à la Lutte Contre la Désertification (the Office of the High Commissioner for Water and Forests and the Fight against Desertification)

EPI - Environmental Performance Index

FAWC - Farm Animal Welfare Committee

GDP - Gross Domestic Product

IUCN - International Union for Conservation of Nature

MPC - Moroccan Primate Conservation Foundation

NGO - Non-governmental Organization

OIE - World Organisation for Animal Health

UNEP-WCMC - United Nations Environment World Conservation Monitoring Centre

CHAPTER 1: INTRODUCTION



1.1 General Introduction

Wildlife trade – defined as the sale or exchange by people of wild animals or plants, whole or in parts – has been a fundamental element of commerce between humans since ancient times, and has shaped both the physical landscape and early and modern societies (Redman 1999). The term ‘wildlife trade’ can vary in its meaning, depending on the context in which it is discussed. The Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) defines wildlife trade as the trade in all flora (plants including timber) and fauna (animals including birds and fish) whereas many interpretations will categorise the trade of timber and fish separately from that of other wildlife (e.g. Nellemann, et al. 2016). For the purposes of this thesis, wildlife trade is defined as the trade in all wild species of flora or fauna. The term ‘wild’ here refers to any animal or plant that is deemed not to have been produced or born in a controlled environment to parents that were also produced in a controlled environment i.e. animals or plants not ‘captive-bred’ according to the CITES Resolution Conf. 10.16. ‘Specimens of animal species bred in captivity’ (CITES 1994).

While much of the trade in wildlife is sustainable, and is of great importance for its subsistence, economic, medicinal and cultural value, the unsustainable trade of wildlife affects a wide variety of flora and fauna across the globe and is increasingly being recognised as a driving factor towards substantial declines in populations for many species (TRAFFIC 2008; Sutherland et al. 2009; Nijman et al. 2011; Milner-Gulland 2018). In addition to the direct negative effects of removing animals from wild populations (Nijman et al. 2011), the trade in wild animals threatens ecosystems through the introduction of alien species (Westphal et al. 2008), threatens human and animal health through disease transmission (Karesh et al. 2005) and often leads to negative welfare for the animals involved (Baker et al. 2013; Bergin et al. 2018). Regulating and monitoring this trade is therefore vital in order to conserve wild animals, protect biodiversity, avoid disease outbreaks and to avoid negatively impacting the animals themselves. A significant portion of wildlife trade also operates outside of the law and, globally, wildlife is one of the most trafficked (illegally transported) commodities (UNODC 2016). Although attempts can be made to predict the effects of removing animals from the wild if it is done in a regulated manner, illegal trade, by its nature, causes difficulties with sustainable use planning because animals are removed in numbers that are not accounted for by action plans.

The strengthening of existing laws and introduction of new laws to combat wildlife trade are often seen as laudable and represent a large step forward for many countries in their attempts to protect their biodiversity. Without strong conservation laws, it is often extremely difficult for countries to effectively protect their biodiversity; with strong laws, countries have the capacity to stem the flow of unsustainable wildlife trade. However, the eventual effects of these laws are not often assessed, and the numbers of animals in markets may remain stable or continue to increase, while attention is drawn away from the issue by on-paper efforts. Morocco, with its introduction of acclaimed wildlife trade laws provides an

opportunity to document the country's wildlife trade before and after their introduction, with an aim to assessing their real-world impact.

Table 1. Table showing pertinent information about the country of Morocco.

Morocco	
Size	710,850km ²
Human population	35,740,000
Population density	50.0/km ²
GDP per capita	\$7,821
Trade partners - export	EU (64.9%), USA (3.5%), India (3.3%)
Trade partners - import	EU (55.6%), China (9.1), USA (6.4%)
Corruption Perception Index	81/180
Ethnic groups	Arab-Berber 99%, other 1%
Religious groups	Muslim 99%, other 1%
Literacy rate 15+	69%
Literacy rate 65+	33%
Party to Convention on:	
Biological Diversity; Climate Change; Climate Change-Kyoto Protocol; to Combat Desertification; International Trade in Endangered Species of Wild Fauna and Flora; Control of Transboundary Movements of Hazardous Wastes and Their Disposal; Law of the Sea; Prevention of Marine Pollution by Dumping of Wastes and Other Matter; Protection of the Ozone Layer; Prevention of Pollution from Ships; Wetlands of International Importance especially as Waterfowl Habitat; Regulation of Whaling.	

Morocco, situated on the north-west coast of the African continent as little as eight miles from the Spanish mainland, is easily accessible from Europe by airplane, ferry or overland via to two small Spanish semi-enclaves (Ceuta and Melilla) and is an important gateway for people, animals and goods travelling from Africa to Europe. With a population of over 35 million, Morocco also has a relatively well-developed tourism sector, in part due to stability the region has enjoyed compared to other North African countries. Morocco has a range of habitat conditions, from mountainous regions to Mediterranean and Atlantic coastlines to arid desert. It was once classified (by virtue of being in the Mediterranean basin) as an area with exceptional concentrations of endemic species undergoing rapid rates of habitat loss and was therefore considered to be a hotspot for conservation priority (Myers et al. 2000). Morocco has 29 endemic species, consisting of 21 reptile and eight mammal species (Franchimont & Saadaoui 1998). The country's links to sub-Saharan Africa, proximity to Europe, diversity of its native fauna and porous international borders, make Morocco a wildlife trade hub for the region (van Lavieren 2008; Nijman et al. 2016). Neighbouring Algeria has comparable levels of wildlife trade, but the composition differs: there is little trade in wildlife for decoration, and birds feature more prominently in the species sold as pets (D. Bergin unpub. data).

1.1.1 Uses of Animals in Wildlife Trade

The form in which a plant or animal is traded and the purpose for which it is traded vary by species, by area and over time. The CITES trade database lists 78 categories for the form in which an item is traded i.e. meat / carvings / live, etc. and 11 categories for the purpose of trade i.e. hunting / scientific / commercial, etc. (CITES 2013). Wild animals are traded in markets for meat, medicine, food, clothing, decoration, superstition, pets, and photo props, and in many instances a single species may be utilised for a range of different purposes (Fig. 1). Even within one family group of primates, for example, adults may be traded for the bushmeat and medicinal trade, while juveniles and babies are taken into the pet or photo-prop trade (Nijman 2005). Understanding the purposes for which animals are sold in markets is important when conducting wildlife trade research as it can help guide policy, legislation, and conservation efforts, while allowing for the traditions and cultures of local people to be considered and preserved. Education and conservation initiatives are more effective when targeted at a specific group, rather than generalised, and an in-depth knowledge of why animals are being traded is useful to tailor these campaigns (Jacobson et al. 2015).

Species that are native to Morocco such as the Mediterranean chameleon *Chamaeleo chamaeleon*, spur-thighed tortoise *Testudo graeca* and desert monitor lizard *Varanus griseus* have been used in medicine since medieval times (Alves et al. 2013) and are known to frequently be used for witchcraft in Morocco (Fogg 1941; Highfield & Bayley 2007). Beliefs surrounding these animals are not always explicitly defined but users believe that: chameleons can be burned for eye ailments; monitor lizard heads are a potent talisman against snake bites; tonics made from monitor lizards are said to increase virility; and stuffed spiny-tailed lizards *Uromastyx* sp. are thought to bring good luck to a new household if placed under the foundation (Highfield and Bayley 2007; Nijman and Bergin 2017a). Mammals, birds and insects are also used in the medicinal trade (Fogg 1938; 1939; 1941; Bergin & Nijman 2014a). Leopard *Panthera pardus* skins, while primarily sold as decorations (Cuyten 2011; Bergin & Nijman 2015), are also believed to alleviate rheumatism and their claws and teeth are part of the traditional herbalist's inventory (Fogg 1938; D. Bergin unpubl. data). The derivatives of animals are used in the production of souvenirs and decorations for both tourists and local people (Highfield & Bayley 1996; Benhardouze et al. 2004; Martin and Perry-Martin 2012; Bergin & Nijman 2014a). At present, ivory is traded in relatively small amounts (Martin & Perry-Martin 2012). Large numbers of spur-thighed tortoises are traded in Morocco as pets (Znari et al. 2005; Nijman & Bergin 2017b) and the trade in Barbary macaques *Macaca sylvanus* as pets and photo props is one of the primary threats facing this species (van Lavieren 2008; Butynski et al. 2008). Raptors are used as photo props in several major cities in Morocco (Bergin et al. 2013), as are snakes (Pleguezuelos et al. 2016; Tingle & Slimani 2017).



Figure 1. Figure showing wild animals traded in Moroccan markets. Clockwise from top left: spur-thighed tortoises and chameleons for sale as pets in Rabat; puff adders and Egyptian cobras used as photo props in Marrakesh; spiny-tailed lizards, ostriches, gazelles and African rock pythons used for medicine in Meknes; African rock pythons and Nile crocodiles for sale as decoration in Marrakesh.

1.1.2 Conservation of Animals Affected by Wildlife Trade

The decline of wild populations caused by unsustainable wildlife trade can be rapid and has the potential lead to drive species towards local or global extinctions before policy or enforcement have a chance to respond, or before the effects of overharvesting are sufficiently realised (Rosser & Mainka 2002; Purcell et al. 2014; McClenachan et al. 2016). In many instances, the anthropogenic pressure on wildlife from trade is becoming more severe for a combination of reasons, such as: rapidly expanding human population, increased per capita wealth, globalisation, increased access to firearms, civil unrest, improvements in infrastructure, increased access to forest and wilderness areas, increased Internet penetration levels, changing consumer preferences for wild meat or exotic pets, and improved hunting and trapping technology (Loucks et al. 2009; Nijman 2010; Brashares et al. 2011; Linder et al. 2013; Lyons & Natusch 2013; Lavorgna 2014). A sudden shift in consumer preference for a wildlife product can rapidly drive a species towards extinction. In the case of the Hose's langur *Presbytis hosei*, a once abundant species in Kayan Mentarang National Park in Borneo, Indonesia, the sudden surge in demand for bezoar stones (visceral excretions found in the stomachs of the langurs) for traditional medicine decreased the local population densities by 50 – 80% in 7 years (Nijman 2005b). The increase in pressure from the international pet trade was a major factor in the rapid population decline of the roti-island snake-necked turtle *Chelodina mccordi*, which may now be extinct in the wild (Rhodin et al. 2011). As populations of

one (or several) species declines, the trade can shift to other species. There has been a significant increase in the trade of African pangolins for medicinal purposes due to population declines in the Asian pangolins (Challender et al. 2014; Heinrich et al. 2016). With national and international trade driving species towards extinction across the globe, monitoring this trade is therefore vital if conservationists and policy-makers are to be able to act quickly in response to changing consumer demands or to halt the slow decline of a species.

Repeated market surveys can be used as a proxy for the abundance of wild populations. Harris et al. (2015) found that there is a specific price / volume signal associated with the trade of populations of birds that are believed to be declining in the wild, which is characterized by increasing market prices and declining volumes. If the volume of a species in a market is declining, with increasing prices and a continuing or increasing demand, it is likely that the population of that species is declining in the wild. As populations decline, the species' perceived value can increase because of their rarity in a process known as the anthropogenic Allee effect (Courchamp et al. 2006). This can override the standard predictive economic model – that a species will not go extinct from exploitation alone because it will eventually become too costly to hunt – and, because of the human perception of rarity, lead to extinction.

Morocco has traditionally not prioritised environmental or biodiversity conservation and as a result, was ranked relatively low (134 out of 177) on the Biodiversity and Habitat protection component of the global Environmental Performance Index (EPI) ranking of countries that were assessed in 2014 (Hsu & Zomer 2014). Compared to its neighbours, Morocco was just above Tunisia (136), but below Mauretania (132), Algeria (130), Spain (101) and Portugal (83). By 2016, Morocco had increased its EPI Biodiversity and Habitat rank to 45 out of 180, higher than Tunisia (143), Mauretania (159), Algeria (138), but still below Spain (13) and Portugal (31) who also increased their rank (Hsu 2016). Despite the high levels of biodiversity, the country's acknowledgements of the importance of protecting its native flora and fauna and recent improvements in their EPI ranking, according to the government body in charge of regulating wildlife trade - le Haut Commissariat aux Eaux et Forêts et à la Lutte Contre la Désertification (The Office of the High Commissioner for Water and Forests and the Fight against Desertification), commonly referred to as Eaux et Forêts - the government does not allocate sufficient resources to biodiversity conservation in the country (Eaux et Forêts, pers. comm. May 2016). Names of government officials were not recorded to protect their identities; any statements are the opinion of the speaker and do not necessarily represent that of their organisation of employment.

1.1.3 Law in the Wildlife Trade

Globally, wildlife trade policy and laws are extremely inconsistent in their scope, implementability and effectiveness (Rees 2018). Many countries have clear, comprehensive laws that are enforced relatively well, some have laws that are unenforceable in practice and others have consistent, comprehensive laws that are not enforced. For example, the ivory trade laws in Malaysia are relatively comprehensive and relatively

well enforced, those in Japan are not comprehensive and are not enforced, and the ivory trade laws in Cambodia are relatively strong but are not well enforced (D. Bergin unpub. data). CITES is an agreement between its member states (referred to as 'Parties') – of which there are 183 in January 2019 – that international trade should not continue to the point at which it endangers the populations of wild animals without being regulated. Although CITES is legally binding on its Parties, it is generally not self-executing, and signatories must therefore take appropriate measures to enforce the provisions of the Convention by enacting wildlife trade laws that reflect the expressed desires of the Convention and the international community and allow them to implement and enforce all aspects of the Convention. CITES allocates a rank of Category 1, 2 or 3 to its Parties according to the comprehensiveness of their CITES-enacting laws (though this does not consider the implementation of those laws). Sanctions can be placed on a country that does not engage with CITES in an effort to limit unsustainable international trade. CITES has proven its effectiveness in many regards but has issues with gaps in reporting by many countries and weak species identification by customs agents (Phelps et al. 2010). CITES has three Appendices, providing different levels of protection to species for which trade is considered a threat. In order to be fully compliant with CITES (Category 1), Parties must have legislation that fulfils four requirements for effective implementation of the Convention:

1. Designation of national CITES authorities.
2. Prohibition of trade in violation of the Convention.
3. Penalisation of illegal trade.
4. Authorisation to confiscate specimens illegally traded or possessed.

