Analysis of the environmental impacts of illegal trade in wildlife

Table of Contents

Key messages 2

I. Introduction 4

II. Status of illegal trade in wildlife 8

III. Environmental impacts of illegal trade in wildlife 20

i. Impacts on the target species 21

ii. Impacts on non-target species 25

iv. Spread of invasive species 38

v. Spread of disease 38

IV. Conclusions and policy implications 40

Contributors and reviewers 43

Editorial team 43

Contributors, advisors and reviewers 43

References 44

Key messages

The severity, diversity and global scale of the illegal trade in wildlife[1] and wildlife products (ITW) has been recognised at various levels of international policy making, including the UN General Assembly (UNGA), the UN Environment Assembly (UNEA), UN ECOSOC, the UN Security Council, the Commission on Crime Prevention and Criminal Justice, and most recently in the Sustainable Development Goals (SDGs), as well as various conventions, agreements and other high-level political conferences.

Government leaders, the international community, and civil society have responded by defining and strengthening commitments to address ITW through a range of measures, including through the development of regional and sub-regional strategies and action plans.

However, considerable gaps in the current state of knowledge about the drivers, status, and impacts of ITW hinder the effectiveness of these efforts. More robust and up-to date evidence is needed if we are to have better-informed and more effective interventions, with greater coherence at the policy and advocacy level. This analysis goes some way to addressing this need by compiling and synthesizing for the first time the evidence base on the environmental impacts of ITW across taxonomic and geographic scales. Using the best available evidence, the analysis provides a cross-section of the currently available information and thus improves the current state of knowledge of the scale and broader impacts of ITW.

The most documented environmental impact directly attributed to ITW is the decline in population size of iconic target species, for example tigers, now driven to the brink of extinction as a result of growing international demand for their parts and derivatives. Poaching and illegal harvesting methods can also alter the demographic and genetic structure of species: illegal logging, for instance, has the tendency to remove the largest and most reproductively valuable trees, which consequently has negative impacts on regeneration and the gene pool of the population.

The impacts of ITW on the environment go beyond the immediate detrimental effects on target species. For instance, ITW can lead to the spread of diseases and invasive species when live animals are moved across international borders. Many illegal harvest methods have limited or no selectivity and result in substantial incidental mortality of non-target species: illegal dynamite fishing, bottom trawling and use of driftnets are all prominent examples of this.

The analysis also highlights the cascading ecological effects deriving from the loss of species through ITW, and the resulting deterioration of ecosystem functions and services of both global and local importance. Compelling case studies such as on the illegal production of charcoal, which has been proven to contribute to deforestation and desertification, illustrate these intertwined effects.

Ultimately, the negative impacts of ITW on ecosystem functioning adversely affect rural livelihoods both in the short- and long-term, creating major barriers to indigenous peoples in sustainably managing their natural resources, undermining good governance, the rule of law and national security. It is of critical importance to strengthen the policy and institutional frameworks to combat ITW at global, regional and national levels, not only to conserve biodiversity, but also to support sustainable development. Environmental policies should provide an enabling environment for communities to be involved in wildlife governance and derive benefits from its conservation and sustainable use.

Furthermore, a robust mechanism for collating and monitoring global data on incidences of ITW, as well as the effectiveness of interventions to combat ITW, should be put in place to improve the evidence base and to provide a reliable and up-to-date information source for targeted actions. This will support the response to ITW at global, regional and national level and provide a foundation to tracking progress in addressing ITW and in meeting the relevant Sustainable Development Goal targets.

Safeguarding biodiversity requires addressing the multiple, and often interconnected threats - not only from illegal trade, but also from habitat loss and fragmentation, pollution, invasive species and climate change. As the international community moves ahead with implementing the numerous commitments already in place, and with more actors, financial resources and knowledge, there is a growing need to ensure coherence and coordination in the international response, and to ensure that such responses are kept under review and are based on the best available scientific evidence to ensure effectiveness.

I. Introduction

Purpose of this analysis

The severity, diversity and global scale of the illegal trade in wildlife[1] and wildlife products (ITW) are increasingly being recognized by the international community.

The impacts of ITW on society, economies and the environment is highlighted as a key issue in the Rio+20 outcome document 'The Future We Want' (UN General Assembly Resolution A/RES/66/288), and addressed explicitly by targets of the Sustainable Development Goals. ITW has been recognized as a serious issue by many Governments and international bodies, including the UN General Assembly (Resolution 69/314) and UN Security Council, the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES), the Convention on Migratory Species (CMS), INTERPOL, the United Nations Office on Drugs and Crime (UNODC), the UN Economic and Social Council, the World Customs Organization (WCO), and the United Nations Environment Assembly (UNEA) (e.g. CITES, 2013b; UN Economic and Social Council, 2013; UNODC, 2013b; WCO, 2014; Interpol, 2015; UN Security Council, 2015). Government leaders, the international community, and civil society have responded by strengthening their commitments to address ITW across a range of measures.

The United Nations Environmental Assembly (UNEA) Resolution 1/3, adopted in June 2014, states that ITW "contributes to damage to ecosystems and rural livelihoods, undermines good governance and the rule of law and threatens national security and has a negative impact on sustainable utilization, including ecotourism and wildlife-based tourism". In response of this recognition, and of the limited information availability relating to the extent and impacts of ITW, UNEA also requested UNEP to provide an analysis on the environmental impacts of illegal trade in wildlife and wildlife products.

There are several aspects of ITW that make it particularly damaging - environmentally, socially and economically (see Box 1), and the impacts of ITW on the environment often go beyond the immediate detrimental effects on the target species, with some activities resulting in long-term degradation of ecosystem function.

This analysis focuses on taxa and areas where the scale of illegal trade, and the environmental impacts of ITW are most serious.

Not all illegal trade has significant environmental impacts, and conversely many environmental impacts can be observed from legal trade that is not sustainable. Indeed, when considering environmental impacts, it is the sustainability of the supply side of trade that is often the most important consideration, and some highly environmentally destructive practices remain legal (e.g. Lawson and MacFaul, 2010; South and Brisman, 2013).

[1] 'Wildlife' is understood to include all non-domesticated terrestrial and aquatic flora and fauna.

Box 1: What makes illegal wildlife trade particularly damaging?

- ITW can lead to **overexploitation**, both where trade is prohibited entirely and where some legal trade is allowed, as illegal offtake occurs in addition to legal offtake;
- The target species are often already **threatened** by other pressures and ITW is an additional pressure;
- Since ITW is conducted outside of legal frameworks there is often **no assessment** of the sustainability of the offtake or considerations about the wider consequences on the environment;
- The individuals involved in ITW may have **no long-term interest** in maintaining the populations or environment affected – indeed there may be incentives for rapid and overharvesting;
- More **damaging** harvest, transport and trade practices are often employed in illicit supply chains to avoid detection or cut costs, and such practices in illegal supply chains can **undermine legal and sustainable practices**;
- ITW can result in all or some members of **local communities** losing resources which are important socially and economically as well as the associated incentives for safeguarding biodiversity as the benefits from ITW are not shared equitably;
- **Social costs** can arise beyond local communities as ITW can impede investment in socioeconomic development;
- Countries' efforts to manage their resources sustainably are undermined, resulting in **economic losses and missed opportunities**;
- Illegal wildlife trade **undermines the rule of law,** affecting the ability of communities and countries to implement broader conservation and sustainable use policies and strategies
- Appropriate levels of enforcement are **extremely costly** to governments;
- Given the nature of illegal wildlife trade, data collection and monitoring makes it difficult to measure the extent of the problem.

For the purposes of this report, ITW is defined as acts relating to the take and trade in wildlife and wildlife products that violate either national law or international agreements and conventions. For example, ITW may include the following:

- Moving specimens across an international border in violation of national legislation;
- Trade in specimens that have been acquired in contravention of national regulations (e.g. trade in the absence of permits required for the exploitation of protected species or from specific areas, harvest from areas where take is prohibited or during closed seasons, use of prohibited methods of harvest, or harvest in excess of permits);
- Trade using illegally-obtained or fraudulent permits for offtake or trade;
- The infiltration of a regulated system through, for instance, laundering of wild specimens as captive-bred or mis-labelling products;
- Trade resulting from harvesting that has avoided required fees or taxes; and
- Trade that has been 'legalised' through special permits, fraudulent legalisation or 'rubber- stamping'.

This analysis reviews available information to provide an overview of the most important illegal supply chains for wildlife (chapter II), and a synthesis of the state of knowledge of the environmental impacts of this illegal trade (chapter III). Where information is available, the analysis also considers the social and economic consequences of such impacts. Possible considerations on the policy implications of the analysis are also provided (chapter IV).

Methodology

Chapter II provides overviews of the available information on legal and illegal trade by taxonomic group. Literature cited primarily includes peer reviewed scientific journals, books and relevant reports, although it is noted that there are many areas of interest in relation to harvest and trade for which comprehensive data and information are lacking. This review includes discussion of these data gaps.

The primary source of data on legal international wildlife trade is maintained by UNEP-WCMC on behalf of the CITES Parties. CITES trade statistics are based on exporter-reported figures for wild-sourced specimens over the period since 2005. Trade data was downloaded on 4 April 2016 as recorded within the CITES Trade Database (http://trade.cites.org). To reduce the heterogeneous trade data, animal and plant terms that reasonably represent a whole animal or plant were combined[2]. Wild-sourced trade includes trade reported as source unknown and that without a specified source. Whilst this inevitably leads to overestimations for some groups and underestimations for others, it provides a rough impression of the trade volumes. Trade is also reported in many other commodities that are not included within these approximations. This document follows CITES taxonomy, where applicable[3]. The sources and availability of data on illegal trade in wildlife is further discussed below.

The structure of chapter III is based on a combination of a framework to explore ecosystem services and factors impacting them, and expert advice. Chapter III is not intended to provide an exhaustive discussion of the available literature documenting the environmental impacts of ITW and their socioeconomic consequences, but rather to present examples that effectively illustrate the range of different impacts. Examples were selected through a literature review and through consultation with experts. Remaining gaps were filled through targeted searches of the scientific literature for particular case studies of environmental impacts. Efforts were made to ensure that the examples encompass a broad range of taxonomic groups and geographic areasThis analysis has been subject to a number of cycles of expert peer reviews including from taxonomic, economic and wildlife trade and sustainable use experts. Peer reviewers assessed and verified the evidence-base presented and provided additional references and expert opinion where gaps in the literature were identified.

When assessing figures for estimates of volumes and value of ITW, it was noted that many available estimates are based on unclear or unsuitable methodologies. Estimates for which limited details on the methodology were provided in the literature or which appeared to be based on unlikely assumptions have been excluded from this document.

Availability of data on illegal wildlife trade

The nature of illegal trade, which evades existing processes of regulation and monitoring, makes it extremely challenging to estimate its true size and value, and to evaluate and predict trends. As yet, there is no comprehensive global mechanism for collecting and monitoring data on domestic or international ITW as there is for some of the key legal trade in wildlife (e.g. through the CITES annual reports for CITES-listed species). Governments often compile their own seizure data based on information from national enforcement authorities and provide reports on the seizures to the World Customs Organization (via the Customs Enforcement Network), INTERPOL (via 'Ecomessages'), the European Commission (through EU-TWIX) and others. CITES Parties also report on 'significant seizures' to the CITES Secretariat through their biennial reports and some further data are also collected through Special Reporting Requirements in CITES. However, in most cases these data are not standardized, suffer from inadequate reporting rates and are not readily accessible for ongoing monitoring and analyses.

Seizures represent geographic and temporal snapshots at a certain point along the trade supply chain and are biased and highly influenced by variables such as:

- Enforcement effort and focus (e.g. spatially, temporally or on specific commodities);
- Ability to detect or identify specific wildlife products in ITW;
- Ability to extract intelligence on the illicit transaction; and

[2] Conversions: mammals: body, ear (/2), foot (/4), genitalia, head, horn (/2; /1 for Indian rhinoceros), live, side (/2), skeleton, skin (except African elephant, as skin can be split multiple times), skull, tails, teeth (only for hippopotamus /12), trophy, tusk (African elephant /1.88; narwhal /1; all others /2); birds: body, head, live, skeleton, skin, skull, trophy; reptiles: body, carapace, foot (/4), head, live, side (/2), skeleton, skin, skull, trophy; amphibians: body, frogs legs (/2), live, skeleton, skull; fish: body, fingerlings, fin, live, skeleton, skin, skull, swim bladder, trophy; Inverts: body, coral (raw), live, shells; plants: dried plant, graft rootstock, live, root.

[3] Not applicable to taxa not listed in the CITES Appendices.

- Reporting effort (e.g. Underwood *et al*., 2013).

ITW is also often reported under a commodity type (e.g. as sawnwood for timber species – see Mark *et al*. 2014), rather than under a taxonomic notation. Direct impacts on species populations or some ecosystem services therefore remain unclear. Furthermore, ITW is often laundered within legal trade, interfering with estimates of both types of trade.

Information on ITW is also often collected through observations of illegal activities, such as market surveys, although more novel methods, such as automated data-mining algorithms for online sales (e.g. Hernandez-Castro and Roberts, 2015), are also being developed. Detailed monitoring data provide valuable information on ITW and within studies the data may be collected in a uniform way. However, the comparability of data across different surveys may be influenced by similar variables as seizure data. Furthermore, observations and surveys need to more rigorously apply consistent methodologies to develop more robust data relating to the scope and scale of ITW (St John *et al*., 2011; Moro *et al*., 2013).

The Monitoring the Illegal Killing of Elephants' (MIKE) and the 'Elephant Trade Information System' (ETIS) system (CITES, 2013c) set up by CITES, TRAFFIC and other partners to monitor poaching of elephants and the illegal trade in ivory are a well-known exception, and provide useful information derived from robust methodologies – but only in relation to elephants and ivory[4]. Some other large mammals, such as great apes[5] and pangolins[6] are particularly well monitored locally or nationally and some good local or national datasets are available, but there are data gaps even for conspicuous species such as Asian Elephants (EN[7]) (UNEP *et al*., 2013) and information on many other groups is often extremely limited.

Other examples of existing information sharing platforms relevant to ITW include the International Monitoring Control and Surveillance Network, which allows fisheries law enforcement professionals to share information about illegal, unreported and unregulated (IUU) practices (MCS, 2014), and the Wildlife Enforcement Monitoring System (WEMS) developed by the UN University (UNU) as a prototype transboundary information sharing platform for ITW (Chandran et al., 2013).

Domestic ITW is also often not systematically monitored, and so data on the level of trade that does not cross international borders is patchy – geographically, temporally and taxonomically. Domestic levels of ITW are often inferred by comparing the levels of production or harvest to the quantities exported, assuming that the difference is consumed within countries – or exported illegally. However, it is believed that domestic trade in wildlife may significantly exceed international trade in terms of volume (Broad *et al*., 2003) and much of ITW may be taking place at local levels (TRAFFIC, 2011). Despite the domestic levels of ITW in some taxa appearing to surpass those of international trade (see e.g. Cantú *et al*., 2007), very little quantitative information is available.

The need for data on ITW at domestic and international scales to be collected systematically has been recognized. Discussions are underway within CITES to consider the establishment of a mechanism for collecting statistical information on illegal trade in CITES-listed species. Concurrently, UNODC is compiling a global wildlife seizures database. UNODC is sourcing illegal wildlife trade data from existing reporting mechanisms, mainly reports that Parties to CITES have provided to the CITES Secretariat and other international, regional and national sources. In addition, the development of a database to compile information on illegal trade in great apes, both at the national and international levels, is planned by the Great Apes Survival Partnership (GRASP). The IUCN SSC Pangolin Specialist Group is planning the development of an online seizures database for pangolins (Challender *et al*., 2014c).

[4] See https://cites.org/eng/prog/mike_etis.php for further information.

[5] See GRASP at http://www.un-grasp.org/?s=illegal for further information.

[6] See IUCN SCC Pangolin Specialist Group Conservation Action Plan for further information.

[7] See Annex for details on IUCN categories.

II. Status of illegal trade in wildlife

Although ITW is believed to be one of the largest illegitimate businesses globally (Wyler and Sheikh, 2008), there has been no comprehensive analysis of the scale of the problem. Research efforts have mainly focussed on international illegal trade in charismatic and/or endangered species, which represent only one aspect of the broader issue.

The scale of illegal trade in wildlife – an overview

A number of estimates of the scale of volumes of ITW exist, but vary widely. These divergent estimates reflect the paucity of available data, but they also reflect the differing definitions of illegality in use - and hence the inclusion of different datasets, measurement methods, data assumptions and conversion factors.

Trade in species that are not listed under CITES[8] is not systematically monitored at the species level, either domestically or internationally. This means that a large proportion of international trade in wildlife, and in particular ITW, is either not systematically monitored at the species level or not tracked at all. Furthermore, only occasionally, for example in the analysis of trade in great apes (Stiles *et al*., 2013), consideration is given to the loss of animals along the supply chain.

Most commonly, seizure or observational data are used to estimate the minimum number of organisms in trade (Stoner and Pervushina, 2013; Burgess *et al*., 2014). The most sophisticated estimates of the volume of ITW have been made for large mammals, such as elephants, and marine fish. The ETIS and MIKE and African Elephant Database datasets have been used in several studies to estimate the total extent of illegal killing of African Elephants (CITES *et al*., 2013; Underwood *et al*., 2013; Wittemyer *et al*., 2014). Several regional and country-level assessments exist for ITW in timber. Illegal fisheries have been assessed even more holistically. For example, Agnew *et al.* (2009) established estimates with upper and lower bounds for the levels of illegal and unreported catches of case study fisheries in 54 Exclusive Economic Zones (EEZ) and 15 high seas fisheries, accounting for 46 per cent of total global fish catch. These figures were then scaled up to provide global estimates of between 11 and 26 million tonnes of fish annually (Agnew *et al*., 2009).

Although the very nature of ITW means that it will not be possible to obtain fully reliable figures of the values of wildlife being traded illegally, various attempts have been made to estimate its global value, based on different methodologies and subsets of data. The international illegal trade in terrestrial animals and non-timber plants (so excluding timber and fish), for example, has been estimated to be worth between US$7.8 and 10 billion (Haken, 2011). In 2009, the value of the global illegal timber trade was estimated to potentially amount to US$7 billion per year (Haken, 2011), while the value of the global illegal and unreported fisheries catch was estimated at between US$10 and US$23.5 billion in the same year (Agnew *et al*., 2009). Some recent available estimates have suggested a considerably higher volume and value of illegal trade, particularly in timber species, and it is clear that estimates of the illegal trade in timber and fisheries surpass those of other wildlife commodities in terms of value. The illegal trade in charcoal is also considered to be extensive (Nellemann *et al*., 2014).

To put the estimates of ITW into context, this section provides an overview of available information on the scale of legal trade. In terms of value of legal wildlife trade, probably the most commonly used figures are those produced by TRAFFIC, which estimated it to be worth US$332 billion (including timber and fisheries), based on 2005 import declarations (Engler, 2008). The value of global forest product exports alone was estimated at US$246 billion in 2013 (FAO, 2015a). Global imports of fisheries products (capture and aquaculture combined) were estimated to be worth US$129.5 billion in 2012, with international trade believed to represent 37 per cent of global fish production (FAO, 2014a).

[8] The Checklist of CITES Species provides the official list of CITES-listed species (http://checklist.cites.org)

In the absence of reliable statistics on ITW, the available data on legal trade in wildlife commodities can provide an indication of demand for certain taxonomic groups globally, although ITW may target different taxa to different extents. The CITES Trade Database is the most comprehensive dataset on international trade in wildlife and allows examination of patterns of legal trade over time. Trade is reported by Parties to CITES on an annual basis and involves many different commodities. To show the relative volumes and patterns of trade, an overview by taxonomic group over time is provided (Figure 1). Between 2005 and 2014, trade volumes of wild-sourced CITES-listed plants surpassed that of any other taxonomic group (Figure 1a). Wild-sourced reptiles and invertebrates were the next most highly traded groups, the former showing some fluctuations in levels over the years. It appears that reported trade in wild-sourced mammals declined over time, whilst trade in birds appears to have been increasing since 2006, until a decrease in trade in 2014 (though note that 2014 data are not yet complete); overall trade in fish and amphibians seems more variable (Figure 1b).

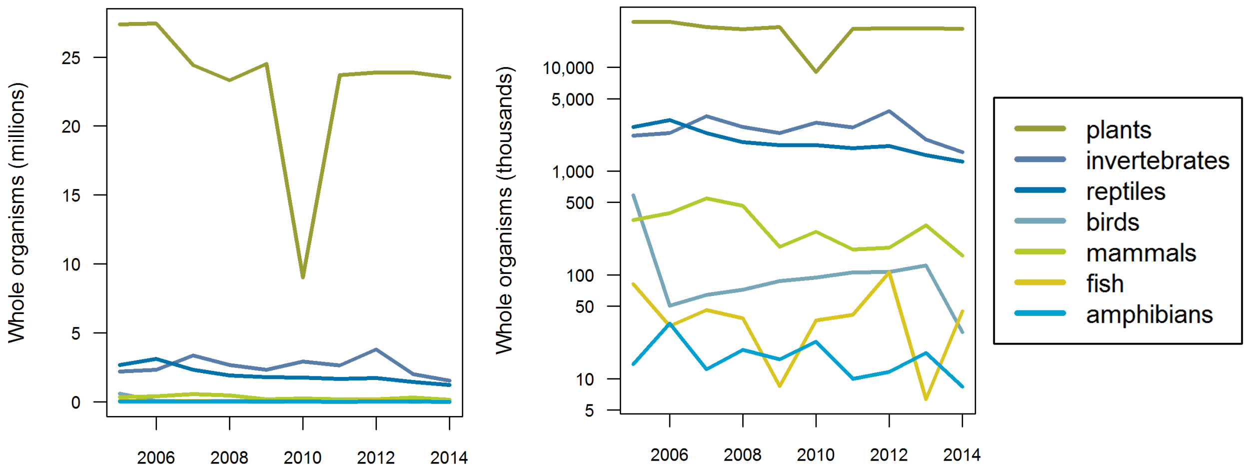

Figure 1: Overview of global direct trade in wild-sourced CITES-listed species 2005-2014 (though note that 2014 data are not yet complete), by taxonomic group, as reported by exporters. Figure a) uses a linear scale in order to showcase the relative volumes by taxonomic group, whereas figure b) presents the data on a logarithmic scale in order to highlight the trends over time within each group. To facilitate a summary of legal trade, CITES trade data has been converted to 'whole organisms', which are those that reasonably add up to a whole individual (see methods section for further details). All other terms reported in trade are excluded from this overview. CITES trade statistics are derived from the CITES Trade Database, UNEP World Conservation Monitoring Centre, Cambridge, UK; trade data was downloaded on 4 April 2016 (www.trade.cites.org).

Taxonomic Overview

To date, approximately 2 million species have been described by science (Mora *et al*., 2011), and tens of thousands of species are used directly by people or traded. These numbers are approximations, given the considerable data gaps on legal trade and ITW. People depend upon biodiversity and use wildlife in a variety of ways. Wildlife are hunted, trapped and collected for food, sport, pets, medicine, materials and other purposes. What is being traded varies depending on a complex mix of consumer demand, species availability, price, harvest incentives, trade controls, enforcement and other variables.

The following sections provide an overview of the best available information on current estimates of the status of legal and illegal trade in wildlife, by taxonomic group. Information on levels of legal trade, where available, has been included within this overview to provide some contextual information on the demand for particular taxa. Given the patchiness of information and that very few attempts have been made to systematically compile figures to understand the bigger picture of ITW, this is not a comprehensive assessment. While illegal domestic trade is included where relevant (e.g. bushmeat[9]), the vast majority of the 'illegal trade' summarised in this review represents trade crossing international borders, which reflects the distribution of information available. Approximate numbers of species

[9] Bushmeat is defined here as the *harvesting of wild animals in tropical and sub-tropical countries for food and for non-food purposes, including for medicinal use,* in line with CBD (2011).

described, in trade and listed by CITES, along with an overview of estimated volumes of legal trade and available information on ITW, are summarized by taxonomic group in Table 1.

The effect of overutilization on the conservation status of species concerned can be variable. Figure 2 illustrates the status of birds, mammals and amphibians within the IUCN Red List Index (RLI) due to impacts of utilisation, owing to the balance between negative trends driven by unsustainable exploitation (figure excludes changes in status driven by other factors, such as habitat loss or climate change), and positive trends driven by measures to reduce overexploitation. For all three groups[10], many species are now threatened with extinction and the RLI for these taxa is gradually declining, indicating that overall levels of utilisation are unsustainable.

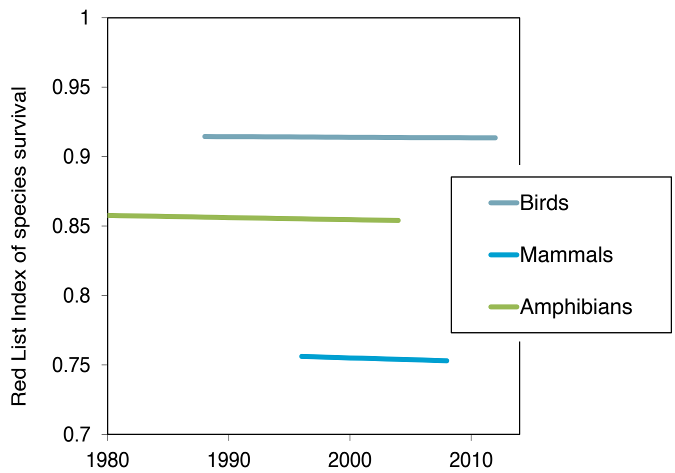

Figure 2: Red List Index of species survival showing impacts of utilisation. A value of 1 indicates that all species are Least Concern while a value of 0 indicates that all species have gone Extinct. Source: analysis by BirdLife International and IUCN using data from the 2015 IUCN Red List.

[10] All described mammals and birds have been assessed, and 87 per cent of described amphibians.

Table 1: Overview of available information on species in use or trade and estimates of legal and illegal trade, by taxonomic group

	Species overview	Legal trade estimates	Illegal trade estimates
Mammals	~ **5,400** species (Wilson and Reeder, 2005); > **1,000** utilized for food and medicine (TRAFFIC, 2010); ~ **900** CITES-listed (UNEP-WCMC (Comps.), 2016).	CITES trade[11]: ~ **280,000** 'whole'[12] wild-sourced mammals annually. Overall, legal international trade, particularly in non-CITES species, appears to be **unquantified.**	No global estimates, but estimates for some taxa and commodities exist (**1,215 rhinos** illegally killed in 2014 (TRAFFIC, 2015), **17,000 elephants** killed in 2011 at MIKE sites (CITES CoP16 Doc.53.1 Addendum), **~18,750 ivory seizures** over the period 1989-2013 recorded in ETIS (CITES Standing Committee document SC65 Doc.42.1), **~227,000 pangolins** killed in Asia between 2000 and 2013 (Challender *et al.,* 2015)); many reports of instances of ITW.
Birds	~ **10,000** species (BirdLife International, 2013b); ~ **4,500** utilized, for example as pets, food, or for sport hunting (BirdLife International, 2008); ~ **3,300** traded (Butchart, 2008); ~ **1,500** CITES-listed (UNEP-WCMC (Comps.), 2016).	CITES trade: ~ **90,000** 'whole' wild-sourced birds annually. **Several million** birds each year in domestic and international trade, particularly finches, weavers, parrots and raptors (BirdLife International, 2015b).	No global estimates although regional estimates for some taxonomic groups exist (**25 million birds** illegally killed in the Mediterranean per year (BirdLife International, 2015b)); many reports of instances of ITW.
Reptiles	~ **10,000** species (Pincheira-Donoso *et al.*, 2013; Uetz and Hošek, 2015); ~ **thousands** utilized and traded (e.g. ~3,500 species/subspecies of reptiles and amphibians imported as pets into the EU (Newman, 2014); ~ **800** CITES-listed (UNEP-WCMC (Comps.), 2016).	CITES trade: ~ **1.8 million** 'whole' wild-sourced reptiles annually. Overall, legal international trade, particularly in non-CITES species, appears to be **unquantified.**	No global estimates, but estimates for some species and commodities exist; many reports of instances of ITW.
Amphibians	~ **7,400** species (Frost, 2014); > **200** utilized for food, > **260** for pet trade and many for medicinal purposes (Carpenter *et al.*, 2007); ~ **150** CITES-listed (UNEP-WCMC (Comps.), 2016).	CITES trade: ~ **15,000** 'whole' wild-sourced amphibians annually. For example, more than **20 million** wild-caught live amphibians (CITES and non-CITES species) legally imported into the United States 2001-2009 (Herrel and van der Meijden, 2014).	No global estimates, but estimates for some taxa and commodities exist; many reports of instances of ITW.
Fish	~ **33,000** species (Froese and Pauly, 2014); > **thousands** utilized (e.g. 1,200 traded as aquarium fish (Cato and Brown, 2003) , ~ 800 traded for food (Ababouch, 2005); ~ **100** CITES-listed; five species of sharks, one sawfish and the genus *Manta* were listed at the most recent CoP (UNEP-WCMC (Comps.), 2016).	CITES trade: ~ **40,000** 'whole' wild-sourced fish annually. Global catch of **90 million tonnes** annually (FAO, 2012).	Global illegal and unreported fishing estimated at **11-12 million tonnes** annually (Agnew *et al.*, 2009).
Invertebrates	~ **1,000,000** species (Roskov *et al.*, 2014); > **thousands** utilized (e.g. > 2,000 insect species (Ramos-Elorduy, 2009) and > 300 marine invertebrate taxa are used as food (Anderson *et al.*, 2011)); ~ **2,200** CITES-listed, predominantly corals (UNEP-WCMC (Comps.), 2016).	CITES trade: ~ **2.5 million** 'whole' wild-sourced invertebrates annually. Marine and freshwater mollusc and crustacean catch alone > **13 million tonnes** in 2012 (FAO, 2014a). Up to **30-50 tonnes** of red and black[13] coral and > **2,500 tonnes** of shells also traded each year (Tissot *et al.*, 2010).	No global estimates, but estimates for some taxa and commodities exist; many reports of instances of ITW.

