NABU International
Foundation for Nature

Pointless

A quantitative assessment of supply and demand in rhino horn and a case against trade

NABU International
Foundation for Nature

Pointless

A quantitative assessment of supply and demand in rhino horn and a case against trade

The only way to save a rhinoceros is to save the environment in which it lives, because there's a mutual dependency between it and millions of other species of both animals and plants.

Sir David Attenborough

Contact

NABU International
Dr Barbara Maas
Head of Endangered Species Conservation

Tel. +44 (0)7970 987742
barbara.maas@nabu.de

Executive Summary

The world is witnessing an unprecedented upsurge in poaching and illegal wildlife trade, which is undoing decades of conservation efforts. Some of the most profitable species include iconic animals such as rhinos, elephants, tigers and even fish. The notion that wildlife trafficking is worth 7-23 billion US dollars (UNEP-Interpol 2016) and ranks amongst the four most lucrative illicit trade commodities has become cliché. Rhinos have been especially hard hit by these developments. Last year, poachers killed at least 1,342 rhinos in Africa, the highest number since records began in 2006 (Emslie et al. 2016, Tab.1). Rhino populations everywhere are under siege from poachers, illegal traffickers, national (Hübschle 2016 a, b) and international criminal networks (CITES, 2013, Milliken & Shaw 2012), art collectors, status and pleasure seekers, medical patients and financial speculators intent on cashing in on their increasing rarity.

Most wildlife and enforcement experts consider resolutely enforced international and national trade bans and effective demand reduction initiatives the most promising route towards reversing the current trend (e.g., Nadal and Agyao, Sellar 2016 a, b). Others vociferously advocate the legalization of trade in rhino horn as the only viable option that can ensure a future for the world's remaining rhinos (DEA 2014, Eustace 2016, Warren 2015, Hume 2015).

The debate about whether legalized rhino horn trade might benefit rhino conservation has produced an abundance of academic and other publication, which include a large number of theory-based analyses. A quantitative appraisal of supply and demand has so far been lacking. This study provides the first quantitative assessment of the relationship between rhino horn supply and demand. Scrutinizing a variety of different supply and demand scenarios it illustrates the significant discrepancy between the reservoir of approximately 141 tonnes of horn carried by the

1,342 African rhinos
died at the hand of poachers - the highest number since records began in 2006 and nearly five percent of the global rhino population.

world's remaining rhinos and those in South Africa and the two main consumer markets in Vietnam and China (Milliken & Shaw 2012).

Policy decisions about trade in rhino horn based on erroneous assumptions risk significant adverse consequences for wild rhinos, as well as adverse downstream effects on the biodiversity of their habitat (Joris et al. 2014, Ripple 2015). It is therefore helpful to recognize that:

- A single standard rhino horn prescription of 3, 9 or 50 grams administered to 3.8%, 1.3% and 0.2% of the current adult population of China and Vietnam respectively, would require the horn mass of the entire global rhino population (29,324).

- South Africa's 6,014 privately owned white rhinos could service a mere 0.97%, 0.32% and 0.06% of Vietnamese and Chinese adult with a single prescription of 3, 9 or 50 grams. This figure is reduced to 0.77%, 0.26% and 0.05% if only rhino owners who indicated an interest in participating in rhino horn trade are considered.

- Rhino horn derived from regular dehorning of South Africa's 6,014 privately owned white rhino population would provide a single prescription of 3, 9 and 50 grams for 0.12%, 0.04% and 0.007% of adults in China and Vietnam, or 0.10, 0.03 and 0.006 percent for rhinos of owners willing to participate in legal trade.

These simple calculations support the notion that lifting the ban on commercial rhino horn trade is likely to facilitate the extinction of rhinos rather than support their survival. Illegal rhino horn trade is an international problem that requires a well-coordinated global response comprising a genuine commitment to strong legislation, uncompromising enforcement and creative demand reduction initiatives.