Morocco ratified CITES in November 1975, becoming the 19th Party to join. In doing this, the Moroccan state pledged to update its existing laws to meet Convention requirements in order to safeguard vulnerable species from unsustainable cross-border trade. However, the general hunting laws, which were the only laws that could be applied to wild animal trade within or from Morocco, remained weak, unclear, non-comprehensive and in some cases contradictory for many years. The penalties for breaking these laws were low and did not reflect the seriousness of wildlife crime. In 2011, with the help of the CITES National Legislation Project, Law 29-05 on the Protection of Species of Flora and Fauna and the Control of their Trade was promulgated at national level. Law 29-05 applies to domestic and international trade and came into effect in 2015. This law is comprehensive, clear and enforceable, prohibiting trade in species that are protected in Morocco according to the national protected species list developed in 1923 (Fig. 2) as well as species listed on the Appendices of CITES. Any protected species in Morocco may not be traded nationally or internationally without a permit and proof that the trade does not threaten wild populations of the species. This raised Morocco from Category 3 (legislation that is believed generally not to meet any of the four requirements for effective implementation of CITES) to Category 1 (legislation that is believed generally to meet all four requirements for effective implementation of CITES) of the CITES legislative-ranking system. With this law, Eaux et Forêts has more power than ever before to effectively combat the

illegal national and international trade of protected wildlife with fines of up to MAD 100,000 (USD 10,500 at 2019 exchange rates).

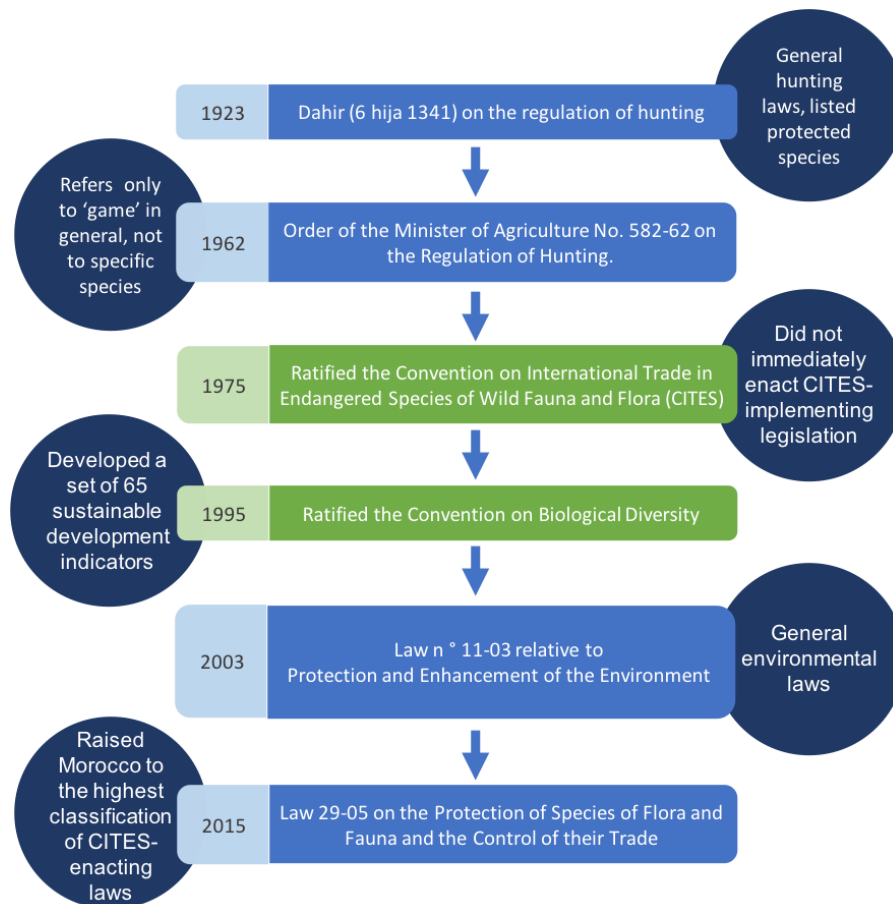


Figure 2. Flowchart showing the most relevant laws and convention signings in Morocco

Many countries suffer from corruption and this can affect the implementation of wildlife trade laws, by reducing conservation efforts and undermining the effectiveness of laws and regulations (van Uhm & Moreto 2017). Wildlife trade crimes are regularly seen as less serious than other criminal activities and repercussions are therefore light (Rees 2017). The Corruption Perception Index (CPI), published annually by Transparency International, measures perceived levels of corruption, as determined by expert assessments and opinion surveys. Morocco falls mid-range with a score of 40 out of 100, where zero is ‘highly corrupt’ and 100 is ‘very clean’. This puts Morocco as 81st of 180 countries assessed and indicates that the human rights situation, assaults on freedom of expression and civil society engagement have deteriorated in the country in recent years (CPI 2017). Corruption in Morocco is driven by “the persistence of a significant degree of impunity for well-connected individuals and members of powerful institutions, the intertwined nature of political and economic interests in the country, and the existence of a large and dynamic informal economy” Denoeux (2007). Corruption has become entrenched in everyday interactions and has therefore taken on a normative aspect, especially within the informal trading of the markets (van Uhm & Moreto 2017).

Globally, the laws protecting the welfare of captive animals date back to the Cruel Treatment of Cattle Act, which was enacted in 1822 in the UK (Rees 2018). These laws primarily affect domestic animals but often apply to any animals that are within the care of humans. Laws protecting the welfare of animals are not as widespread as those regulating their trade, but countries are increasingly recognising the importance of preserving good welfare (Rees 2018). Many countries incorporate the Farm Animal Welfare Committee (FAWC) Five Freedoms into their national legislation. These are defined as: freedom from hunger and thirst; freedom from discomfort; freedom from pain, injury, or disease; freedom to express normal behaviour; and freedom from fear and distress (FAWC 2009).

Morocco is a member of the World Organisation for Animal Health (OIE). In 2013, the government proposed draft legislation (Law 122-12) prohibiting the mistreatment or abuse of animals in captivity, with fines of up to MAD 20,000 (USD 2,100). Article 14 of this legislation states that animals must be kept in conditions compatible with the biological requirements of their species. However, the proposed legislation does not appear to apply to mistreatment due to negligence and does not incorporate all the OIE's guiding principles and standards for animal welfare (World Animal Protection 2014). This legislation has finished its public consultation period but has yet to be enacted.

1.1.4 Welfare of Animals in Wildlife Trade

Humans, by virtue of removing animals from the wild for use as pets, in medical practices, or for entertainment, become responsible for the welfare of the animals involved. Mellor et al. (2009) argued that in any situation in which animals are used for human purposes, we are obliged to consider, and where possible improve, the welfare of these animals using scientific criteria and rigorous observations to monitor them. Animal sanctuaries often receive animals that have been confiscated from markets or that are ex-pets. In many instances it is clear from the conditions of the animals that their welfare has been compromised, often for many years, prior to their arrival at the sanctuary (Soulsbury et al. 2009; Bush et al. 2013). Although animal welfare is potentially compromised at all stages of wildlife trade, Baker et al. (2013) observed that wildlife trade studies have not traditionally addressed the welfare of the animals involved, especially in the case of animals caught in the wild. Baker et al. argued that although the issue of welfare and wildlife trade has been raised, more attention must be paid to the conditions in which live animals are traded, in particular those animals traded in large numbers for use as pets or entertainment.

Animal welfare, however, does not exist in a vacuum. When animals are brought into captivity, we are necessarily limiting their freedom so some restrictions on their normal behaviour have to be allowed for, and this does not necessarily equate to poor welfare. The Farm Animal Welfare Council (renamed the Farm Animal Welfare Committee in 2011) was established in 1979 as an independent advisory body to the government of Great Britain. When establishing FAWC, they also announced the Five Freedoms, which were initially focused only on the space an animal required but were updated in 1993 to represent conditions essential for the basic physical and mental well-being of animals in captivity (Anonymous

1993). Initially developed for livestock and poultry, these recommendations have been incorporated into the good practice guidelines of such entities as the Federation of Veterinarians of Europe (Magalhães-Sant'Ana et al. 2015) and the OIE (Bayvel 2004). The Five Freedoms have remained virtually unchanged since 1993 and while they provide a good, easy to convey basis for animal welfare, Mellor (2016) argues that although the absence of negative influences is important for good welfare, it does not account for all of it. He notes that some negative experiences can never be completely removed and are a normal part of an animal's life and argues that what we consider good welfare should provide animals with opportunities to have positive experiences. Complete accordance with the Five Freedoms is therefore not always practically achievable or necessarily sufficient, and in reality, animal welfare exists on a continuum with a complex relationship between suffering and welfare in which a reduction of one does not necessarily lead to an increase in the other (Mellor et al., 2009).

Several studies have focused on the links among wildlife trade, welfare, and mortality (Iñigo-Elias & Ramos 1991; Ashley et al. 2014; Robinson et al. 2015; Carder et al. 2016; Fuller et al. 2016), welfare aspects of animals confiscated from the illegal wildlife trade (Moore et al. 2015; Schmidt-Burbach et al. 2015; Fuller et al. 2016), welfare of pet animals in online videos (Nekaris et al. 2016) and the legal implications of the link between wildlife trade and welfare (Sollund 2011; Das & Narayan 2016). The above studies found welfare conditions to be poor for animals at different points in the wildlife trade, or found that poor welfare conditions in the past often result in stereotypic behaviours. Fuller et al (2016), Iñigo-Elias & Ramos (1991) and Ashley et al (2014) found high levels of mortality within the pet trade, though Robinson et al (2015) found that for some species, mortality rates were significantly lower. However, despite this wealth of research very few have assessed the welfare of the animals within wildlife markets. In wildlife markets, welfare is generally not prioritised. This therefore represents, in some cases, a great deal of time in which animals are suffering from poor welfare. In addition to the inherent right to positive welfare that, according to welfare advocates, animals should have, poor welfare, as noted above, leads to higher rates of mortality during and after the trade, thereby increasing the number of animals that must be taken from the wild to fulfil demand.

Live animals are present in the markets of many Moroccan cities: they are kept in containers or cages for sale as pets, kept alive for the medicinal trade or they may be tied or chained for use as photo props (Znari et al. 2005; van Lavieren 2008; Bergin & Nijman 2014a; Nijman & Bergin 2015; Nijman et al. 2015; Nijman & Bergin 2017a; Nijman & Bergin 2017b). The welfare of wild animals in the markets is not prioritised (Shipp 2002; Highfield & Bayley 2007; Pleguezuelos et al. 2016; Bergin & Nijman 2018) and the welfare of domestic animals in the markets has been the focus of an intervention in the past by the Society for the Protection of Animals Abroad (Jones 2003). This intervention greatly increased the focus on the welfare of horses used to pull tourist carts in Marrakesh and has since improved conditions for these animals.

1.2 Prior Research

Prior to my first visit to Morocco in 2013, published articles focusing on wildlife trade within, to or from the country were very limited. Before 2013, there were 13 published studies that mentioned the topic of wildlife trade in Morocco. Of all of the available reports, few were conducted in multiple cities and many only mentioned a single species. Of these papers, only Benhardouze et al. (2004) and Martin and Perry-Martin (2012) reported on multiple species in multiple locations though each quantified only a single species. Almost all of the studies previously conducted in Morocco mentioned the uses of the animals traded, five studies mentioned the conservation or sustainability of the animals in trade, four mentioned the laws in Morocco relating to wildlife trade and two mentioned welfare of animals in trade in Morocco (Table 1.). Many of the studies reference these topics only in passing, as secondary information to their primary focus and some are contradictory or incomplete in the information that they provide, especially with regard to the laws.

Table 2. Table showing the previous and concurrent research conducted on Moroccan wildlife trade, the number of cities visited, the number of species reported in trade, the number of species quantified in trade and the topics mentioned in the publications.

Paper	Cities visited	Species reported	Species quantified	Use	Conservation	Law	Welfare
Fogg (1938)	1	2	0	✓			
Fogg (1939)	1	17	0	✓			
Fogg (1941)	1	10	0	✓			
Lambert (1969)	1	1	1	✓	✓		
Deag (1977)	1	1	0	✓	✓	✓	
Highfield & Bayley (1996)	1	2	1	✓	✓	✓	
Shipp (2002)	1	9	8				✓
Benhardouze et al. (2004)	6	2	1	✓			
Znari et al. (2005)	1	1	1	✓	✓		
Highfield & Bayley (2007)	?	8	1	✓			✓
van Lavieren (2008)	13	1	1	✓	✓	✓	
Cuyten (2011)	1	4	1				
Martin & Perry-Martin (2012)	2	11	1	✓		✓	
Schweiger (2013)	?	6	0	✓		✓	✓
Pleguezuelos et al. (2016)	14	8	0*	✓	✓	✓	✓
Van Uhm (2016)	8	1	0*	✓	✓	✓	
Van Uhm & Moreto (2017)	1	1	0			✓	
Tingle & Slimani (2017)	6	7	0	✓	✓	✓	✓
Stazaker & Mackinnon (2018)	1	1	0	✓	✓	✓	✓

*Numbers of animals in trade were estimated from interviews.

Since I began my project in 2013, there have been five other studies that have focused on or mentioned the wildlife trade in Morocco. Two studies were conducted from a criminological perspective: Van Uhm & Moreto (2016) focuses on the trade of Barbary macaques in eight cities and internationally and van Uhm (2017) looks at the effects of corruption in the wildlife trade, using Morocco as a case study. There have also been two studies that have investigated the snake charming in Morocco (Pleguezuelos et al. 2016; Tingle & Slimani 2017) and one study that looked at visitor perceptions of the macaques used as photo props in Marrakesh (Stazaker & Mackinnon 2018). While these studies have provided important insights into Moroccan wildlife trade, their focus has been different from my study, and mine remain the only studies to directly quantify the wildlife trade in multiple species in multiple cities in Morocco.

1.3 Aims and objectives of this research programme and thesis outline.

This study was conceived while I was working in sanctuaries in South Africa and Cameroon between 2006 and 2011, upon seeing the animals that had been rescued from the pet and photo prop trade (Table 2). While in Cameroon, I also visited the markets and saw wild animals for sale as meat and experienced another side to the trade. During my MSc at Oxford Brookes University, I further developed the idea of focusing on the wildlife trade and chose Morocco as a suitable study site. I chose Morocco because there was a lack of comprehensive systematic data being collected on the wildlife trade, but what information was available suggested the trade was significant. Throughout its implementation, the study grew and changed as I gathered more data and spoke with local people, NGOs, the Moroccan government, foreign tourists and members of the scientific community.

Because of the dearth of published research, I decided to write a series of papers that focused on different aspects of the wildlife trade in Morocco. Many on-the-ground organisations struggle to gain access to scientific journals and conservation practitioners are not always trained in science (Sutherland 2009). This limits the practical effectiveness of publishing only scientific articles, which are often only read in academic circles. In interacting with local NGOs, however, I learned that the Moroccan government values published scientific literature in designing its policy, and the NGOs appreciate this type of research for this reason. For these reasons, I targeted a range of publication types, to try to disseminate the information to a varied audience and inform all of the relevant stakeholders about the wildlife trade in Morocco. Some papers were targeted at general scientific journals (e.g. *Biodiversity and Conservation*), some were targeted at wildlife-trade-focused journals (e.g. the *TRAFFIC Bulletin*) and some were designed to be read by a wider audience (e.g. *SWARA*, the magazine of the East African Wildlife Society). I also worked with journalists to report my findings on news websites and blogs, both Moroccan and international, such as the Huffington Post and Mongabay to continue to try and disseminate my findings as widely as possible (e.g. Annex 13).