[11] Throughout Table 1, CITES trade statistics are based on the median values of exporter-reported figures over the period 2005-2014 available from the CITES Trade Database.
[12] Throughout Table 1, trade in 'whole' animals or plants refers to terms that reasonably represent a whole animal or plant. Trade is also reported in many other commodities that are not included within these approximations.
[13] Four species of Red Corals *Corallium* spp. are listed on CITES Appendix III; Black Corals Antipatharia spp. are listed on Appendix II.

	Species overview	Legal trade estimates	Illegal trade estimates
Timber	~ **100,000** species of trees (BCGI, 2007) - not all produce exploitable timber; > **1,600** traded commercially (Mark *et al*., 2014); ~ **700** CITES-listed trees; five species and two genera were listed at the two most recent CoPs (UNEP-WCMC (Comps.), 2016).	**137 million m^3** roundwood, **124 million m^3** sawnwood, **77 million m^3** wood-based panels and **223 million tonnes** of pulp/paper products in 2013 (FAO, 2015a).	**8-10 per cent** of the value of global wood products (Seneca Creek Associates and Wood Resources International, 2004); In 2004, just under half of all tropical logs, sawn timber and plywood in trade were estimated to be illegally sourced (Lawson and MacFaul, 2010).
Plants	~ **300,000** species (BGCI, 2014); > **20,000** traded for medicinal purposes alone (WHO *et al*., 1993); ~ **30,000** CITES-listed, the majority orchids (UNEP-WCMC (Comps.), 2016).	CITES trade: ~ **24 million** 'whole' wild-sourced plants annually.	No global estimates, but estimates for some taxa and commodities exist; many reports of instances of ITW.

Mammals

As of 2015, an estimated 5,515 species of mammals had been described – all of which are evaluated by the IUCN Red List (IUCN, 2015a). Of these, approximately 26 per cent[14] (22-27 per cent) of species are globally threatened[15] (IUCN, 2015a) and many charismatic mammals are traded illegally, both internationally and domestically, as high value commodities. For example:

- Illegal trade in **African elephant** (VU) ivory increased substantially in the 2000s and early 2010s (CITES *et al*., 2013; Lawson and Vines, 2014). According to ETIS data, approximately 18,750 ivory seizures have taken place over the period 1989-2013 (CITES Standing Committee document SC65 Doc.42.1). Vira *et al*. (2014) estimated that between 2009 and mid-2014, 170 tonnes of ivory were illegally exported out of Africa. Based on MIKE data, 17,000 elephants may have been killed in 2011 in 44 MIKE sites alone, representing 7.4 per cent of the population in 44 MIKE sites - which is above the growth rate of 4-5 per cent (CITES CoP16 DoC.53.1 Addendum). In 2013 and 2014, levels of illegal killing remained above the growth rate, according to MIKE data (CITES, 2015). Based on modelling of natural and illegal mortality, the number of African Elephants illegally killed was estimated at up to 40,000 in 2011 (Wittemyer *et al.*, 2014), at the peak of illegal killing, according to MIKE and ETIS data (CITES, 2014c). Based on genetic assignment, the majority of large ivory seizures made since 2006 was believed to stem from elephants illegally killed in two key areas: East Africa, with a focus on Tanzania and adjacent northern Mozambique and Southern Kenya, and the TRIDOM area of northern Gabon, the Republic of Congo and the adjacent southwestern Central African Republic (Wasser *et al*., 2015).

- The number of detected **rhinos** illegally killed in South Africa alone increased from 36 rhinos in 2006, to over 1,000 in each of the last three years (South African Department of Environment Affairs)[16]. Although rhino are being poached from across the continent, the South African and Zimbabwean populations are particularly affected, with recent 2013 levels of illegal hunting estimated at approximately 5 per cent of the South African and almost 3 per cent of the Zimbabwean populations, as calculated from the 2012 population estimates (Milliken, 2014).

- Extrapolation of illegal trade in **great apes** is challenging (see e.g. Stiles *et al*., 2013), but reports of individual species illustrate the scale at which apes are killed. Between 750 and 1,800 orangutans, for example, were estimated to have been illegally killed over one year in 2007-2008 in Kalimantan, and an annual average of 1,950 and 3,100 animals within the lifetime of the survey respondents (Meijaard *et al*., 2011). Orangutans were mainly killed due to human-ape conflicts over crop raiding resulting from habitat loss, as well as hunting for food, and sometimes for trade in baby orangutans for pets and in parts for medicinal use (Meijaard *et al*., 2011). It is speculated that there is an important domestic market for both live and killed apes in Africa, and a limited international trade in live apes (Stiles *et al.* 2013).

- Over 2,800 **bears** were estimated to have been traded illegally in Asia for their parts and derivatives between 2000 and 2011 (Burgess *et al.*, 2014), particularly for trade in gall for traditional medicine.

- **Big cats** are subject to illegal hunting and trade for pelts and for the use of their derivatives in traditional medicines. Figures reported include the seizure of 1,452 tigers (EN) between 2000 and 2012, with the actual volume of illegal trade believed to be much higher (Stoner and Pervushina, 2013). The illegal trade in tigers and their products was believed to have increased in the last 10 years, particularly in Southeast Asia (CITES, 2014b), yet only 3,200 wild tigers may remain worldwide (TRAFFIC, 2011). The illegal trade and hunting of 1,127

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[14] Percentage based on the "best estimate" by IUCN of the percentage of threatened mammal species in 2015 (number threatened as a percentage of extant data sufficient evaluated species) (IUCN, 2015a), with a range estimated to be 22-27 per cent (IUCN, 2015a). Range of estimates also provided due to uncertainty over the degree of threat to Data Deficient (DD) species (IUCN, 2011).

[15] Assessed as Critically Endangered (CR), Endangered (EN) or Vulnerable (VU) according to the IUCN Red List (www.iucnredlist.org).

[16] Reported levels of rhinos illegally killed were: 36 (2006); 13 (2007), 1004 (2013), 1215 (2014) and 1175 (2015). Source: South African Department of Environment Affairs

leopards (NT) in India during 2001-2010 (Raza *et al.*, 2012) and the seizure of 151 snow leopards (EN) skins in range States in 2000-2012 was also reported (EIA, 2012b).

- **Pangolins** are declining in Asia as a result of illegal hunting and trade for their meat and scales (Challender *et al.*, 2014a and b); the demand in China alone has been estimated at over 150,000 pangolins per year (UNODC, 2013a). Illegal international trade in African species is also increasing to supply international markets and there continues to be domestic trade in these species (Waterman *et al.*, 2014). At least 227,000 pangolins were estimated to have been seized in Asia between 2000 and 2013 (Challender *et al.* 2015) though actual volumes in trade have been estimated at 1,000,000 animals within the last decade (Challender *et al.*, 2014c).

- Illegal hunting of saiga **antelopes** (CR) for their horns for traditional Chinese medicine and of Tibetan antelopes (EN) for trade in shahtoosh[17] is the main threat to these two species (Mallon, 2008b, 2008a). Around 2,000 saiga antelopes were estimated to have been illegally caught each year during the period 2000-2005, contributing to population declines (von Meibom *et al.*, 2010). While some saiga populations appear to have stabilised, others continue to progressively decline in areas of high poaching pressure (CMS, 2010; 2015). The species has also been subject to mass mortality events (Milner-Gulland, 2015), with the most recent one (May 2015) leading to the death of more than a third of the global population, with more than 120,000 animals confirmed dead in Kazakhstan (UNEP, 2015).

- The International Whaling Commission (IWC) has banned commercial whaling[18] since 1986 (IWC, 2015). Trade in the majority of **marine mammals** is regulated under CITES. However, domestic exploitation is regulated locally, nationally or regionally and consumption was reported to have increased over the last decades due to an increase of harvest of small cetaceans in some regions (Costello and Baker, 2011). There are also many reports of international ITW in cetacean meat products (see e.g. Robards and Reeves, 2011) from by-catch or illegal take (Baker, 2010).

- Mammals are also targeted for the **illegal bushmeat take and trade**, and although accurate figures of the scale of this trade are not available, the annual extraction of animals (predominantly mammals) in the Amazon and Congo basins alone, for example, was estimated at 6 million tonnes (Nasi *et al.*, 2011). Bushmeat trade is recognized as a major threat to forest biodiversity in Central and West Africa; it also poses a significant problem in other ecosystems, including savannas (Lindsey *et al.*, 2012). However, in some areas bushmeat trade may not be problematic in terms of sustainability, particularly in species less vulnerable to over-exploitation (e.g. Robinson and Bennett, 2004; Cowlishaw *et al.* 2005). For example, harvest of ungulates and rodents in dry forest and open savannah is reportedly more likely to be sustainable due to the preponderance of such taxa in comparison to primates (Robinson and Bennett, 2004).

Birds

An estimated 1,373 (~13 per cent[19]) of the 10,425 described and evaluated bird species are globally threatened[20] (IUCN, 2015a) and some species of birds are seriously threatened by ITW (Cooney and Jepson, 2006). Live birds were found to be the second most frequent CITES Appendix I commodity in online wildlife trade, after elephant ivory, with the majority thought likely to be illegal (Todd and Place, 2010).

Some bird taxa are particularly in demand, such as the following:

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[17] Shawls made of down hair.

[18] Iceland and Norway have entered objections/reservations against the moratorium and continue to take a limited number of species; Iceland, Japan and Norway also continue to harvest whales for scientific research purposes.

[19] This represents the best estimate of per cent threatened bird species in 2015 calculated by the number threatened as per cent of extant data sufficient evaluated species, , with a range estimated to be 13-14 per cent (IUCN, 2015a). Range of estimates due to uncertainty over the degree of threat to Data Deficient (DD) species (IUCN, 2011).

[20] Assessed as Critically Endangered (CR), Endangered (EN) or Vulnerable (VU) according to the IUCN Red List (www.iucnredlist.org).

- The vast majority of illegal trade in **parrots** for pets is believed to take place domestically within range countries, with only a small proportion traded internationally (Pires, 2012). In Mexico, for example, the most sought-after species were found to be traded above and beyond their legal availability (Tella and Hiraldo, 2014). Illegal trapping in the country was estimated at 65,000-78,500 parrots each year, 86-96 per cent of which were being traded domestically; seizures were believed to only represent 2 per cent of the actual volume of the illegal parrot trade (Cantú *et al*., 2007). Similar orders of magnitude of illegal trade were reported from the Plurinational State of Bolivia and Peru (Herrera and Hennessey, 2007; Gastañaga *et al.*, 2011).

- Twenty five million birds, the majority of which are **songbirds**, are captured illegally each year in the Mediterranean for food, sports hunting and to keep as pets (BirdLife International, 2015b). In Brazil, the annual illegal trade of predominantly songbirds in eight markets alone was estimated at more than 40,000 birds (Regueira and Bernard, 2012).

- Since 2011, illegal trade in the CITES Appendix I listed **helmeted hornbill** (CR) has dramatically increased due to demand for its "ivory" casque (the "horn" on its bill) in China (Collar, 2015). This "red ivory" can reportedly be worth up to five times more than real ivory on the black market (EIA 2015). Severe hunting pressure driven by the illegal trade was one of the contributing factors that led to the up-listing of the species from Near Threatened to Critically Endangered on the IUCN Red List in 2015 (BirdLife International, 2015c). In 2012-2013, around 6,000 of these birds were harvested each year in West Kalimantan alone (Hii, 2015), for trade with Hong Kong and Taiwan (Collar, 2015).

In terms of legal international trade in CITES listed species, West African, South American and Southeast Asian countries were the main exporting countries of wild birds in trade over the period 1996-2010 (UNEP-WCMC, 2013). While Europe and the United States used to be main importers of wild birds (Thomsen *et al*., 1992), legal trade declined substantially following the introduction of trade restrictions in the mid-2000s. Based on figures available from the CITES Trade Database, the remaining legal imports of wild birds has shifted primarily to Mexico.

Reptiles

An estimated 931 (20 per cent) of the 4422 described and evaluated reptile species are considered threatened with extinction (Böhm et al., 2013); however this may be an underestimate due to only 44 per cent of the 10,038 described reptilian species having been evaluated (IUCN, 2015a). There are no overall estimates of the level of ITW in reptiles, although there are many reports of specific cases involving considerable volumes. Harvesting is reported to affect 64 per cent of threatened terrestrial reptilian species (Böhm et al., 2013). Examples are presented below for illustrative purposes.

- The harvest of **marine turtles** (all listed on CITES Appendix I) for food and other uses is currently permitted in 42 countries, with overall harvest estimated at more than 42,000 animals per year (Humber *et al.*, 2014). Illegal trade in turtles was believed to be significantly under-recorded; recent estimates refer to the annual illegal take of 13,900 turtles across 46 countries (Humber *et al*., 2014). Illegal trade in marine turtles in the Indian Ocean and South Asian region was believed to be increasing (IOSEA, 2014). Much of the illegal hunting appears to occur in the waters of Indonesia, but also in Malaysia, Papua New Guinea, Philippines, Solomon Islands and Timor-Leste; more than 9,180 marine turtle derivatives originating in Indonesia, Malaysia and Philippines were reportedly traded to East Asia over the period 2000-2008 (IOSEA, 2014). Commercial activities are also reported from East Africa; in 2010, the direct and illegal harvesting of turtles by fishermen in southwest Madagascar was estimated at between 10,000 and 16,000 turtles per year (Humber *et al.*, 2011), with widespread illegal hunting also reported from the north of the country (IOSEA, 2014).

- **Turtles and tortoises** are sought after as pets and for food, many being severely impacted by ITW (TFTSG, 2007) such as the Palawan forest turtle (CR) in the Philippines (Fidenci and Maran, 2009), freshwater turtles in Pakistan (Noureen, Khan and Arshad, 2012), the ploughshare tortoise (CR) and the common batagur (CR) (Baillie and Butcher, 2012). Six species of CITES Appendix I listed tortoises were observed for sale at a Thai market during surveys over the period 2006-2010, including the Malagasy endemic radiated tortoise (CR) (Nijman *et al.*, 2012b), and a single shipment of pig-nosed turtles (VU) seized *en route* from Papua to Jakarta, Indonesia, consisted of 12,247 live animals (Burgess and Lilley, 2014). Increases in ITW were reported for a number of tortoise and turtle species, including studies in Jakarta, Indonesia (Stengel *et al.* 2011) and Thailand (Chng, 2014). China was believed to be the largest consumer of both native and imported turtle species (Gong *et al*., 2009), among other substantial Asian and Southeast Asian trade hubs identified in the literature.

- There are many reports of illegal trade in **lizards and snakes** for pets, for traditional medicine, food or other uses, often involving large numbers. For example, around 38,000 clouded monitor lizards (NA) were confiscated in Malaysia during 2005-2009 (Nijman *et al.*, 2012b), and national quotas for Javan filesnakes (LC) and tokay geckos (NA) were reported to be largely exceeded in Indonesia (Nijman *et al.,* 2012a). Illegal trade in the tokay gecko for traditional medicine was also reported from Cambodia, Peninsular Malaysia, and the Philippines (TRAFFIC, 2011).

- Considerable levels of **crocodilian** skins were traded illegally in the 1960s and 1970s, with estimates that less than 20 per cent of caiman skins traded prior to 1984 were legal (Thorbjarnarson, 1999). However, the large-scale illegal trade in crocodilians was virtually eliminated in the 1990s through CITES mechanisms that supported and promoted legal trade from ranched specimens (Oldfield, 2003).

- There are also concerns over false captive breeding claims used to export wild-sourced reptiles from Indonesia (Nijman and Shepherd, 2009). For example, more than 5,300 green tree pythons (LC) were thought to be illegally collected each year in Indonesia for the pet trade, with breeding farms playing a key role in laundering such animals into the legal market (Lyons and Natusch, 2011). At least 80 per cent of the green tree pythons exported from Indonesia annually were thought to have been illegally caught from the wild (Lyons and Natusch, 2011).

- The extent of illegal trade in python skins overall in Southeast Asia was thought to potentially be equal to the extent of the legal trade (Kasterine *et al*., 2012). The illegal trade in reptiles from Southeast Asia, and from Indonesia in particular, has been highlighted as an important threat to biodiversity (Nijman *et al*., 2012b).

Amphibians

An estimated 1,961 (41 per cent[21]) of the 6,424 amphibians assessed by the IUCN are globally threatened[22] (IUCN, 2015a) and this group is declining rapidly, with overexploitation a key driver in declines. Stuart *et al.* (2004) reported that of the 435 species facing rapid decline, 50 species (11 per cent) are declining due to heavy extraction.. Amphibians are mainly exploited for food and as pets:

- Indonesia was reported to be the major exporter of **frog legs** (Warkentin *et al*., 2009), although the domestic market was estimated to be two to seven times larger than the export market (Kusrini and Alford, 2006). The largest amphibian species, the endemic Chinese giant salamander is considered Critically Endangered through a combination of threats including illegal exploitation for food, despite being protected in China (Gang *et al*., 2004; Wang *et al*., 2004).

- Illegal trade in amphibians for the pet trade has been documented for example in Brazil (Pistoni and Toledo, 2010); the Brazilian endemic splash-backed poison frog (LC) is widely held in captivity in Europe and the United States (Overkamp, 2009 cited in Hoogmoed and Avila-Pires, 2012), yet Hoogmoed and Avila-Pires (2012) reported there had been no legal exports of the species from Brazil (aside from scientific specimens), and according to the CITES Trade Database, no commercial exports have taken place from Brazil since the species' Appendix II listing in 1987 (UNEP-WCMC (Comps.), 2016).

[21] This represents the best estimate of per cent threatened amphibian species in 2015 calculated by the number threatened as per cent of extant data sufficient evaluated species, with a range estimated to be 41-56 per cent (IUCN, 2015a). Range of estimates due to uncertainty over the degree of threat to Data Deficient (DD) species (IUCN, 2011)
[22] Assessed as Critically Endangered (CR), Endangered (EN) or Vulnerable (VU) according to the IUCN Red List (www.iucnredlist.org). Best estimate (IUCN, 2015a).

Fish

Due in part to technological advances and increasing demand, many fisheries have now reached unsustainable levels on a global scale (FAO, 2014b). The following provides an overview of key estimates and considerations:

- **Global catch** stagnated at around 90 million tonnes per year in recent years, around 11 million tonnes of which from inland fisheries, with 80 per cent of the world's fish stocks reported as fully- or over-exploited (FAO, 2012). **Marine fish capture** had increased substantially, before reaching a plateau around 30 years ago (Steffen *et al*., 2015).

- China is the main exporter of fish by far (it is also both the top fishing country and has the highest aquaculture production); the European Union, Japan, and the United States were the largest importers of fish in 2012 (FAO, 2014a). Asia is the largest consumer of fish globally, with China's consumption in particular noted to be increasing (FAO, 2012).

- **Illegal Unreported and Unregulated (IUU) fishing**[23] is a significant problem that contributes to the overexploitation of fish stocks. It occurs in virtually all capture fisheries and all areas of the world. However, estimating the level of IUU fishing is extremely difficult. The most commonly used approach is to calculate IUU fishing as a proportion of reported catch (see e.g. Doulman, 2000; Pauly and McLean 2003), but resulting estimates vary, sometimes substantially. Agnew *et al*. (2009), in an attempt to provide clarity on the true magnitude of global illegal and unreported (IU) fishing within Exclusive Economic Zones (EEZ) and high seas subject to Regional Fisheries Management Organisations (RFMOs), completed a large-scale analysis which estimates annual IU fishing at between 11 and 26 million tonnes; these figures span the range of many other estimates (Figure 3).

- There are a number of limitations in the approaches used to date to estimate the scale of IUU fishing. Firstly, the magnitude of IUU fishing may be skewed as countries where IUU fishing is low are often not included. Secondly, local or regional estimates are up-scaled to the global level (e.g. MRAG, 2005) despite substantial variation in levels of IUU fishing between countries and regions. There are major challenges in estimating artisanal catches, which are generally unregulated but a very important source of fish for subsistence consumption and trade. The magnitude of IUU fishing also varies in relation to the species targeted, due to differences in regulatory frameworks, levels of enforcement, quotas and demand. While current global estimates of IUU fishing have their limitations, studies nevertheless appear to be coalescing around **similar estimates**.

- Around 50 million sharks were estimated to have been subject to IUU in 2010, with total shark exploitation (legal and IUU) believed to be 30 per cent above the median rebound rates of populations (Worm *et al*., 2013). The quantity of **Russian sockeye salmon** (LC) caught illegally was estimated to be 60-90 per cent above the levels reported (Clarke *et al.*, 2009), and the illegal trade in **Patagonian toothfish** (NA) from waters around Antarctica was estimated to be between five and ten times greater than the official reported catch (Sovacool and Siman-Sovacool, 2008).

Invertebrates

A wide range of aquatic and terrestrial invertebrate species are harvested for use as sources of food, silk, honey, dye, medicine, ornaments (Bodenheimer, 1951 in Durst *et al*., 2010; TRAFFIC, 1995) and other products. Marine and freshwater invertebrates support major fisheries; mollusc and crustacean catch alone amounted to over 13 million tonnes in 2012, both from marine and freshwater systems (FAO, 2014a). Invertebrate catch was noted to have increased six-fold since 1950 (Anderson *et al*., 2011). However, estimates of global trade for many terrestrial invertebrate species are lacking, and as a group, invertebrates are the least studied taxa in trade.

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[23] The term IUU can cover a wide range of issues (see Agnew *et al*., 2009). FAO (2001) provides further details on the activities that are generally understood to fall within IUU.

Estimates of illegal and unreported catch for different marine invertebrate groups (such as lobsters, crustaceans and clams) range from 13 to 31 per cent of the reported catch (Agnew *et al.*, 2009). Examples of illegal exploitation and trade in individual species, particularly aquatic invertebrates, include the following:

- **Abalone** (NA) from South Africa, for example, was harvested illegally for consumption at an estimated 1,000 per cent of the total allowable catch until the fishery was closed entirely (Plagányi *et al*., 2011), although illegal trade remains a concern (FAO, 2014a).

- Illegal harvest and trade of **queen conch** (NA), as a source of food, was estimated at over 1 million specimens over the period 2003-2006 (Daves, 2009) and, together with concerns over the levels of exploitation, led to the species being reviewed in the CITES Review of Significant Trade process (Theile, 2005).

- There is also demand for rare ornamental species such as **birdwing butterflies** and **beetles**, with evidence of illegal trade in some stag beetles (e.g. New, 2005).

Timber and timber products

The FAO (2015b) estimated that that there was a net loss of 129 million hectares of forest in the period 1990-2015, although the net annual loss has reportedly slowed in the last five years to an average of 3.3 million hectares per year. Tropical forests in particular show a continuing long-term decline, with a high rate of loss (Steffen *et al*., 2015). Although it is difficult to ascertain to which extent illegal logging contributes to this forest loss, there is a range of estimates of the scale of illegal extraction and the volume of the global trade in illegal timber products:

- In the early 2000s, it was estimated that 8-10 per cent of the value of global wood products was likely to have been illegally sourced (Seneca Creek Associates and Wood Resources International, 2004), although some estimates suggest a much higher proportion particularly in relation to tropical wood products. Lawson and MacFaul (2010) noted that, by some estimates, in five of the top ten most forested countries at least half of all trees cut were being cut illegally in the early 2000s, while just under half of all tropical logs, sawn timber and plywood in trade in 2004 were illegally sourced.

- UNEP (2011) noted that while the Democratic Republic of the Congo has a timber production potential estimated at 10 million m^3 per year, official timber production was only 310,000 m^3 in 2006, while artisanal and illegal production was eight times that (estimated at 1.5-2.4 million m^3 in 2003). However, these figures are vastly overshadowed by fuelwood and charcoal production, estimated at 72 million m^3 annually (UNEP, 2011).

- In Ghana, Hansen and Treue (2008) estimated that 70 per cent, or around 2.5 million m^3, of timber was illegally cut annually between 1996 and 2005. In Cameroon, rates of illegal logging were also reported to be high (Alemagi and Kozak, 2010).

- In mid-2004, up to 96 per cent of the timber harvested in southern Tanzania was thought to be illegal (Milledge *et al.,* 2007). Illegal logging and trade of forest products was reported to continue in the south of Tanzania (Sulle, 2013) and the Eastern Arc Mountains (Schaafsma *et al*., 2014), with widespread illegal timber trade from Mozambique into Tanzania (Sulle, 2013).

- As one of the largest single markets for wood products, China sources considerable quantities of timber from countries with high levels of illegal logging (LLC, 2004; Thornton, 2005, in Milledge *et al*., 2007; EIA, 2012a), and despite some important steps taken to address these illegal flows into China, it is likely that much illegal trade enters into otherwise legal supply chains (Wellesley, 2014).

- High value CITES-listed species particularly affected by illegal extraction include ramin, rosewood, big-leaf mahogany (VU), Afrormosia/African teak (EN) and red cedar (VU) (Ferriss, 2014). In the case of rosewood, global demand appears to be increasing, particularly since 2010 (Wenbin and Xiufang, 2013). Chinese customs data shows an increase in rosewood imports from 66,000 m^3 in 2005 to 565,000 m^3 in 2011 (EIA, 2012a), and 1.2 million m^3 in 2013, when rosewood logs accounted for over a third of all hardwood log imports into China

(ITTO, 2014). Extensive illegal trade in rosewood, driven by scarcity and high prices, has been reported to involve organised smuggling in a number of countries including Madagascar, Lao PDR, Guatemala and Brazil (Ferriss, 2014).

- In Tanzania, an estimated 80 per cent of **charcoal trade** was reported to take place outside of the formal system (Peter and Sander, 2009). While most charcoal consumption is local, there is an important illegal and unregulated international trade, such as from Somalia (Nellemann *et al*., 2014). Nellemann *et al.* (2014) reported that the predominantly unregulated fuelwood and charcoal trade conceals various illegal practices and that demand for charcoal was projected to at least triple in the coming three decades.

Other plants

Little quantitative information is available on the level and trends of illegal trade in plants other than timber, with many anecdotal accounts of illegal harvest and trade within specific localities. Plant groups which predominate in illegal trade appear to include ornamental orchids and succulents (all orchids and cacti are CITES listed[24], as are some additional succulent plant species), and plants used for medicinal purposes, some examples of which are provided below:

- **Orchids** are among the most valuable plants traded internationally, with rare species highly sought-after by collectors. The illegal export of wild orchids from Nepal to China, Hong Kong, and India is reported to be widespread, with an estimated 9.4 tons of wild orchids illegally traded at markets in 2008-2009 (Subedi *et al.*, 2013). Substantial illegal trade in orchids is also reported to involve Lao PDR, Myanmar, and Thailand (Phelps and Webb, 2015). Illegal trade in orchid tubers for medicinal and culinary use has recently increased in the Islamic Republic of Iran, with an estimated 5.5-6.1 million orchid tubers illegally extracted in the Golestan province in 2013 alone (Ghorbani *et al.*, 2014). In Africa, the illegal harvest and trade in edible orchid tubers 'chikanda' was reported to have increased to meet growing demand across the region, and local extinctions were reported from Tanzania (Davenport and Ndangalasi, 2003). TRAFFIC (2014) estimated that 3.5 million orchid tubers originating from Tanzania are exported illegally to Zambia annually; further trade was reported to originate from Mozambique (600,000 tubers annually), Malawi (300,000 tubers annually), Angola and the Democratic Republic of the Congo.