All of South Africa's privately owned white rhinos put together only have enough horn to provide a single dose of 3, 9 and 50 grams to 0.97%, 0.32% and 0.06% of adults in Vietnam and China. Rhino horn derived from annual dehorning could at best service 0.12%, 0.04% and 0.007% of adults in these countries with the same prescriptions.

Portrait of an Indian rhino (*Rhinoceros unicornis*). Photo: Wikimedia

Introduction

Rhinoceroses first evolved 50 million years ago and roamed across North America, Europe, Africa, and Asia in great numbers (Prothero 1993). Modern rhinos have not only shared the world with us for millennia but captured Man's imagination since prehistoric times. At the beginning of the 20th century, an estimated 500,000 rhinos still roamed across Africa and Asia (IRF 2016). By 1970 the global population had been decimated to around 70,000 (Leader-Williams 2002). Today there are just over 29,000 (Knight 2016, Haryono et al. 2015, Nardelli 2014, IRF 2016) – a 94% drop. Almost 70% of the world's and 80% of Africa's rhinos live in South Africa (Emslie et al. 2016). In South Africa, some 6,000 rhinos live on privately owned farms (Knight 2016, DEA 2014). Many of them are regularly dehorned in anticipation of trade and dependent on supplementary food (Warren 2015). Several hundred thousand heads strong, black rhinos were the most abundant of all rhino species well into the 20th century (Emslie 2011). Today the population stands at 5,250 (Knight 2016).

White rhino mother and calf. Photo: Hen Washford

The Chauvet cave paintings in France represent some of the oldest in the world, dating back to between 32,000 - 36,000 years. A UNESCO world heritage site since 1994, these beautiful prehistoric paintings depict a variety of wild animal species, including rhinos. Photo: Wikimedia

The big rhino crash

At the beginning of the 20th century an estimated 500,000 rhinos roamed across Africa and Asia. Today there are just over 29,000.

What is Rhino Horn?

Rhino horn consist of keratin, a protein that also makes up human toenails, fingernails and hair. CT scans and cross-sections of rhino horns show a dense central region that is reinforced by a combination of calcium and the pigment melanin. These two components at the centre of the horn increase its resistance to physical wear and damage as a result of UV exposure. The softer outer layer wears away more quickly during normal use. The difference in consistency between the outer and inner layers leads to the horn's characteristic long and sharply pointed shape. The horns grow solely from the base and are attached to the skin covering the animals' frontal and nasal bones (Nowell 2012).

Rhino horns confiscated in the United States. Photo: USFWS

Rhino Horn Use

Rhino horn has been used as an ingredient in traditional Chinese medicines for several thousand years and later spread to Vietnam, Japan and Korea (Nowell 2012). It is used either as a single ingredient or as part of compound prescriptions and prepared as a decoction or as a powder. Li Shih Chen's 1597 Materia Medica lists rhino horn as a treatment for a long list of ailments, including "devil possession, keep away evil spirits and miasmas, gelsemium poisoning,

hallucinations, bewitching nightmares, intermittent twitches with delirium, loss of vision, calming the liver, fear, anxiety, arthritis, loss of voice, typhoid, headache, fever."

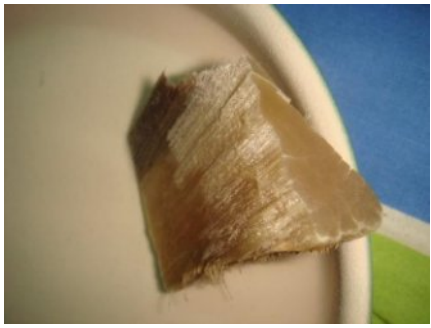
A study into the effectiveness of rhino horn and its alternatives conducted at the Chinese University of Hong Kong by Paul But and colleagues (1990) found that while rhino horn and high doses of water buffalo horn had mild fever-reducing and antitoxic effects, a combination of herbs without any type of horn had the same effect (Nowell 2012). "Consensus now appears to be that even if rhino horn is mildly anti-pyretic to lower fever symptoms, the benefits do not outweigh those of cheap over-the-counter medicines readily available in any pharmacy", says Rookmaaker from the Rhino Resource Centre (2011).