The original aim of this study was to: uncover the extent to which wildlife was being traded in Morocco; explore the drivers and conservation concerns of this trade; and investigate the effectiveness and limitations of (now outdated) wildlife trade laws. As the study grew, further research questions were added. I aimed to: understand the effect of the implementation of new wildlife trade laws in Morocco; focus on species-specific aspects of the trade; look at Morocco in the wider context as an importer and exporter; investigate the trade of wildlife online; and investigate the welfare implications of keeping wild animals in markets. I aimed to use the information I gathered to improve our knowledge of the wildlife trade in Morocco, identify areas or species that need conservation attention, provide data that could be used to inform policy in Morocco and draw attention to the understudied welfare implications of the wildlife trade. The specific research questions I aimed to address were:

- What species are being traded in Moroccan markets? – by identifying and quantifying the animals in a market, I aimed to gather information on species that are being targeted by trade that may require conservation attention.
- Where are the hotspots of wildlife trade? – I aimed to uncover the cities or areas that contained the highest numbers of wild animals being traded.
- What are the drivers of wildlife trade? – I aimed to gain insights into why people purchased wildlife.
- How much of the trade is illegal? – I aimed to investigate the effectiveness and limitations of (now outdated) wildlife trade laws and interpret and track the effectiveness of new laws that were brought in over the course of this study.
- From where are wild animals sourced? – by identifying species that do not occur locally and talking with vendors, I aimed to uncover trade routes of animals that are transported to markets and to learn about any captive-breeding operations that may be in operation.
- What is the turnover of wild animals in Moroccan markets? – by visiting some markets regularly, I aimed to monitor the rate of sale / death of each species and compare these numbers to estimate the yearly turnover and seasonality of the trade.
- Are there any observed changes in preference for particular species or changes in uses? – the decline or increase in presence of certain species over time can indicate changing consumer preferences and I aimed to use this information to guide conservation and education efforts.

- Could a decline of species populations in the wild be inferred from Moroccan market data? – an increase in price and a decrease in presence of a certain species can, if demand increases or remains constant, indicate that populations in the wild are decreasing. I aimed to see if this could be applied to Moroccan wildlife.
- What is the economic value of the wildlife trade in Morocco? – prices are occasionally displayed or often readily given for wildlife in markets. Using turnover data and knowledge of the seasonality of the trade, I aimed to calculate the economic value of the wildlife traded.
- What are the age classes of animals in the trade? – by studying the life history of a species and identifying the age class of animals in markets, I aimed to predict the impacts of removing these animals from the wild on reproductive cycles and population structures.
- Who is the target consumer for wildlife trade? – conservation and education efforts are more effective if they are targeted at specific groups. I aimed to gather information on the profiles of the consumers to aid conservation efforts.
- What are the market dynamics of trade in Morocco? – I aimed to gather information on the supply chain and main players in market trade to allow enforcement efforts to effectively and efficiently work against illegal trade.
- Has there been a shift of wildlife to online platforms? – I aimed to assess the use of online platforms in the wildlife trade in Morocco.
- What are the welfare implications of keeping animals in markets in Morocco? – I aimed to scientifically assess the welfare of animals in trade in Morocco.

These research questions have been addressed and explored in my publications and, to a lesser and greater extent, I have been able to provide insights or answers to many of them. The continually shifting focus of my research, however, meant that not all of these questions were explored in depth (Table 6, section 3.1).

1.4 Publications included in this research programme

The papers I am submitting as a body of work for the PhD by Published Work are presented below. They are grouped from more in-depth papers to lesser in-depth papers. They are a part of my total body of published works and represent a progression in my research. As they are multi-authored works, I have

detailed extent and scope of my contribution to each in relation to the other authors. Co-author statements relating to my contribution to each publication included in this thesis can be found in Annex (A) 14. These publications (A1-12) cover the topics of animal uses (A1-4, A6, A8-12), conservation (A2-12), wildlife trade laws (A1, A3-5, A6, A12) and welfare (A1, A2, A11) and move from articles with general information on wildlife trade in Morocco to species specific articles and book chapters putting Moroccan wildlife trade into a global context. Each grouping contains at least one in depth paper, with a number of surrounding papers in which the topic is mentioned, but not necessarily discussed in detail: for animal uses, A3, A12 and A8 are the most significant papers; for the conservation A4 and A6 are the most significant; for the wildlife trade laws, A4 and A5 are the most significant; and for the welfare A1 is the most significant. These papers represent the core of the body of work, with supplemental papers included in this thesis to give context and show the progression of the research.

A1. Bergin, D., & Nijman, V. (2018). An assessment of welfare conditions in wildlife markets across Morocco. *Journal of Applied Animal Welfare Science*, online first.

This paper is one of the first to grade the welfare of wild animals in markets in a scientific manner. The concept for this paper was developed in the various sanctuaries I worked in throughout Africa. The data were collected in 2016 and 2017. My involvement was: constructing a system for grading the welfare of animals in markets non-invasively, collecting and analysing the data, writing the first draft, and contributing to the writing thereafter.

A2. Bergin, D., Atoussi, S., & Waters, S. (2018). Online trade of Barbary macaques *Macaca sylvanus* in Algeria and Morocco. *Biodiversity and Conservation*, 27, 531-534.

In this paper, we investigate online trade of pet Barbary macaques in Algeria and Morocco. The concept for this paper was developed while I was in Indonesia and through collaboration with Professor Sadek Atoussi in Algeria. The data were collected from 2015 – 2017. My involvement was: the Algerian data collection, writing the first draft of the entry, and contributing to the writing thereafter.

A3. Nijman, V., & Bergin, D. (2017a). Reptiles traded in markets for medicinal purposes in contemporary Morocco. *Contributions to Zoology*, 86, 39-50.

In this paper, we focus on the medicinal trade of animals. The concept for this paper was developed while I was in South Africa in the muti (traditional medicine) markets. Data were collected in 2013 and 2014 in 20 cities in Morocco. My involvement was: the field data collection and contributing to the manuscript.

A4. Nijman, V., & Bergin, D. (2017b). Trade in spur-thighed tortoises *Testudo graeca* in Morocco: volumes, value and variation between markets. *Amphibia-Reptilia*, 38, 275-287.

In this paper, we looked in more detail at the trade in spur-thighed tortoises, the most numerous species found in markets in Morocco, and assessed predictor variables for tortoise presence in markets. This paper was conceived while I was in Morocco. Data were collected in 2013 and 2014 in 20 cities in Morocco. My involvement was: the field data collection, writing the first draft of the paper, and contributing to the writing thereafter.

A5. Bergin, D., & Nijman, V. (2016). Potential benefits of impending Moroccan wildlife trade laws, a case study in carnivore skins. *Biodiversity and Conservation*, 25, 199-201.

In this paper, we summarise the Moroccan wildlife trade laws in English in an understandable and accessible manner and use carnivores as a case study to explore the legality of wildlife trade in Morocco. This paper was conceived during my time working in law offices in Dublin. Data were collected in the field in 2013 and 2014 in 20 cities in Morocco and from a desk-based study in 2015. My involvement was: the field data collection, the translation and interpretation of the laws, writing the first draft of the paper, and contributing to the writing thereafter.

A6. Nijman, V., Bergin, D., & van Lavieren, E. (2016). Conservation in an ever-globalizing world – wildlife trade in, from, and through Morocco, a gateway to Europe. *Tropical conservation: perspectives on local and global priorities* (pp. 313-323). Oxford: Oxford University Press.

This book chapter was written to put Morocco in context as a global exporter and re-exporter of wildlife. The concept for this book chapter came from my work in Morocco. The literature review and CITES review were conducted in 2014. My involvement was: collecting the market data, partially contributing to the literature review and the CITES data collection and adding to the initial manuscript.

A7. Van Lavieren, E., Bergin, D., & Nijman, V. (2016). Case Study II the trade in Barbary macaques and the link to the Moroccan diaspora in Europe. *Tropical conservation: perspectives on local and global priorities* (pp. 324-326). Oxford: Oxford University Press.

This book chapter box was written to put the trade of Barbary macaques in an international context. The concept for this chapter came from E. van Lavieren's and my work in Morocco. My involvement was: contributing to the manuscript.

A8. Nijman, V., & Bergin, D. (2015). Trade in hedgehogs (Mammalia: Erinaceidae) in Morocco, with an overview of their trade for medicinal purposes throughout Africa and Eurasia. *Journal of Threatened Taxa*, 7, 7131-7137.

This paper was written to show the medicinal trade of hedgehogs in a broader, global context. The concept for this paper came from my work in Morocco. The data were collected in the field in 2013 and 2014 in 20 cities in Morocco and from a desk-based study in 2015. My involvement was: the field data collection and contributing to the manuscript.

A9. Nijman, V., Bergin, D., & van Lavieren, E. (2015). Barbary macaques exploited as photo-props in Marrakesh's punishment square. *SWARA (July–September)*, 38-41.

In this paper, we highlight the use of Barbary macaques in Marrakesh's main square. The concept for this paper came from my previous work in South Africa and Cameroon with primates used as photo props and from collaborating with the local Non-governmental Organisation (NGO), Moroccan Primate Conservation (MPC, directed by E. van Lavieren), in Morocco who work on all aspects of Barbary macaque conservation. The data were collected in Marrakesh and Meknes throughout 2013 and 2014. My involvement was: contributing data to that collected by MPC and contributing to the writing of the manuscript.

A10. Bergin, D., Gray, M., & Nijman, V. (2015). Marrakesh: a centre for tortoise trade. *Oryx*, 49, 205.

This paper was written as a "conservation news" segment to expedite the dissemination of the information. The paper was conceived while I was in Morocco. The data were collected over 7 visits to the market in Marrakesh in 2013 and 2014, independently by me and M. Gray. My involvement was: the data collection on 5 visits, writing the first draft, and contributing to the writing thereafter.

A11. Bergin, D., & Nijman, V. (2014b). Illegal and open wildlife trade In Morocco's capital. *SWARA (July–September)*, 54-57.

This paper was written to appeal to a broader audience and highlight the trade in Morocco's capital, Rabat. The paper was conceived while I was in Morocco in 2013 but was not begun until completion of my MSc dissertation. The data were collected in 2013 in Rabat. My involvement was: collecting, compiling and interpreting the data, writing the first draft of the paper, contributing to the writing thereafter and incorporating reviewer comments.

A12. Bergin, D., & Nijman, V. (2014a). Open, unregulated trade in wildlife in Morocco's markets. *TRAFFIC Bulletin*, 26, 65-70.

In this paper, we provide an overview of the wildlife trade in Morocco. It was conceived while I was working in South Africa (2006, 2007, 2008) and Cameroon (2011) and saw the wildlife traded in markets. The data were collected in 2013 in 17 towns and cities in Morocco at a time I was registered for an MSc in Primate Conservation at Oxford Brookes University, with parts of the data being used for my final dissertation. Following the dissertation submission, all data were reanalysed, resulting in a different interpretation than what was presented in my dissertation, the paper was rewritten for submission and further revised following the reviewers' comments and suggestions. My involvement was: collecting, compiling and interpreting the data, writing the first draft of the paper, contributing to the writing thereafter and incorporating reviewer comments.

Chapter 2. METHODS



2.1 Study Timeline

This PhD by Published Work is based on my studies in Morocco. I visited Morocco on six occasions between 2013 and 2018. Each of these survey-periods except one (December 2014) were conducted between April and June, allowing the data to be directly compared, without the influence of tourist peaks or other seasonal factors. Data relating to the online trade of wildlife on classified advertisement websites were gathered between 1st of January 2017 and 1st of July 2017.

Table 3. Timeline of my practical experience relating to wildlife conservation and research on wildlife trade – showing the time spent in the field, the topic of study and the outcomes relating to each period.

Year	Country	Fieldwork days	Topic	Outcomes
2006 - 2008	South Africa	160 (over 3 visits)	Welfare and reintroduction of monkeys rescued from wildlife trade	
2008	Bolivia	70	Welfare of pumas rescued from the pet/entertainment trade.	
2010	South Africa	180	Animal conservation awareness and outreach	
2010	South Africa	150	Welfare and reintroduction of animals rescued from wildlife trade	
2011	Cameroon	170	Welfare of animals rescued from the pet trade.	
2013	Morocco	55	Occupancy modelling in wildlife trade surveys; General wildlife trade	Bergin, D., Amezian, M., & Nijman, V. (2013, December 23) Commerce illégal des oiseaux sauvages au Maroc: photo-reportage. MaghrebOrnitho. Retrieved Jan 2019 from http://www.magornitho.org/2013/12/wild-bird-trade/
2014	Morocco	35 (over 2 visits)	General wildlife trade; Wildlife trade in mammals; Wildlife trade in reptiles; Wildlife trade legislation	Bergin, D., & Nijman, V. (2014a). Open, unregulated trade in wildlife in Morocco's markets. <i>TRAFFIC Bulletin</i> , 26, 65-70. Bergin, D., & Nijman, V. (2014b). Illegal and open wildlife trade In Morocco's capital. <i>SWARA (July-September)</i> , 54-57. Bergin, D., & Nijman, V. (2015). Trade of ungulates in Moroccan markets for decoration and medicinal use. <i>Gnusletter</i> 32, 4 - 5. Nijman, V., Bergin, D., & van Lavieren, E. (2015). Barbary macaques exploited as photo-props in Marrakesh's punishment square. <i>SWARA (July-September)</i> , 38-41.