- The volume and species richness of illegally traded **epiphytes** was found to be high within Veracruz, Mexico. During 1.5 years of monitoring in markets, over 200 species and over 7,500 individual plants were recorded; illegal trade levels were considered equal to the average volume of legal exports of orchids from Mexico (Flores-Palacios and Valencia-Díaz, 2007).

- Approximately one third of all species of **cacti** are threatened, around half of which reportedly due to harvest for horticultural trade and private ornamental collections (Goettsch *et al.,* 2015). In a study of international online trade in Appendix I listed cacti in 2010, at least 90 per cent of plants were traded illegally (Sajeva *et al.,* 2013). The threat of illegal trade continues to be high, particularly for newly described species and in countries where CITES regulations have only recently been enforced (Robbins, 2003; Goettsch *et al.,* 2015).

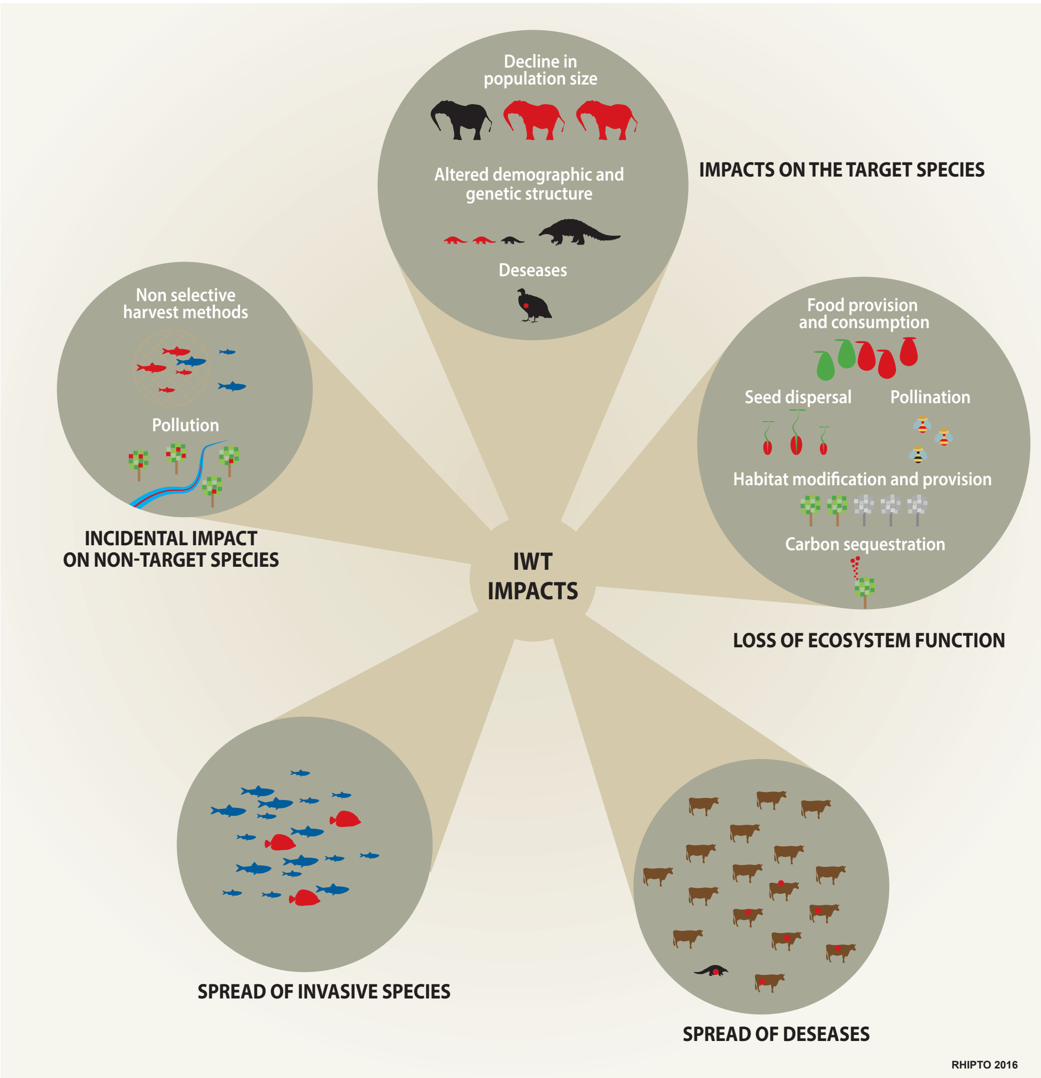
- There is concern over the illegal trade in South Asia in seven Asian CITES-listed **medicinal plant** species, including; *Cistanche deserticola* (NA), *Dioscorea deltoidea* (NA), *Nardostachys grandiflora* (NA), *Picrorhiza kurrooa* (NA), *Pterocarpus santalinus* (EN), *Rauvolfia serpentina* (NA), and *Taxus wallichiana* (EN) (Schippmann, 2006).

- Illegal trade is also common for many **plant derivatives** including agarwood (Lim and Awang Anak, 2010; Antonopoulou *et al*., 2010), costus root (NA) (CITES PC19 Inf. 7), African cherry (VU) (Stewart, 2003), cape aloe (NA) (Wabuyele and Kyalo, 2008) and Hoodia spp. (Swart, 2008).

[24] With some exceptions.

III. Environmental impacts of illegal trade in wildlife

The environmental impacts of ITW range from an immediate detrimental effect on the target species and incidental loss of non-target species, to a long-term deterioration in ecosystem services with regional and global consequences.



This chapter provides information on the known impacts of ITW on the environment, and identifies additional potential impacts if current levels of ITW are not reduced. Case studies throughout the chapter illustrate the various types of environmental impacts, and additionally provide examples of socioeconomic consequences of these impacts, where such information is available.

The most obvious and well-documented environmental impacts of ITW are the deleterious effects on target species; in many cases, declines in wild populations can be directly attributed to illegal harvest and trade, with certain species driven to the brink of local, national, or global extinction as a result. While there has been much focus on large and charismatic species, ITW affects a range of other wildlife whose loss may potentially have more notable long-term impacts on the environment, national economies and local livelihoods. The impacts of ITW on the target species are described in the first section of this chapter.

Moreover, the environmental consequences of ITW go beyond the impacts on the target species. Many illegal harvest methods, particularly in the marine environment, have limited or no selectivity and result in substantial incidental mortality of non-target species.. The loss of populations of species as a result of ITW may have cascading effects across the ecosystem resulting in a deterioration of ecosystem functions and services of national, regional and global importance. Other environmental impacts of ITW include the spread of diseases and invasive species. The environmental impacts of ITW beyond those on the target species are described in subsequent sections below. However, while linkages can be found between ITW and a wide range of environmental impacts, the relative importance of ITW as a contributing factor compared to other potential pressures is often difficult to determine and requires further investigation.

i. Impacts on the target species

Decline in population size

The harvest of individual animals or plants from wild populations will have a detrimental impact on the populations concerned if the level of harvest is unsustainable. While illegality does not necessarily equate to unsustainability, in cases where the relevant legislation has been put in place for the purpose of maintaining harvest and trade at sustainable levels, such as fishing quotas or export quotas established under CITES, illegal harvest may push the total harvest over sustainable levels (MRAG, 2005; CITES Resolution Conf. 11.3 (Rev. CoP16)). Declines in population size, reductions in geographic range (O'Grady *et al*., 2004) and genetic diversity (Frankham, 2005), all contribute to an increased risk of extinction for the species concerned.

There are cases where declines in particular populations, and in some cases entire species, can be attributed primarily to illegal trade. Examples include many charismatic, high-profile mammals, such as African elephant (VU), rhinoceroses, and tiger (EN) (**case study 1**). There are also examples of lesser known species that have been severely affected by illegal trade. For example, Spix's macaw (CR) is thought likely to be extinct in the wild in Brazil, primarily as a result of illegal trapping for trade (BirdLife International, 2013a). In Madagascar, illegal collection of Critically Endangered ploughshare tortoise (CR) for the international pet trade represents a significant threat to the persistence of this species in the wild. Despite the last remaining population of this species occurring entirely within the boundaries of a protected National Park, illegal collection is ongoing and may be increasing (Jenkins *et al*., 2014). Luristan newt (CR), a species with approximately 1,000 adults remaining in the wild (Sharifi *et al*., 2009), is also threatened by illegal take for the pet trade (Baillie and Butcher, 2012). Illegal harvesting is inextricably linked to the extinction in the wild of the blue cycad (EW) in South Africa, due to the cycad's popularity with collectors (Rogers and Pillay, 2010). A number of other South African plant species are threatened by illegal harvest due to their medicinal properties (Williams *et al*., 2013), such as the Strydom's yam (CR), which are thought to number fewer than 250 mature individuals in the wild (von Staden *et al*., 2012). Pangolin species are subject to very high levels of illegal trade and declining population sizes (Challender *et al*., 2014c) and there is increasing evidence for the substitution of Asian species with African pangolin species (**case study 2**).

Illegal extraction and trade are also the main drivers in the decline of certain timber species. For example, in southern Tanzania, indigenous tree species such as Mninga (NT) are approaching local extinction due to illegal logging (Makoye, 2015). Other examples of some of the most threatened timber species that are under high pressure from illegal timber harvest include *Diospyros katendei* (CR), *Euphorbia tanaensis* (CR) and *Ficus katendei* (NA) (Baillie and Butcher, 2012).

Various high value wildlife commodities, such as caviar and rosewood are under particular threat and populations have suffered dramatic declines, due to a combination of prolonged unsustainable legal trade and illegal trade (**case study 3**).

Case study 1: The impacts of ITW on a selection of iconic species

The plight of elephants, rhinos and tigers has become emblematic of the current poaching crisis. Various populations of these species have suffered dramatic declines at the hands of illegal hunters, fueled by growing international demand for their parts and derivatives. Here we summarise the impacts of ITW on populations of three species protected under CITES: African elephant, black rhinoceros and tiger. Commercial international trade in these species is prohibited, although some exports of hunting trophies of African elephant and black rhinoceros are permitted, under strict conditions.

Seizures of illegal **elephant** ivory more than doubled between 2007 and 2011 (Underwood *et al*., 2013). Between 2010 and 2012, illegal killing exceeded the intrinsic growth capacity of many African elephant populations; while populations in Central Africa were most affected, even previously stable Eastern and Southern African populations suffered declines (Wittemyer *et al*., 2014). Overall, numbers of African Elephant fell from an estimated 1.1 million in the 1970s (Jackson, 1982) to between 0.4 million and 0.7 million by 2012 (IUCN/SSC AfESG, 2013). Associated with the decline has been a significant contraction in geographic range, with African forest elephants experiencing a 30 per cent reduction in range between 2002 and 2011 (Maisels *et al*., 2013); in addition, genetic bottlenecks are evident in certain populations (Whitehouse and Harley, 2001; Okello *et al.*, 2008).

The total illegal trade in **rhino** horn (from both black and white rhinos) from Africa was estimated to have increased over 30-fold between 2000 and 2013 (Milliken, 2014). Illegal hunting of rhinos in South Africa has increased every year since 2010, despite intensive and multifaceted intervention (DEA, 2014). Black rhino (CR) numbers declined from over 100,000 in the 1960s to a low of 2,410 in 1995, mainly due to illegal hunting (Emslie, 2012). The species also suffered a drastic reduction in range in the 20th century (Harley *et al*., 2005), becoming locally extinct across large areas of Africa (Leader-Williams, 1992). Although total numbers of Black rhino have recently been increasing, reaching 4,880 by the end of 2010 (Emslie, 2012), the Western black rhino subspecies was declared extinct in 2011 (Emslie, 2011). White rhino (NT) population growth rates in Kruger National Park in South Africa were believed to be below zero in 2013 due to ITW, and levels of ITW have increased since. Asian rhinos too, are threatened by ITW, with the Javan rhino (CR) extinction in Viet Nam confirmed in 2010 (Brook e*t al*., 2012), and the remaining population in Indonesia estimated at up to 60 animals (SOS, 2014).

The number of **tigers** killed for illegal trade has gradually increased since 2000 (Stoner and Pervushina, 2013). Wild tiger numbers declined throughout the 20th century (Wikramanayake *et al*., 2011), and the species, considered globally Endangered (Chundawat *et al*., 2011), has lost 93 per cent of its historical range (Dinerstein *et al*., 2006). There are estimated to be more captive tigers in China today than wild tigers across their range, and since the 1940s, three tiger subspecies have been declared extinct; an additional subspecies is considered likely to be extinct in the wild (Chundawat *et al*., 2011). However, there are also local successes. Following concerted enforcement efforts to tackle illegal hunting, the tiger population in India, now home to 70 per cent of the world's wild tigers, increased by 30 per cent between 2010 and 2014 to an estimated 2,226 animals (Jhala *et al.*, 2015).

Case study 2: Substitution of Asian pangolins with African pangolins

Pangolins are insectivorous mammals covered in epidermal scales comprised of keratin. There are eight extant species, four of which occur in Africa and four in Asia, and each has been subject to exploitation and trade historically. This has primarily been for meat consumption and the use of scales and other body parts in traditional medicines domestically, but also for international trade, both legal and illegal (e.g. Boakye *et al*., 2014; Challender *et al.*, 2015).

Pangolins have been exploited most heavily in Asia and in particular in China, where estimates suggest up to 160,000 animals were harvested from the wild annually between the 1960s and 1980s (Yue, 2008). Overexploitation led to commercial extinction[25] of pangolins in the mid-1990s in China and the country has since been dependent on imports from other pangolin range states (Challender *et al.,* 2015). This demand has been met with international supply from Southeast Asia (e.g. Lao PDR, Myanmar, Thailand and Viet Nam) and South Asia (e.g. India; Newton *et al*., 2008; WCMC *et al.*, 1999).

[25] Species or population becomes too rare to exploit for profit.

All species of Asian pangolin have been listed in CITES Appendix II since 1975 and up to the year 2000, some legal international trade was reported (Challender *et al.,* 2015). However, large volumes of illegal trade also took place in the period 1975-2000, and in recognition of the unsustainable nature of this trade (e.g. WCMC *et al*., 1999), and in order to better manage international trade in pangolins, the CITES Parties established zero export quotas for wild-caught Asian pangolins traded for primarily commercial purposes at the 11th Conference of the Parties to CITES in 2000.

Despite these measures, illegal harvest and international trade in Asian pangolins continues (Challender *et al.,* 2015). It is estimated that up to 227,000 pangolins have been seized in Asia since 2000 (Challender *et al.,* 2015), although the actual number of animals in trade since then has been estimated at over 1,000,000 (Challender *et al.,* 2014c). Recent assessments for the IUCN Red List resulted in the Chinese and Sunda Pangolins being listed as Critically Endangered and the Indian and Philippine Pangolins being listed as Endangered, based on population declines due to levels of exploitation (Baillie *et al.*, 2014; Challender *et al.,* 2014c).

Since 2000, illegal trade in pangolins has primarily been destined to China and Viet Nam to meet luxury, urban demand for pangolin meat and demand for scales for use in traditional medicines. Due to declines in populations of Asian pangolins, but seemingly increasing demand, an emerging trend is the substitution of Asian pangolin parts for those of African pangolins. There has recently been an increasing number of seizures involving all four species of African pangolins illegally exported from Angola, Cameroon, Central African Republic, Congo, Guinea, Kenya, Liberia, and Nigeria, among many others (Challender and Hywood, 2012). This trend is against the backdrop of increasing economic ties between East Asia and many African nations which has likely facilitated trade, as well as apparent increasing awareness of the high value of pangolin parts, which has likely catalysed trade.

Case study 3: Illegal trade in a selection of high value wildlife commodities

While **caviar** had long been sustainably exploited and was previously one of the world's highest value wild-sourced commodities, overexploitation, including massive illegal fishing, contributed to a dramatic decline in stocks during the 1990s. In 1998, Caspian sturgeon stocks were listed on CITES Appendix II, and later were subject to zero export quotas for the relevant countries. Caviar nonetheless continued to be harvested and exported, and hundreds of large seizures of smuggled caviar have been made. Now 24 out of 27 sturgeon species assessed by the IUCN are considered to be threatened[26] (IUCN, 2015b). However, the precise contribution of illegal trade to the decimation of stocks remains unclear, with current Iranian and Russian caviar exports come from aquaculture and representing a fraction of previous export levels, compared to over 600 tons of caviar exported from the Caspian Sea in the early 1980s by Iran and the (then) Soviet Union. Beyond its economic value, caviar plays an important role in Russian culinary culture, and the true value of its loss to the country is difficult to quantify.

There are 48 **rosewood *Dalbergia* spp.** species endemic to Madagascar, several of which are of particular value in trade. In 2013, CITES (2013a) reported that 10-25 per cent of all rosewood trees were found in protected areas, while in 2015, Caramel (2015) stated that no mature trees remained outside protected areas - and even inside parks few remained with trunks greater than 20 cm in diameter. Protected areas in the north-east of the country may contain the most extensive remaining populations (Randriamalala and Liu, 2010).

Around 90 per cent of rosewood harvested is exported (CITES, 2013a) and in 2009, 99 per cent of precious wood harvested was thought to have been rosewood (Randriamalala and Liu, 2010). However, since 2006, there has been no legal harvesting of rosewood in Madagascar, although some timber has been licensed for export by the government, including stockpiles held by traders and seized wood held by the government (Global Witness and EIA, 2009).

In 2009, loggers were reported to be targeting trees with diameters as low as 10 cm (Randriamalala and Liu, 2010), suggesting depletion of larger treesSome 100,000 rosewood and ebony trees were thought to have been illegally felled in north-east Madagascar alone in 2009, with two-thirds of the logs thought to have originated in Masoala National Park, and the rest in Marojely National Park and surrounding areas (Randriamalala and Liu, 2010). A total of 25,000 m^3 of illegal rosewood was estimated to have been exported in 2009 (Ratsiazo, 2014).

Approximately 36,700 tonnes of rosewood and ebony were thought to have been shipped mainly to China in 2009, for a total export sale price estimated at US$220 million (Randriamalala and Liu, 2010). Between November 2013 and April 2014, more than 4,000 tonnes of Malagasy rosewood were seized, including a seizure of 29,000 logs (> 3,000 tonnes) in Singapore - the largest illegal

[26] Assessed as Critically Endangered, Endangered or Vulnerable according to the IUCN Red List.

rosewood seizure to date (EIA, 2014). This wood was thought to be worth approximately US$75 million at its intended destination in China (EIA, 2014).

Illegal rosewood harvest also has detrimental effects on other species: the logging leads to habitat loss for Madagascar's five endemic lemur families, which are among the most threatened groups of mammals (Schwitzer *et al*., 2014). Moreover, as rosewood is too dense to float, up to five trees of lighter wood are felled to form rafts for each log (Global Witness and EIA, 2010), totalling 200-400 secondary trees per day in the Masoala National Park in 2009 (Global Witness and EIA, 2009).

While illegal trade in rosewood was believed to mainly benefit a small number of people, local communities often have no alternatives beyond employment in the illegal logging industry – a situation exacerbated when vanilla farming experiences prices collapses (Schuurman and Lowry, 2009).

Altered demographic and genetic structure

In some cases, the tendency of illegal hunters to target individuals with specific characteristics within a population may have a disproportionate effect in reducing the long-term viability of that population. Reproductive collapse in saiga antelope (CR) has been attributed to a strong sex ratio bias resulting from selective illegal hunting of adult males for their horns (Milner-Gulland *et al*., 2003). The tendency of fisheries to target larger, older individuals may lead to demographic effects, impacts on migration or parental effects that may disrupt the ability of a population to withstand, or adjust to, climate change (Planque *et al*., 2010). Marine ecosystems that are under intense exploitation, often due to IUU fishing, are therefore expected to have greater sensitivity to climate change, compromising the longer-term viability of fish stocks (Perry *et al.*, 2010). Logging has the tendency to remove the largest and most reproductively valuable trees, which has disproportionately negative impacts on regeneration; for example, this effect has been documented in big-leaf mahogany (VU) and contributes to the high vulnerability of this species to logging (Snook, 1996). The season or life stage in which specimens are removed from a population can also have a significant effect on the demographic structure and survival rates of a species. Neotropical parrot species are generally characterised by low reproduction rates and low juvenile recruitment rates and targeted illegal collection of the nestling stage severely reduces the ability of the population to recover and increases chances of extinction (Wright *et al*., 2001). Migratory species may comprise of various populations with slightly differing characteristics joining one another during migration - selective offtake focussing on certain characteristics, whether legal or illegal, may affect some populations more than others (Allendorf *et al*., 2008).

Loss of genetic diversity, such as that resulting from over-harvesting, can also increase the susceptibility of populations to disease *in situ* (e.g. Spielman *et al*., 2004). For example, parasite loads were found to be higher in those populations of Galapagos hawk (VU) with the lowest genetic diversity and highest inbreeding (Whiteman *et al.*, 2006).

Disease

Various activities associated with illegal trade may increase the risk of disease transmission to wild populations of the target species, in addition to the wider impacts of disease on the environment and human health (see Chapter III section V). The capture and transport of live animals, which is likely to have less regard for animal welfare where the trade is illegal, may increase the susceptibility of the animals concerned to disease by placing them under stress and housing them in poor conditions, often in large numbers. In addition to increasing the risk of mortality of the animals in trade, these diseases may ultimately have detrimental impacts on wild populations, if affected animals are returned to the wild without appropriate screening. For example, there have been documented cases of illegally traded Asian houbara bustard (VU) becoming exposed to numerous infectious diseases during transport. These diseases pose a risk both to wild populations if confiscated birds are released, and to captive populations used in breeding programmes (Bailey *et al*., 2000).

Disease may pose a more direct risk to wild populations where illegal hunters come into physical contact with the target species. A number of infectious diseases common in humans have the potential to be transmitted to animals, in particular great apes due to their close evolutionary relationship with humans (Köndgen *et al*., 2008; Pedersen and Davies, 2009). Live primates kept as pets may transmit diseases from humans to wild primate populations (Jones-Engel *et al*., 2001). The risk that human transmission of zoonotic diseases poses to wild animals is, however, much less well documented than the risk posed to humans by these diseases; there has been much research, for example, investigating the link between human consumption of bushmeat and the recent Ebola outbreak in West Africa (see e.g. Kümpel *et al*., 2015; Saéz *et al*., 2015).

ii. Impacts on non-target species

In addition to the impacts on the target species of trade, non-target species may also be detrimentally affected by harvesting methods or direct persecution. Many harvest methods have been banned or restricted in some areas due to their lack of selectivity; in these cases, the impacts on non-target species can be directly linked to the illegal use of these methods. There are many examples, for instance, where the by-catch or incidental mortality of certain marine species has been attributed to illegal fishing practices. The use of cyanide to collect live fish from coral reefs for the international aquarium and food trade, which results in the mortality of many marine organisms, including corals; cyanide fishing appears to remain a common practice despite being illegal in most countries (Barber and Pratt, 1997; Cervino *et al*., 2003; Vaz *et al.*, 2012). The illegal use of dynamite fishing has similarly destructive impacts on the environment (Riegl and Luke, 1998; Wells, 2009). Bottom trawling has significant detrimental impacts on benthic ecosystems; illegal bottom trawling (see also section on habitat provision) in the southwest Mediterranean littoral zone was found to reduce the density of seagrass *Posidonia oceanica* (LC), a keystone species in the ecosystem (Sánchez-Jerez and Ramos Esplá, 1996). Illegal driftnet vessels operating in the Mediterranean have been found to be responsible for high rates of by-catch, for example of loggerhead turtle (EN) (Echwikhi *et al*., 2012). While all fisheries have the potential to impact non-target species, IUU fisheries are, by definition, less likely to employ mandatory preventative measures such as the use of circle hooks and Turtle Excluder Devices (TEDs) to prevent incidental catch of sea turtles or the use of streamers or hookpods on longlines to avoid seabird by-catch. IUU longline fisheries targeting Patagonian toothfish (NA) have had considerable detrimental impacts on many seabird populations due to high levels of by-catch (**case study 4**).

However, this type of impact is not restricted to the marine environment. Trapping systems in tropical forests often capture a wide range of species beyond those targeted. For example, declines in Critically Endangered saola ungulates in Lao PDR and Viet Nam, where the species is protected by national legislation, have been attributed to the impacts of indiscriminate snares set to capture other species destined for the illegal trade in medicine and bushmeat (Timmins *et al.*, 2008; Baillie and Butcher, 2012). Incidental snaring also poses a major threat to Critically Endangered Edward's pheasant in Viet Nam, including within protected reserves (Brickle *et al.*, 2008; Birdlife International, 2014). Local Southeast Asian hunters applying non-selective traps such as (terrestrial) drift nets ensnare a wide range of non-target species (Newton *et al*., 2008). Since the 1960s, 12 animal species have become extinct, or virtually extinct in Viet Nam due to unsustainable hunting practices (Wilkie *et al.*, 2011).

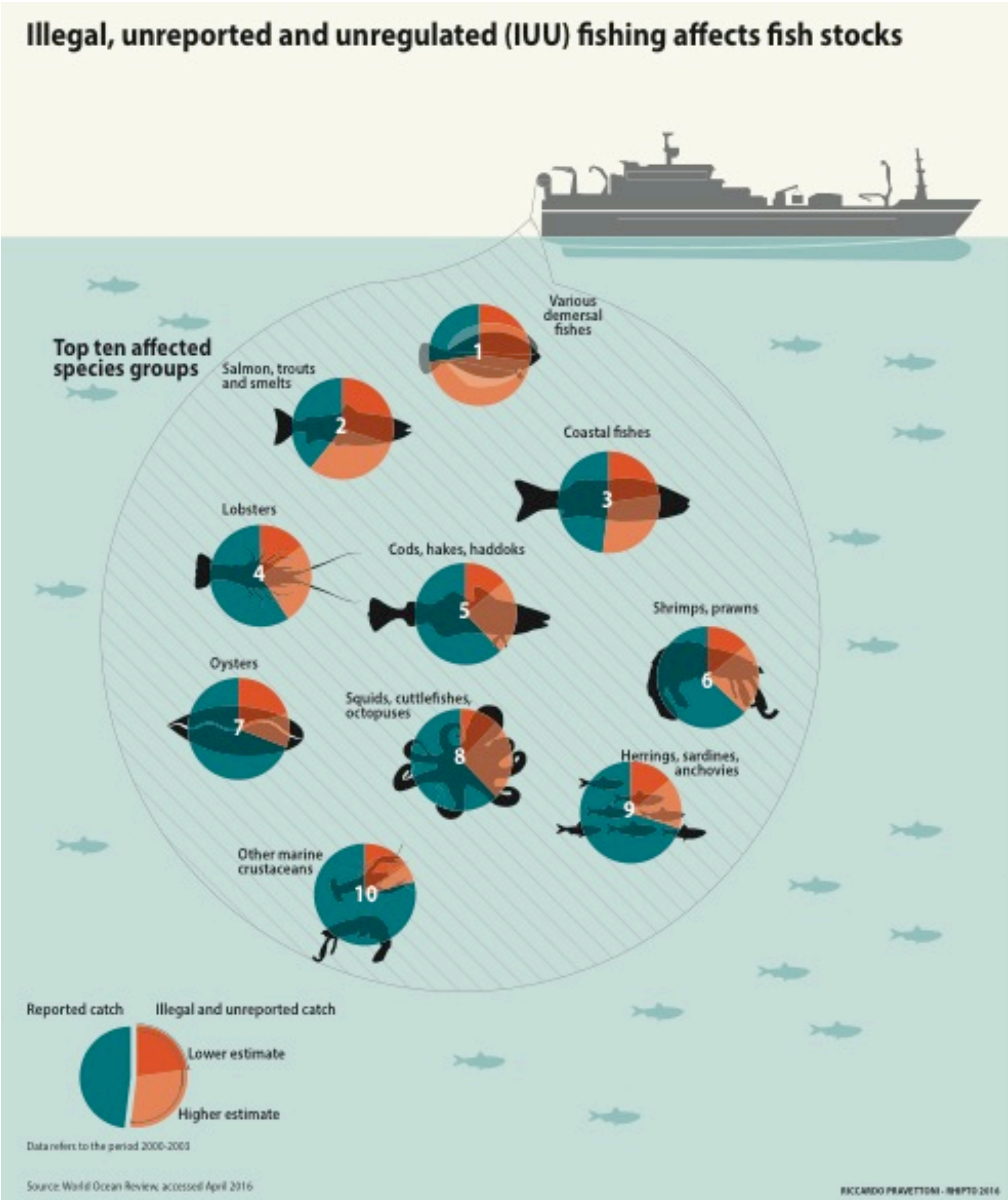
Whilst most incidental mortality of non-target species are a result of non-selective harvesting methods, species that are not the target of trade might also be selectively killed to enable ITW practices to continue. For example, African vultures are directly targeted and killed to facilitate the hunting of target species such as rhinoceros and elephant (**case study 5).**

Case study 4: Seabird by-catch in Illegal, Unreported and Unregulated Patagonian Toothfish longline fisheries

Illegal, Unreported and Unregulated (IUU) fishing is globally widespread (Sumaila *et al.*, 2006) and is of global conservation concern. **By-catch** and **incidental mortality** within IUU fisheries are major threats in particular to large, long-lived marine mammals, birds, turtles and sharks, which are typically caught in gillnets, longlines and purse-seines. Tens of thousands of seabirds are killed annually in IUU longline fisheries as they become hooked while scavenging on bait.