Rhino horn jewellery, drinking cups, decorations and slabs and segments of horns for sale in Vietnam. Photo: Environmental Justice Commission

Recommended doses for rhino horn in traditional Asian and allied medicines vary widely from daily or repeat doses of 0.5 -1g (Do et al. 2006) to 180 g (Liu et al. 2004) (Appendix I). Hübschle (2016a) describes an example of a two-week treatment. Dosage of rhino horn was subject to considerable variation, which is part explained by whether the ingredients are administered by themselves or as part of compound prescription or how they are prepared.

In the mid-2000s the rumour that rhino horn offers a cure for cancer began to sweep across Vietnam, from where it has spread to China and other parts of East Asia (Milliken 2012). There is no evidence of rhino horn as an effective cure for cancer from clinical research in traditional Chinese medicine or elsewhere, nor is not documented or approved as such in traditional medicine manuals. Yet, the use of rhino horn as a cancer treatment has become one of the primary drivers behind the dramatic surge in rhino poaching. Vietnam has a cancer mortality rate of 73 percent, one of the highest in the world (Huang 2011, 2014, Amel 2014,) Rhino horn is no medicine. With around 150,000 new cancer cases are diagnosed each year and poor access to treatment, people are desperate for a cure for themselves or their relatives and are willing to pay almost anything (Patton 2011). The effects on demand were devastating.

Rhino horn supplies a growing market in Chinese and allied medicines, as a party drug, status symbol, jewellery, ornament or hard-nosed investment. Top end buyers purchase entire horns for medicinal use, to display as "face objects" that confer status, as gifts or investments (Emslie et al. 2016, Hübschle a) or as party drugs relieve hangovers. Most medicinal consumers of rhino horn buy small quantities of horn as powder or roughly cut pieces (Amman 2015a, Patton and Amman 2016). This type of use transcends Vietnam's urban centres and extends to traditional rural communities, which represent a huge potential market that might spring to live if trade is legalized (Patton & Amman 2016). Amman (2015a, b) also identified a new market for rhino horn artefacts and jewellery, such as bracelets, beads, newly manufactured libation cups, bowls and rings etc. in the north of Vietnam. These items are sought after by Chinese visitors, which according to Vigne & Martin now constitute the main market for rhino horn in Vietnam.



Rhino horn on special grinding plate in Vietnam. Photo: Thang Nguyen

Poachers' guns, hunters' guns

Poaching constitutes the primary threat to the survival of the world's rhinos. Wild rhinos have no enemies apart from humans. Since the current crisis erupted in 2008, at least 5,940 African rhinos have lost their lives at the hand of poachers and almost 200 rhinos were killed in India between 2006 to 2015 (Emslie et al. 2016). While the number of rhinos killed by poachers in South Africa appears to have dropped marginally from 1,215 in 2014 to 1,175 in 2016 (Knight 2016), poaching figures for the whole of Africa have been rising for six successive years, reaching a high of at least 1,342 individuals in 2015 – the equivalent of 5% of Africa's entire population (Emslie et a l. 2016) (Fig. 1). Rhinos are being killed inside the most heavily guarded areas, including South Africa's flagship Kruger National Park, where both black and white rhino populations may now be in decline (Ferreira et al. 2015, AfRSG,Emslie et al. 2016). A growing Chinese presence in Africa since the early 2000s has moved the frontline of demand for rhino horn and other wildlife products perilously close to local supplies (Larson 2010, Vigne & Martin 2008, French 2014.
Between October 2012 and December 2015 an estimated 8,691 rhino horns entered the illegal market (2,674 horns a year) (Emslie et al. 2012). Over 90 percent of these horns stem from illegally killed rhinos. This figure represents almost 22 tonnes of rhino horn and is the highest

death toll in over two decades - twice that reported in 2012 (Emslie et al. 2012). The Western subspecies of the Black rhino and the Vietnamese subspecies of the Javan rhino have already become extinct as a result of poaching in recent years. The Northern White rhino is down to three individuals only one of which is a male, too old to breed. Unless the overwhelming surge of illegal killing can be stopped, the remaining rhino species may well follow them, one animal at a time.