				<p>Nijman, V., & Bergin, D. (2015). Trade in hedgehogs (Mammalia: Erinaceidae) in Morocco, with an overview of their trade for medicinal purposes throughout Africa and Eurasia. <i>Journal of Threatened Taxa</i>, 7, 7131-7137.</p> <p>Bergin, D., Gray, M., & Nijman, V. (2015). Marrakesh: a centre for tortoise trade. <i>Oryx</i>, 49, 205.</p> <p>Bergin, D., & Nijman, V. (2016). Potential benefits of impending Moroccan wildlife trade laws, a case study in carnivore skins. <i>Biodiversity and Conservation</i>, 25, 199-201.</p> <p>Nijman, V., Bergin, D., & van Lavieren, E. (2016). Conservation in an ever-globalizing world – wildlife trade in, from, and through Morocco, a gateway to Europe. <i>Tropical conservation: perspectives on local and global priorities</i> (pp. 313-323). Oxford: Oxford University Press.</p> <p>Van Lavieren, E., Bergin, D., & Nijman, V. (2016). Case Study 11 the trade in Barbary macaques and the link to the Moroccan diaspora in Europe. <i>Tropical conservation: perspectives on local and global priorities</i> (pp. 324-326). Oxford: Oxford University Press.</p>
2015	Borneo, Indonesia	70	General wildlife trade; Cross-border wildlife trade; Bird trade in markets	<p>Internal report for TRAFFIC Southeast Asia</p> <p>Bergin, D., Chng, S. C., Eaton, J. A., & Shepherd, C. R. (2018). The final straw? An overview of Straw-headed bulbul <i>Pycnonotus zeylanicus</i> trade in Indonesia. <i>Bird Conservation International</i>, 28, 126-132.</p> <p>Leupen, B.T.C., Krishnasamy, K., Shepherd, C.R., Chng, S.C.L., Bergin, D., Eaton, J.A., Imron, M.A., Yukin, D.A., Hue, S.K.P., Miller, A., Nekaris, K.A.I, Nijman, V., & Saaban, S. (In Press) Trade in White-rumped Shamas <i>Copsychus malabaricus</i> demands strong national and international responses. <i>Forktail</i></p>
2015	Java, Indonesia	40	General wildlife trade	<p>Nekaris, K. A. I., & Bergin, D. (2016). Primate trade (Asia). <i>The International Encyclopaedia of Primatology</i> (pp. 1089-1095). Wiley Blackwell, Oxford, UK.</p> <p>Nijman, V., Morcatty, T., Shepherd, C. R., Siriwat, P., Nekaris, K. A. I., & Bergin, D. (In Press) Illegal wildlife trade – surveying open animal markets and online platforms to understand poaching of wild cats. <i>Biodiversity</i></p>

				Nijman, V., Ardiansyah, A., Bergin, D., Birot, H., Brown, E., Langgeng, A. Morcatty, T., Spaan, D., Siritat, P., Imron, M.A., & Nekaris, K.A.I. (In Press) Dynamics of Illegal Wildlife Trade in Indonesian Markets over Two Decades, Illustrated by Trade in Sunda Leopard Cats. <i>Biodiversity</i>
2016	Morocco	15	General wildlife trade; Reptile trade	Nijman, V., & Bergin, D. (2017a). Reptiles traded in markets for medicinal purposes in contemporary Morocco. <i>Contributions to Zoology</i> , 86, 39-50. Nijman, V., & Bergin, D. (2017b). Trade in spur-thighed tortoises <i>Testudo graeca</i> in Morocco: volumes, value and variation between markets. <i>Amphibia-Reptilia</i> , 38, 275-287.
2017	Morocco	25	General wildlife trade; Online wildlife trade; Welfare of animals in markets	Bergin, D., Atoussi, S., & Waters, S. (2018). Online trade of Barbary macaques <i>Macaca sylvanus</i> in Algeria and Morocco. <i>Biodiversity and Conservation</i> , 27, 531-534. Bergin, D., & Nijman, V. (2018). An assessment of welfare conditions in wildlife markets across Morocco. <i>Journal of Applied Animal Welfare Science</i> , online first.
2017	Lao PDR	30	General wildlife trade; Wildlife trade legislation; Animal welfare in the wildlife trade	Internal report on the international trade of long-tailed macaques for Cruelty Free International
2018	United Kingdom	40	Wildlife trade legislation; General wildlife trade	Internal report on tiger ownership and trade in the UK, the Netherlands and Belgium for Four Paws International
2018	Morocco	16	General wildlife trade; Barbary squirrel trade; Bird trade	Publications in prep.
2018	Algeria	30	General wildlife trade	Publications in prep.
2018	Desk-based study	30	Wildlife trade methods	Bergin, D., & Nijman, V. (In Press) Wildlife trade methods. <i>Evolution, ecology and conservation of lorises and pottos</i> , Cambridge University Press

2.2 Study Area

Before I began my work in Morocco, I conducted a literature review to find reports of wildlife trade in published articles, newspaper reports and blogs. I also contacted local NGOs and researchers who had worked in Morocco to get advice on areas with high levels of wildlife trade and species commonly traded. Using this information, I identified factors that I believed would indicate a higher likelihood that a city would contain wildlife for sale. These factors included: verbal or written reports of wildlife trade; cities with high human populations; popular tourist destinations; cities with large markets; cities with / near functioning ports; cities in close proximity to borders; and cities with ferry routes to Europe. In addition to this initial assessment, cities were added during the study-periods if local contacts or vendors mentioned that there was wildlife on offer and other cities were visited opportunistically where possible, often en route to known wildlife trading spots. In total, I visited 27 Moroccan cities and two Spanish cities within Morocco over the six survey periods (Fig. 3). Not every city was visited during every survey period but a core of six, which were identified as having significant numbers of wild animals traded, were visited each time. These were Marrakesh, Casablanca, Fez, Meknes, Rabat, and Tangier and were chosen because 93% of the trade discovered in the first study-period was found in these cities, with only 7% in the remaining 11 cities. The dominance of these six cities with regards to wildlife trade continued throughout the study as more cities were added. I designed the surveys to include Morocco's ten largest cities and four border cities (Oujda to Algeria; Tangier to Spain; Fnideq and Beni Nsar to the Spanish cities of Ceuta and Melilla, respectively). Although the border crossing at Oujda is closed (as are all land borders between Morocco and Algeria), it is reportedly still possible to cross for a small fee, and goods are said to be smuggled across. I also included the Spanish cities in Morocco. Ceuta (85,000 inhabitants) and Melilla (86,000) are referred to as semi-enclaves because they are wholly surrounded by a single foreign State, but part of their border is a sea-border. This makes them the only (barring Spanish military outposts also within Morocco) land border between Africa and Europe and the only part of the European Union on the African mainland. Morocco considers these areas to be Moroccan territory that is still to be decolonised and they represent complex political entities in Morocco (Ferrer-Gallardo 2008). They were therefore considered to be potential targets for wildlife trade smuggling, though no such evidence was found.



Figure 3. Figure showing the cities and towns visited in Morocco over the course of this study and the number of repeat visits to each of those cities.

2.3 Study Species

All species that could be identified were recorded on each visit. Where I could not accurately identify animals to species level, I identified them to the lowest taxon for which reliable identification could assured. Species that are domesticated and/or bred in captivity were not included in this study.

Table 4. Species I observed in Morocco during my study, indicating their current status in the wild in Morocco, their protection level in Morocco as of 2019 (either on the Moroccan nationally protected species list or protected by Moroccan law by virtue of being included on the CITES Appendices) and the threat level assigned to each species according to the IUCN Red List of .Threatened Species.

Common name	Scientific name	Native	Protected	IUCN
Spur-thighed tortoise	<i>Testudo graeca</i>	✓	✓	VU
European pond terrapin	<i>Emys orbicularis</i>	✓	×	NT
Unidentified sea turtle	Cheloniidae	✓	✓	
Green turtle	<i>Chelonia mydas</i>	✓	✓	EN
Red-eared slider	<i>Trachemys scripta</i>	×	×	LC
Mediterranean turtle	<i>Mauremys leprosa</i>	✓	×	NE
Spiny-tailed lizard	<i>Uromastyx</i> sp.	✓	✓	NE
Iguana	Iguanidae	×	×	

Chameleon	<i>Chamaeleo chamaeleon</i>	✓	✓	LC
Desert monitor	<i>Varanus griseus</i>	✓	✓	NE
Nile crocodile	<i>Crocodylus niloticus</i>	×	✓	LC
Egyptian cobra	<i>Naja haje</i>	✓	×	LC
Puff adder	<i>Bitis arietans</i>	✓	×	NE
African rock python	<i>Python sebae</i>	×	✓	NE
North African hedgehog	<i>Atelerix algirus</i>	✓	×	LC
Barbary ground squirrel	<i>Atlantoxerus getulus</i>	✓	×	LC
Barbary macaque	<i>Macaca sylvanus</i>	✓	✓	EN
Dama gazelle	<i>Nanger dama</i>	Extinct	✓	CR
Gazelle	<i>Gazella sp.</i>	✓	✓	
Giraffe	<i>Giraffa camelopardalis</i>	×	×	VU
Zebra	<i>Equus sp.</i>	×		
Wild boar	<i>Sus scrofa</i>	✓	×	LC
Barbary stag	<i>Cervus elaphus</i>	Reintroduced	✓	LC
Barbary sheep	<i>Ammotragus lervia</i>	✓	✓	VU
African elephant	<i>Loxodonta africana</i>	×	✓	VU
Common genet	<i>Genetta genetta</i>	✓	×	LC
Lion	<i>Panthera leo</i>	Extinct	✓	VU
Leopard	<i>Panthera pardus</i>	✓	✓	VU
Red fox	<i>Vulpes vulpes</i>	✓	✓	LC
African golden wolf	<i>Canis anthus</i>	✓	✓	LC
Serval	<i>Leptailurus serval</i>	✓	✓	LC
European otter	<i>Lutra lutra</i>	✓	✓	NT
Egyptian mongoose	<i>Herpestes ichneumon</i>	×	×	LC
Least weasel	<i>Mustela nivalis</i>	✓	×	LC
Crested porcupine	<i>Hystrix cristata</i>	✓	×	LC
Armadillo	<i>Dasybus sp.</i>	×		
Striped hyaena	<i>Hyaena hyaena</i>	✓	×	NT
Little owl	<i>Athene noctua</i>	✓	✓	LC
Black kite	<i>Milvus migrans</i>	✓	✓	LC
Common buzzard	<i>Buteo buteo</i>	✓	✓	LC
Common kestrel	<i>Falco tinnunculus</i>	✓	✓	LC
Barbary falcon	<i>Falco pelegrinoides</i>	✓	✓	LC
Atlas long-legged buzzard	<i>Buteo rufinus</i>	✓	✓	LC
Lanner falcon	<i>Falco biarmicus</i>	✓	✓	LC
Common hoopoe	<i>Upupa epops</i>	✓	×	LC
Common peacock	<i>Polyplectron bicalcaratum</i>	×	✓	LC
Ruppells vulture	<i>Gyps rueppelli</i>	×	✓	CR
Common ostrich	<i>Struthio camelus</i>	✓	✓	LC
Berber skink	<i>Eumeces schneideri</i>	×	×	NE

IUCN Threat categories: NE = Not Evaluated; LC = Least Concern; NT = Near Threatened; VU = Vulnerable; EN = Endangered; CR = Critically Endangered.

2.3.1 Taxonomy and Identification

Species identification of live animals during market surveys can be difficult if the animal is a juvenile or has been mistreated / malnourished because the identifying markings may not be as clear as on healthy adult animals. Identifying bushmeat or animals used in the medicinal trade can also be difficult if the animal parts are small, processed, old, or the pieces do not include readily-identifiable features (e.g. a bat's wing). In these instances, species identification may only be possible to a genus or family level.

In order to identify the animals in markets, I made identification charts with species that had previously been observed in trade in Morocco, and those that I considered likely to be present. I also used resources such as the “Guide Sommaire des Espèces CITES Commercialisées au Maroc” (Summary guide of CITES species sold in Morocco) in the report “Application de la Convention sur le Commerce International des Espèces de Faune et de Flore Sauvages Menacées d’Extinction (CITES) au Royaume du Maroc” (Application of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) in the Kingdom of Morocco) and the “List of CITES Listed Species in the Kingdom of Morocco” which were created by the Species Survival Network and given to me by Eaux et Forêts on my first trip to Morocco. Vendors were not found to be able to accurately distinguish species that they were selling, and the information given in markets was therefore not used to identify species. This may have been a lack of knowledge on the part of vendors or may have been because I did not speak Arabic and they, or the translators I worked with, did not know the French or English words for the animals. I could not accurately identify marine animals other than sea turtles and these were therefore discounted. If photographs could easily be taken (or found online), I occasionally sent these to experts to help with identifications. Ultimately, I was able to identify the majority of animals to species level with a high degree of confidence. Where I was uncertain, I recorded animals only to the taxonomic level in which I had confidence. With the exception of the *Uromastix* and *Canis* species (see below), animals that I could not identify to species level or for which the taxonomy has been updated occurred only in very small numbers and, overall, I do not expect these issues to negatively affect the study.

Based on genetic research published in 2018, the ranges and genetic relationships of the spiny-tailed lizards have been clarified and redefined, as previous research on the taxonomy was incomplete or inconclusive (Tamar et al. 2018). Current taxonomy places Moroccan spiny-tailed lizard *Uromastix nigriventris* as the most likely species to be present in Moroccan markets (with the Sudan spiny-tailed lizard *U. dispar* possibly also being present in the south), rather than Bell's Dabb Lizard *U. acanthinura*, as was stated in Bergin and Nijman (2014a; 2018), Niman et al. (2016), and Nijman and Bergin (2017a).

In 2015, the taxonomy of the golden jackal *Canis aureus* was revised and the African and Eurasian populations were split into the African golden wolf *C. anthus* and the Eurasian golden jackal, which remained as *C. aureus* (Koepfli et al. 2015). Given the geographic location in which the ‘jackal’ pelts were

observed and vendor reports that they had been locally sourced, all specimens recorded as *C. aureus* (Bergin & Nijman 2014a; 2015; Nijman et al. 2016) are now thought to be *C. anthus*.

In instances where animals could not be identified to species level because of their condition e.g. dried chameleons, the distribution of the genus was considered: there is only one species of chameleon – *Chamaeleo chamaeleon* – in Morocco or in the adjoining countries (Dimaki 2008) and this was therefore taken to be the species observed in markets. Although it is possible that specimens of other species were present, based on the geographical distance to their extant range, as well as vendor reports that they were locally sourced, the numbers are considered to be negligible, if not absent entirely.

2.4 Data Collection

Because of the unregulated and sometimes clandestine nature of wildlife trade, clear, comprehensive, reliable data are rarely available (Barber-Meyer 2009). In order to estimate levels of offtake, to gain insights into which species are being targeted, to understand how much of the trade is unsustainable and/or illegal, or to measure the welfare of wild animals in markets we can combine data from reported legal trade and confiscations online with surveys of legal and illegal trade (Linder et al. 2013). The resulting information can be used to inform policy measures and guide enforcement efforts, thereby contributing to wildlife conservation as a whole. Systems such as the IUCN Red List and CITES also require high-quality data inputs to accurately assess the threat levels of animals in the wild or in trade. These data are not gathered by the organisations themselves and therefore rely on research such as presented here to keep up to date. These assessments, as well as the papers published can influence government policy by highlighting areas and species most in need of attention.

With a wide range of possible forms in which animals are sold and a variety of uses for which they are sold, the methods by which we investigate the trade vary. The methods used to investigate wildlife trade also depend on the questions we are trying to answer, the time and funding available for the study, the pre-existing information available and how open or clandestine the trade is. Any method of investigation has advantages and limitations and every situation must be considered carefully when deciding the appropriate methods to use.