A lucrative longline fishery of the Patagonian toothfish first opened in the Southern Ocean around the Kerguelen and South Georgia Islands in 1985-86. IUU fishing activities expanded drastically around a decade later (Agnew, 2000) and continued for over 15 years within the region (Österblom and Sumaila, 2011), also expanding into the Indian Ocean. Substantial seabird mortality resulting from the toothfish fishery, in particular unregulated fishing, threatened collapse of seabird populations (CCAMLR, 1997). The level of by-catch in unregulated fisheries was conservatively estimated at 16,000-26,000 seabirds for 1996-1997, and considered around 20 times higher than the regulated fisheries in specific areas (CCAMLR, 1997). Compliance with conservation measures adopted by the Convention on the Conservation of Antarctic Marine Living Resources (CCAMLR) has gradually reduced by-catch rates, but IUU operators have continued to disregard measures introduced to mitigate by-catch (Österblom and Sumaila, 2011).

Most of the seabirds caught in toothfish longline fisheries were albatrosses and petrels, which are long-lived species with low reproductive rates and high susceptibility to changes in survival rates (Croxall *et al*., 1990). Species particularly affected by by-catch included black-browed albatross (NT), wandering albatross (VU), grey-headed albatross (EN) and white-chinned petrel (VU) (Kock, 2001). Consistent male-biased mortality of some species of albatrosses and petrels within the toothfish fishery was also reported, exacerbating the population impacts on these monogamous birds (Ryan and Boix-Hinzen, 1999). On the basis of suspected declines due to longline fisheries, white-chinned petrel was classified by the IUCN Red List as Vulnerable (Birdlife International, 2012), while black-browed albatross was categorised as Endangered in 2012, but later reclassified as Near Threatened as a result of slowing declines (Birdlife International, 2014).



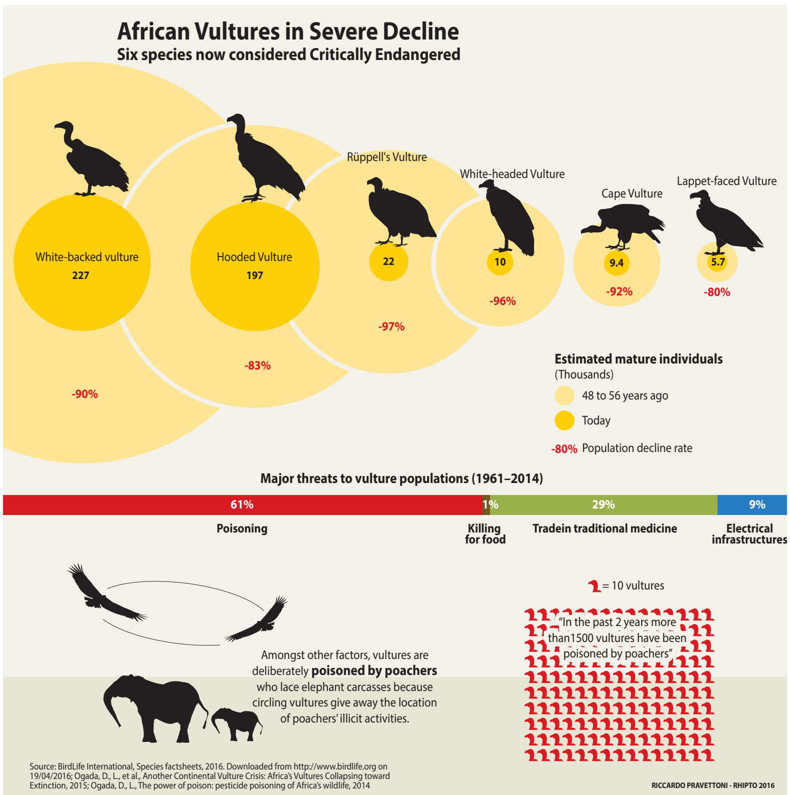
Case study 5: Illegal trade in wildlife affecting vultures, and its environmental impacts

African vultures are increasingly threatened by ITW, both as a target species and as a **victim of the illegal harvest and trade in rhino and elephant**. The result, exacerbated by other causes of mortality (Ogada et al. 2015a), is a significant ongoing decline in vulture populations across Africa, with seven of Africa's eleven vulture species now listed as Critically Endangered or Endangered (BirdLife International 2015a). The environmental impacts of these declines in Africa are already becoming apparent, and additional future impacts can be predicted from the documented declines (for other reasons than trade) that have taken place in South Asia.

Vultures are widely hunted and traded in Africa for use in **traditional medicine** (Saidu & Buij 2013, Williams et al. 2014, Amezian & El Khamlichi 2015). In West Africa, particularly Nigeria where the trade is most active, annual offtake was recently estimated at around 4,000 – 6,000 raptors per year (for the period 2008-2013), including an estimated 1,341-2,011 raptors per year from four Critically Endangered vulture species (Buij *et al*. 2015). These results suggest that trade is likely to be contributing significantly to declines (Buij *et al*. 2015), including a 98 per cent decline of large vultures outside protected areas in central West Africa between 1969 and 2004 (Thiollay 2006).

Beyond their harvest and trade, a new threat to vultures has emerged in recent years, particularly in Southern Africa, as ivory poachers use poison to kill elephants or to contaminate their carcasses **specifically to eliminate vultures**, whose overhead circling might otherwise reveal the presence of the carcass. Between 2012 and 2014, Ogada et al. (2015b) reported 11 poaching-related incidents in seven African countries, in which 155 elephants and 2,044 vultures were killed, and showed that vulture mortality associated with ivory poaching accounted for one-third of all vulture poisonings recorded since 1970, implying a surge in the illegal use of toxic chemicals.

Vultures are the only scavenging-dependent vertebrates, providing a key environmental service by removing rotting carcasses and, through that, **limiting disease transmission**. One study based in India estimates that 600 vultures could dispose of the same amount of animal matter as a medium utility plant, with a single vulture providing a lifetime scavenging benefit worth around US$ 10,000 (Ishwar *et al.* 2015). In Spain, scavenging birds, mainly vultures, have been estimated to remove 9.9 thousand tons of carcasses per year (Margalida *et al*. 2012). After a crash in formerly vast Indian vulture populations (Green *et al*. 2004), feral dog populations increased due to the availability of cattle carcasses that would previous have been cleared by vultures; this is believed to have resulted in a corresponding increase in human deaths from rabies, as well as many other (unquantified) health impacts (Markandya *et al.* 2008).



iii. Loss of ecosystem function

All species perform a functional role within the ecosystem of which they are a component (Kaiser and Jennings, 2001). The impacts of the loss of individual species are not well understood, but can be considerable. The time scales within which effects become evident, however, can vary substantially (Gascon *et al*., 2015). Even relatively small proportional declines in the abundance of common species can result in significant disruption to ecosystem function (Gaston and Fuller, 2008); equally, species that are rare are not necessarily less functionally significant than those that are common (Lyons *et al*., 2005; Mouillot *et al*., 2013). 'Empty forest syndrome' leads to apparently intact forests systems that have, however, become devoid of species through overharvest (Redford, 1992); the effects of the loss of some of their ecological functions, such as seed dispersal and predation may only become evident decades later (Robertson *et al*., 2006).

Although it is extremely difficult to demonstrate a direct link between illegal trade and loss of ecological function, there is increasing evidence that ITW is contributing, in some cases significantly, to declines in population size in increasing numbers of ecologically important species (**case study 6**). The sections that follow provide examples of particular functions performed by species that are known, or are highly likely, to be impacted following population declines as a result of ITW.

Case study 6: Medicinal plants

Over 70,000 plant species, the majority collected from the wild, are used for **medicinal properties** globally (Schippmann *et al.,* 2006). These plants provide a source of raw materials for local use and for the manufacture of a wide variety of **pharmaceutical, herbal, food, cosmetic and fragrance products**. They also provide a critical source of household income, particularly for the rural poor. Plants used in traditional medicine are not only important in local health care, but an estimated 4,000-6,000 (Iqbal, 1993; Secretariat of the Convention on Biological Diversity, 2001) are also important in international trade.

The estimated annual value of Non-Wood Forest Products (NWFP) removal from forests globally - both of plant and animal origin - was US$20.6 billion in 2010 (FAO, 2015b). This is thought to be a gross under-estimation as NWFPs are rarely captured in national statistics despite local, regional and national demands being significant (Shackleton and Pandey, 2014). In a recent study, the export of plant-based NWFPs from China was estimated at over 1.3 billion kg, with a reported Customs value of over US$5 billion, representing around 15 per cent of the world's exports in terms of reported Customs value (Brinckmann, in prep.). It is estimated that the global reported trade in medicinal plants alone is valued at over US$2.5 billion and is increasing due to industry demand (DESA/UNSD, 2014). The conservation status of medicinal plants is little understood (CBD and SCBD, 2010), but it is globally estimated that one in five plant species is **threatened with extinction** in the wild (Kew, 2012).

Illegal and unsustainable harvesting and trade of NWFPs has an impact on local livelihoods and national economies, as well as the conservation of forests and individual species. Estimating the levels of illegal trade in plant NWFPs is challenging, however, as there is little regulation and monitoring of legal or illegal trade. For these species, there is generally little control and enforcement of legality and sustainability, and a lack of management planning for the majority of species harvested and traded (Laird *et al.,* 2009). CITES controls for trade in NWFPs provide, in many cases, the major (or only) legal instrument to address the legality of trade. Over 60 medicinal plant species are listed in the CITES Appendices. These include: African cherry bark, harvested in a number of African range States, mostly for exports for the EU pharmaceutical industry where it is used as an ingredient in a prostate cancer drug (e.g. Cunningham *et al.,* 2014); Ginseng, the root of which is harvested in the US and Canada and traded internationally mainly to supply Traditional Asian Medicine demand; and most recently CITES-listed East African sandalwood, harvested in Eastern Africa and traded for its valuable essential oil (Machua *et al.,* 2009).

The wider environmental impacts of illegal and unsustainable harvest and trade in many medicinal plant species are evident, for instance the impact of African cherry harvesting and trade on the fragile montane habitats where the trees are distributed, and on associated bird and mammal species (e.g. Betti 2008; Bodeker *et al.*, 2014). Unsustainable and illegal harvest and trade in medicinal plants and other NWFPs are health options (the long-term availability of ingredients of traditional medicine as well as potential drug discovery) and livelihoods (from trade in plants). Wild plants also provide an important source of food and nutrition, in particular in times of climate stress e.g. when crops fail (Romanelli *et al.,* 2015).

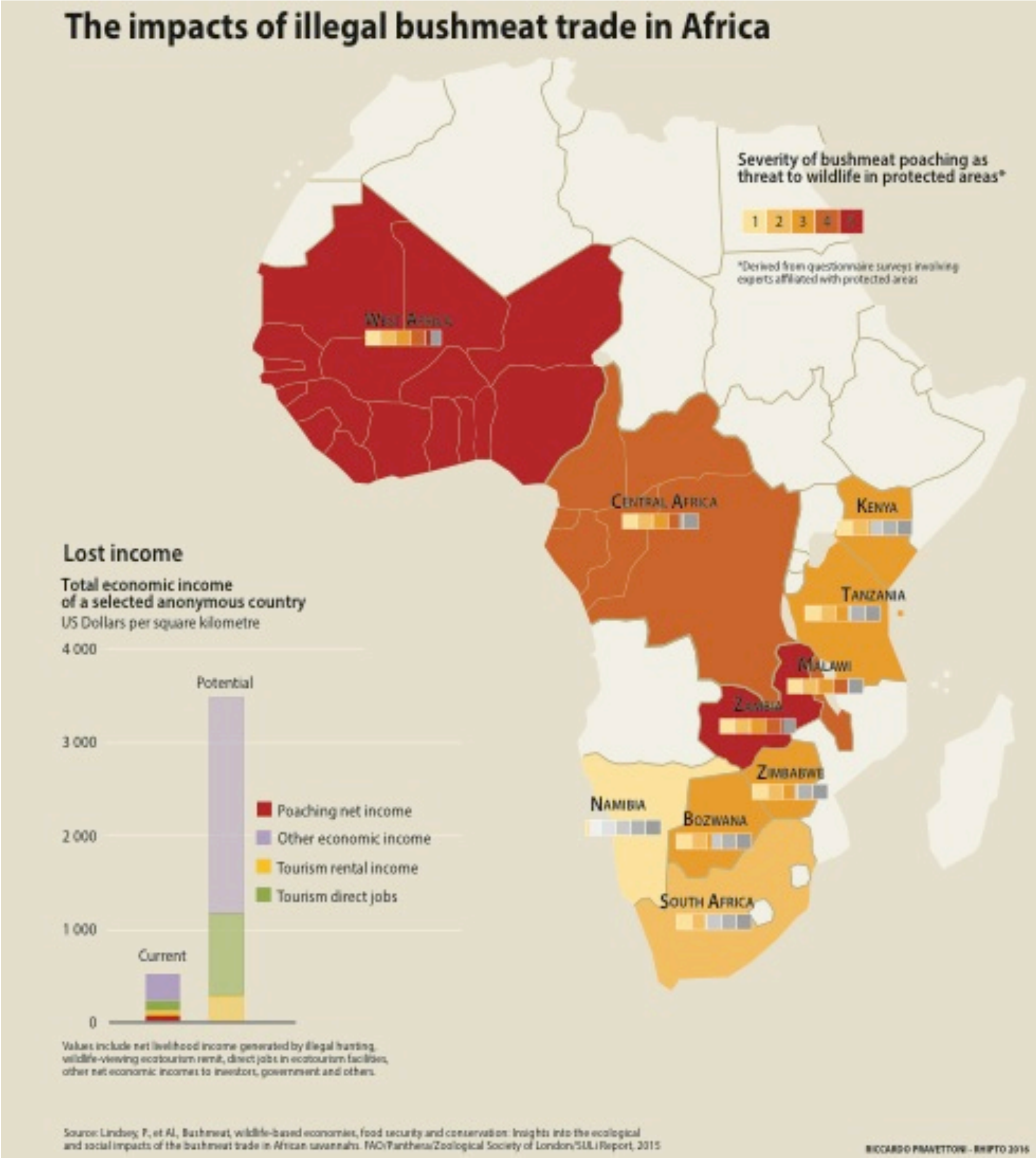
While the role of plants is recognized for their contribution to primary healthcare around the world and sustainable livelihoods (e.g. Brummitt and Backman, 2010; Shackleton and Pandey, 2014), increased efforts are necessary to ensure legal and sustainable practices are not undermined by illegal trade.

Food provision and consumption

A key function of a species within its ecosystem is its role as a food source for other species, and/or as a consumer of other species. A decline in the population size of a particular species therefore has the potential to result in a chain of effects across the whole food chain, and there are a number of well-documented examples of these so-called 'trophic cascades' (Pace *et al*., 1999). Many of these examples relate to the impacts of overfishing in marine ecosystems. For example, the loss of sharks from coral reef ecosystems due to overfishing for the fin trade has been linked to an increase in numbers of middle-level predators and a corresponding decline in numbers of herbivorous fish (Ruppert *et al*., 2013). Overfished coral reefs are prone to algal overgrowth due to the decreased abundance of algae-grazing herbivores, which in turn causes reefs to be less resilient to other stressors, such as disease and the impacts of invasive species (Hughes *et al*., 2007; Raymundo *et al*., 2009; Mumby and Harborne, 2010).. Conversely, the loss of predators may result in an increase in numbers of grazing organisms with equally damaging effects. For example, the elimination of cod from marine ecosystems in North America, in part due to illegal overfishing, led to a significant increase in the numbers of grazers such as urchins, crabs and lobsters, resulting in the disappearance of much of the kelp forest previously extensive along the Maine coast (Jackson *et al*., 2001). The cascading ecosystem effects of bushmeat hunting in tropical forests are also well documented (**see case study 7**).

Seed dispersal

In tropical forests, seeds of the majority of tree species are dispersed by animals; loss of these animals will therefore have considerable impacts on tree species diversity and composition. Bushmeat hunting can result in heavy offtake of seed-dispersing mammals (**case study 7**); in an average village hunting offtake in Central Africa, over 70 per cent of animals have a seed dispersal role (Abernethy *et al*., 2013). The resulting impacts of bushmeat hunting on forest diversity have been documented throughout the tropics; regeneration in hunted forests has been shown to favour faster-growing plants with lower wood density, and result in lower overall tree species diversity (Nuñez-Iturri *et al*., 2008; Effiom *et al*., 2013; Harrison *et al*., 2013). The decline in higher-density tree species may, in turn, decrease the carbon storage capacity of the forest (Brodie and Gibbs, 2009). African forest elephants play a very significant role in seed dispersal; they may consume more seeds from more species than any other large seed-dispersing vertebrate (Campos-Arceiz and Blake, 2011). Hornbills are also considered key seed dispersers in Asian forest ecosystems (Kitamura, 2011), but the illegal harvesting and trade of species such as the helmeted hornbill, a keystone frugivore in the Sundaic lowland forests that is now Critically Endangered due to illegal trade (BirdLife International, 2015c), could disrupt this crucial function.



Case study 7: Ecological impacts of the bushmeat trade

Wild animals (bushmeat) continue to be an important source of animal protein and income for many forest-living people globally. Much of this trade is illegal due to the targeting of protected species (e.g. elephants, great apes), and large-scale commercial hunting and trade often disregard customary community hunting rights and violate any established hunting quotas. The scale of commercial bushmeat hunting has become a serious threat to many rainforest species (Fa *et al*., 2002), leading to **local extirpations** of species, with West and Central Africa particularly hard hit (Milner-Gulland *et al*., 2003).

While the loss of wild animals as food will have serious repercussions on the **livelihoods** of many people, the removal of certain forest vertebrates ('defaunation', see Dirzo *et al*., 2014) will also **impoverish the functional ecology** of tropical rainforests. Such species perform a range of ecological roles – as browsers, as predators and prey, as seed dispersers. These functions become impaired when populations are depleted through hunting for bushmeat (e.g. Vanthomme *et al*., 2010; Lindsey *et al*., 2013). The reduction or complete disappearance of 'keystone species', 'ecosystem engineers', or other ecologically important species can have disproportionate impacts on the ecosystem, compared to the loss of other species (Fragoso *et al*., 1997; Keuroghlian and Eaton, 2009; Campos-Arceiz and Blake, 2011). These are often the larger-bodied species, such as large primates, carnivores and antelopes as well as tapirs, buffaloes or elephants, which tend to be the hunters' preferred target species (Fa and Peres, 2001). At the same time, these species have lower breeding rates than smaller species and are less resistant to intensive hunting (Robinson and Redford, 1994).

Changes in the abundance of these species brought about by hunting for ITW can have far-reaching impacts on the ecosystem (Abernethy *et al*., 2013). For example, many forest vertebrates, including primates and elephants, have a significant role in **seed dispersal**. In an average village in Central Africa, over 70 per cent of animals killed are seed dispersers (Abernethy *et al*., 2013). Primates make up 6.2 per cent of the traded individuals (despite being legally protected) and 3.6 per cent of the forest vertebrate biomass; approx. 162,000 tons (Petrozzi *et al*., in press). Elephants (Cochrane, 2003) and gorillas (Tutin *et al*., 1991) have unique ecological relationships with particular tree species. The removal of such large seed dispersers has a knock-on effect on forest diversity, resulting in lower overall tree species diversity (Nuñez-Iturri *et al*., 2008; Effiom *et al*., 2013; Harrison *et al*., 2013). The decline in higher-density tree species, in turn, decreases the **carbon storage capacity** of the forest (Brodie and Gibbs, 2009). Furthermore, plant regeneration (influenced by pollinators, seed dispersers and predators) and plant diversity (affected by a change in herbivory patterns or pest increase) are often dependent upon the presence of specific disperser species or groups of species (Nasi *et al*., 2011).

In another example, the apex predator in the Congo Basin, the leopard (NT), has disappeared from heavily-hunted areas due to depletion of its prey base (Henschel *et al*., 2011). Reduced predation can lead to **changes in the abundance and composition of prey species**, which can in turn affect forest structure and composition, and result in overall biodiversity decreases (Fa and Brown, 2009; Nasi *et al*., 2011).

These ecological impacts can also have socioeconomic consequences, since bushmeat has a high value for human livelihoods. In remote forests of Central Africa and the Amazon, for example, bushmeat is often the main source of animal protein available and plays an essential role in people's diets, especially where livestock husbandry is not a feasible option and wild fish not available (Nasi *et al*., 2011). Controlling for known deforestation and population growth rates, at current exploitation rates, future bushmeat protein supplies would likely drop 81 per cent in the Congo Basin in less than 50 years, and only three countries would be able to maintain a protein supply above the recommended daily requirement (Fa *et al.*, 2003). These findings imply that a significant number of forest mammals could become locally extinct relatively soon, and that protein **malnutrition** is likely to increase dramatically if food security in the region is not promptly addressed. Moreover, if locally-produced beef replaced bushmeat consumption in the Congo Basin, an area as large as 25 million hectares would have to be converted to pastures. Whilst pigs and chickens have much higher feed conversion rates, producing an additional 4.5 million tons of meat would be laced with its own environmental issues (Nasi *et al*., 2011).

Habitat modification

Species often play fundamental roles in supporting the ecosystem as a whole by physically influencing the environment which they live. Plants provide many such functions, including water redistribution and soil stabilisation, and natural hazard protection. Certain animal species also have important physical impacts on their environment that contributes to healthy ecosystem functioning. Examples include aquatic suspension-feeding organisms, such as bivalve molluscs, which play a role in regulating water quality (Newell, 2004), and grazing animals which contribute to nutrient cycling (McNoughton *et al*., 1997). Large herbivores shape the environments in which they occur, influence food webs and modify key abiotic ecosystem processes that cannot be replaced by smaller species. Despite their importance, over 70 per cent of the 74 largest terrestrial herbivores are threatened by hunting for meat and nearly 30 per cent by hunting for body parts, with 60 per cent (44 of the 74 species) considered threatened by extinction due to overharvest, illegal hunting and other threats (Ripple *et al*., 2015).

The physical modification of habitats by organisms, also termed 'ecosystem engineering', promotes spatial heterogeneity (Jones *et al*., 1997) and has been shown to increase species richness (Romero *et al*., 2014). Every single organism may act as an ecosystem engineer during some phase of their life (Hastings *et al*., 2007). The African elephant is a significant ecosystem engineer; although elephants have been reported to have negative impacts on certain ecosystems due to the damage caused to woody vegetation during browsing, there is evidence that this damage promotes herpetofaunal species richness by creating habitat for certain species (Pringle, 2008; Nasseri *et al.*, 2011) and provides favourable conditions for mixed feeders and grazers (Haynes, 2012). Siberian marmot (EN) are also important ecosystem engineers, their burrows providing shelter for numerous other animals. The many ecological functions performed by this keystone species in Mongolian steppe and mountain ecosystems, where populations have been heavily impacted by illegal hunting, are described in **case study 8**.

Case study 8: Marmots: keystone species threatened by illegal trade in Mongolia

Siberian marmot *Marmota sibirica* can be described as a 'keystone species' due to the variety of important ecological functions that they perform within their Mongolian steppe and mountain ecosystems habitats. Marmots are **ecosystem engineers**, their burrows providing shelter for many native species, such as Corsac fox (LC) (Murdoch *et al*., 2009) and wheatears (Zahler *et al*., 2004). The disturbance caused by burrowing also acts to recycle nutrients and aerate the soil (Wingard and Zahler, 2006) and has been shown to increase the spatial heterogeneity of plant communities, which has in turn been linked to an increased abundance and diversity of insect pollinators (Yoshihara *et al*., 2009, 2010) and enhanced forage quality through increased nitrogen concentrations (Van Staalduinen and Werger, 2007). Marmots are also an important food source for numerous mammals and raptors, such as snow leopard (EN) and upland buzzard (LC) (Wingard and Zahler, 2006).

Marmots are hunted by Mongolian herders for meat, fur and body parts used in traditional medicine; these products are sold for income as well as being used domestically (Reading *et al*., 1998; Pratt *et al.*, 2004; Wingard and Zahler, 2006). Furs have also been traded illegally, in particular to China and Russia (Wingard and Zahler, 2006). Harvest levels have consistently exceeded established quotas, and harvesting has continued despite the enactment of temporary hunting bans (Wingard and Zahler, 2006). Mongolian populations are thought to have declined by approximately 70 per cent during the 1990s, with some evidence that numbers have since declined even further; this decline has resulted in the classification of this species as Endangered in the IUCN Red List (Batbold *et al.*, 2008). According to Wingard and Zahler (2006), overhunting is "the only real present threat" to marmots in Mongolia. Given their **keystone role**, the unsustainable and illegal trade in Siberian marmot is likely to have disproportionate impacts on the biodiversity of Mongolian steppe and mountain ecosystems.

Siberian marmots are also **important in economic terms**; many rural people in Mongolia depend heavily on wildlife products for their livelihoods (Pratt *et al*. 2004). The economic value of skins alone (meat and parts often being sold separately (Wingard and Zahler, 2006)), both legally and illegally harvested, was estimated at nearly US$34 million in 2004 and more than US$10 million around 2008 – 0.87 per cent and 0.26 per cent of the 2007 Mongolian GDP (Reuter, 2008).

Habitat provision

The loss of habitat is one of the important impacts of illegal harvest and trade in wildlife. Seventy seven per cent of all threatened bird species are found in forests (BirdLife International, 2012). Primary forests account for more than one third of global forests, but their area has decreased by more than 40 million hectares over a ten year-period, largely due to degradation from logging and other human impacts (FAO, 2010). The impacts of illegal logging are considered to be far greater than for legal logging in concessions (Nellemann *et al.*, 2007); in particular, the destructive impacts of selective logging are likely to be greater where it is carried out illegally by untrained and unsupervised workers (Felton *et al.*, 2003). The decline in a number of forest-dwelling species has been linked to habitat destruction as a result of illegal logging, including some of the world's most endangered primates such as the Madame Berthe's mouse lemur (EN) in Madagascar, the grey-shanked douc langur (CR) in Viet Nam and the pygmy three-toed sloth (CR) in Panama (Baillie and Butcher, 2012; Schwitzer *et al.*, 2012). Illegal logging also results in indirect negative impacts on non-target species by providing increased access to forest areas through road construction; for example, logging roads constructed in the Congo Basin have been shown to increase bushmeat hunting by improving access to previously unexploited forest areas and decreasing the costs of transportation to markets (Wilkie *et al.*, 2000).

The effects of bottom trawling on structurally complex marine habitats have been likened to the effects of forest clear-cutting (Watling and Norse, 1999). The illegal use of this fishing technique continues to challenge management efforts (**case study 9**). Similar effects are also observed for other highly destructive harvest methods, such as explosives. The overharvest of European date mussels (NA) through destructive harvest methods destroys the habitat of the species and that of other species, and by changing the species composition it makes recovery of the habitat challenging (**case study 10**).

Case study 9: Impacts of illegal bottom trawling

In addition to physical environmental impacts (Palanques *et al*. 2014), bottom trawling fundamentally alters the **ecological structure of the seabed**, typically from areas characterized by large, long-lived and potentially fragile species to areas dominated by smallbodied, opportunistic species (Olsgard *et al*., 2008). There is evidence that bottom trawling also has the potential to cause **long-term impacts on** sediment nutrient fluxes (Olsgard *et al*., 2008).

In the Republic of Korea in the early 1990s, it is reported that there were 3000 illegal bottom trawling vessels (Cho, 2012) using non-selective nets with small mesh sizes which caught fish of all types and sizes (Cho, 2012). Average catches per illegal bottom trawl vessel were estimated at about 15 tons annually, of which about 75–80 per cent were juvenile fish (Han, 2002 in Cho, 2012), suggesting that a total of 36,000 tons of fry were caught by illegal bottom trawling annually (Cho, 2012). The motivation for involvement in illegal bottom trawling was strong, as fishermen involved in illegal bottom trawling earned 150 per cent of the income of legal fishermen (Cho, 2012). Illegal bottom trawl fishing was an important source of **employment for the poor**. It is estimated that up to 45,000 people were employed in illegal bottom trawling in the early 1990s (Cho, 2012).

Despite a national Fisheries Act and efforts to implement the FAO Code of Conduct for Responsible Fisheries (FAO, 1995) and FAO International Plan of Action to Prevent, Deter and Eliminate IUU Fishing (FAO, 2001), little headway was made in the country in reducing illegal bottom trawling. Strong political pressure from illegal bottom trawler fishermen to legalize the practice undermined enforcement efforts. In a change of approach, the National Assembly passed the 'Special Law for Eliminating Small Bottom Trawl Fishing Vessels' in 2004, which created a buy-back program for illegal boats and loan financing for the owners of illegal bottom trawl fishing vessels to transition into legal fishing. Following the introduction of this scheme, the number of illegal bottom trawling vessels began to decrease and there was clear evidence of the legal catch increasing. The increase in legal catch was thought to relate to the increase in juvenile fish growing to a reasonable size, rather than being removed illegally early in their life cycle (Cho, 2012).

Case study 10: Destructive harvest of European date mussel

The European date mussel *Lithophaga lithophaga* (NA) is a rock-boring bivalve mollusk widespread along the whole Mediterranean coast (CITES, 2014a) and is a key element of complex, highly diversified benthic communities (Guidetti, 2011).

The mussels have been traditionally exploited for food in various Mediterranean countries. Their exploitation and trade is regulated under several international multilateral agreements, such as CITES (Appendix II listed since 2005), Bern and Barcelona Conventions, and harvest has been banned in a number of range states (CITES, 2014a). However, illegal trade in this species, both national and international, is taking place on a considerable scale. Demand from areas from where the species has vanished due to overexploitation has been satisfied through trade from previously unexploited areas (Fanelli *et al.,* 1994). In recent years, international trade in *L. lithophaga* has been taking place mainly in North West Africa and among the southeastern European countries, as well as between these countries and the European Union (CITES, 2014a).

The species is slow-growing (Fanelli *et al.,* 1994) and unsuitable for commercial breeding (CITES, 2014a). When mussels are harvested, the rocks they inhabit are broken into fragments, often by very destructive methods such as pneumatic hammers and explosives (Fanelli *et al.,* 1994). Cleared rocks thus become **unsuitable for recolonisation** by the species and other marine organisms, resulting in **decrease in species richness and total abundance**, including of near-shore (littoral) fish species (Guidetti, 2011). Sea urchins increase in abundance instead and play a major role in preventing settlement of benthic organisms through intense unselective grazing (Fanelli *et al.,* 1994; Guidetti, 2011). The restoration of littoral communities is therefore very slow and often impossible (Fanelli *et al.,* 1994). Habitat destruction caused by the date mussel fisheries reduces the abundance of other organisms and **habitat diversity** (Fanelli *et al.,* 1994; Fraschetti *et al.*, 2001).

Carbon sequestration

The FAO (2010) estimates that the world's forests store around 289 gigatonnes of carbon in their biomass alone, and that between 2005 and 2010, forest biomass carbon stocks decreased by an estimated 0.5 gigatonnes per year, mainly due to deforestation. Based on the Intergovernmental Panel on Climate Change (IPCC)'s 5th Assessment Report (Stocker *et al*., 2013), emissions of carbon dioxide (CO_2) from tropical deforestation and degradation between 2002 and 2011 equated to approximately 10 per cent of global CO_2 emissions in this period. A significant environmental impact associated with the production of charcoal is the release of greenhouse gases, (**case study 11**), and the illegal harvest of timber from tropical forests on peatlands has particularly significant impacts on CO_2 emissions (**case study 12**).

Case study 11: Environmental impacts of illegal charcoal trade

Charcoal has a key importance in African local energy consumption: according to FAO, wood fuel and charcoal account for up to 90 per cent of the household energy consumption in some countries (FAOSTAT, 2014). In Kenya, for example, charcoal provides energy for 82 per cent of urban households and in Madagascar 85 per cent of the population rely on charcoal (Nellemann *et al*., 2014).

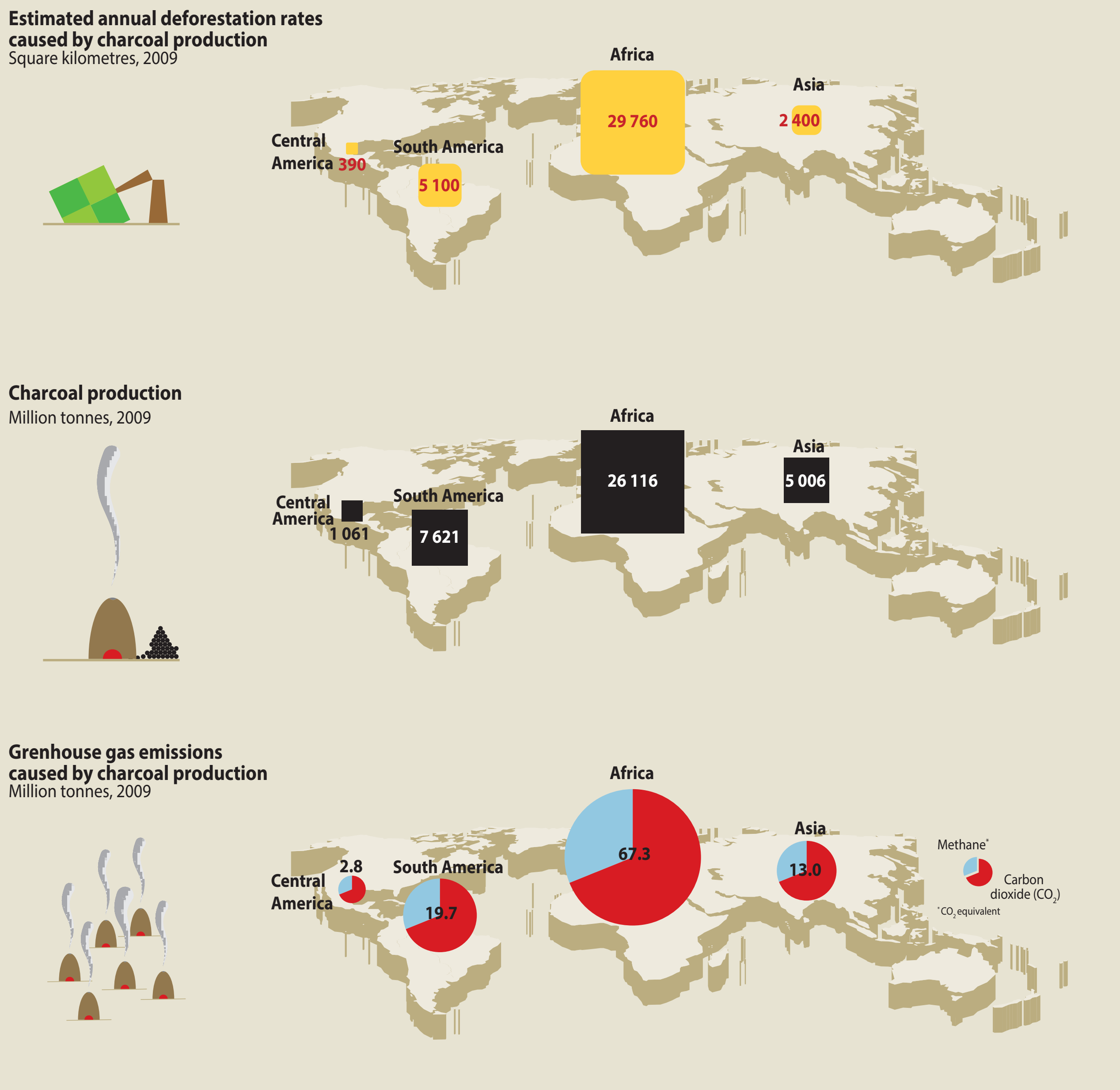
The FAO estimated a global charcoal production of 50.6 million tonnes in 2013, 61 per cent of which was produced in Africa (FAOSTAT, 2014). Nevertheless, in Sub-Saharan Africa, the charcoal sector was reported to operate mostly outside the formal economy, reducing the space for policymakers to foster sustainable forest management (IEA, 2014). The unregulated, illicit or informal charcoal trade is without comparison on of the largest causes of deforestation in Africa. In Tanzania, an estimated 80 per cent of charcoal trade was estimated to take place outside of the formal system (Peter and Sander, 2009). While most charcoal is used locally, illegal international trade has also been reported, such as from Somalia (Nellemann *et al*., 2014). The unregulated charcoal trade is estimated to account for a direct loss of revenues of US$1.9 billion to African countries yearly. "This indicates a vast illicit, unregulated trade in charcoal, involving illegal logging often in protected areas, large-scale deforestation, involvement of organized dealers and transboundary shipments, including to other continents" (Nellemann *et al*., 2014).

Charcoal as a commodity has a legal status that ranges broadly between jurisdictions in and between countries (Nelleman *et al*., 2014). The trade varies from regulated, through unregulated, illicit, and to illegal, and in some cases to comprise a conflict-fuelling currency: charcoal has indeed become a key source of income to both terrorist groups, rebel groups and organized crime in Africa (UNSC resolution S/res 2195; Nellemann et al., 2014). An investigation in the conflict zone of eastern DRC in 2015 by a joint taskforce by UNEP, MONUSCO and The Special Envoy for the Secretary-General to the Great Lake region revealed that illicit natural resources exploitation, including charcoal and timber, in eastern DRC was valued at over USD 1 billion per year (UNEP-MONUSCO-OSESG, 2015). This exploitation has had severe impacts on deforestation and logging inside protected areas, such as in the Virungas and has threatened the mountain gorillas (UNEP-MONUSCO-OSESG, 2015).

The demand for charcoal is projected to triple in the coming thirty years (Nellemann *et al*., 2014), with severe environmental implications, such as large-scale deforestation, and associated soil erosion and other impacts such as increasing desiccation for neigbouring forests (Chidumayo and Gumbo, 2013). Charcoal production in Malawi, which is estimated to result in the cutting of over 15,000 hectares of forest annually, has also encroached into protected areas within the country, with nearly 60 per cent of charcoal reported to be produced in Forest Reserves and National Parks (Kambewa *et al*., 2007). An additional significant environmental impact associated with the production and use of charcoal is the release of **greenhouse gases**, that results in black carbon pollution and consequent health problems -- in 2009, carbon dioxide emissions from charcoal production were estimated to exceed 100 million tonnes, and result in a greater contribution to global warming than from charcoal burning (Chidumayo and Gumbo, 2013).

Not only has the decimation of forests to supply the charcoal trade caused tremendous environmental damage, but the implications of illegal charcoal production and trade can impact on intact forests required for the **provision of food and other resources**. Indeed, deforestation and desertification triggered by charcoal production degrades the environment and reduces the amount of land useable for agriculture or grazing for livestock, which increases the vulnerability of rural livelihoods (Zulu and Richardson, 2013).

The impacts of unsustainable charcoal production



Source: Chidumayo, E., N., Gumbo, D., J., The environmental impacts of charcoal production in tropical ecosystems of the World, 2012

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Case study 12: Ecosystem impacts of illegal logging of tropical forests in Borneo

Illegal logging has been widespread in Indonesia from the mid-1990s, reaching a peak between 1999 and 2003 in the aftermath of the Asian financial crash and the Indonesian financial and political crisis of the late 1990s. Illegal logging reportedly took place in 37 of 41 of the country's national parks (Nellemann *et al*., 2007) and was prevalent across Kalimantan (CITES, 2004). It was estimated that 73 to 88 per cent of timber logged in Indonesia in 2003 was illegal (Schroeder-Wildberg and Carius, 2003), with most material exported as processed materials rather than logs (Nellemann *et al*., 2007).

A wave of indiscriminate illegal logging began in the peat-swamp forests of Central Kalimantan in 1997 following the end of legal concession tenures (Currey *et al*., 2001). In contrast to concession logging, which targeted only a limited number of species of a specified size, large numbers of people were involved in illegal logging activities, with all timber species of value targeted. Ramin was one of the most lucrative species targeted; it is used for a wide range of products including furniture, window frames, blind slats and picture frames (CITES, 2004). Networks of drainage canals were cut into the peatland to float timber out to the main rivers, with these frequently being spaced at less than 1 km apart within the forested areas of the Sebangau catchment (Husson *et al*., in prep.).

Tropical peat swamp forest ecosystems are extremely sensitive to changes in the hydrological balance of peat soils and overlying forest (Page *et al*., 1999) and this extraction method causes drainage, peat subsidence and hence degradation of the peatland ecosystem. This in turn results in an increased risk of fire (Turetsky *et al*., 2014). **Forest fires** in Central Kalimantan were frequent from 1998 to 2010, with the most destructive fires associated with El Niño events (Husson *et al*., in prep.). Tropical peatlands play an important **ecological role in global carbon storage** and their burning results in release of carbon; around 0.2 gigatonnes of carbon were estimated to have been released in 1997 across 2.5 millon hectares of peatland in Central Kalimantan (Page *et al*., 2002). Further carbon dioxide emissions result from decomposition of drained peatlands (Hooijer *et al*., 2010).

Logging activities were also observed to **impact on non-target mammal species** in Sebangau forests. A globally important population of the Endangered Bornean orangutan (EN) was estimated to have declined by 40 per cent in a 500 km^2 study site within the Sebangau forest as a result of illegal logging disturbance (Husson *et al*., in prep.).

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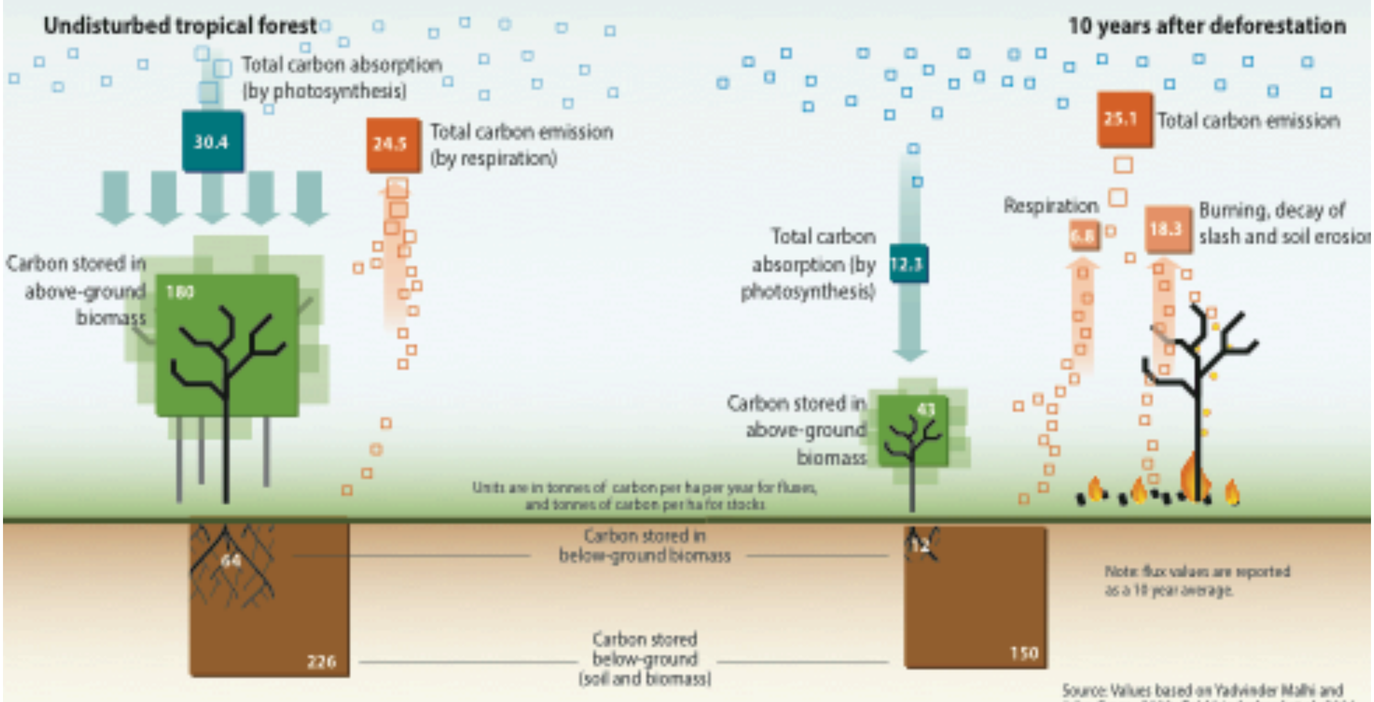
Deforestation of tropical forests results in less carbon storage and more carbon emissions



Source: Values based on Yadvinder Malhi and John Grace, 2000; Frédéric Achard et al., 2004.

Massive deforestation in Indonesian Borneo

Source: Margono B.A., et al., Primary forest cover loss in Indonesia over 2000-2012. Nature Climate Change 2014, WRI, Global Forest Watch, accessed August 2014

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Other key ecosystem functions

A number of other key ecosystem functions can also be negatively affected by illegal wildlife trade, including pollination, soil erosion control, water regulation and quality, and coastal protection, as highlighted through the examples below.

Animal pollinators are vital to the maintenance of wild plant communities in most terrestrial ecosystems, and particularly in the tropics. Certain species may be particularly significant pollinators within an ecosystem and their loss may in turn have considerable detrimental impacts on the plants it pollinates. Flying foxes in Samoa have been termed 'keystone pollinators' (Cox and Elmqvist, 2000), with 79 per cent of canopy-forming trees dependent on these animals for either pollination or seed dispersal (Banack, 1998). Samoan flying foxes are primarily threatened by overexploitation and forest loss, with hunting continuing despite the enactment of protective legislation (Brooke and Wiles, 2008; Hamilton and Helgen, 2008).

Illegal logging of primary forest can also threaten other vital ecosystem functions and services, such as soil erosion control, water regulation and maintenance of water quality. For example, in a study in the Ziwuling region of the Loess Plateau, China, Zheng (2006) showed that soil erosion in the region increased markedly following destruction of even secondary forest, with erosion rates between 800 and 1,600 times greater than prior to deforestation.

Likewise, the unsustainable and illegal harvesting of coral reef organisms degrades reefs and affects the various services they provide, such as coastal protection, and the provision of suitable conditions for the persistence of other highly productive coastal ecosystems such as seagrass beds and mangroves (Moberg and Folke, 1999; Richmond, 1993). The large-scale degradation of Caribbean coral reefs between the 1970s and 1990s for example was primarily attributed to the effects of overfishing, with fishing effort several times above sustainable levels (Hughes, 1994).

iv. Spread of invasive species

Invasive species are a leading cause of declines and extinctions (Wilcove *et al*., 1998; Clavero and García-Berthou, 2005), particularly on islands. Worldwide, recent rates of invasion by non-native species are several orders of magnitude higher than historic rates (Ricciardi, 2007), facilitated by increasing globalization of international trade in wildlife and other products (Hulme, 2009). Detrimental impacts of invasive species on populations of native species include predation, competition for resources, alterations of ecosystems, hybridization and introduction of pathogens (Williamson, 1996; Manchester and Bullock, 2000; Kraus, 2009). Release of unwanted exotic pets is a frequent source of invasive species (Wittenberg and Cock, 2001). For example, the red-eared terrapin (LC) is popular in the pet trade but is now subject to import bans in many countries due to its invasive potential. It is native to southern North America but has become established in Asia (Ramsay *et al.*, 2007), Australia (Burgin, 2006), Europe (Perez-Santigosa *et al*., 2008), and South America (De Magalhães and São-Pedro, 2012). In Europe the species has been associated with high mortality of native turtle species due to competition for resources (Cadi and Joly, 2004). In spite of bans on import into Australia, shipments of red-eared terrapin have been intercepted by Australian authorities (Alacs and Georges, 2008). However, in many cases import bans are only implemented once an invasion has already occurred, and the environmental impact of the legal trade that took place prior to the ban is likely to be more significant than that of any subsequent illegal trade.

v. Spread of disease

Transport of wildlife within or between countries provides a pathway for transmission of pathogens that are a threat beyond the target species to biodiversity, agricultural production and human health (Smith *et al*., 2009). Although the impacts on wildlife are less-well documented than the impacts on humans and livestock, the risk of disease transmission from illegally traded wildlife is highlighted by the wide range of pathogens documented from confiscated animals (Gómez and Aguirre, 2008). For example, seized mountain hawk-eagle *(NA)* which had been smuggled from Thailand to Belgium were diagnosed with a highly pathogenic avian influenza A/H5N1 virus, a disease that poses a threat to wild and domestic birds and to humans (van Borm *et al*., 2005). International trade in amphibians, though primarily legal, has been implicated in the spread of chytridiomycosis, a disease responsible for amphibian population declines in several continents (Weldon *et al*., 2004; Kilpatrick *et al*., 2010). Illegally harvested or traded timber and plant products were believed to be more likely to have by-passed pest and pathogen prevention measures (Jenkins and Fitzgerald, 2011). The chestnut gall wasp, whilst harmless in its native China, has become the most severe insect pest of American chestnut after it was introduced into the U.S. in 1974 on illegally imported budwood (Rieske, 2007).

IV. Conclusions and policy implications

The preceding chapters demonstrate a wide range of environmental impacts of ITW – many of which go far beyond the direct impacts on the traded species themselves. ITW has various adverse impacts on ecosystem functioning, and as a result negatively affects rural and other livelihoods in the short- and long-term, creates significant barriers to the ability of indigenous peoples and local communities to sustain and manage their natural resources, and negatively impacts on the opportunities for sustainable use of wildlife and forest resources. Strengthening the policy and institutional frameworks to address illegal wildlife trade at global, regional and national levels is therefore not only critical for biodiversity conservation efforts, but is also essential to ensure that the opportunities provided by the environmental dimensions of sustainable development are fully realized.

Although it is widely recognized that ITW is one of the most lucrative forms of illicit trade, with significant environmental, social and economic impacts, high-level expressions of concern and commitment are not always turned into tangible action. In particular, environmental legislation is often not adequately implemented, and most legislative processes fail to treat ITW as a serious issue. Consequently, limited budgetary provisions have been made to finance implementation of programs designed to reduce the direct and wider environmental impacts of ITW.

Critical institutional barriers have to be addressed to provide the necessary conditions to enable effective policy implementation. Based on the knowledge and data presented in the preceding chapters, this chapter presents some key policy implications and options to tackle the underlying enabling conditions, such as insufficient coordination at the international level, scarce implementation of national legislation and supporting legal frameworks, and knowledge gaps in relation to the drivers and consequences of ITW.

Enhancing the evidence-base for interventions

There needs to be a concerted effort to improve the current state of knowledge on the scale, impacts and drivers of ITW in order to gain a comprehensive understanding of its environmental and socioeconomic impacts, and effective responses. The scale of ITW, the volume of the illegal trade and the number of people involved in it are largely unknown. The clandestine nature of the trade, and the lack of comprehensive research make it challenging to know the true size of the phenomenon. Indeed, many figures circulated in various reports and articles are the result of guesswork rather than of systematic analysis. Suggested actions include:

- Supporting efforts currently underway[27] to create an international mechanism for monitoring, reporting, collating and analysing data on ITW in a standardised way to inform targeted actions;

- Encouraging further investigation of the environmental impacts of ITW, ensuring that the environmental and associated socioeconomic implications of ITW are effectively communicated to those involved in wildlife governance at national and local scales;

- Compiling and sharing the best possible information on the use of non-selective extractive methods and by-catch in ITW in order to minimise environmental impacts; and

- Sharing experiences and good practices on effective mechanisms for reducing ITW and the associated environmental impacts.

[27] Such efforts include a potential illegal trade reporting mechanism currently under discussion within the context of the CITES Working Group on Special Reporting, as well as efforts by UNODC to compile global statistics on wildlife seizures.

Strengthening legislation and law enforcement

The updating of legal and regulatory systems, and their effective implementation, is a fundamental element for combating wildlife and forest crime. This may include creating clear definitions of illegal activities, establishing significant deterrent sanctions, and specifying relevant control and enforcement powers at every stage in the supply chain.

Interventions to address the problem of weak enforcement and prosecution include:

- Addressing gaps in legislation identified in evaluating impactful practices;
- Enhancing international and regional cooperation within the framework of the ICCWC, the Convention on Transboundary Crime and among regional wildlife enforcement networks (WENs), and seek opportunities for synergies between these different frameworks to reduce duplication of effort;
- Ensuring that wildlife commodities not listed under CITES, in particular timber, fish, charcoal and bushmeat are also taken into account within the abovementioned frameworks, where relevant;
- Developing mechanisms to facilitate rapid intelligence exchange among enforcement networks nationally (where not yet implemented) and internationally;
- Supporting the development of forensic investigation techniques and ensure that appropriate resources and expertise are available to assist in the detection of ITW;
- Recognizing ITW as serious transnational crime;
- Ensuring that penalties are sufficiently severe to be an effective disincentive for those engaged in ITW;
- Capacity building not only of enforcement officials, judiciary and customs officers, but also protected area managers and local communities involved in wildlife protection and management;
- Supporting the development of traceability systems to reduce laundering of illegal goods within legal supply chains, for example through the development of best-practice guidelines;
- Ensuring laws are in place which protect legitimate social interest of people at the same time ensuring long-term economic use of a wildlife resource; and
- Reviewing the legal status of trapping/harvesting methods that are detrimental to non-target individuals and species.

Strengthening demand-side strategies

The role of communications, outreach and public awareness to address the issues around ITW, especially unsustainable demand for wildlife products, is also an essential response. However there is also an urgent need to better understand and target the key market drivers of unsustainable demand, including:

- Supporting efforts to identify the most effective interventions in reducing unsustainable demand for wildlife products; and
- Disseminate best practice for successful implementation of demand-side strategies for addressing the illegal and unsustainable trade in wildlife.

Promoting sustainable livelihoods

Chapter III presented case studies highlighting the role of the communities as victims and sometimes as drivers of ITW. Some policy considerations to strengthen the role of communities in sustainably managing and conserving wildlife include:

- Providing incentives, and enabling conditions for them to be realized, for communities to manage wildlife sustainably;

- Empowering local communities to sustainably manage wildlife, for example through ‘Community-Based Natural Resource Management’ initiatives; and

- Seeking creative solutions for alternative means of supporting livelihoods and local economy needs, with support from both the private and public sectors.

- Identifying opportunities whereby sustainable trade in wildlife can reduce incentives for illegal and unsustainable trade.

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References

Ababouch, L. 2005. World inventory of fisheries. Trade implications of fish species identification. Issues Fact Sheets. In: *FAO Fisheries and Aquaculture Department* [online]. Rome. Available at: http://www.fao.org/fishery/topic/14807/en. [Accessed: 7/02/2015].

Abernethy, K.A., Coad, L., Taylor, G., Lee, M.E. and Maisels, F. 2013. Extent and ecological consequences of hunting in Central African rainforests in the twenty-first century. *Philosophical Transactions of the Royal Society of London. Series B: Biological Sciences*, 368(1625): 20120303.

Agnew, D.J. 2000. The illegal and unregulated fishery for toothfish in the Southern Ocean, and the CCAMLR catch documentation scheme. *Marine Policy*, 24: 361–374.

Agnew, D.J., Pearce, J., Pramod, G., Peatman, T., Watson, R., Beddington, J.R. and Pitcher, T.J. 2009. Estimating the worldwide extent of illegal fishing. *PLoS ONE*, 4(2).

Alacs, E. and Georges, A. 2008. Wildlife across our borders: a review of the illegal trade in Australia. *Australian Journal of Forensic Sciences*, 40(2): 147–160.

Alemagi, D. and Kozak, R. a. 2010. Illegal logging in Cameroon: causes and the path forward. *Forest Policy and Economics*, 12(8): 554–561.