For my studies in Morocco, I decided to conduct a series of market surveys, use online databases and monitor the online trade. Because of the lack of comprehensive prior research in the area, as well as a desire to gather information from as broad a geographical area as possible, I decided that a quantitative approach was the most appropriate method of data collection. While quantitative methods lack some of the depth of knowledge that can be gained through qualitative data collection (Marshall 1996), such as an in-depth understanding of the uses of animals in the medicinal trade, they allow for a greater number

of markets to be surveyed, allow for repeat surveys in a single market, provide data that can be compared over time on a broad scale, and aligned with my ethical approach (Linder et al. 2013). Although some anthropologists argue that spreading oneself too thin cannot give an accurate representation of a culture, Wogan (2004) notes that there is merit to long-term, in-depth field studies as well as broad far-reaching studies.

While conducting desk-based research on Moroccan wildlife trade, I formed collaborations and co-authored papers with researchers from Moroccan NGOs – Barbary Macaque Awareness and Conservation (BMAC); Moroccan Primate Conservation Foundation (MPC); Birding and Ornithology in Morocco and the Maghreb (MaghrebOrnitho); and S.O.S Malabata birds –, academic institutions in the UK – Durham University and Oxford Brookes University – and an academic institution in Algeria – Université 8 mai 1945 Guelma. Unless otherwise specified, I was involved in all of the data collection for this study. Data that were collected by other researchers are included in Bergin et al. (2015), Nijman et al. (2016) and Nijman and Bergin (2017b).

Although general market survey data (such as presence, abundance and price of animals) were collected during every survey, specific research questions such as the size of tortoises in markets (Nijman & Bergin 2017b) and the welfare of animals in markets (Bergin & Nijman 2018) were only investigated during some survey-periods. These focused questions required different data collection methods and are detailed in their respective papers. Below are general data collection methods for this study and the justification for their use.

2.4.1 Market Surveys

Animal markets are a focal point of wildlife trade research. Animals are frequently brought from source locations to a central area to be sold: this may be a dedicated market, a section of a larger market, a small group of shops or a single shop. Wildlife markets can range from a group of roadside stalls that operate on a weekly basis (e.g. Nijman & Shepherd 2007) to permanent structures containing thousands of animals on a given day (e.g. Chng et al. 2015). Surveys in these markets provide a snapshot of what species are being traded, the numbers in which they are present, the price of the animals and information on the target consumer (Greatorex et al. 2016). Market surveys are an efficient and popular method of data collection because the markets are often easy to access and can be surveyed in a short time with non-invasive and inexpensive methods (Harris et al. 2015).

Market trade surveys can be done covertly or overtly. Covert surveys – in which the researcher does not make it known that they are doing research – often provide more accurate data because vendors do not feel any need to hide their goods. However, the data the researcher can collect from the vendors is often limited to surface information such as species, price and origin of animals because ethical and practical reasons do not allow for in-depth data collection. Overt surveys can allow for the inclusion of formal

interviews but can be received poorly by vendors and may result in limited data or backlash against the researcher, especially in situations in which some of the trade is not legal. For this study, covert methods were employed; I did not inform the vendors that I was researching wildlife trade. However, at no point in the study was any form of deception necessary, I simply allowed the assumption that I was a tourist to persist (Section 2.5).

Market surveys were used as the primary method of data collection throughout this study. I surveyed each of the 29 cities in Morocco on which the papers are based at least once, with repeat surveys in many of these cities for a total of 82 surveys. I collected data on the presence of birds, mammals and reptiles in markets. I primarily surveyed the markets alone but in large markets, I occasionally employed guides during my first study-period (as is quite common for tourists to do) to find my way around. These guides would also informally act as translators. On several occasions, I surveyed markets with fellow researchers. These surveys allowed me to assess inter-observer reliability where both observers would count and identify the animals present in markets and compare observations subsequently. When comparing notes, observers were found to have recorded very similar numbers of animals and to have matched on the identification of all species observed, lending credibility to the data collected.

I surveyed medinas—distinct, typically walled, city sections in which markets are often found, also known as Old Towns—exhaustively for wildlife and markets outside the medinas were visited when learned about. When possible, I conducted both daytime and evening surveys on the same day in order to minimize the chances of stalls or shops being overlooked. Market stalls with similar products tend to be clumped and no method of random selection was seen as appropriate to collect robust data. Although the majority of wildlife tended to be concentrated in a single section of the market, outlying shops were common, and surveys could therefore not be considered complete once the main wildlife section had been found. I surveyed markets by walking on any streets that contained shops of any kind in the market area. Sections in which there were no wildlife would often lead to other sections of the market so even areas of the markets such as technology sections were surveyed quickly to determine that they were not attached to wildlife sections. Occasionally I would ask local people or guides for directions to shops that I found to be associated with wildlife – such as herbalists – but I did not ask for wildlife specifically to avoid appearing overly interested or stimulating the trade. Where possible, I gathered information on the prices, sizes, welfare conditions, origins, uses, and target consumers through observations and informal conversations with vendors. Conversations were held in French, English or a mixture of the two. I used a mobile phone to record the data, directly into a premade table, using the app ‘Keep Notes’. This allowed me to record the above data, without appearing out of place.

To assess the welfare of animals in trade, I developed non-invasive welfare indicators from which I could quickly assess different species’ welfare conditions. These indicators were: (a) access to appropriate food (scored as a yes or no), (b) access to water (yes/no), (c) ability to control heat or sun exposure (able/

unable), (d) material of the floor of the enclosure (uncovered steel bars/plastic, wood, or otherwise comfortable floors), (e) proximity to conspecifics (sufficient space/overcrowded), and (f) ability to retreat from stressors (able to hide/unable to hide). The requirements for each of the species differ and I took this into account when determining the appropriateness of the conditions, for instance, the food requirements for different species vary greatly. Spur-thighed tortoises eat at least 34 species of plants in the wild (Cobo & Andreu, 1988), while Barbary ground squirrels (*Atlantoxerus getulus*) eat mainly fruit, seeds, and nuts (López-Darias & Nogales, 2008) so leafy greens that would suit a tortoise's diet, would be insufficient for a squirrel. I then noted these data (per enclosure, rather than per animal) in Keep Notes as I did with other data.

2.4.2 Online Data Collection

With the growing ubiquity of the Internet, much of the trade in wildlife is moving to online platforms (Sajeva et al. 2013). This increases the ease with which people can trade wildlife and often, the ease with which we can monitor it (Phelps et al. 2010). Wildlife is sold on classified advertisement websites and social media all over the world. Including online analyses in wildlife trade research is vital to get a full picture of the species and number of animals being traded as many of these animals will not pass through markets. Social media platforms allow people to form exotic animal appreciation groups and advertise their animals to a wide group of potential buyers for no cost. Classified advertisement websites similarly allow vendors to interact directly with customers, without the need for a middle-man (Yu & Jia 2015). Although many of these website state that illegal activities may not be carried out and others even explicitly state that protected animals may not be sold, the trade is poorly regulated on many of the smaller sites. Online trade research can be very efficient because data can be gathered quickly or even automatically once a system is developed for their collection and with a low requirement for time and resources.

Monitoring the online trade gives us similar insights into the popularity of certain species, prices, locations of sale, turnover and uses of animals that we can get from market surveys but can provide additional data on the vendor such as the words used in the advertisements, which can help researchers identify what people consider to be desirable traits in the species that people are purchasing. This information can help inform education campaigns and spot trends in animal ownership.

The move to online platforms presents unique difficulties in monitoring wildlife trade. In a market, seeing an animal provides certainty that an animal is present. An advertisement online, however, may represent a real animal, a scam, an animal that has already been sold or a vendor who will remove the animal from the wild to fulfil an order. Species identification can also pose problems because photos may not be available, may not be good quality, may be reused or may not include identifying markings. Monitoring wildlife trade online must be done systematically, and searches must be aware of their limitations. Searching with a single search engine or using a limited number of key words can miss important data,

while giving the appearance of being comprehensive. Searches may miss postings with wildlife for sale if they originate from a different country, are written in a different language, or contain misspellings, alternative names or code words.

For this study, I investigated popular Moroccan and Algerian classified advertisement websites for a 6-month period, from 1st of January 2017 to 1st of July 2017, searching for trade in Barbary macaques. I searched eight websites in Morocco and four in Algeria using search terms in English, French and Arabic (i.e. monkey, macaque, singe, magot, المكاك, قرد) and browsed their 'pet' and/or 'miscellaneous' sections. I collected information on the, age, price and description of the macaques, as well as general locations and other goods offered by the vendor. The number of views received by each advertisement was used as a metric for a post's popularity.

As is the case with any online advertisements, there is no certainty that the vendor is actually in possession of the product at the time of advertising; there is a chance that it is a scam. However, the presence of photos in most cases – different for each advertisement and not found on an online reverse-image search – indicates a likelihood that the vendors were in possession of the monkeys. It is therefore assumed that they are selling the individuals advertised.

2.4.3 Using the CITES Database

Wildlife trade can be monitored using online databases that consolidate wildlife trade records and make them accessible to the public or to certain groups. The UN Environment World Conservation Monitoring Centre (UNEP-WCMC) manage the CITES Trade Database, a collection of records of internationally-traded, CITES-listed animals. Although the level of compliance varies greatly, all parties to CITES are officially required to submit annual reports detailing the numbers of CITES-listed animals traded internationally and the purpose of this trade. Care must be taken when analysing the CITES trade database, as errors are common and can lead to seemingly accurate data that over-represents trade levels (Robinson and Sinovas 2018).

I collected data from the CITES Trade Database for the paper Bergin and Nijman (2015) and I, along with V. Nijman, collected data from the CITES Trade Database for the papers Nijman et al. (2016) and Nijman and Bergin (2017a). V. Nijman collected CITES Trade Database data for the paper Nijman and Bergin (2017b). For data collection, I accessed the CITES Trade Database at trade.cites.org. I entered the relevant dates, ensuring to select only up to two calendar years before the date of the data collection: countries are given a leeway period to submit their trade data to the database and CITES have a set period in which they upload this data to the database so data can only be considered complete up to two years prior to the point of collection. I then selected Morocco as either the importing or the exporting country (depending on the paper) and set the taxon as carnivora for Bergin and Nijman (2015) and left it as all species for Nijman et al. (2016). I downloaded the reports as a .csv file and used Microsoft Excel to clean

and present the data. Firstly, I compared the data from the importer and exporter columns; for Morocco, importer reported quantities were more complete, so I chose these data to represent the trade. I filtered the columns of 'term' and 'unit' to only include entries that could be unambiguously represented as individual animals i.e. I removed terms such as 'kilograms' or 'pieces'. I then assessed the entries based on their purpose (commercial, personal confiscated etc) and included only those relevant to the paper. These steps left me with a dataset that represented a minimum number of individuals of a given species traded to or from Morocco, or for which Morocco was a re-exporter.

2.4.4 Literature Review

I searched Google, Google Scholar, the TRAFFIC Bulletin, and the Web of Science for articles or reports that included any information on Moroccan wildlife trade. References were discovered using a snowball method where citations in one text would lead to others. Google searches were performed in English and French to find media reports of wildlife trade.

2.5 Data Analysis

The methods and analysis involved were varied and depended on the question being asked. For many of the papers, we chose to use descriptive (or otherwise simple) statistics to represent the data. Descriptive statistics provide summaries of a dataset to help describe and understand the features of a dataset but stop short of detailed analyses (Hays, 1973). We chose this method as appropriate for many of the smaller papers. In some instances, this was because the datasets were not large enough to perform more in-depth statistics (i.e. A₂, A₈); in some it was because statistics-heavy paper would not have been appropriate for the journal / book (A₆, A₇, A₉, A₁₁, A₁₂); in some, descriptive or simple statistics were more appropriate for the type of paper (A₁₀, A₅). For the papers A₁, A₃, A₄ and A₁₀, we chose more in-depth statistics to explore and represent the data. We used Microsoft Excel and R to analyse the data. The tests used are detailed below:

Chi-square: A chi-square test is used to test whether a relationship exists between two categorical (named) variables (Lancaster & Seneta 2005). Chi-square tests were used in A₁ and A₃. In A₁, chi-square tests were used to test if there was a significant difference in the welfare of animals between years, between welfare indicators and between cities. In A₃, we used this test to see if the presence of reptiles in 20 cities was as expected across all species or if some species occurred more frequently than predicted. For the expected frequencies, we assumed that reptiles were randomly distributed and were observed at a rate that was proportional to the sampling effort per market or per survey.

Analysis of Variance (ANOVA): ANOVAs are statistical tools used to assess whether two or more population means are equal (Girden 1992). We used an ANOVA in A₃ to test the different composition of reptiles between cities.

Pearson product-moment correlation: A Pearson product-moment correlation tests the strength of a linear association between two variables by drawing a line of best fit and measuring how far the data points are from this line (the r coefficient) (Rodgers & Nicewander, 1988). We used this in A₃ and A₄ to explore the relationships between corelates with trade volume, and aspects of tortoises that may affect their sale. In A₃, we used the r value to explore the correlation between: the size of the city and the number of reptiles in markets; the size of the city and the number of herbalist shops observed; the number of herbalists and the number of reptiles observed for sale; the mean value of the reptile species and the volumes observed in trade. In A₄, we used it to explore the correlation between the price and the size of tortoises observed in markets.

Univariate linear regression model: A univariate linear regression model is a model that determines the relationship between one independent (explanatory) variable and one dependent variable (Rao & Toutenburg, 1995). It aims to help visualise the relationship between variables. We used it in A₄ to show the relationships between the volume of tortoises observed in cities in Morocco and the number of surveys, the number of wildlife shops, the species diversity, the human population of the city and the distance to a large city. (over 600,000 people).

2.6 Ethics

The ethical implications of conducting wildlife trade research are important to consider when designing and implementing a study (ESRC 2015; Dillman et al. 2014), especially when some of this trade is being conducted illegally. According to the Economic and Social Research Council Framework for Research Ethics (2015), although it should not be undertaken lightly, covert research ‘may be undertaken when it may provide unique forms of evidence that are crucial to the research objectives and methodology or where overt observation might alter the phenomenon being studied’. This is agreed with by Spicker (2007) who also notes that for research in the public interest or on criminal activity, such as my study, informed consent should not be the default position. I designed this study to collect data in a covert manner, i.e. I made observations of trade in markets and had casual conversations with vendors without informing them that I was collecting data. I somewhat followed the anthropological method of ‘serial hanging out’ (Sandu et al. 2007) by which the researcher immerses themselves in a culture to better learn about it for only a short period of time, but I avoided ‘deep hanging out’ (Geertz 1998) in which a researcher builds a relationship with people and works with them to gather information. In the case of my study, requesting informed consent would be impractical, given the hundreds of shops I was

surveying, and would be contrary to the research design, as it would likely lead to poorer-quality data and may prevent repeated surveys. During my study, I surveyed hundreds of shops in dozens of markets. For many of the vendors, informed consent could only be achieved with significant explanation from an Arabic-speaking researcher who understood the nature of the study as many of the vendors may be partially or wholly illiterate (UNESCO 2012). Fully disclosing the nature of research on sensitive issues can lead to lower-quality data because people are less likely to trust a researcher and may therefore lie about, or omit, some information if they do not believe it is what the researcher wants to hear (Li 2008). Repeat surveys of the same markets during and between survey-periods relied on my anonymity to the vendors as repeat visits to a shop may indicate a strong desire to purchase an animal which may inadvertently stimulate the trade and would make surveys difficult if vendors strongly pushed for me to buy animal products. Covert market surveys therefore provided unique data that are crucial to the objectives of this study that overt market surveys could not accomplish.