Allendorf, F.W., England, P.R., Luikart, G., Ritchie, P.A. and Ryman, N. 2008. Generic effects of harvest on wild animal populations. *Trends in Ecology and Evolution*, 23(6): 327-337.

Amezian, M. & El Khamlichi, R. 2015. Significant population of Egyptian Vulture *Neophron percnopterus* found in Morocco. *Ostrich*, doi:10.2989/00306525.2015.1089334.

Anderson, S.C., Flemming, J.M., Watson, R. and Lotze, H.K. 2011. Rapid global expansion of invertebrate fisheries: trends, drivers, and ecosystem effects. *PLoS One*, 6(3): e14735.

Antonopoulou, M., Compton, J., Perry, L.S. and Al-Mubarak, R. 2010. *The trade and use of agarwood (oudh) in the United Arab Emirates*. TRAFFIC Southeast Asia, Petaling Jaya, Malaysia.

Ash, N., Blanco, H. and Brown, C. 2010. *Ecosystems and human well-being: a manual for assessment practitioners*. Island Press, London.

Bailey, T., Silvanose, C.-D., Naldo, J., Combreau, O., Launay, F., Wernery, U., Kinne, J., Gough, R. and Manvell, R. 2000. Health considerations of the rehabilitation of illegally traded houbara bustards *Chlamydotis undulata macqueenii* in the Middle East. *Oryx*, 34(04): 325.

Baillie, J.E.M. and Butcher, E.R. 2012. *Priceless or worthless? The world's most threatened species*. Zoological Society of London, London, United Kingdom.

Baillie, J., Challender, D., Kaspal, P., Khatiwada, A., Mohapatra, R. and Nash, H. 2014. *Manis crassicaudata*. The IUCN Red List of Threatened Species. Version 2014.2. Available at: www.iucnredlist.org. [Accessed: 6/07/2015].

Baker, C.S., Steel, D., Choi, Y., Lee, H., Kim, K.S., Choi, S.K., Ma, Y.-U., Hambelton, C., Psihoyos, L., Brownell, R.L. and Funahashi, N. 2010. Genetic evidence of illegal trade in protected whales links Japan with the US and South Korea. *Biology Letters*, 6(5): 647-650.

Banack, S.A. 1998. Diet selection and resource use by flying foxes (genus *Pteropus*). *Ecology*, 79(6): 1949–1967.

Barber, C. V. and Pratt, V.R. 1997. Policy reform and community-based programmes to combat cyanide fishing in Philippines. *SPC Live Reef Information Bulletin*, 3: 26–35.

Batbold, J., Batsaikhan, N., Tsytsulina, K. and Sukhchuluun, G. 2008. *Marmota sibirica*. Available at: www.iucnredlist.org. [Accessed: 21/01/2015].

BCGI 2007. *Tree-BOL to barcode world's 100,000 trees*. Available at: http://www.bgci.org/resources/news/0463/. [Accessed: 7/02/2015].

Betti, J 2008. *Non-Detriment Findings Report on Prunus Africana (Rosaceae) in Cameroon*. Case Study 9.

BGCI 2014. *Botanic gardens conservation international. Major threats to plant diversity*. Available at: http://www.bgci.org/global/threats/. [Accessed: 26/01/2015].

BirdLife International 2008. *Nearly half of all bird species are used directly by people. Presented as part of the BirdLife State of the World's Birds website*. Available at: http://www.birdlife.org/datazone/sowb/casestudy/98. [Accessed: 27/01/2015].

BirdLife International 2012. *Threatened birds occur in all habitats, but the majority are found in forest*. Available at: http://www.birdlife.org/datazone/sowb/casestudy/174. [Accessed: 3/02/2015].

BirdLife International 2013a. *Cyanopsitta spixii*. Available at: www.iucnredlist.org. [Accessed: 15/01/2015].

BirdLife International 2013b. *State of the world's birds: indicators for our changing world*. Cambridge, UK.

BirdLife International 2014. *Lophura edwardsi*. Available at: www.iucnredlist.org. [Accessed: 21/01/2015].

BirdLife International 2015a. IUCN Red List for birds. Available at: http://www.birdlife.org. [Accessed: 15/12/2015].

BirdLife International 2015b. *Wild bird trade and CITES*. Available at: http://www.birdlife.org/worldwide/policy/wild-bird-trade-and-cites. [Accessed: 27/01/2015].

BirdLife International 2015c. *2015 Red List – vultures, shorebirds and other iconic species*. Available at: http://www.birdlife.org/worldwide/news/2015-red-list-vultures-shorebirds-and-other-iconic-species. [Accessed: 11/04/2016].

Bodeker, G., van 't Klooster, C. and Weisbord, E. 2014. *Prunus africana* (Hook.f.) Kalkman: The overexploitation of a medicinal plant species and its legal context. *Journal of Alternative and Complementary Medicine*, 20(11): 810–822.

Bodenheimer, F.S. 1951. *Insects as human food*. The Hague, Netherlands, Junk. 352 pp.

Böhm, M. *et al*. 2013. The conservation status of the world's reptiles. *Biological Conservation*. 157: 372-385.

Van Borm, S., Thomas, I., Hanquet, G., Lambrecht, B., Boschmans, M., Dupont, G., Decaestecker, M., Snackern, R. and Van den Berg, T. 2005. Highly pathogenic H5N1 influenza virus in smuggled Thai eagles, Belgium. *Emerging Infectious Diseases*, 11(5): 702–705.

Boakye, M.K. Pietersen, D.W., Kotze, A., Dalton, D.L. and Jansen, R. 2014. Ethnomedicinal use of African pangolins by traditional medical practitioners in Sierra Leone. *Journal of Ethnobiology and Ethnomedicine*, 10: 76.

Brickle, N.W., Duckworth, J.W., Tordoff, A.W., Poole, C.M., Timmins, R. and McGowan, P.J.K. 2008. The status and conservation of Galliformes in Cambodia, Laos and Vietnam. *Biodiversity and Conservation*, 17: 1393–1427.

Broad, S., Mulliken, T. and Roe, D. 2003. The nature and extent of legal and illegal trade in wildlife. In: Oldfield, S. (Ed.). *The trade in wildlife: regulation for conservation*. Earthscan Publications Ltd, UK and USA. 3–22.

Brodie, J.F. and Gibbs, H.K. 2009. Bushmeat hunting as climate threat. *Science*, 326(5951): 364–365.

Brook, S.M., van Coeverden de Groot, P., Scott, C., Boag, P., Long, B., Ley, R.E., Reischer, G.H., Williams, A.C., Mahood, S.P., Minh Hien, T., Polet, G., Cox, N. and Thanh Hai, B. 2012. Integrated and novel survey methods for rhinoceros populations confirm the extinction of *Rhinoceros sondaicus annamiticus* from Vietnam. *Biological Conservation*, 155: 59-67.

Brooke, A. and Wiles, G. 2008. *Pteropus samoensis*. Available at: Available at: www.iucnredlist.org. [Accessed: 18/02/2015].

Brummitt, N. and Backman, S. 2010. *Plants under pressure – a global gssessment: The first report of the IUCN sampled Red List Index for plants*. Royal Botanic Gardens, Kew, UK.

Buij, R., Nikolaus, G., Whytock, R., Ingram, D.J. and Ogada. D. 2015. Trade of threatened vultures and other raptors for fetish and bushmeat in West and Central Africa. *Oryx*, doi:10.1017/S0030605315000514.

Burgess, E.A. and Lilley, R. 2014. *Assessing the trade in pig-nosed turtles Carettochelys insculpta in Papua, Indonesia*. TRAFFIC. Petaling Jaya, Selangor, Malaysia.
Burgess, E.A., Stoner, S.S. and Foley, K.-E. 2014. *Brought to bear: an analysis of seizures across Asia (2000-2011)*. Petaling Jaya, Selangor, Malaysia.
Burgin, S. 2006. Confirmation of an established population of exotic turtles in urban Sydney. *Australian Zoologist*, 33(3): 379–384.
Butchart, S.H.M. 2008. Red List Indices to measure the sustainability of species use and impacts of invasive alien species. *Bird Conservation International*, 18(S1): S245–S262.
Cadi, A. and Joly, P. 2004. Impact of the introduction of the red-eared slider (*Trachemys scripta elegans*) on survival rates of the European pond turtle (*Emys orbicularis*). *Biodiversity and Conservation*, 13(13): 2511–2518.
Campos-Arceiz, A. and Blake, S. 2011. Megagardeners of the forest - the role of elephants in seed dispersal. *Acta Oecologica*, 37(6): 542–553.
Cantú, J.C.G., Sánchez Saldaña, M.E., Grosselet, M. and Gamez, J.S. 2007. *The illegal parrot trade in Mexico. A comprehensive assessment.* Defenders of Wildlife, Bosques de las Lomas, Mexico.
Caramel, L. 2015. *China's rosewood craving cuts deep into Madagascar rainforests.* Available at: http://www.theguardian.com/environment/2015/feb/16/rosewood-madagascar-china-illegal-rainforest. [Accessed: 17/06/2015].
Carpenter, A.I., Dublin, H., Lau, M., Syed, G., McKay, J.E. and Moore, R.D. 2007. Over-harvesting. In: Gascon, C., Collins, J.P., Moore, R.D., Church, D.R., McKay, J.E. and Mendelson, J.R. (Eds.). *Amphibian Conservation Action Plan*. *Proceedings IUCN/SSC Amphibian Conservation Summit*. IUCN/SSC Amphibian Specialist Group, Gland, Switzerland and Cambridge, UK.
Cato, J.C. and Brown, C.L. (Eds.) 2003. *Marine ornamental species: Collection, culture, and conservation*. Iowa State Press, Ames, Iowa, USA.
CBD and SCBD 2010. Global Biodiversity Outlook 3. Secretariat of the Convention on Biological Diversity. Montreal.
CBD 2011. *Outcomes of the joint meeting of the CBD Liaison Group on Bushmeat and the CITES Central Africa Bushmean Working Group.* UNEP/CBD/LG-Bushmeat/2/4, 4 July 2011. Nairobi, 7-10 June 2011.
CCAMLR 1997. *Report of the sixteenth meeting of the Scientific Committee*. Hobart, Australia.
Cervino, J.M., Hayes, R.L., Honovich, M., Goreau, T.J., Jones, S. and Rubec, P.J. 2003. Changes in zooxanthellae density, morphology, and mitotic index in hermatypic corals and anemones exposed to cyanide. *Marine Pollution Bulletin*, 46(5): 573–586.
Challender, D.W.S. and Hywood, L. 2012. African pangolins under increased pressure from poaching and international trade. *TRAFFIC Bulletin*, 24(2): 53-55.
Challender, D.W.S., Nguyen Van, T., Shepherd, C., Krishnasamy, K., Wang, A., Lee, B., Panjang, E., Fletcher, L., Heng, S., Seah Han Ming, J., Olsson, A., Nguyen The Truong, A., Nguyen Van, Q. and Chung, Y. 2014a. *Manis javanica*. The IUCN Red List of Threatened Species. Version 2015.2. Available at: www.iucnredlist.org [Accessed on 08/07/2015].
Challender, D.W.S., Baillie, J., Ades, G., Kaspal, P., Chan, B., Khatiwada, A., Xu, L., Chin, S., KC, R., Nash, H. and Hsieh, H. 2014b. *Manis pentadactyla*. The IUCN Red List of Threatened Species. Version 2015.2. Available at: www.iucnredlist.org [Accessed on 08/07/2015].
Challender, D.W.S, Waterman, C., and Baillie, J.E.M. 2014c. *Scaling up pangolin conservation*. IUCN SSC Pangolin Specialist Group Conservation Action Plan. Zoological Society of London, London, UK.
Challender, D.W.S., Harrop, S.R., MacMillan, D.C. 2015. Understanding markets to conserve trade threatened species in CITES. *Biological Conservation*, 187: 249-259. Chandran, R., Chong, N.S.T., Doll, C.N.H., Lee, L.Y., Mathai, M.V., Nguyen, K. and Parayil, G. 2013. *Bytes beyond borders: strengthening transboundary information sharing on wildlife crime through the Wildlife Enforcement Monitoring System (WEMS) Initiative.* Policy Brief (pp. 8). Yokohama: United Nations University Institute of Advanced Studies.
Chidumayo, E.N. and Gumbo, D.J. 2013. The environmental impacts of charcoal production in tropical ecosystems of the world: a synthesis. *Energy for Sustainable Development*, 17(2): 86–94.
Chng, S.C.L. 2014. *Escalating black spotted turtle Geoclemys hamiltonii trade in Asia: a study of seizures.* TRAFFIC. Petaling Jaya, Selangor, Malaysia.
Cho, D.-O. 2012. Eliminating illegal bottom trawl fishing in the coastal waters of Korea. *Marine Policy,* 36(2): 321-326.
Chundawat, R.S., Habib, B., Karanth, U., Kawanishi, K., Ahmad Khan, J., Lynam, T., Miquelle, D., Nyhus, P., Sunarto, S., Tilson, R. and Wang, S. 2011. *Panthera tigris*. Available at: www.iucnredlist.org. [Accessed: 22/01/2015].
CITES 2004. *Consideration of proposals for amendment of Appendices I and II. Inclusion of* Gonystylus *spp. in Appendix II*. CoP13 Prop. 50.
CITES 2013a.*Consideration of proposals for amendment of Appendices I and II. Inclusion of the genus* Dalbergia *(populations of Madagascar) in CITES Appendix II.* CoP16 Prop. 63.
CITES 2013b. *Sixteenth meeting of the Conference of the Parties. Bangkok (Thailand), 03-14 March 2013*. Available at: http://www.cites.org/eng/cop/index.php. [Accessed: 29/01/2015].
CITES 2013c. *The Elephant Trade Information System (ETIS)*. Available at: http://www.cites.org/eng/prog/etis/index.php. [Accessed: 6/02/2015].
CITES 2014a *Consideration of proposals for amendment of Appendices I and II. Inclusion of* Lithophaga lithophaga *in CITES Appendix II.* CoP13 Prop. 35.
CITES 2014b. *Interpretation and implementation of the Convention. Species trade and conservation. Asian big cats.* SC65 Doc. 38.
CITES 2014c. *Interpretation and implementation of the Convention. Species trade and conservation. Elephants.* SC65 Doc. 42.1.
CITES 2015. *Elephant poaching rates virtually unchanged in 2014*. Available at: http://cites.org/eng/mike_figures2014. [Accessed: 24/03/2015].
CITES, IUCN and TRAFFIC 2013. *Status of African elephant populations and levels of illegal killing and the illegal trade in ivory: a report to the African Elephant Summit*. CITES Secretariat, IUCN/SSC African Elephant Specialist Group, and TRAFFIC International.
Clarke, S.C., McAllister, M.K. and Kirkpatrick, R.C. 2009. Estimating legal and illegal catches of Russian sockeye salmon from trade and market data. *ICES Journal of Marine Science*, 66(3): 532–545.
Clavero, M. and García-Berthou, E. 2005. Invasive species are a leading cause of animal extinctions. *Trends in Ecology and Evolution*, 20(3): 110.
CMS 2010. *Second meeting of the signatories to the memorandum of understanding concerning conservation, restoration and sustainable use of the saiga antelope.* SA-2 Doc.6. Convention on Migratory Species.
CMS 2015. *Third meeting of the signatories to the memorandum of understanding concerning conservation, restoration and sustainable use of the saiga antelope. Overview report on conservation status and MOU implementation.* MOS3 Doc.6. Convention on Migratory Species.
Cochrane, E.P. 2003. The need to be eaten: *Balanites wilsoniana* with and without elephant seed-dispersal. *Journal of Tropical Ecology* 19(5): 579–589.
Collar, N. 2015. Catch this falling star. World Birdwatch. BirdLife International. 11–13.
Cooney, R. and Jepson, P. 2006. The international wild bird trade: what's wrong with blanket bans? *Oryx*, 40(01): 18.
Costello, M.J. and Baker, S.C. 2011. Who eats sea meat? Expanding human consumption of marine mammals. *Biological Conservation*, 144(12): 2745–2746.
Cowlishaw, G., Mendelson, S. and Rowcliffe, J. 2005. Evidence for post□depletion sustainability in a mature bushmeat market. *Journal of Applied Ecology*, 42(3): 460-468.
Cox, P.A. and Elmqvist, T. 2000. Pollinator extinction in the Pacific Islands. *Conservation Biology*, 14(5): 1237–1239.
Croxall, J.P., Rothery, P.,ickering, S.P. and Prince, P.A. 1990. Reproductive performance, recruitment and survival of wandering albatrosses *Diomedea exulans* at bird island, South Georgia. *Journal of Animal Ecology*, 59: 779–796.

Cunningham, A.B., Tientcheu, M.L.A., Anoncho, V.F., Nkuinkeu, R. and Sunderland, T. 2014. *Power, profits and policy: A reality check on the Prunus africana bark trade.* Vol. 153. CIFOR.
Currey, D., Doherty, F., Lawson, S., Newman, J. and Ruwindrijarto, A. 2001. *Timber trafficking. Illegal logging in Indonesia, SE Asia and international consumption of illegally sourced timber*. Environmental Investigation Agency and Telapak Indonesia, Emmerson Press.
Davenport, T.R.B. and Ndangalasi, H.J. 2003. An escalating trade in orchid tubers across Tanzania's southern Highlands: assessment, dynamics and conservation implications. *Oryx*, 37(1): 55–61.
Daves, N.K. 2009. CITES gives hope to the Queen Conch. *Endangered Species Bulletin*, 34: 14–15.
DEA 2014. *South African government is aware that ongoing scourge of rhino poaching is linked to worldwide Illicit wildlife trade*. Available at: https://www.environment.gov.za/mediarelease/rhinopoaching_wildlifetrade. [Accessed: 21/01/2015].
DESA/UNSD. 2014. *United Nations Comtrade Database*. Available at: http://comtrade.un.org/ [Accessed: 27/10/2015].
Dinerstein, E., Loucks, C., Heydlauff, A., Wikramanayake, E., Bryja, G., Forrest, J., Gingsberg, J., Klenzendorf, S., Leimgruber, P., O'Brien, T. *et al*. 2006. *A user's guide: Setting priorities for the conservation and recovery of wild tigers: 2005-2015*. Washington, D.C. and New York.
Dirzo, R., Young, H.S., Galetti, M., Ceballos, G., Isaac, N.J.B. and Collen, B. 2014. Defaunation in the Anthropocene. *Science,* 345(6195): 401–406.
Doulman, D. 2000. A general overview of some aspects of illegal, unreported and unregulated fishing. Report of and Papers Presented at the Expert Consultation on Illegal, Unreported and Unregulated Fishing. *FAO fisheries report*, Rome.
Durst, P.B., Johnson, D.V., Leslie, R.N. and Shono, K. 2010. Forest insects as food: humans bite back. *RAP Publication 2010/02*. Bangkok, Thailand.
Echwikhi, K., Jribi, I., Bradai, M.N. and Bouain, A. 2012. Overview of loggerhead turtles coastal nets interactions in the Mediterranean Sea. *Aquatic Conservation: Marine and Freshwater Ecosystems*, 22(6): 827–835.
Effiom, E.O., Nuñez-Iturri, G., Smith, H.G., Ottosson, U. and Olsson, O. 2013. Bushmeat hunting changes regeneration of African rainforests. *Proceedings of the Royal Society of London B: Biological Sciences*, 280(1759): 20130246.
EIA 2012a. *Appetite for destruction: China's trade in illegal timber*. London, UK.
EIA 2012b. *Briefing on snow leopards in illegal trade - Asia's forgotten cats*. Available at: http://www.eia-international.org/wp-content/uploads/EIA-Briefing-on-Snow-Leopards-in-Illegal-Trade-%E2%80%93-Asia%E2%80%99s-Forgotten-Cats.pdf. [Accessed: 23/01/2015].
EIA 2014. *The ongoing illegal logging crisis in Madagascar – An EIA Briefing for CITES SC65.*
EIA 2015. Seeing 'red' – the often hidden colour of wildlife contraband. Available at: https://eia-international.org/seeing-red-the-often-hidden-colour-of-wildlife-contraband. [Accessed: 11/12/2015].
Emslie, R. 2011. *Diceros bicornis ssp. longipes*. The IUCN Red List of Threatened Species. Version 2014.3. Available at: www.iucnredlist.org. [Accessed: 22/01/2015].
Emslie, R. 2012. *Diceros bicornis.* The IUCN Red List of Threatened Species. Version 2012.2. Available at: www.iucnredlist.org. [Accessed: 22/01/2015].
Engler, M. 2008. The value of wildlife trade. *TRAFFIC Bulletin*, 22(1): 4–5.
Fa, J.E. and Brown, D. 2009. Impacts of hunting on mammals in African tropical moist forests: a review and synthesis. *Mammal Review*, 39(4): 231–264.
Fa, J.E., Currie, D. and Meeuwig, J. 2003. Bushmeat and food security in the Congo Basin: linkages between wildlife and people's future. *Environmental Conservation* 30: 71–78.
Fa, J.E. and Peres, C.A. 2001. Game vertebrate extraction in African and Neotropical forests: an intercontinental comparison. In: Reynolds, J.D., Mace, G.M., Redford, K.H. and Robinson, J.G. (Eds.). *Conservation of Exploited Species*. Cambridge University Press, Cambridge, U.K. 203–241.
Fa, J.E., Peres, C.A. and Meeuwig, J. 2002. Bushmeat exploitation in tropical forests: an international comparison. *Conservation Biology* 16: 232–237.
Fanelli, G., Piraino, S., Belmonte, G., Geraci, S. and Boero, F. 1994. Human predation along Apulian rocky coasts (SE Italy): desertification caused by *Lithophaga lithophaga* (Mollusca) fisheries. *Marine ecology progress series. Oldendorf.* 110(1): 1-8.
FAO 1995. Code of conduct for responsible fisheries. Food and Agriculture Organization of the United Nations (FAO), Rome, Italy.
FAO 2001. International Plan of Action to prevent, deter and eliminate illegal unreported and unregulated fishing. Food and Agriculture Organization of the United Nations (FAO), Rome, Italy.
FAO 2005. *State of the World's Forests 2005.* Food and Agriculture Organization of the United Nations (FAO), Rome, Italy.
FAO 2009. *State of the World's Forests 2009*. Food and Agriculture Organization of the United Nations (FAO), Rome, Italy.
FAO 2010. *Global Forest Resources Assessment 2010 – Key findings*. Food and Agriculture Organization of the United Nations (FAO), Rome, Italy.
FAO 2011. *State of the World's Forests 2011*. Food and Agriculture Organization of the United Nations (FAO), Rome, Italy.
FAO 2012. *The State of World Fisheries and Aquaculture*. Food and Agriculture Organization of the United Nations (FAO), Rome, Italy.
FAO 2014a. *FAO yearbook. Fishery and Aquaculture Statistics. 2012/FAO annuaire. Statistiques des pêches et de l'aquaculture. 2012/FAO anuario. Estadísticas de pesca y acuicultura. 2012.* Food and Agriculture Organization of the United Nations (FAO), Rome, Italy.
FAO 2014b. *The state of world fisheries and aquaculture 2014*. Food and Agriculture Organization of the United Nations (FAO), Rome, Italy.
FAO 2015a. *Forest products statistics. Facts and figures*. Available at: http://www.fao.org/forestry/statistics/80938/en/. [Accessed: 18/02/2015].
FAO 2015b. *Global Forest Resources Assessment 2015 - How are the world's forests changing?*. Food and Agriculture Organization of the United Nations (FAO), Rome, Italy.
FAOSTAT 2014. *Forestry production and trade: wood charcoal*. Food and Agriculture Organization of the United Nations Statistics Division. Available at: http://faostat3.fao.org/download/F/FO/E. [Accessed: 02/02/2015].
Felton, A.M., Engström, L.M., Felton, A. and Knott, C.D. 2003. Orangutan population density, forest structure and fruit availability in hand-logged and unlogged peat swamp forests in West Kalimantan, Indonesia. *Biological Conservation*, 114(1): 91–101.
Ferriss, S. 2014. *An analysis of trade in five CITES-listed taxa*. London.
Fidenci, P. and Maran, J. 2009. Illegal domestic trade of the Philippine forest turtle (*Siebenrockiella leytensis*) in the Philippines. *TurtleLog*, 3.
Flores-Palacios, A. and Valencia-Díaz, S. 2007. Local illegal trade reveals unknown diversity and involves a high species richness of wild vascular epiphytes. *Biological Conservation*, 136(3): 372–387.
Frankham, R. 2005. Genetics and extinction. *Biological Conservation*, 126(2): 131-140.
Fraschetti, S., Bianchi, C.N., Terlizzi, A., Fanelli, G., Morri, C. and Boero, F. 2001. Spatial variability and human disturbance in shallow subtidal hard substrate assemblages: a regional approach. *Marine Ecology Progress Series:* 212: 1-12.
Fragoso, C., Brown, G.G., Patron, J.C., Blanchart, E., Lavelle, P., Pashanasi, B., Senapati, B. and Kumar, T. 1997. Agricultural intensification, soil biodiversity and agroecosystem function in the tropics: the role of earthworms. *Applied Soil Ecology,* 6(1): 17–35.
Froese, R. and Pauly, D. 2014. *FishBase, version 11/2014*. Available at: www.fishbase.org. [Accessed: 11/02/2015].

Frost, D.R. 2014. *Amphibian species of the world: an online reference. Version 6.0*. Available at: http://research.amnh.org/vz/herpetology/amphibia/. [Accessed: 29/01/2015].

Gang, L., Baorong, G. and Ermi, Z. 2004. *Andrias davidianus*. The IUCN Red List of Threatened Species. Version 2014.3. Available at: www.iucnredlist.org. [Accessed: 13/02/2015].

Gascon, C., Brooks, T.M., Contreras-MacBeath, T., Heard, N., Konstant, W., Lamoreux, J., Launay, F., Maunder, M., Mittermeier, R.A., Molur, S., Khalifa Al Mubarak, R., Parr, M.J., Rhodin, A.G.J., Rylands, A.B., Soorae, P., Sanderson, J.G. and Vie, J.-C. 2015. The importance and benefits of species. *Current Biology,* 25: 431–438.

Gastañaga, M., Macleod, R., Hennessey, B., Núñez, J.U., Puse, E., Arrascue, A., Hoyos, J., Chambi, W.M., Vasquez, J. and Engblom, G. 2011. A study of the parrot trade in Peru and the potential importance of internal trade for threatened species. *Bird Conservation International*, 21(01): 76–85.

Gaston, K.J. and Fuller, R. 2008. Commonness, population depletion and conservation biology. *Trends in Ecology and Evolution*, 23(1): 14–19.

Ghorbani, A., Gravendeel, B. and Naghibi, F. 2014. Wild orchid tuber collection in Iran: a wake-up call for conservation. *Biological Conservation*, 23(11): 2749–2760.

Global Witness and EIA 2009. *Investigation into the illegal felling, transport and export of precious wood in Sava Region Madagascar*. Global Witness, London.

Global Witness and EIA 2010. *Investigation into the global trade in Malagasy precious woods: rosewood, ebony and pallisander*. Global Witness and the Environmental Investigation Agency, US.

Goettsch, B., Hilton-Taylor, C., Cruz-Pinon, G., Duffy, J.P., Frances, A., Hernandez, H.M., Inger, R. *et al.* 2015. High proportion of cactus species threatened with extinction. Nature Plants, 15142.

Gómez, A. and Aguirre, A. 2008. Infectious diseases and the illegal wildlife trade. *Annals of the New York Academy of Sciences*, 1149(1): 16–9.

Gong, S.P., Chow, A.T., Fong, J.J. and Shi, H.T. 2009. The chelonian trade in the largest pet market in China: scale, scope and impact on turtle conservation. *The International Journal of Conservation*, 43(02): 1–2.

Green, R., Newton, I., Shulz, S., Cunningham, A.A., Gilbert, M., Pain, D.J., Prakash, V., 2004. Diclofenac poisoning as a cause of vulture population declines across the Indian subcontinent. *Journal of Applied Ecology* 41: 793–800.

Guidetti, P. 2011. The destructive date-mussel fishery and the persistence of barrens in Mediterranean rocky reefs. *Marine Pollution Bulletin*, 62: 691-695.

Haken, J. 2011. *Transnational crime in the developing world*. Global Financial Integrity - A Program of the Center for International Policy.

Hamilton, S. and Helgen, K. 2008. *Pteropus tonganus*. The IUCN Red List of Threatened Species. Version 2014.3. Available at: www.iucnredlist.org. [Accessed: 18/02/2015].