Because informed consent could not be requested from vendors, I designed my study in such a way to avoid conflicts of interests.

- While more in-depth knowledge could have been gathered if I had posed as a buyer or as a trader intending to export wildlife internationally, this approach was not employed because it would require me to deceive the traders. One way to avoid conflict in this situation, and the method I decided to use, was to act as an interested outsider, rather than a participating observer or an insider (Li 2008). This allowed me to gather surface-data on the trade without entering into a relationship of trust with the vendors.
- I chose to observe the wildlife trade only in markets and open areas (including shops within markets). The rules that apply to research collected from an individual's personal or private life are not necessarily the same as those that apply to research collected in a public sphere (Spicker 2007). Wildlife trade was only observed in public situations in which the people involved could reasonably expect to be observed by strangers. The Social Research Association (2003) note that 'there can be no reasonable guarantee of privacy in "public" settings since anyone from journalists to ordinary members of the public may constitute "observers" of such human behaviour and any data collected thereby would remain, in any case, beyond the control of the subjects observed'. Tacit refusal i.e. any attempt to deliberately make observations difficult was accepted as a refusal of consent and in these situations, observations were not pursued.
- I chose to study the wildlife being traded, not the people trading it. The only data that I gathered were observations of wildlife that were openly on display in markets, factual information about those animals (price, size etc.), and general information about their uses (e.g. 'what do people use chameleons for?'). No interviews were conducted and no personal information about the

vendors or consumers was inquired about or recorded – including names, reasons for selling or buying wildlife, personal views, addresses of shops, phone numbers, or any other sensitive information relating to the vendors. I assigned shops a code so that I could compare them between survey periods.

- Knowledge relating to medicinal trade is protected by the Convention on Biological Diversity and there is a growing concern about ‘the ethics of exploiting indigenous knowledge and resources from tropical countries, without sharing the benefits with those who are the traditional custodians of the knowledge and land’, which is known as bioprospecting (Alves & Rosa 2013). I therefore limited any inquiries about the medicinal use of animals to surface information and did not study this practice in-depth. To supplement this information, I drew from published reports of the uses of wildlife in medicine in Morocco (Nijman & Bergin 2017a).

I recorded data on the location of the shops in maps for my personal use (so that I could revisit shops that were visited in previous study-periods) and these, along with all data collected in Morocco were stored in password-protected folders on my laptop and on a password-protected external hard drive. When reporting these data, no specific shops or stalls were mentioned, and GPS points were not provided. I did not buy any animals or pay for photos of them over the course of this study. To avoid stressing animals and compromising their welfare, I did not handle any animals in the course of this study. Initial prices given for many goods in Moroccan markets can be lowered if the buyer is willing to negotiate the price down. These price reductions are dependent on the bargaining power of the buyer and, reportedly, on their nationality so I could not make an estimation of the minimum price of an animal. To avoid stimulating the trade only starting prices were recorded. If I took photographs, I attempted only to capture the animals that were being sold, rather than the vendors. If the vendors were visible, I cropped the photograph or blurred the face for publication.

In contrast to online research of social media sites, the profiles of classified advertisement websites do not contain personal information other than that necessary to conduct a transaction. Although this information is freely available online, the data was immediately anonymised so that no identifying information (usernames, phone numbers, email addresses) was recorded about the vendors. Location data was only recorded to city level and the other goods sold were recorded in broad categories (car, property etc.).

This research complied with the laws of Morocco and with the ethics protocols proposed by the Association of Social Anthropologists of the United Kingdom and Commonwealth regarding research purposes, confidentiality of the information and the anonymity of subjects (ASA 2011) and fieldwork practices were approved by the Ethics Review Board of Oxford Brookes University. Ethical approval was granted for my fieldwork in 2013. From then on, I operated independently but maintained the same

methods and ethical standards. In 2018, I was again granted ethical approval by Oxford Brookes University.

2.7 Dissemination

In this study, I set out to uncover various aspects of the wildlife trade in a previously-understudied region. To use these data, I decided to disseminate my work in a variety of ways with the aim of causing real-world change. As detailed above (section 1.3), I chose to publish my papers in a variety of formats and a variety of journals to make my research accessible to people of different academic experience. This meant that people with no experience could still learn aspects of the trade, while in academia, we were still statistically investigating the causes and factors that influence the trade so that conservation actions could be more targeted. After each survey period, I prepared a summary document in English and French, which I would send to Eaux et Forêts and to NGOs working on animal conservation in Morocco. This document highlighted, in a succinct manner, the major findings of my research – the species of primary concern, the trade hotspots and any significant changes from previous surveys. On three occasions, I visited the Eaux et Forêts office in Fez to present them with my most recent report. On two of these occasions, I spoke with the same high-level official about the issues of wildlife trade in the country. On the third occasion, I presented the office with my report but the official was not present and I was not invited to speak with anybody else. I do not deem my engagement with Eaux et Forêts to be a success, as they did not respond to my emails and no action appeared to come out of my visits to the office. I do, however, consider my interactions with NGOs to have effected change as they say they have used my findings to lobby the government in wildlife trade situations and have found the published articles to carry weight. They have also factored in my data of trade hotspots to target conservation activities and thus more effectively stretch a limited budget.

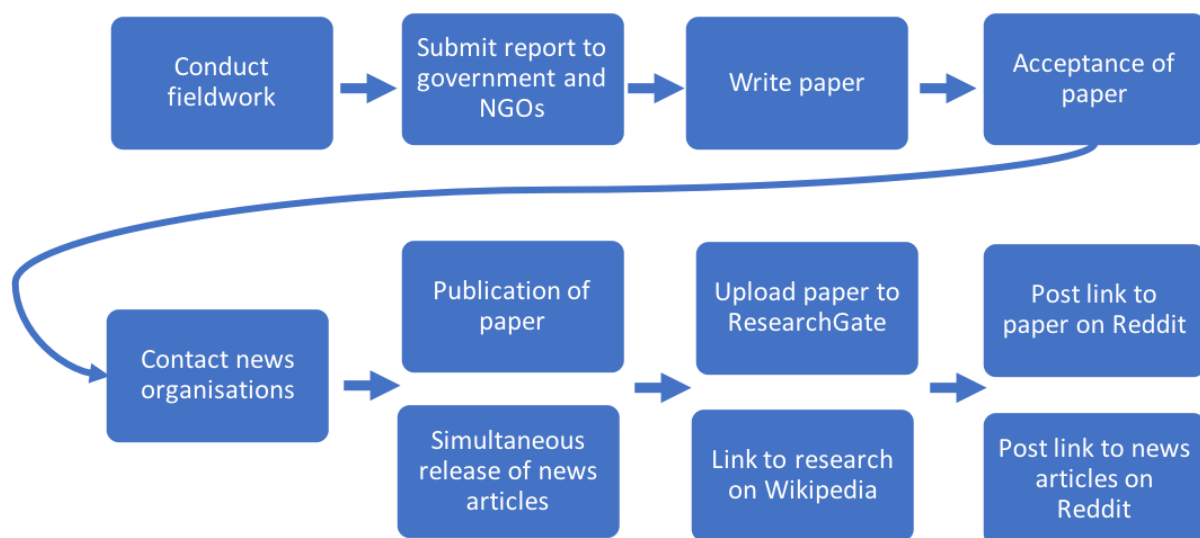


Figure 4. Flowchart of standard dissemination actions.

In the wider conservation community, I contacted news websites and wrote, co-authored or provided input into news articles about my research. These articles were strategically timed to be released at the same time as my papers for maximum impact. I also used online resources to disseminate my findings (Fig 4.). I added my findings to relevant Wikipedia pages and added sections relating to wildlife trade to Wikipedia pages about any species or area for which I deemed my findings to be relevant. Within the format of Wikipedia, these changes are then reviewed by fellow editors and there is often discussion surrounding the edits. For these pages, I summarised my previously-conducted literature reviews so that I was not biased towards my own findings. Upon publication of a new paper, I also posted links to the text on online forums such as Reddit and engaged with questions or comments about the topic. Funding did not allow for publication in open-access journals, but each paper was uploaded to Academia.com and ResearchGate.com if the copyright allowed for me to do so. For papers I was not permitted to upload due to copyright, I ensured I responded promptly to ‘full text requests’ on ResearchGate. These activities noticeably increased engagement from the general public and wider conservation community, though I did not quantify this.

I presented the results of my work at international conferences on wildlife trade, conservation and primatology (Table 5) and gave guest lectures to MSc students in Primate Conservation at Oxford Brookes University. The presentation at the European Federation of Primatology led to a collaboration with Barbary Macaque Awareness and Conservation, and NGO operating in Morocco, with whom I had not previously worked, which proved beneficial for both parties.

Table 5. Table showing the conferences at which I disseminated my work

Conference	Year	Presentation type	Title
ZSL Wildlife Trade Symposium	2014	Poster	Wildlife Trade in Moroccan markets., February
WildCru Symposium	2014	Oral presentation	Fieldwork and data collection in Moroccan markets
European Federation of Primatology	2017	Poster	Trade and Welfare of Barbary Macaques in Moroccan Markets.
Oxford Martin Programme on the Illegal Wildlife Trade	2017	Poster	Ongoing, Illegal Trade of Spur-thighed Tortoises in Morocco

CHAPTER 3: DISCUSSION



3.1 General Discussion

The main aims of my study were to uncover the extent and nature of wildlife trade in Morocco, draw attention to the potential conservation concerns that the trade may be having and explore specific aspects of the trade. Much of my research involved exploratory fieldwork in areas and topics that had not received a great deal of attention in the past. With my results, I hope to create a baseline for future research and show the utility of particular methods for further investigations. Using market and online surveys, the CITES trade database, and published literature, I was able to gather data that provided me with a broad overview of the trade in, to and from Morocco and explore different particulars of the trade that I considered important, understudied or potentially enlightening. The broad nature of my research has allowed me to be adaptable and my study has evolved according to the information I have uncovered. This was important as it allowed me to change the focal points of my study and add or remove aspects as the study progressed. In this study I provide robust, scientific research that will enable future conservation interventions and government policy initiatives to operate in a well-informed manner. Comprehensive, robust data are particularly necessary for NGOs and underfunded government agencies as they often have to operate within a very limited budget.

In my study, I was able to answer the majority of my original research questions as well as the questions I added as the research progressed. A summary of this is given in Table 6.

Table 6. Table showing a summary of my research questions, the methods I used to investigate them, the resolution of these questions or lack thereof of these questions and the papers that address them.

Research question	Method	Outcomes	Paper
What species are being traded in Moroccan markets?	Market surveys: I recorded the species on sale. I used a chi-square test to determine if the species composition was as expected.	I identified and quantified at least 47 species. The majority of species could be identified to species level.	A3, A6, A11, A12
Where are the hotspots of wildlife trade?	ANOVA, Pearson product-moment correlation: We used these tests to compare trade between cities and thereby determine the hotspots.	Marrakesh, Casablanca, Tangier, Rabat, Fez and Meknes are the cities with the highest degrees of wildlife trade.	A3, A4, A12
What are the drivers of wildlife trade?	I conversed with vendors to determine the reasons animals were being sold. We used a Univariate linear regression model to determine the factors that most influence spur-thighed tortoise trade.	Desire for pets was the primary purchase-driver. Large cities with a greater number of wildlife shops offering a wide range of species besides spur-thighed tortoises are the main centres for trade in tortoises.	A4

How much of the trade is illegal?	I compared species observed in trade to Morocco's protected species list to determine if the trade was legal.	Almost 70% of the trade in wild animals is in protected species. No certificates were ever mentioned by vendors; all of this trade is thought to be illegal. This proportion did not diminish under the new laws.	A5, A12
From where are wild animals sourced?	I conversed with vendors who provided descriptions of the source of animals (geographic source and whether the animals were captive bred).	Animals are sourced mostly from within Morocco; crocodile, python, leopard and lion skins are sourced from sub-Saharan Africa. Tortoises are sourced nearby the cities in which they are sold. No vendor claimed to captive breed animals.	A6, A11
What is the turnover of wild animals in Moroccan markets?	I calculated the turnover of animals through repeat visits to markets, most successfully for spur-thighed tortoises.	Turnover of spur-thighed tortoises reached 75% after 12 weeks, and for other reptiles was 66% after 4 weeks	A3, A4, A11
Are there any observed changes in preference for particular species or changes in uses?	I compared my data between survey periods.	Species composition within the markets did not differ significantly between the survey periods.	
Could a decline of species populations in the wild be inferred from Moroccan market data?	By tracking the price and availability, I assessed whether any species could be determined to be decreasing significantly in the wild according to the criteria set out by Harris et al. (2015)	No decline in the wild could be inferred from the available data.	
What is the economic value of the wildlife trade in Morocco?	I recorded prices of animals, accounted for variations between cities and turnover, to estimate the overall value of the trade, specifically in spur-thighed tortoises.	The annual monetary value of the tortoise trade in Morocco is around USD 30,000-60,000. Reptiles observed over 3 survey periods had a value of around USD 100,000	A3, A4
What are the age classes of animals in the trade?	I estimated the size of spur-thighed tortoises in markets for 3 survey periods and compared my results to the size / age classes given by Znari et al (2005)	We saw proportionally fewer juvenile spur-thighed tortoises than Znari et al (2005) and found a clear relationship between the size of a tortoise and the price.	A4
Who is the target consumer for wildlife trade?	I conversed with vendors to determine who the animals or the animal products were aimed at.	Vendors tended to steer the conversation away from this topic and I was unable to get detailed information on it.	
What are the market dynamics of trade in Morocco?	I conversed with vendors to gain information on the supply chain for wildlife.	The trade chain does not seem extensively organised. Vendors get their goods from travelling 'middlemen', from whom they can order more stock.	A4

Has there been a shift of wildlife to online platforms?	I conducted online surveys to investigate the trade of wildlife on classified advertisement websites.	Online trade of wildlife is currently very low in Morocco, even compared to neighbouring Algeria, where Internet penetration rates are lower.	A ₂
What are the welfare implications of keeping animals in markets in Morocco?	I developed a grading system for wild animals in trade in Morocco and assessed their welfare. I used chi-square tests to compare my results.	Welfare conditions are almost universally unsuitable for the needs of the animals being sold in markets or kept as photo props in Morocco.	A ₁

My primary objective in this study was to provide a comprehensive overview of the wildlife trade in Morocco as previous research had operated within geographical or species specifications that narrowed the foci of their studies. In Bergin and Nijman (2014a), I provided an overview of the trade of all species identifiable to me in 17 cities in Morocco. I continued to build upon this information over the following five years, gathering detailed information on the nature and extent of wild animals being traded in 27 Moroccan cities and two Spanish cities. Of these cities, wildlife or their parts was quantified by other researchers before or during this study in several cities (Table 7). Only Shipp (2002) and Benhardouze et al (2004) were searching for species that they did not find in the markets: Shipp was recording all species and Benhardouze et al were searching for all marine turtle species. All of the other studies in Table 7 aimed to quantify only a single species.