Han G.S. 2002. The problem of small bottom trawl fishing, *Sunhaksa*.

Hansen, C.P. and Treue, T. 2008. Assessing illegal logging in Ghana. *International Foresty Review*, 10(4): 573–590.

Harley, E.H., Baumgarten, I., Cunningham, J. and O'Ryan, C. 2005. Genetic variation and population structure in remnant populations of black rhinoceros, *Diceros bicornis*, in Africa. *Molecular Ecology*, 14(10): 2981–2990.

Harrison, R.D., Tan, S., Plotkin, J.B., Slik, F., Detto, M., Brenes, T., Itoh, A. and Davies, S.J. 2013. Consequences of defaunation for a tropical tree community. *Ecology letters*, 16(5): 687–94.

Hastings, A., Byers, J.E., Crooks, J.A., Cuddington, K., Jones, C.G., Lambrinos, J.G., Talley, T.S. and Wilson, W.G. 2007. Ecosystem engineering in space and time. *Ecology Letters*, 10(2): 153–164.

Haynes, G. 2012. Elephants (and extinct relatives) as earth-movers and ecosystem engineers. *Geomorphology*, 157: 99–107.

Henschel, P., Hunter, L.T.B., Coad, L., Abernethy, K.A. and Mühlenberg, M. 2011. Leopard prey choice in the Congo Basin rainforest suggests exploitative competition with human bushmeat hunters. *Journal of Zoology*, 285(1): 11–20.

Hernandez-Castro, J. and Roberts, D. L. 2015. Automatic detection of potentially illegal online sales of elephant ivory via data mining. *PeerJ Computer Science*, 1, e10.

Herrel, A. and van der Meijden, A. 2014. An analysis of the live reptile and amphibian trade in the USA compared to the global trade in endangered species. *Herpetological Journal*, 24(2): 103–110.

Herrera, M. and Hennessey, B. 2007. Quantifying the illegal parrot trade in Santa Cruz de la Sierra, Bolivia, with emphasis on threatened species. *Bird Conservation International*, 17(4): 295–300.

Hii, R. 2015. Helmeted Hornbills on the verge of extinction. Huffington Post. Available at: http://www.huffingtonpost.com/robert-hii/helmeted-hornbills-on-the_b_6804302.html [Accessed on 11/12/2015].

Hoogmoed, M.S. and Avila-Pires, T.C.S. 2012. Inventory of color polymorphism in populations of *Dendrobates galactonotus* (Anura: Dendrobatidae), a poison frog endemic to Brazil. *Phyllomedusa*, 11(2): 95–115.

Hooijer, A., Page, S., Canadell, J.G., Silvius, M., Kwadijk, J., Wösten, H. and Jauhiainen, J. 2010. Current and future CO 2 emissions from drained peatlands in Southeast Asia. *Biogeosciences*, 7: 1505–1514.

Hughes, T.P. 1994. Catastrophes, phase shifts and large-scale degradation of a Caribbean coral reef. *Science*, 265(5178): 1547–1551.

Hughes, T.P., Bellwood, D.R., Folke, C.S., McCook, L.J. and Pandolfi, J.M. 2007. No-take areas, herbivory and coral reef resilience. *Trends in Ecology and Evolution*, 22(1): 1–3.

Hulme, P.E. 2009. Trade, transport and trouble: managing invasive species pathways in an era of globalization. *Journal of Applied Ecology*, 46(1): 10–18. Humber, F., Godley, B.J. and Broderick, A.C. 2014. So excellent a fishe: a global overview of legal marine turtle fisheries. *Diversity and Distributions*, 20: 579–590.

Humber, F., Godley, B.J. and Broderick, A.C. 2014. So excellent a fishe: a global overview of legal marine turtle fisheries. Diversity and Distributions, 20: 579–590.

Humber, F., Godley, B.J., Ramahery, V. and Broderick, A.C. 2011. Using community members to assess artisanal fisheries: the marine turtle fishery in Madagascar. *Animal Conservation*, 14(2): 175-185.

Husson, S.J., Morrogh-Bernard, H., Santiano, Purwanto, A., Harsanto, F., McLardy, C.S. and D'Arcy, L.J. *in prep*. The dramatic crash and subsequent recovery of a population of Bornean orangutans: the results of a 15-year monitoring study in the Sabangau peat-swamp forest. In: *Status of non-captive apes*.

IEA 2014. *Africa energy outlook*. International Energy Agency, Paris.

Iqbal, M. 1993. *International Trade in Non-Wood Forest Products: An Overview*. FO: Misc/93/11 Working Paper. Food and Agriculture Organization of the United Nations, Rome.

Interpol 2015. *Environmental crime*. Available at: http://www.interpol.int/Crime-areas/Environmental-crime/Environmental-crime. [Accessed: 6/02/2015].

IOSEA 2014. *Memorandum of Understanding on the conservation and management of marine turtles and their habitats of the Indian Ocean and South-East Asia. Illegal take and trade of marine turtles in the IOSEA region*.

ITTO 2014. *Tropical timber market report: 1 - 15 April 2014*. 18(7)

IUCN 2011. *Guidelines for appropriate uses of IUCN Red List Data. Incorporating the Guidelines for Reported on Proportion Threatened and the Guidelines on Scientific Collecting of Threatened Species*. Version 2. Adopted by the IUCN Red List Committee and IUCN SSC Steering Committee.

IUCN/SSC AfESG 2013. *2013 provisional African elephant status report: an update from the African Elephant Database*. Gland, Switzerland.

IUCN 2015a. Summary statistics table 1: numbers of threatened species by major groups of organisms (1996–2015). Available at: http://cmsdocs.s3.amazonaws.com/summarystats/2015_2_Summary_Stats_Page_Documents/2015_2_RL_Stats_Table_1.pdf [Accessed on 23/06/2015].

IUCN 2015b. *The IUCN Red List of Threatened Species.* Version 2015.2. Available at: www.iucnredlist.org [Accessed on 24/06/2015].

Ishwar, N. M., Das, S., Kumari, J., Prakash, V. and Sinha, P. R. 2015. Economic valuation saves vultures. The Economics of Ecosystems and Biodiversity - India Initiative, Factsheet T11. MoEFCC India & GIZ.

IWC 2015. *Whaling*. International Whaling Commission. Available at: https://iwc.int/whaling [Accessed: 17/06/2015].

Jackson, J.B., Kirby, M.X., Berger, W.H., Bjorndal, K.A., Botsford, L.W., Bourque, B.J., Bradbury, R.H., Cooke, R., Erlandson, J., Estes, J.A. *et al*. 2001. Historical overfishing and the recent collapse of coastal ecosystems. *Science*, 293(5530): 629–37.

Jackson, P. 1982. *Elephants and Rhinos in Africa: a time for decision*. IUCN. Gland, Switzerland. 36pp.

Jenkins, R.K.B., Tognelli, M.F., Bowles, P., Cox, N., Brown, J.L., Chan, L., Andreone, F., Andriamazava, A., Andriantsimanarilafy, R.R., Anjeriniaina, M. *et al*. 2014. Extinction risks and the conservation of Madagascar's reptiles. *PLoS ONE*, 9(8): e100173.

Jhala, Y.V., Qureshi, Q. and Gopal, R. (Eds.) 2015. *The status of tigers in India 2014*. National Tiger Conservation Authority, New Delhi and The Wildlife Institute of India, Dehradun.

Jenkins, P.T. and Fitzgerald, J. 2011. *Recommendations for protecting forests from introduced forest pests and plant pathogens*. Society for Conservation Biology, December 2011.

Jones, C.G., Lawton, J.H. and Shachak, M. 1997. Positive and negative effects of organisms as ecosystem engineers. *Ecology,* 78(7): 1946–1957.

Jones-Engel, L., Engel, G.A., Schillaci, M.A., Babo, R. and Froehlich, J. 2001. Detection of antibodies to selected human pathogens among wild and pet macaques (*Macaca tonkeana*) in Sulawesi, Indonesia. *American Journal of Primatology*, 54(3): 171–178.

Kaiser, M.J. and Jennings, S. 2001. Ecosystem perspectives on conserving targeted and non-targeted species. In: Reynolds, J.D., Mace, G.M., Redford, K.H. and Robinson, J.G. (Eds.). *Conservation of exploited species*. Cambridge University Press, Cambridge, U.K. 343–369.

Kambewa, P., Mataya, B., Sichinga, K. and Johnson, T. 2007. *Charcoal: the reality - a study of charcoal consumption, trade and production in Malawi.* Small and Medium Forestry Enterprise Series. No. 21. London.

Kasterine, A., Arbeid, R., Caillabet, O. and Natusch, D. 2012. *The trade in south-east Asian python skins*. International Trade Centre, Geneva, Switzerland.

Keuroghlian, A. and Eaton, D.P. 2009. Removal of palm fruits and ecosystem engineering in palm stands by white-lipped peccaries (*Tayassu pecari*) and other frugivores in an isolated Atlantic Forest fragment. *Biodiversity and Conservation,* 18(7): 1733–1750.

Kew. 2012. *Plants Under Pressure – A Global Assessment: IUCN Sampled Red List Index for Plants*. Royal Botanic Gardens, Kew, UK.

Kilpatrick, A.M., Briggs, C.J. and Daszak, P. 2010. The ecology and impact of chytridiomycosis: an emerging disease of amphibians. *Trends in Ecology and Evolution*, 25(2): 109–118.

Kitamura, S. 2011. Frugivory and seed dispersal by hornbills (Bucerotidae) in tropical forests. *Acta Oecologica*. 37(6): 531-541.

Kock, K.H. 2001. The direct influence of fishing and fishery-related activities on non-target species in the Southern Ocean with particular emphasis on longline fishing and its impact on albatrosses and petrels - a review. *Reviews in Fish Biology and Fisheries*, 11(1): 31–56.

Köndgen, S., Kühl, H., N'Goran, P.K., Walsh, P.D., Schenk, S., Ernst, N., Biek, R., Formenty, P., Mätz-Rensing, K., Schweiger, B. *et al*. 2008. Pandemic human viruses cause decline of endangered great apes. *Current Biology,* 18(4): 260–4.

Kraus, F. 2009. *Alien reptiles and amphibians: a scientific compendium and analysis*. Springer - Verlag, New York.

Kümpel, N.F., Cunningham, A.A., Fa, J.E., Jones, J.P.G., Rowcliffe, J.M. and Milner-Gulland, E.J. 2015. *Ebola and bushmeat: myth and reality.* NWFP Update. 5pp.

Kusrini, M.D. and Alford, R.A. 2006. Indonesia's exports of frogs' legs. *TRAFFIC Bulletin*, 21(1): 13–24.

Laird, S.A., Wynberg, R.P. and McLain, R.J. 2009. *Wild product governance: laws and policies for sustainable and equitable non-timber forest products use.*

Lawson, K. and Vines, A. 2014. *Global impacts of the illegal wildlife trade. The costs of crime, insecurity and institutional erosion*. Chatham House, London, UK.

Lawson, S. and MacFaul, L. 2010. *Illegal logging and related trade: indicators of the global response*. Chatham House (The Royal Institute of International Affairs), London.

Leader-Williams, N. 1992. *World trade rhino horn*. TRAFFIC International.

Lim, T.W. and Awang Anak, N. 2010. Wood for trees: a review of the agarwood (gaharu) trade in Malaysia*TRAFFIC Southeast Asia*, Petaling Jaya, Selangor, Malaysia.

Lindsey, P., Balme, G., Becker, M., Begg, C., Bento, C., Bocchino, C., Dickman, A., Diggle, R., Eves, H., Henschel, P. *et al.* 2012. *Illegal hunting and the bush-meat trade in savanna Africa: drivers, impacts and solutions to address the problem.* Panthera/Zoological Society of London/Wildlife Conservation Society. New York. 74 pp.

Lindsey, P.A., Balme, G., Becker, M., Begg, C., Bento, C., Bocchino, C., Dickman, A., Diggle, R.W., Eves, H., Henschel, P. *et al*. 2013. The bushmeat trade in African savannas: Impacts, drivers, and possible solutions. *Biological Conservation*, 160: 80–96.

Lyons, J.A. and Natusch, D.J.D. 2011. Wildlife laundering through breeding farms: illegal harvest, population declines and a means of regulating the trade of green pythons (Morelia viridis) from Indonesia. *Biological Conservation*, 144(12): 3073–3081.

Lyons, K.G., Brigham, C.A., Traut, B.H. and Schwartz, M.W. 2005. Rare species and ecosystem functioning. *Conservation Biology*, 19(4): 1019–1024.

De Magalhães, A.L.B. and São-Pedro, V.A. 2012. Illegal trade on non-native amphibians and reptiles in southeast Brazil: the status of e-commerce. *Phyllomedusa*, 11(2): 155–160.

Machua, J., Kamondo, B., Mwangi, L., Gitehi, G., Chahilu, O., Muchiri, M.N., Ochieng, D., Tuwei, P. and Wanjiku, J. 2009. Propagation of *Osyris lanceolata* (East African Sandalwood). In: *Recent Advances in Forestry Research for Environmental Conservation, Improved Livelihood and Economic Development*. Proceedings of the 4th KEFRI Scientific Conference, KEFRI Headquarters, Muguga, Kenya, 6 to 9 October 2008. Kenya Forestry Research Institute. Pp: 207-218.

Maisels, F., Strindberg, S., Blake, S., Wittemyer, G., Hart, J., Williamson, E.A., Aba'a, R., Abitsi, G., Ambahe, R.D., Amsini, F. *et al*. 2013. Devastating decline of forest elephants in central Africa. *PloS one*, 8(3).

Makoye, K. 2015. *Armed illegal loggers devastate Tanzania's coastal forest*. Available at: http://www.reuters.com/article/2015/01/13/us-tanzania-logging-idUSKBN0KM00720150113. [Accessed: 3/02/2015].

Mallon, D.P. 2008a. *Pantholops hodgsonii.* The IUCN Red List of Threatened Species. Version 2014.3. Available at: www.iucnredlist.org. [Accessed: 23/01/2015].

Mallon, D.P. 2008b. *Saiga tatarica.* The IUCN Red List of Threatened Species. Version 2010.4. Available at: http://www.iucnredlist.org. [Accessed: 23/01/2015].

Manchester, S.J. and Bullock, J.M. 2000. The impacts of non-native species on UK biodiversity and the effectiveness of control. *Journal of Applied Ecology*, 37(5): 845–864.
Margalida, A., Carrete, M., Sánchez-Zapata, J. A. and Donázar, J. A. 2012. Good News for European Vultures. *Science* 335: 284 (with correction in *Science* 337: 524).
Mark, J., Newton, A.C., Oldfield, S. and Rivers, M. 2014. *The international timber trade: a working list of commercial timber tree species*. Botanic Gardens Conservation International, London, UK.
Markandya, A., Taylor, T., Longo, A., Murty, M. N., Murty, S. and Dhavala, K. 2008. Counting the cost of vulture decline—An appraisal of the human health and other benefits of vultures in India. *Ecological Economics,* doi:10.1016/j.ecolecon.2008.04.020.
McNoughton, S.J., Banyikwa, F.F. and McNoughton, M.M. 1997. Promotion of the cycling of diet-enhancing nutrients by African grazers. *Science*, 278(5344): 1798–1800.
MCS 2014. *International monitoring, control and surveillance (MCS) network for fisheries-related activities*. Available at: http://www.imcsnet.org/about-us/. [Accessed: 6/02/2015].
Von Meibom, S., Vaisman, A., Neo Liang, S.H., Ng, J. and Xu, H. 2010. *Saiga antelope trade: global trends with a focus on South-East Asia*. TRAFFIC Europe, Brussels, Belgium.
Meijaard, E., Buchori, D., Hadiprakarsa, Y., Utami-Atmoko, S.S., Nurcahyo, A., Tjiu, A., Prasetyo, D., Nardiyono, C.L., Ancrenaz, M. *et al*. 2011. Quantifying killing of orangutans and human-orangutan conflict in Kalimantan, Indonesia. *PloS One*, 6(11): e27491.Milledge, S.A.H., Gelvas, I.K. and Ahrends, A. 2007. *Forestry, governance and national development: Lessons learned from a logging boom in southern Tanzania*. TRAFFIC East/Southern Africa, Tanzania Development Partners Group and Ministry of Natural Resources of Tourism, Dar es Salaam, Tanzania.
Milliken, T. 2014. *Illegal trade in ivory and rhino horn: an assessment to improve law enforcement under the wildlife TRAPS project*. Cambridge, UK.
Milner-Gulland, E.J., Bukreeva, O.M., Coulson, T., Lushchekina, A.A., Kholodova, M. V., Bekenov, A.B. and Grachev, I.A. 2003. Reproductive collapse in saiga antelope harems. *Nature*, 422(6928): 135.
Milner-Gulland, E.J. 2015. Catastrophe and hope for the saiga. *Oryx,* 49(4):577.
Moberg, F.d Folke, C. 1999. Ecological goods and services of coral reef ecosystems. *Ecological Economics*, 29(2): 215–233.
Mondol, S., Karanth, K.U. and Ramakrishnan, U. 2009. Why the Indian subcontinent holds the key to global tiger recovery. *PLoS Genetics*, 5(8).
Mora, C., Tittensor, D.P., Adl, S., Simpson, A.G.B. and Worm, B. 2011. How many species are there on Earth and in the ocean? *PLoS biology*, 9(8): e1001127.
Moro, M., Fischer, A., Czajkowski, M., Brennan, D., Lowassa, A., Naiman, L.C. and Hanley, N. 2013. An investigation using the choice experiment method into options for reducing illegal bushmeat hunting in western Serengeti. *Conservation Letters*, 6(1): 37-45.Mouillot, D., Bellwood, D.R., Baraloto, C., Chave, J., Galzin, R., Harmelin-Vivien, M., Kulbicki, M., Lavergne, S., Lavorel, S., Mouquet, N. *et al*. 2013. Rare species support vulnerable functions in high-diversity ecosystems. *PLoS Biology*, 11(5): e1001569.
MRAG 2005. *IUU fishing on the high seas: impacts on ecosystems and future science needs*. Marine Resources Assessment Group (MRAG), London, UK.
Mumby, P.J. and Harborne, A.R. 2010. Marine reserves enhance the recovery of corals on Caribbean reefs. *PloS ONE*, 5(1): e8657.
Murdoch, J.D., Munkhzul, T., Buyandelger, S., Reading, R.P. and Sillero-Zubiri, C. 2009. The endangered Siberian marmot *Marmota sibirica* as a keystone species? Observations and implications of burrow use by corsac foxes *Vulpes corsac* in Mongolia. *Oryx*, 43(3): 431–434.
Nasi, R., Taber, A. and Vliet, N. V 2011. Empty forests, empty stomachs? Bushmeat and livelihoods in the Congo and Amazon Basins. *International Forestry Review*, 13(3): 355–368.
Nasseri, N.A., Mcbrayer, L.D. and Schulte, B.A. 2011. The impact of tree modification by African elephant (*Loxodonta africana*) on herpetofaunal species richness in northern Tanzania. *African Journal of Ecology*, 49(2): 133–140.
Nellemann, C., Henriksen, J., Raxter, P., Ash, N. and Mrema, E. 2014. *The environmental crime crisis - Threats to sustainable development from illegal exploitation and trade in wildlife and forest resources*. UNEP and GRID-Arendal, Nairobi, Kenya and Arendal, Norway.
Nellemann, C., Miles, L., Kaltenborn, B.P., Virtue, M. and Ahlenius, H. (Eds.) 2007. *The last stand of the orangutan - state of emergency: illegal logging, fire and palm oil in Indonesia's national parks*. UNEP and GRID-Arendal, Nairobi, Kenya and Arendal, Norway.
New, T. 2005. 'Inordinate fondness': A threat to beetles in south east Asia? *Journal of Insect Conservation*. 9: 147-150.
Newell, R.I.E. 2004. Ecosystem influences of natural and cultivated populations of suspension-feeding bivalve molluscs: a review. *Journal of Shellfish Research*, 23(1): 51–61.
Newman, C. 2014. *Overview of the reptiles trade in the UK*. Reptile Forum, London Zoo 25th March 2-14.
Newton, P., Van Thai, N., Roberton, S., and Bell, D. 2008. Pangolins in peril: using local hunters' knowledge to conserve elusive species in Vietnam. *Endangered Species Research*, 6(1): 41-53.
Nijman, V. and Shepherd, C.R. 2009. *Wildlife trade from ASEAN to the EU: issues with the trade in captive-bred reptiles from Indonesia*. TRAFFIC Europe Report for the European Commission, Brussels, Belgium.
Nijman, V., Shepherd, C.R., Sanders, K.L. and Sanders, M. 2012a. Over-exploitation and illegal trade of reptiles in Indonesia. *Herpetological Journal*, 22(2): 83–89.
Nijman, V., Todd, M. and Shepherd, C.R. 2012b. Wildlife trade as an impediment to conservation as exemplified by the trade in reptiles in Southeast Asia. In: Gower, D.J., Richardson, J.E., Rosen, B.R., Rüber, L. and Williams, S.T. (Eds.). *Biotic evolution and environmental change in Southeast Asia*. Cambridge University Press, Cambridge, UK. 390–405.
Noureen, U., Khan, A. and Arshad, M. 2012. Exploring illegal trade in freshwater turtles in Pakistan. *Records Zoological Survey of Pakistan*, 21: 19–24.
Nuñez-Iturri, G., Olsson, O. and Howe, H.F. 2008. Hunting reduces recruitment of primate-dispersed trees in Amazonian Peru. *Biological Conservation*, 141(6): 1536–1546.
O'Grady, J.J., Reed, D.H., Brook, B.W. and Frankham, R. 2004. What are the best correlates of predicted extinction risk? *Biological Conservation*, 118(4): 513-520.
Ogada, D., Shaw, P., Beyers, R.L., Buij , R., Murn, C., and Thiollay, J. M. et al. 2015a. Another continental vulture crisis: Africa's vultures collapsing toward extinction. *Conservation Letters.* Available at: http://dx.doi.org/10.1111/conl.12182. [Accessed: 29/03/2016].
Ogada, D., Botha, A. and Shaw, P. 2015b. Ivory poachers and poison: drivers of Africa's declining vulture populations. *Oryx*, doi:10.1017/S0030605315001209.
Okello, J.B., Wittemyer, G., Rasmussen, H.B., Arctander, P., Nyakaana, S., Douglas-Hamilton, I. and Siegismund, H.R. 2008. Effective population size dynamics reveal impacts of historic climatic events and recent anthropogenic pressure in African elephants. *Molecular Ecology*, 17(17): 3788–3799.
Oldfield, S. 2003. *The trade in wildlife: regulation for conservation*. Earthscan Publications Ltd., London.
Olsgard, F., Schaanning, M.T., Widdicombe, S., Kendall, M.A. and Austen, M.C. 2008. Effects of bottom trawling on ecosystem functioning. *Journal of Experimental Marine Biology and Ecology* 366(1): 123–133.

Österblom, H. and Sumaila, U.R. 2011. Toothfish crises, actor diversity and the emergence of compliance mechanisms in the Southern Ocean. *Global Environmental Change*, 21(3): 972–982.
Pace, M.L., Cole, J.J., Carpenter, S.R. and Kitchell, J.F. 1999. Trophic cascades revealed in diverse ecosystems. *Trends in Ecology and Evolution*, 14(12): 483–488.
Page, S.E., Rieley, J.O., Shotyk, W. and Weiss, D. 1999. Interdependence of peat and vegetation in a tropical peat swamp forest. *Philosophical Transactions of the Royal Society of London. Series B, Biological Sciences*, 354(1391): 1885–1897.
Page, S.E., Siegert, F., Rieley, J.O., Boehm, H.D. V, Jaya, A. and Limin, S. 2002. The amount of carbon released from peat and forest fires in Indonesia during 1997. *Nature*, 420(6911): 61–65.
Palanques, A., Puig, P., Guillén, J., Demestre, M. and Martin, J. 2014. Effects of bottom trawling on the Ebro continental shelf sedimentary system (NW Mediterranean). *Continental Shelf Research.* 72: 83-98.
Pauly, D. and Maclean, J. 2003. *In a perfect ocean: the state of the world's oceans series*. Island Press, Washington DC, USA.
Pedersen, A.B. and Davies, T.J. 2009. Cross-species pathogen transmission and disease emergence in primates. *EcoHealth*, 6(4): 496–508.
Perez-Santigosa, N., Diaz-Paniagua, C. and Hidalgo-Vila, J. 2008. The reproductive ecology of exotic *Trachemys scripta elegans* in an invaded area of southern Europe. *Aquatic Conservation-Marine and Freshwater Ecosystems*, 18: 1302–1310.
Perry, R.I., Cury, P., Brander, K., Jennings, S., Möllmann, C. and Planque, B. 2010. Sensitivity of marine systems to climate and fishing: concepts, issues and management responses. *Journal of Marine Systems*, 79(3-4): 427–435.
Peter, C. and Sander, K. 2009. *Environmental crisis or sustainable development opportunity? Transforming the charcoal sector in Tanzania. A Policy Note*. The World Bank.
Petrozzi, F., Amori, G., Franco, D., Gaubert, P., Pacini, N., Eniang, E.E., Akani, G.C., Politano, E. and Luiselli, L. *in press*. Ecology of the bushmeat trade in West and Central Africa. *Tropical Ecology.*
Phelps, L. and Webb, E.L. 2015. ''Invisible'' wildlife trades: Southeast Asia's undocumented illegal trade in wild ornamental plants. *Biological Conservation,* 186: 296–305.
Pincheira-Donoso, D., Bauer, A.M., Meiri, S. and Uetz, P. 2013. Global taxonomic diversity of living reptiles. *PLoS ONE*, 8(3): 1–10.
Pires, S.F. 2012. The illegal parrot trade: a literature review. *Global Crime*, 13(3): 176–190.
Pistoni, J. and Toledo, L.F. 2010. Amphibian illegal trade in Brazil: what do we know? *South American Journal of Herpetology*, 5(1): 51–56.
Plagányi, É., Butterworth, D. and Burgener, M. 2011. Illegal and unreported fishing on abalone-quantifying the extent using a fully integrated assessment model. *Fisheries Research*, 107(1): 221–232.
Planque, B., Fromentin, J., Cury, P., Drinkwater, K.F., Jennings, S., Perry, R.I. and Kifani, S. 2010. How does fishing alter marine populations and ecosystems sensitivity to climate? *Journal of Marine Systems*, 79(3): 403–417.
Pratt, D.G., Macmillan, D.C. and Gordon, I.J. 2004. Local community attitudes to wildlife utilisation in the changing economic and social context of Mongolia. *Biodiversity and Conservation*, 13(3): 591–613.
Pringle, R.M. 2008. Elephants as agents of habitat creation for small vertebrates at the patch scale. *Ecology*, 89(1): 26–33.
Ramsay, N.F., Ng, P.K.A., O'Riordan, M. and Chou, L.M. 2007. The red-eared slider (*Trachemys scripta elegans*) in Asia: a review. In: Gherardi, F. (Ed.). *Biological invaders in inland waters: profiles, distribution and threats*. Springer, Dordrecht, the Netherlands. 161–174.
Ramos-Elorduy, J. 2009. Anthropo□entomophagy: cultures, evolution and sustainability. *Entomological Research*, 39(5): 271-288.
Randriamalala, H. and Liu, Z. 2010. Rosewood of Madagascar: between democracy and conservation. *Madagascar Conservation and Development,* 5(1): 11-22.
Ratsiazo, L. 2014. *Un bateau suspect au large de Mananara*. Available at: http://www.madagascar-tribune.com/Un-bateau-suspect-au-large-de,20629.html. [Accessed: 17/06/2015].
Raymundo, L.J., Halford, A.R., Maypa, A.P. and Kerr, A.M. 2009. Functionally diverse reef-fish communities ameliorate coral disease. *Proceedings of the National Academy of Sciences of the United States of America*, 106(40): 17067–17070.
Raza, R.H., Chauhan, D.S., Pasha, M.K.S. and Sinha, S. 2012. *Illuminating the blind spot: a study on illegal trade in leopard parts in India (2001-2010)*. TRAFFIC/WWF India, New Delhi, India.
Reading, R.P., Mix, H., Lhagvasuren, B. and Tseveenmyadag, N. 1998. The commercial harvest of wildlife in Dornod Aimag, Mongolia. *Journal of Wildlife Management*, 62(1): 59–71.
Redford, K.H. 1992. The empty forest. *BioScience*, 42(6): 412-422.
Regueira, R.F.S. and Bernard, E. 2012. Wildlife sinks: quantifying the impact of illegal bird trade in street markets in Brazil. *Biological Conservation*, 149(1): 16–22.
Reuter, E. 2008. *The ecological and economic impact of Siberian marmots in the eastern steppe of Mongolia*. WCS Living Landscapes Program. CERC Independent Project, 34pp.
Ricciardi, A. 2007. Are modern biological invasions an unprecedented form of global change?. *Conservation Biology*, 21(2): 329–336.
Richmond, R.H. 1993. Coral reefs: present problems and future concerns resulting from anthropogenic disturbance. *American Zoologist*, 33(6): 524–536.
Riegl, B. and Luke, K.E. 1998. Ecological parameters of dynamited reefs in the northern Red Sea and their relevance to reef rehabilitation. *Marine Pollution Bulletin*, 37(8): 488–498.
Rieske L.K. 2007. Success of an exotic gallmaker, *Dryocosmus kuriphilus*, on chestnut in the USA: a historical account. *EPPO Bulletin,* 37: 172–74.
Ripple, W.J., Newsome, T.M. Wolf, C., Dirzo, R., Everatt, K.T., Galetti, M., Hayward, M.H., Kerley, G.I.H., Levi, T., Lindsey, P.A., Macdonald, D.W., Malhi, Y., Painter, L.E., Sandom, J.E., Terborgh, J., and Van Valkenburgh, B. 2015. Collapse of the world's largest herbivores. *Science Advances*. 1(4): e1400103.
Robards, M.D. and Reeves, R.R. 2011. The global extent and character of marine mammal consumption by humans: 1970-2009. *Biological Conservation*, 144(12): 2770–2786.
Robbins, C.S. (Ed.) 2003. *Prickly trade: trade and conservation of Chihuahuan desert cacti*. TRAFFIC North America, Washington DC, USA.
Robertson, A.W., Trass, A., Ladley, J.J. and Kelly, D. 2006. Assessing the benefits of frugivory for seed germination: the importance of the deinhibition effect. *Functional Ecology,* 20(1): 58–66.
Robinson, J.G. and Bennett, E.L. 2004. Having your wildlife and eating it too: an analysis of hunting sustainability across tropical ecosystems. *Animal Conservation*, 7(4): 397-408.
Robinson, J.G. and Redford, K.H. 1994. Measuring the sustainability of hunting in tropical forests. *Oryx* 28(4): 249–256.
Rogers, S. and Pillay, D. 2010. *Encephalartos nubimontanus.* The IUCN Red List of Threatened Species. Version 2014.3. Available at: www.iucnredlist.org. [Accessed: 19/01/2015].
Romanelli, C., Cooper, D., Campbell-Lendrum, D., Maiero, M., Karesh, W.B., Hunter, D. and Golden, C.D. 2015. *Connecting global priorities: biodiversity and human health – a state of knowledge review*. World Health Organistion/Secretariat of the UN Convention on Biological Diversity.
Romero, G.Q., Gonçalves-Souza, T., Vieira, C. and Koricheva, J. 2014. Ecosystem engineering effects on species diversity across ecosystems: a meta-analysis. *Biological Review*, publ. online.