Table 7. Table showing the cities in which animals have been quantified by other researchers and the species which have been quantified.

City	Source	Species
Marrakesh	Shipp (2002)	Desert hedgehog
		Spur-thighed tortoise
		Chameleon
		Spiny-tailed lizard
		Leopard
		Lion
Casablanca	Znari et al (2005)	Kestrel
		Spur-thighed tortoise
		Barbary macaque
		Leopard
		African elephant
Casablanca	Lambert (1969)	Spur-thighed tortoise
		Benhardouze et al (2004)
Fez	Van Lavieren (2008)	Barbary macaque
		Martin and Perry-Martin (2012)
Tangier	Benhardouze et al (2004)	Loggerhead
		Van Lavieren (2008)
Tetouan	Benhardouze et al (2004)	Loggerhead
Agadir	Highfield and Bayley (1996)	Spur-thighed tortoise

I found wildlife being traded in otherwise unreported quantities in cities across the country. The trade in Marrakesh is relatively well-documented but trade in (most notably) Fez, Casablanca, Rabat, Tangier, Agadir and Oujda was either unreported or underreported (mostly because wildlife trade studies in these cities did not quantify the animals seen or because they focused on a single species). These cities contained relatively high levels of trade, some of which was in species that are often overlooked (Bergin & Nijman 2014a, 2014b).

Previously, 10 wild animal species had been quantified in trade in Morocco (Table 6). I identified and quantified 39 species during my first survey period in 2013 and a further eight species in trade in subsequent survey-periods. The species accumulation curve (Fig. 5) shows a large increase in the first survey period, as would be expected, but has not reached an asymptote, indicating that further research may yet uncover species that have I have not observed. However, the species that were not observed in the first survey period make up less than 0.2% of the overall trade by volume so it is expected that, if further trade that is uncovered, it will not change the overall picture.

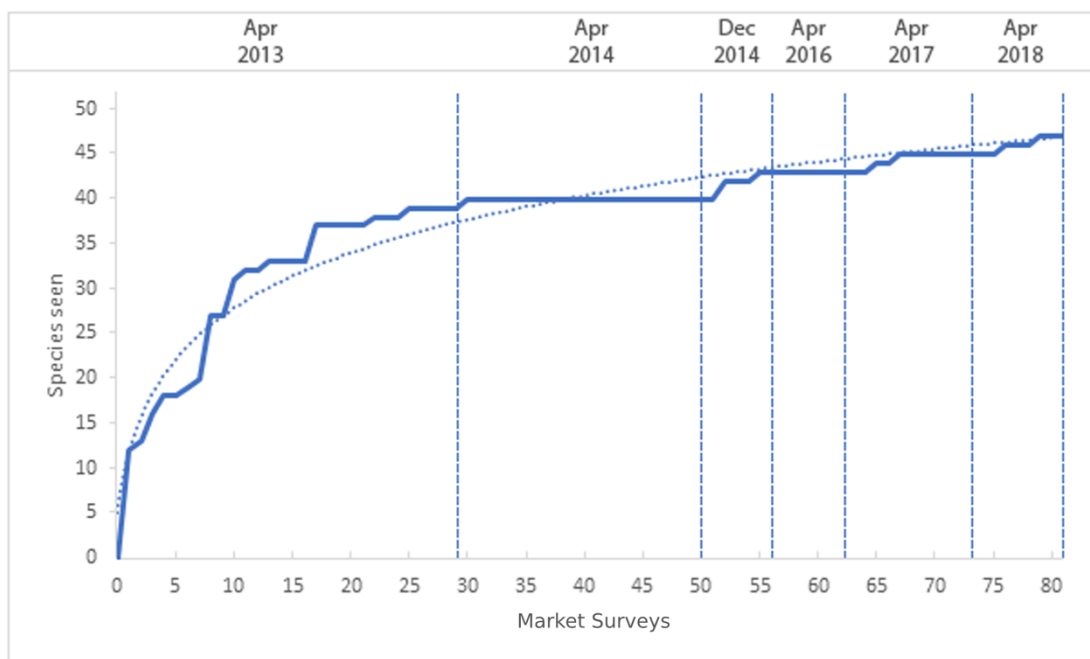


Figure 5. Species accumulation curve showing the increase in species seen over the course of the study, with each study period marked. Solid line: number of species seen; dotted line: Log scale curve ($y = 9.5122\ln(x) + 5.025$); dashed lines: end of study period.

The number of tortoises observed in trade has diminished since they were legally exported from Morocco for the pet trade in large numbers during the 1960s. Spur-thighed tortoises were exported without restrictions from Morocco until 1965, when the government issued carapace size limits and number restrictions on the tortoises that could be traded (Lambert 1979). Lambert (1969) quotes numbers of over 300,000 spur-thighed tortoises being exported to Britain from Morocco each year and found 13,500 tortoises being packaged for export after the restrictions when he visited three wholesale exporters in

Casablanca. A total ban on the export of spur-thighed tortoises came into force in 1978 and Morocco ceased the legal commercial export of this species (Nijman & Bergin 2017b). The numbers of tortoises in markets observed in this study were found to be less than in 2001, when Znari et al. (2005) saw 692 tortoises for sale in Marrakesh in a single visit and Shipp (2002) saw 534. In my study, the number of tortoises in Marrakesh was 194 on average. Sea turtle carapaces have remained at a low rate, as observed by Benhardouze et al. (2004). The numbers of leopard skins I observed in Marrakesh during my study (average = 8) were similar to those observed by Cuyten (2011) who found eight skins and lower than Shipp (2002) who found 17. Shipp found more live Spiny-tailed lizards (100 vs average of 15), and chameleons (50 vs 27) in Marrakesh in 2001 that I found in my study. Ivory was observed in smaller quantities than Martin and Perry-Martin (2012) though they used a targeted approach to data collection, asking directly for ivory and rhino horn which may have contributed to the numbers observed. The ten most numerous species I observed in trade in Morocco are shown in Table 8.

Table 8. Table showing the ten most commonly observed species in Morocco and the number observed in each study-period.

Common name	Scientific name	Apr 2013	Apr 2014	Dec 2014	Apr 2016	Apr 2017	Apr 2018	Total*
Spur-thighed tortoise	<i>Testudo graeca</i>	1722	1134	542	957	1075	1074	6504
Chameleon	<i>Chamaeleo chamaeleon</i>	417	214	80	547	550	227	2035
Spiny-tailed lizard	<i>Uromastyx</i> sp.	150	86	105	63	24	56	484
African rock python	<i>Python sebae</i>	54	68	67	95	78	80	442
Gazelle	<i>Gazella</i> sp.	68	44	27	13	25	38	215
North African hedgehog	<i>Atelerix algirus</i>	41	60	12	15	40	24	192
Red fox	<i>Vulpes vulpes</i>	70	27	16	17	16	14	160
Leopard	<i>Panthera pardus</i>	37	26	17	16	18	19	133
Common hoopoe	<i>Upupa epops</i>	58			24		42	124
Barbary ground squirrel	<i>Atlantoxerus getulus</i>	48	11	4	13	10	28	114

* The number of cities surveyed, and the number of days spent conducting market surveys was not equal in each survey period.

The species I observed in markets were overwhelmingly those that are native Morocco; only 6% (n=697) of the animals seen are not currently found in the country. Of the species that originate from outside of the country, the African rock python made up the majority of observed individuals (63%, n=442), followed by the leopard (19%, n=133). The numbers of animals observed that are native to areas outside Africa represent less than 1% of the overall trade. The species that were observed in markets that originated from outside of Africa comprised a single armadillo *Dasypus* sp, six red-eared sliders *Trachemys scripta*, two blue-and-yellow macaws *Ara ararauna* and a scarlet macaw *Ara macao*.

Although I have divided my discussion into four themes: uses, conservation, laws and welfare, the topics are linked and there is crossover between them. When speaking about laws and policy, it is often relevant to bring in the conservation status of the species involved as this directly and indirectly affects a species' protection-level. When speaking about the welfare, the laws relating to animal welfare are relevant and the reason for which an animal is being traded (i.e. the use) may influence the treatment of that animal.

3.1.1 Uses of Wild Animals in Morocco

All of the publications included in this thesis except Bergin and Nijman (2015) and van Lavieren et al. (2016) describe the uses of animals in trade in Morocco. All species observed in trade were categorised as being sold for pets (67%), medicine (18%), decoration (12%), photo props (3%), or clothing (<1%). An in-depth study of the medicinal uses of animals was not possible in this study but was not deemed necessary to answer the research questions. In this study, I decided to highlight the reasons for which animals are traded because policy and conservation initiatives are likely to be different depending on the purpose of the trade. The use of animals in traditional medicine, for example, has deep cultural roots that the trade of tourist trinkets often does not (Alves & Rosa 2005). If the government are to make necessary interventions while being culturally sensitive, it is therefore vital that they know the reason wildlife is being traded.

I found that the primary reason that animals are sold in Morocco is for the pet trade, followed by the medicinal and decorative trade. Many species observed in the trade are sold for multiple purposes. Raptors, chameleons, snakes, and monkeys are used as photo props – tourists would pay the handlers or shop vendors to take photos with the animals – but in many instances these animals would also be offered for sale, with some shops advertising prices for photos as well as prices to buy the animal. Live reptiles were sold as pets and as medicine and when dead, they would be stuffed and their bodies are used in the traditional medicine. There is also some ambiguity surrounding taxidermied animals as they may instead be intended to be sold for decoration. In these instances, the context of the shop was taken into account: if stuffed animals were sold with other medicinal products (e.g. stuffed lizards), I recorded them as medicinal trade; higher quality animals sold in souvenir shops (e.g. stuffed foxes) were recorded as decoration.

These findings mirror results in other countries in which wildlife are regularly sold. Reptiles are generally traded as pets and are used as medicine (Gibbons et al. 2000, Alves et al. 2013, Capinha et al. 2017), as observed in Morocco (Lambert 1969; Shipp 2002; Znari et al. 2005 Nijman & Bergin 2017a). Primates are used as photo props in Asia (Nekaris & Bergin 2017), as they are in Morocco (van Lavieren 2008; Nijman et al. 2015). Carnivores are used in the medicinal trade (Alves & Rosa 2013) as I noted in 2018 surveys. Birds are used in traditional medicine globally (Alves and Rosa 2013), as they are in Morocco (Fogg 1939, 1941; Alves & Rosa 2013; Schweiger 2013). Snake charming was popular in India until recent enforcement by the government drove it underground (Higgins 2016) and continues unabated in Morocco (Pleguezuelos et

al. 2016; Tingle & Slimani 2017). Pythons are sold for their leather in Africa and Asia (Luiselli 2012), as they are in Morocco (Bergin & Nijman 2014a). Hedgehogs have been recorded in trade for food and medicine globally as is found in Morocco (Nijman & Bergin 2015).

While the uses of the majority of animals aligned closely with reports that had been published elsewhere, there appears to have been a significant change in the use of spur-thighed tortoises in markets in Morocco (Highfield and Bayley 1996). Previously, the carapaces were commonly used to make banjos and fire bellows for the tourist market. These tourist goods were common in the markets, with Highfield and Bayley quoting an unpublished report by Raxworthy et al. (1983) that in Agadir, Marrakesh and Tangier, there were a very large number of shops, each selling 10 to 20 banjos made with tortoise carapaces. Raxworthy et al. (1983) estimated seeing 1,500 of these banjos in these three cities. Highfield and Bayley (1996) wrote that this trade appeared not to have diminished in the intervening years. They also noted that few tortoises were offered for sale alive but live tortoises for sale as pets are now a common presence in many markets (Nijman & Bergin 2017b). The use of spur-thighed tortoise for banjos and bellows, however, appears to have gone out of fashion, and the trade in these items has decreased steadily during my study from 39 in April 2013 to none observed in April 2018.

3.1.2 Conservation of Species Affected by Trade in Morocco

The conservation of species that may be overexploited by trade was one of the driving forces that led me to conduct this study. All of the publications included in this study except Bergin and Nijman (2018) mention the conservation of the species in trade in Morocco. Market surveys can be used as an important indicator in the decline of species in the wild (Harris et al. 2015) and having baseline data of trade numbers is extremely valuable when designing conservation initiatives (Murray et al. 2012). Markets in Morocco are fluid, informal spaces where trade occurs without regulation (van Uhm & Moreto 2017) and there is therefore little way of knowing the effects of trade without conducting surveys on the animals in markets and / or in the wild.

Many of the animals observed in this study were of conservation concern, with 63% of the individual animals in trade considered threatened with extinction according to the International Union for Conservation of Nature (IUCN), while 28% were considered Least Concern or Near Threatened, and 9% have not been evaluated. Given the high number of Vulnerable spur-thighed tortoises observed in trade, they are of special note as a conservation concern. Lambert (1969) called for the conservation of spur-thighed tortoises based on the numbers being exported and although the large-scale commercial trade was indeed stopped after this point, Znari et al. (2005) warned that continuous over-collection would drive this species towards extinction. We echoed this sentiment in Nijman and Bergin (2017b) and called for the Moroccan government to regulate this trade in the face of potentially unsustainable offtake. Repeated surveys in many cities allowed me to estimate the annual turnover of tortoises in Morocco, which further bolstered my argument. The trade of animals is reported to continue throughout the year,

and I observed this in December 2014, as did A. Benattabou (pers. comm.) throughout the year. No evidence for captive-breeding was observed and vendors did not claim that animals had been bred in captivity.

The trade of animals online is a significant risk for many species, with the ease and anonymity creating a perfect platform for people the illegal sale of animals. My findings in Bergin et al. 2017 show that this has not yet become significant for Barbary macaques and for other species, it does not appear to be a major driving factor yet, especially compared to its neighbour, Algeria (D. Bergin unpubl. data). Monitoring this trade, however, is still vital as the online trade of species has the potential to significantly alter the way in which animals are sold.

3.1.3 Wildlife Trade Laws in Morocco

The laws relating to wildlife trade in Morocco changed dramatically during my study with the introduction of Law 29-05, and the laws relating to animal welfare are in the process of changing. Five of my publications mention the laws relating to trade in Morocco, with Bergin and Nijman (2016) specifically focusing on them. The openness of the wildlife trade in Morocco reflects a lack of fear of prosecution, even in the presence of police (Nijman & Bergin 2017b). It is unclear whether the current open trade of illegal animals can be attributed to corruption or to apathy on the part of law enforcement officials, though corruption levels in Morocco are perceived to be increasing (CPI 2017). The open, illegal sale animals in markets is common in countries where wildlife is exploited at high levels, especially for 'low-profile' species such as birds or reptiles (e.g. Chng et al. 2015). Law enforcement is an important predictor for the survival of populations of animals that are facing extinction risk (Tranquilli 2012) and is therefore an important point on which to focus when conducting wildlife trade research. Much of the trade of wildlife in Morocco is illegal, with over 60% of the species and almost 70% of the animals observed categorised as protected according to Law 29-05 (71% of the animals in 2014, 69% in 2018). This illegal trade has not diminished over time, despite the new laws brought in. While the enactment of new laws is important and laudable, they cannot have a positive effect on biodiversity without widespread education of the law and consistent enforcement. It is clear from my, and others', research that the laws relating to wildlife trade have not been sufficiently implemented. The government are aware of the problem of wildlife trade but have not yet devoted sufficient resources to enforcing these laws. Given the openness of the trade, enforcing these laws would provide a monetarily and temporally efficient way of conserving wildlife in Morocco.

3.1.4 Animal Welfare in Markets in Morocco

The poor welfare standards of wild animals in markets became immediately apparent to me on my first visit to Morocco. I mentioned the welfare of animals in trade in Morocco in three of my publications, focusing on it for one of these (Bergin & Nijman 2018). It is quite obvious to any researcher that spends

time in wildlife markets that in most cases animal welfare is not prioritised, but the topic is rarely studied in a robust scientific manner for wild animals (Baker et al. 2013). To study the welfare of wild animals in markets, I decided to adapt the FAWC five freedoms into a grading mechanism that could be utilised unobtrusively and quickly, making it ideal for markets. This was important as I did not want to cause the animals any undue stress. This method proved effective and could easily be adapted to situations such as transit or other markets, yielding data that are comparable and scientifically robust. Welfare in the markets is comparatively transitory but in some cases animals can suffer from poor welfare conditions for several months before dying. Animals in Morocco are almost universally suffering from continuous poor welfare when it would be relatively easy to rectify this: simply adding water and preventing overcrowding would cost very little while dramatically improving the lives of a large number of animals. In conversations with vendors, however, they possessed little knowledge of proper care and advised poor care and transportation practices, reflecting those observed in the markets. They did not take on board the suggestions of previous researchers about how best to keep their animals alive and in good condition.

Welfare conditions were scored for 2113 animals in 61 enclosures in 48 shops and over 88% of animals being kept in situations in which all four measured freedoms were broken. An animal's ability to control its sun exposure and access to water were notably poor. These conditions were widespread, with few differences observed between the cities. Vendor apathy indicated they are unlikely to work toward eliciting positive welfare states in animals if the effort level is high and the incentives are low or absent.

These findings mirror those found by that conditions of animals in different stages of the pet trade are below optimal (Ashley et al. 2014; Schmidt-Burbach et al. 2015; Carder et al. 2016; Nekaris et al. 2016). These conditions, although transitory are likely to negatively affect the animals' long-term survival and welfare post-trade, even if they are rescued (Iñigo-Elias & Ramos 1991; Moore et al. 2015, Fuller et al. 2016).

CHAPTER 4: CONCLUSION AND RECOMMENDATIONS



4.1 Conclusion and Recommendations

The dialogue surrounding wildlife trade has changed in recent years, and especially over the course of the previous two decades. In the early 2000's, and even up until the early 2010s, the level of political and public interest surrounding the topic was low and involvement from enforcement agencies or the transport sector was lower still. Now, people at all levels are more willing than ever before to acknowledge that wildlife trade is a serious threat to the survival of animal species in the wild. The high level of political engagement has been reflected in three UN general assembly resolutions (Resolution 69/314 on 30th July 2015; Resolution 70/301 9th September 2016; and Resolution 71/326 on 28th September 2017) relating to wildlife trade which called for it to be treated as a serious crime and linked it to the transnational organized crime and corruption conventions. CITES have also broadened their scope, with resolutions on fighting corruption, demand reduction strategies and closing domestic markets that launder wildlife. These steps forward have seen wildlife trade moved to a different platform in many discussions, and the laws of many countries have been updated to provide more consistency and to incorporate harsher penalties for wildlife crimes. These on-paper improvements do not, however, always translate into real-world consequences. The reasons for this potential gap are numerous: there is a lack of political will to follow through on resolutions relating to wildlife crime; there is often a lack of funding for the enforcement of wildlife laws; the onus is too often still on environmental agencies to combat what is a law enforcement issue; corruption can hamper enforcement efforts; there often remains a perception of wildlife trade as a taboo subject because of its links to culturally-sensitive topics; and many other reasons.

Morocco, as a country that has transitioned from having a very weak legal system with regards to wildlife crime to having exemplary wildlife trade laws (developed with the aid of the CITES National Legislation Project) provides a good case study of how more work is needed to combat illegal and unsustainable trade than on-paper solutions alone. My study found that the trade in wild animals did not diminish with the implementation of comprehensive laws. A representative of Eaux et Forêts attributed this to a lack of funding and said that the environmental branch of the Moroccan does not have the resources to survey the markets for illegal wildlife trade. My study provides a comprehensive, scientific overview of the trade that can be used by officials to target enforcement efforts and effectively use limited resources. The Moroccan government are reportedly more convinced by published articles than first-hand accounts as they see them as being more robust. These data, freely available in my papers or in the summary reports I have provided to Eaux et Forêts, can be used to convince the Moroccan government of the importance of implementing their wildlife trade laws and can further-inform policy at a time when many countries are looking to increase their efforts to combat unsustainable wildlife trade and at a time when Morocco is well-placed to increase efforts to conserve its biodiversity.

The wildlife trade in Morocco is concentrated most heavily in in Marrakesh, Casablanca, Tangier, Rabat, Fez and Meknes, and these are the focal points where a limited budget could be used to effectively target

areas in which wildlife trade is concentrated. Due to its location and economic stability, Morocco also functions as a significant country in the trade of wildlife between Africa and Europe, especially in the importing of cacti, reptile leather and caviar, and the exporting of cacti, cycads, eels and falcons. Domestically, the majority of animals are sold as pets, followed by medicine and spur-thighed tortoises, as the most commonly-traded animal, represent the greatest conservation concern. Vendors pay little attention to the welfare of animals in markets and relatively simple measures could make a significant difference to the mortality and welfare of the animals that are being sold.

From this study, I give the following recommendations:

- If public opinion and national and international pressure are to effect positive change, it is imperative that Moroccan officials publicise the new wildlife trade law widely and devote sufficient resources to its enforcement. Consistent law enforcement in areas that have a high concentration of wildlife for sale could make a significant difference to biodiversity conservation in Morocco.
- Conservationists working in Morocco should collaborate and agree on a message that can be presented to the government. Multiple organisations working towards a common goal is positive, but conservationists must ensure that they are not duplicating efforts and must present a united message to the government, as mixed messages will only serve to undermine their effectiveness. This collaboration should involve local NGOs and conservationists so that the message is not simply being directed from external sources.
- Plan for the long term (minimum of 3-5 years). Short-term initiatives do not allow time for behaviour change and generally do not assess their impact, meaning failed initiatives cannot be identified and lessons cannot be learned from them. Collaboration amongst conservationists will facilitate longer campaigns with a targeted approach, rather than a scattering of smaller projects.
- Future research questions should include an ethnopharmacological study of the medicinal trade in Morocco. In this study, I was limited in the amount of data I could gather on this practice and although this trade has a significant impact on species usage in markets, no detailed accounts of the uses of animals in the medicinal trade in Morocco have been conducted since Fogg (1941). If Moroccan authorities are to bring this trade to within the law, it is vital they work with medicinal practitioners and consumers to approach this topic in a sensitive manner.
- Additional further research could involve direct questionnaires with vendors, purchasers or other people involved in the wildlife trade. This study was not targeted at in-depth or comparable

questions. This information would be valuable to discover the drivers of trade, the deterrents and would help identify the messages that would be most effective in demand reduction campaigns.

- The use of Barbary macaques in the main square of Marrakesh undermines Morocco's attempts at conserving this Endangered species. The majority of people who visit the square consider that Marrakesh would be a better place without macaques as photo props and their perception of the animals as having poor welfare may be negatively impacting their trip (Stazaker & Mackinnon 2018).
- Focus on the less charismatic species. Barbary macaques receive a lot of attention from national and international NGOs. However, rescuing a macaque carries a high financial burden as it has to be cared for for many years. Species such as tortoises or chameleons may be easier to reintroduce into the wild and are less likely to cause controversy in their rescue (NGOs in Morocco state that they experience significant backlash when collaborating with the government to confiscate macaques).
- One group that may respond well to demand reduction campaigns, especially for the use of photo props, are international tourists. This group have been shown to generally prioritise the macaque welfare over the opportunity to take a photograph with one (Stazaker & Mackinnon 2018). Providing this segment with conservation information in hostels and on trip-planning websites would further drive them to avoid this practice.

With the introduction of new laws, Morocco is now well placed to combat illegal and unsustainable trade in its native biodiversity. Hopefully, political will reflect public opinion and Morocco will act upon this law in a decisive and consistent manner that will have a positive impact on the country's wildlife.

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ANNEXES

Publications submitted, with statements outlining the scope of the candidate's contribution in relation to the other authors in multi- authored work.

(Annexes 1 – 13 have been removed from this version for copyright reasons)

Annex 14

Co-author statements on the
contributions of Daniel Bergin to the
Publications included in this PhD by Published Work.

MEMO

TO: PhD Committee
FROM: Professor Vincent Nijman
DATE: 11 June 2019

Daniel Bergin - Statement on contributions to joined / co-authored papers

Dear Members of the PhD Committee

Starting in 2014 Daniel Bergin and I have co-authored several papers and book chapters together. A number of these he wishes to include in his PhD by Published Work. These all deal with the wildlife trade in Morocco and North Africa. Daniel has worked extensively in various parts of Africa – I have not—and all field data were collected by Daniel. For the following papers I can confirm that Daniel made the following contributions:

Bergin D, Nijman V 2014. Open unregulated trade in wildlife in Morocco's markets. *Traffic Bull* 26: 65-70. Data collection – DB; Analysis – DB, VN; Writing of paper – DB, VN.

Bergin D, Nijman V 2014. Illegal and open wildlife trade In Morocco's capital. *Swara* (Jul-Sep): 54-57. Data collection – DB; Analysis – DB, VN; Writing of paper – DB, VN.

Bergin D, Nijman V 2016. Potential benefits of impending Moroccan wildlife trade laws, a case study in carnivore skins. *Biodiv Conserv* 25: 199-201. Data collection – DB; Interpretation of legislation – DB; Writing of paper – DB, VN.

Nijman V, Bergin D 2015 Trade in hedgehogs (Mammalia: Erinaceidae) in Morocco, with an overview of their trade for medicinal purposes throughout Africa and Eurasia. *J Threatened Taxa* 7: 7131-7137. Data collection – DB, VN; Analysis– VN; Preparation of manuscript – VN, DB

Nijman V, Bergin D 2017. Reptiles traded in markets for medicinal purposes in contemporary Morocco. *Contrib Zool* 86: 39-50. Data collection – DB; Analysis – DB, VN; Writing of paper – DB, VN.

Nijman V, Bergin D 2017. Trade in spur-thighed tortoises *Testudo graeca* in Morocco: volumes, value and variation between markets. *Amphibia-Reptilia* 38: 275-287. Data collection – DB; Analysis of data – VN, DB; Preparation of manuscript – VN, DB

Bergin, D. and Nijman, V., 2019. An Assessment of Welfare Conditions in Wildlife Markets across Morocco. *Journal of Applied Animal Welfare Science*, 22, pp.279-288. Data collection – DB; Analysis of data – DB, VN; Preparation of manuscript DB, VN

Sincerely yours

Vincent Nijman
Professor in Anthropology
Oxford Brookes University



Dr Sian S Waters
Director,
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20th October 2017

To whom it may concern,

I hereby, as a co-author, confirm Daniel Bergin's involvement in the following paper: Bergin, D., Atoussi, S. and Waters, S. (2017) Online trade of Barbary macaques *Macaca sylvanus* in Algeria and Morocco. *Biodiversity and Conservation* (2017): 1-4.

Daniel invited me to contribute to this paper with my data and experience from Morocco. I can confirm that Daniel collected the data for this paper and wrote the first draft. This was then added to by myself and the other co-author and finalised by Daniel.

Please do not hesitate to contact me should you require further information.

Yours faithfully,

Dear members of the PhD committee,

I write this at the request of Daniel Bergin in support of his application for a PhD by published work. I have co authored the following three papers with Daniel:

Nijman, V., Bergin, D., & van Lavieren, E. (2015). Conservation in an ever-globalizing World: wildlife trade in, from, and through Morocco, a gateway to Europe. *Tropical conservation: a view from the South on local and global priorities*, Oxford University Press, Oxford, UK.

The contributions of the different authors: initiated the study: VN, DB, EVL; collected data online: VN, DB; collected data in country: DB, EVL; analysis of data: VN, DB, EVL; wrote the chapter: VN, DB, EVL; all authors approved the final submission.

van Lavieren, E., Bergin, D., & Nijman, V. (2016). The Trade in Barbary Macaques and the Link to the Moroccan Diaspora in Europe. *Tropical Conservation: Perspectives on Local and Global Priorities*, 324.

The contributions of the different authors: initiated the study: EVL, DB, VN; collected data: EVL, DB; wrote the paper: EVL, DB, VN; all authors approved the final submission.

Nijman, V., Bergin, D., & van Lavieren, E. (2015). Barbary macaques exploited as photo-props in Marrakesh's punishment square. *Swara*. July-Sept, 38-41.

The contributions of the different authors: initiated the study: DB, EVL, VN; collected data: EVL, DB; analysis: VN, DB, EVL; wrote the paper: VN, DB, EVL.

I confirm that Daniel made the contributions as indicated above.

 Els van Lavieren

Dear members of the PhD committee,

I write this letter at the request of Daniel Bergin. I was a co-author with Daniel on the paper: Bergin, D., Gray, M. and Nijman, V. (2015) Marrakesh, a centre for tortoise trade. *Oryx*, 49(2), 205.

Daniel conceived of the idea for this study. I collected data for this paper in June 2014 and Daniel collected data in June 2013 and December 2014. All authors contributed to the writing of this paper, with Daniel acting as the lead author.

Sincerely,

A handwritten signature in black ink, appearing to read 'Molly Gray', with a stylized flourish at the end.

Molly Gray