Roskov, Y., Kunze, T., Orrell, T., Abucay, L., Paglinawan, L., Culham, A., Bailly, N., Kirk, P., Bourgoin, T., Baillargeon, G. *et al*. 2014. *Species 2000 and ITIS Catalogue of Life, 2014 Annual Checklist.* Available at: www.catalogueoflife.org/annual-checklist/2014. [Accessed: 23/01/2015].

Ruppert, J.L.W., Travers, M.J., Smith, L.L., Fortin, M.-J. and Meekan, M.G. 2013. Caught in the middle: combined impacts of shark removal and coral loss on the fish communities of coral reefs. *PLoS ONE*, 8(9): e74648.

Ryan, P.G. and Boix-Hinzen, C. 1999. Consistent male-biased seabird mortality in the Patagonian toothfish longline fishery. *Auk*, 116(3): 851–854.

Saéz, A.M., Weiss, S., Nowak, K., Lapeyre, V., Zimmerman, F., Düx, A., Kuhl, H.S., Kaba, M., Regnaut, S., Merkel, K. *et al*. 2015. Investigating the zoonotic origin of the West African Ebola epidemic. *EMBO Molecular Medicine*, 7(1): 17–24.

Saidu, Y. & Buij, R. 2013. Traditional medicine trade in vulture parts in northern Nigeria. *Vulture News,* 65: 4-14.

Sajeva, M., Augugliaro, C., Smith, M.J. and Oddo, E. 2013. Regulating internet trade in CITES species. *Conservation Biology*. 27(2): 429-430.

Sánchez-Jerez, P. and Ramos Esplá, A.A. 1996. Detection of environmental impacts by bottom trawling on *Posidonia oceanica* (L.) Delile meadows: sensitivity of fish and macroinvertebrate communities. *Journal of Aquatic Ecosystem Health*, 5(4): 239–253.

Schaafsma, M., Burgess, N.D., Swetnam, R.D., Ngaga, Y.M., Turner, R.K. and Treue, T. 2014. Market signals of unsustainable and inequitable forest extraction: assessing the value of illegal timber trade in the Eastern Arc Mountains of Tanzania. *World Development*, 62: 155–168.

Schippman, U. 2006. *CITES News*. Newsletter of the Medicinal Plant Specialist Group of the IUCN Species Survival Commission, Volume 12, 56 pp.

Schippmann, U., Leaman, D. and Cunningham, A.B. 2006. A comparison of cultivation and wild collection of medicinal and aromatic plants under sustainability aspects. In: Bogers, R.J., Craker, L.E. and Lange, D. (Eds.) *Medicinal and aromatic plants: agricultural, commercial, ecological, legal, pharmacological and social aspects*. Springer, Dordrecht. 75-95.

Schroeder-Wildberg, E. and Carius, A. 2003. *Illegal logging, conflict and the business sector in Indonesia*. InWEnt, Capacity Building International, Berlin, Germany.

Schuurman, D. and Lowry II, P.P. 2009. The Madagascar rosewood massacre. *Madagascar Conservation and Development,* 4(2): 98-102.

Schwitzer, C., Mittermeier, R.A., Johnson, S.E., Donati, G., Irwin, M., Peacock, H., Ratsimbazafy, J., Razafindramanana, J., Louis, E.E.., Chikhi, L., Colquhoun, I.C., Tinsman, J., Dolch, R., LaFleur, M., Nash, S., Patel, E., Randrianambinina, B., Rasolofoharivelo, T. and Wright, P.C. 2014. Averting lemur extinctions amid Madagascar's political crisis. *Science,* 343: 842–843.

Schwitzer, C., Mittermeier, R.A., Rylands, A.B., Taylor, L. A., Chiozza, F., Williamson, E.A., Wallis, J. and Clark, F.E. 2012. *Primates in peril: the world's 25 most endangered primates 2012–2014*. IUCN SSC Primate Specialist Group (PSG), International Primatological Society (IPS), Conservation International (CI), and Bristol Zoological Society, Arlington, VA, USA.

Secretariat of the Convention on Biological Diversity. 2001. *Sustainable management of non-timber forest resources*. CBD Technical Series 6. SCBD, Montreal.

Seneca Creek Associates and Wood Resources International 2004. *'Illegal' logging and global wood markets: the competitive impacts on the U.S. wood products industry*.

Shackleton, C.M. and Pandey, A.K. 2014. Positioning non-timber forest products on the development agenda. *Forest Policy and Economics*, 38: 1-7.

Sharifi, M., Papenfuss, T., Rastegar-Pouyani, N., Anderson, S. and Kuzmin, S. 2009. *Neurergus kaiseri*. The IUCN Red List of Threatened Species. Version 2014.3. Available at: www.iucnredlist.org. [Accessed: 4/02/2015].

Smith, K.F., Behrens, M., Schloegel, L.M., Marano, N., Burgiel, S. and Daszak, P. 2009. Reducing the risks of the wildlife trade. *Science*, 324(5927): 594–595.

Snook, L.K. 1996. Catastrophic disturbance, logging and the ecology of mahogany (*Swietenia macrophylla* King): grounds for listing a major tropical timber species in CITES. *Botanical Journal of the Linnean Society*, 122(1): 35–46.

SOS. 2014. *Strengthening protection and habitat management for the critically endangered Javan Rhino*. Available at: http://www.sospecies.org/sos_projects/mammals/javan_rhino/?18572/A-Brighter-Future-for-Javan-Rhinos. [Accessed: 27/10/2015].

South, N. and Brisman, A. 2013. *Routledge international handbook of green criminology*. Routledge, Abingdon, UK, 450 pp.

Sovacool, B.K. and Siman-Sovacool, K.E. 2008. Creating legal teeth for toothfish: Using the market to protect fish stocks in Antarctica. *Journal of Environmental Law*, 20(1): 15–33.

Spielman, D., Brook, B.W., Briscoe, D.A. and Frankham, R. 2004. Does inbreeding and loss of genetic diversity disease resistance? *Conservation Genetics*, 5(4): 439-448.

St John, F.A., Keane, A.M., Edwards-Jones, G., Jones, L., Yarnell, R.W. and Jones, J.P. 2011. Identifying indicators of illegal behaviour: carnivore killing in human-managed landscapes. *Proceedings of the Royal Society of London B: Biological Sciences*, 279(1729): 804-812.Van Staalduinen, M.A. and Werger, M.J.A. 2007. Marmot disturbances in a Mongolian steppe vegetation. *Journal of Arid Environments*, 69(2): 344–351.

Von Staden, L., Victor, J., Raimondo, D. and Hurter, P.J.H. 2012. *Dioscorea strydomiana*. The IUCN Red List of Threatened Species. Version 2014.3. Available at: www.iucnredlist.org. [Accessed: 19/01/2015].Steffen, W., Broadgate, W., Deutsch, L., Gaffney, O. and Ludwig, C. 2015. The trajectory of the Anthropocene: the great acceleration. *The Anthropocene Review*, 2(1): 81-98.

Stengel, C., Shepherd, C. and Caillabet, O. 2011. *The trade in tortoises and freshwater turtles in Jakarta revisited*. TRAFFIC Southeast Asia, Petaling Jaya, Malaysia.

Stewart, K.M. 2003. The African cherry (*Prunus africana*): can lessons be learned from an over-exploited medicinal tree? *Journal of Ethnopharmacology*, 89(1): 3–13.

Stiles, D., Redmond, I., Cress, D., Nellemann, C. and Formo, R.K. 2013. *Stolen apes - the illicit trade in chimpanzees, gorillas, bonobos and orangutans*. GRID-Arendal, UNEP, Norway.

Stocker, T.F., Qin, D., Plattner, G.-K., Tignor, M.M.B., Allen, S.K., Boschung, J., Nauels, A.A., Xia, Y., Bex, V. and Midgley, P.M. (Eds.) 2013. *Climate Change 2013: the physical science basis. Working Group I contribution to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change*. Cambridge University Press, Cambridge, UK and New York, USA.

Stoner, S. and Pervushina, N. 2013. *Reduced to skin and bones revisited: an updated analysis of tiger seizures from 12 tiger range countries*. Kuala Lumpar, Malaysia.

Stuart, S.N., Chanson, J.S., Cox, N.A., Young, B.E., Rodrigues, A.S.L., Fischman, D.L. and Waller, R.W. 2004. Status and trends of amphibian declines and extinctions worldwide. *Science*, 306: 1783–1786.

Subedi, A., Kunwar, B., Choi, Y., Dai, Y., van Andel, T., Chaudhary, R.P., de Boer, H.J. and Gravendeel, B. 2013. Collection and trade of wild-harvested orchids in Nepal. *Journal of Ethnobiology and Ethnomedicine*, 9(1): 1–10.

Sulle, E. 2013. *A rapid assessment of the illegal timber trade across the Ruvuma River on the Tanzania–Mozambique border*. TRAFFIC East/Southern Africa Sub-Regional Office.

Sumaila, U.R., Alder, J. and Keith, H. 2006. Global scope and economics of illegal fishing. *Marine Policy*, 30: 696–703.

Swart, E. 2008. Case study 6: *Hoodia gordonii* in Southern Africa. *NDF Workshop case studies. WG3 - Succulents and Cycads*, Available at: http://www.euppublishing.com/doi/abs/10.3366/abib.2007.13.

Tella, J.L. and Hiraldo, F. 2014. Illegal and legal parrot trade shows a long-term, cross-cultural preference for the most attractive species increasing their risk of extinction. *PloS ONE*, 9(9): e107546.

TFTSG 2007. *Turtles in trouble: the world's top 25 most endangered tortoises and freshwater turtles - 2007*. IUCN/SSC Tortoise and Freshwater Turtle Specialist Group. 56 pp.

Theile, S. 2005. Status of the Queen Conch Strombus gigas stocks, management and trade in the Caribbean: a CITES review. In: *Proceedings of the 56th annual Gulf and Caribbean Fisheries Institute*. TRAFFIC Europe, Brussels, Belgium. 675-694.

Thiollay, J.M. 2006. The decline of raptors in West Africa: longterm assessment and the role of protected areas. *Ibis,* 148: 240-254.

Thomsen, J.B., Edwards, S.R. and Mulliken, T.A. 1992. *Perceptions, conservation and management of wild birds in trade*. TRAFFIC International, Cambridge, UK.

Thorbjarnarson, J. 1999. Crocodile tears and skins: international trade, economic constraints, and limits to the sustainable use of Crocodilians. *Conservation Biology*, 13(3): 465–470.

Timmins, R.J., Robichaud, W.G., Long, B., Hedges, S., Steinmetz, R., Abramov, A., Tuoc, D. and Mallon, D.P. 2008. *Pseudoryx nghetinhensis.* The IUCN Red List of Threatened Species. Version 2014.3. Available at: www.iucnredlist.org. [Accessed: 21/01/2015].

Tissot, B.N., Best, B.A., Borneman, E.H., Bruckner, A.W., Cooper, C.H., D'Agnes, H., Fitzgerald, T.P., Leland, A., Lieberman, S., Mathews Amos, A. *et al*. 2010. How U.S. ocean policy and market power can reform the coral reef wildlife trade. *Marine Policy*, 34(6): 1385–1388.

Todd, P. and Place, J. 2010. *Investigating the Internet Wildlife Trade*. Available at: http://www.cites.org/eng/news/world/19/7.php. [Accessed: 20/01/2015].

TRAFFIC 1995. *Marine invertebrates or the South Pacific: an examination of the trade*. A TRAFFIC Network report, October 1995. 7pp.

TRAFFIC 2010. *Biodiversity for food and agriculture: indicator factsheet 4.5.2*. Biodiversity Indicators Partnership.

TRAFFIC 2011. Editorial. *TRAFFIC Bulletin*, 23(3): 1-122.

TRAFFIC 2014. Efforts urged to tackle thriving illegal orchid trade in Tanzania and Zambia for chikanda production. *TRAFFIC Bulletin*, 26(2): 47–50.

TRAFFIC 2015. *South Africa confirmed 2014 worst on record for rhino poaching*. Available at: http://www.traffic.org/home/2015/1/22/south-africa-confirms-2014-worst-on-record-for-rhino-poachin.html. [Accessed: 17/02/2015].

Turetsky, M., Benscoter, B., Page, S., Rein, G., van der Werf, G. and Watts, A. 2014. Global vulnerability of peatlands to fire and carbon loss. *Nature Geoscience*, 8(1): 11–14.

Tutin, C.E.G., Williamson, E.A., Rogers, M.E. and Fernandez, M. 1991. A case study of a plant-animal relationship: *Cola lizae* and lowland gorillas in the Lopé Reserve, Gabon. *Journal of Tropical Ecology,* 7(2): 181–199.

Uetz, P. and Hošek, J. 2015. *The Reptile Database*. Available at: http://www.reptile-database.org. [Accessed: 25/03/2015].

UN Economic and Social Council 2013. *2013/40. Crime prevention and criminal justice responses to illicit trafficking in protected species of wild fauna and flora*. Available at: http://www.unodc.org/documents/commissions/CCPCJ/Crime_Resolutions/2010-2019/2013/ECOSOC/Resolution_2013-40.pdf.

UN Security Council 2015. *Resolution 2198 (2015)*. Available at: http://www.un.org/en/ga/search/view_doc.asp?symbol=S/RES/2198 (2015).

Underwood, F.M., Burn, R.W. and Milliken, T. 2013. Dissecting the illegal ivory trade: an analysis of ivory seizures data. *PLoS ONE*, 8(10): e76539.

UNEP 2011. *The Democratic Republic of the Congo. Post-Conflict Environmental Assessment. Synthesis for Policy Makers*. United Nations Environment Programme, Nairobi, Kenya.

UNEP 2015. Catastrophic Collapse of Saiga Antelopes in Central Asia. UNEP News Centre. Available at: http://www.unep.org/newscentre/Default.aspx?DocumentID=26816&ArticleID=35061&l=en [Accessed: 17/06/2015].

UNEP, CITES, IUCN and TRAFFIC 2013. *Elephants in the dust - the African elephant crisis. A rapid response assessment*. GRID-Arendal, Arendal, Norway.

UNEP-MONUSCO-OSESG 2015. Experts' background report on illegal exploitation and trade in natural resources benefitting organized criminal grounds and recommendations on MONUSCO's role in fostering stability and peace in eastern DR Congo. Final report. April 15th 2015.

UNEP-WCMC 2013. *CITES at 40: perspectives, trade patterns and future prospects*. CoP16 Inf. 35.

UNEP-WCMC (Comps.) 2016. *The checklist of CITES species website.* CITES Secretariat, Geneva, Switzerland. Compiled by UNEP-WCMC, Cambridge, UK. Available at: http://checklist.cites.org. [Accessed: 11/04/2016].

UNODC 2012. *Wildlife and Forest Crime Analytic Toolkit*. Revised edition. United Nations Office on Drugs and Crime, Vienna, Austria.

UNODC 2013a. *Transnational organized crime in East Asia and the Pacific*. United Nations Office on Drugs and Crime, Vienna, Austria.

UNODC 2013b. *Wildlife and forest crime*. United Nations Office on Drugs and Crime, Vienna, Austria.

Vanthomme, H., Bellé, B. and Forget, P.-M. 2010. Bushmeat hunting alters recruitment of large-seeded plant species in Central Africa. *Biotropica*, 42(6): 672–679.

Vaz, M.C.M., Rocha-Santos, T.P., Rocha, R.J.M., Lopes, I., Pereira, R., Duarte, A.C., Rubec, P.J. and Calado, R. 2012. Excreted thiocyanate detects live reef fishes illegally collected using cyanide - a non-invasive and non-destructive testing approach. *PLoS ONE*, 7(4): e35355.

Vira, V., Ewing, T. and Miller, J. 2014. *Out of Africa: mapping the global trade in illicit elephant ivory*. C4ADS and Born Free, USA.

Wabuyele, E. and Kyalo, S. 2008. Sustainable use of East African aloes: the case of commercial aloes in Kenya*. NDF workshop case studies, WG3 - Succulents and Cycads: case study 1*..

Wang, X., Zhang, K., Wang, Z., Ding, Y., Wu, W. and Huang, S. 2004. The decline of the Chinese giant salamander *Andrias davidianus* and implications for its conservation. *Oryx*, 38(2): 197–202.

Warkentin, I.G., Bickford, D., Sodhi, N.S. and Bradshaw, C.J. 2009. Eating frogs to extinction. *Conservation Biology*, 23(4): 1056–1059.

Waterman, C., Pietersen, D., Soewu, D., Hywood, L. and Rankin, P. 2014. *Phataginus tricuspis*. The IUCN Red List of Threatened Species. Version 2015.2. Available at: www.iucnredlist.org [Accessed on 08/07/2015].

Wasser, S.K., Brown, L., Mailand, C., Mondol, S., Clark, W., Laurie, C. and Weir, B.S. 2015. Genetic assignment of large seizures of elephant ivory reveals Africa's major poaching hotspots. *Science*, 349(6243): 84-87.

Watling, L. and Norse, E.A., 1999. Disturbance of the seabed by motile fishing gear: a comparison to forest clear-cutting. *Conservation Biology,* 12(6): 180–197.

WCO 2014. *Declaration of the customs co-operation council on the illegal wildlife trade*. World Customs Organisation.

WCMC, IUCN/SSC and TRAFFIC 1999. *Review of significant trade in animal species included in CITES Appendix II: Detailed reviews of 37 species*. Draft report to the CITES Animals Committee. WCMC (World Conservation Monitoring Centre), IUCN Species Survival Commission and TRAFFIC Network.

Weldon, C., Du Preez, L.H., Hyatt, A.D., Muller, R. and Speare, R. 2004. Origin of the amphibian chytrid fungus. *Emerging Infectious Diseases*, 10(12): 2100–2105.

Wellesley, L. 2014. *Trade in illegal timber: the response in China*. Chatham House (The Royal Institute of International Affairs), London, UK. 31 pp.

Wells, S. 2009. Dynamite fishing in northern Tanzania - pervasive, problematic and yet preventable. *Marine Pollution Bulletin*, 58(1): 20–23.

Wenbin, H. and Xiufang, S. 2013. Tropical hardwood flows in China: case studies of rosewood and okoumé. *Forest Trends Association, Washington DC, USA*.
Whitehouse, A.M. and Harley, E.H. 2001. Post-bottleneck genetic diversity of elephant populations in South Africa, revealed using microsatellite analysis. *Molecular Ecology*, 10(9): 2139–2149.
Whiteman, N.K., Matson, K.D., Bollmer, J.L. and Parker, P. G. 2006. Disease ecology in the Galapagos Hawk (*Buteo galapagoensis*): host genetic diversity, parasite load and natural antibodies. *Proceedings of the Royal Society of London B: Biological Sciences*, 273(1588): 797-804.
WHO, IUCN and WWF 1993. *Guidelines on the Conservation of Medicinal Plants*. Gland, Switzerland.
Wikramanayake, E., Dinerstein, E., Seidensticker, J., Lumpkin, S., Pandav, B., Shrestha, M., Mishra, H., Ballou, J., Johnsingh, A.J.T., Chestin, I. *et al*. 2011. A landscape-based conservation strategy to double the wild tiger population. *Conservation Letters*, 4(3): 219–227.
Wilcove, D.S., Rothstein, D., Dubow, J., Phillips, A. and Losos, E. 1998. Quantifying threats to imperiled species in the United States. *BioScience*, 48(8): 607–615.
Wilkie, D., Shaw, E., Rotberg, F., Morelli, G. and Auzel, P. 2000. Roads, development, and conservation in the Congo Basin. *Conservation Biology*, 14(6): 1614–1622.
Wilkie, D., Bennett, E., Peres, C. and Cunningham, A. 2011. The empty forest revisited. *Annals of the New York Academy of Sciences*, 1223: 120-128.
Williams, V., Victor, J.E. and Crouch, N.R. 2013. Red listed medicinal plants of South Africa: status, trends, and assessment challenges. *South African Journal of Botany*, 86: 23–35.
Williams, V.L., Cunningham, A.B., Kemp, A.C. & Bruyns, R.K. 2014. Risks to birds traded for African traditional medicine: a quantitative assessment. *PLoS ONE,* 9(8): e105397.
Williamson, M. 1996. *Biological invasions*. Chapman and Hall, London, UK.
Wilson, D.E. and Reeder, D.M. 2005. *Mammal species of the world - a taxonomic and geographic reference*. 3rd Ed. Smithsonian Institution Press, Baltimore, USA.
Wingard, J.R. and Zahler, P. 2006. *Silent steppe: the illegal wildlife trade crisis in Mongolia*. World Bank, Washington D.C.
Wittemyer, G., Northrup, J.M., Blanc, J., Douglas-Hamilton, I., Omondi, P. and Burnham, K.P. 2014. Illegal killing for ivory drives global decline in African elephants. *Proceedings of the National Academy of Sciences*, 111(36): 1–5.
Wittenberg, R. and Cock, M.J.W. 2001. *Invasive alien species: a toolkit of best prevention and management practices*. CABI.
Worm, B., Davis, B., Kettemer, L., Ward-Paige, C.A., Chapman, D., Heithaus, M.R., Kessel, S.T. and Gruber, S.H. 2013. Global catches, exploitation rates, and rebuilding options for sharks. *Marine Policy*, 40: 194-204.
Wright, T.F., Toft, C.A., Enkerlin□Hoeflich, E., Gonzalez□Elizondo, J., Albornoz, M., Rodríguez□Ferraro, A., Rojas□Suárez, F. *et al.* 2001. Nest poaching in Neotropical parrots. *Conservation Biology*, 15(3): 710-720.
Wyler, L. and Sheikh, P. 2008. *International illegal trade in wildlife: threats and U.S. policy*. CRS Report for Congress, Washington D.C., USA.
Yoshihara, Y., Ohkuro, T., Bayarbaatar, B. and Takeuchi, K. 2009. Effects of disturbance by Siberian marmots (*Marmota sibirica*) on spatial heterogeneity of vegetation at multiple spatial scales. *Japanese Journal of Grassland Science*, 55(2): 89–95.
Yoshihara, Y., Ohkuro, T., Buuveibaatar, B., Undarmaa, J. and Takeuchi, K. 2010. Pollinators are attracted to mounds created by burrowing animals (marmots) in a Mongolian grassland. *Journal of Arid Environments*, 74(1): 159–163.
Yue, Z. 2008. Conservation and trade control of pangolins in China. *Proceedings of the Workshop on Trade and Conservation of Pangolins Native to South and Southeast Asia.* TRAFFIC Southeast Asia, Petaling Jaya, Selangor, Malaysia: 66-74.
Zahler, P., Lhagvasuren, B., Reading, R.P., Wingard, J.R., Amgalanbaatar, S., Gombobaatar, S., Barton, N. and Onon, Y. 2004. Illegal and unsustainable wildlife hunting and trade in Mongolia. *Mongolian Journal of Biological Sciences*, 2(2): 23–31.
Zheng, F. 2006. Effect of vegetation changes on soil erosion on the Loess Plateau. *Pedosphere*, 16(4): 420–427.
Zulu, L.C. and Richardson, R.B. 2013. Charcoal, livelihoods, and poverty reduction: Evidence from sub-Saharan Africa. *Energy for Sustainable Development*, 17(2): 127-137.

Annex 1

Table 1: List of acronyms and abbreviations

Acronym	Full name
ABS	Nagoya Protocol on Access to Genetic Resources and the Fair and Equitable Sharing of Benefits Arising from their Utiliz
CBD	Convention on Biological Diversity
CCAMLR	Convention on the Conservation of Antarctic Marine Living Resources
CITES	Convention on International Trade in Endangered Species of Wild Fauna and Flora
CMS	Convention on Migratory Species
COMIFAC	Commission des Forêts d'Afrique Centrale
CR	Critically Endangered (IUCN Red List of Threatened Species category)
DD	Data Deficient (IUCN Red List of Threatened Species category)
EEZ	Exclusive Economic Zone
EN	Endangered (IUCN Red List of Threatened Species category)
ETIS	Elephant Trade Information System
EU TWIX	European Union Trade in Wildlife Information eXchange
FAO	Food and Agriculture Organization of the United Nations
FLEGT	Forest Law Enforcement, Governance and Trade
FRA	Forest Resources Assessment
GRASP	Great Apes Survival Partnership
ICCWC	International Consortium on Combating Wildlife Crime
IPCC	Intergovernmental Panel on Climate Change
ITTO	International Tropical Timber Organization
ITW	Illegal Trade in Wildlife and Wildlife Products
IU	Illegal and Unreported
IUU	Illegal, Unreported, Unregulated
IWC	International Whaling Commission
LC	Least Concern (IUCN Red List of Threatened Species category)
MEA	Multilateral Environmental Agreement
MIKE	Monitoring the Illegal Killing of Elephants
MIKES	Minimising the Illegal Killing of Elephants and Other Endangered Species
NA	Not yet assessed by IUCN
NT	Near Threatened (IUCN Red List of Threatened Species category)
NWFP	Non-Wood Forest Products
RFMO	Regional Fisheries Management Organisation
RLI	Red List Index
TAG	Technical Advisory Group
TED	Turtle Excluder Devices
UNEA	United Nations Environmental Assembly
UNFF	United Nations Forum on Forests
UNODC	United Nations Office on Drugs and Crime
UNU	United Nations University
VU	Vulnerable (IUCN Red List of Threatened Species category)
WCO	World Customs Organization
WEMS	Wildlife Enforcement Monitoring System
WEN	Wildlife Enforcement Network
WJC	Wildlife Justice Commission
WTO	World Trade Organization