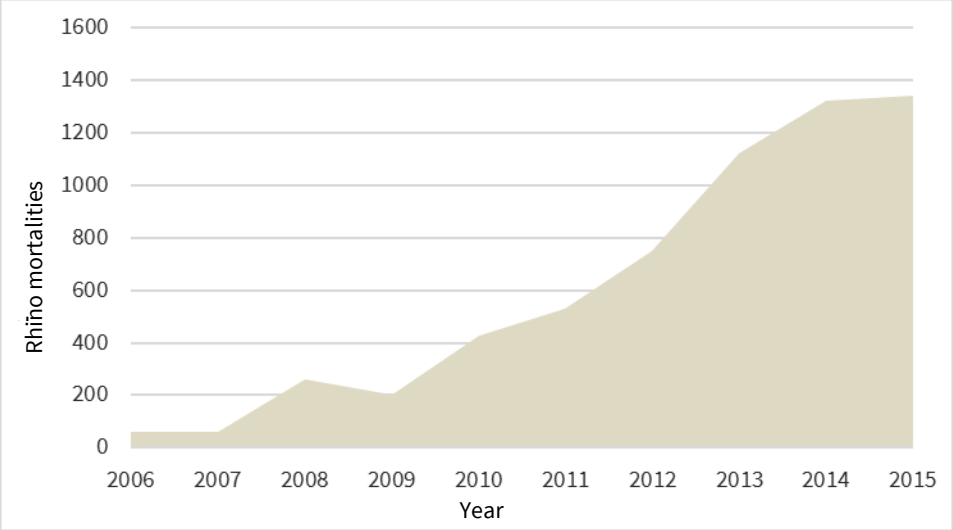


Figure 1. Reported rhino poaching mortalities in Africa 2006-2015
Rhino poaching in Africa has escalated dramatically since 2008. Data from Emslie 2016.

Due to relentless persecution for their horn, our time with rhinos could soon be running out. Alternatively, our relationship with their kind may irreversibly degenerate into that between farmer and livestock. Africa's second largest land mammal finds itself in the teeth of a global conservation battle, where range states in Africa and Asia are engulfed by a mounting wave of violence that exacts high numbers of human and animal casualties. It is ironic that the use of traditional healing remedies and growing prosperity amongst those who prize it, should be at the root of such carnage.

The potential loss of rhinos in itself is a tragedy, but their disappearance through poaching could threaten savannah ecosystems as a whole (Joris et al. 2014, Ripple 2015). Rhinos enrich the soil, spread plant seeds and create areas populated with grass species consumed by smaller grazers such as zebra, wildebeest, impala.

Faraway consumers in Asia are not the only ones to contribute to the rhino's demise. Unscrupulous individuals from within South Africa's rhino conservation and enforcement community have also been implicated in rhino horn trafficking (Annonymus 2015, Milliken & Shaw 2012, Rademayer 2012, Roane 2014, Bloch 2015, Rademayer 2015, Hübschle 2016a,b, Rademayer 2016). Lack of transparency, recordkeeping and reporting on private rhino horn stockpiles in South Africa's powerful private wildlife industry facilitate illegal transactions and fuel demand. Traders have also exploited a legal loophole in the system governing legal rhino trophy hunts to bypass the international ban on horn trading under the UN Convention on International Trade in Endangered Species (CITES). Under these regulations, exporting rhino horn is illegal, while exporting rhino hunting trophies is not.

Not Rhino Proof

For some rhino owners „*it is far easier and safer to sell illegal hunts and avoid compliance with the law by operating in a clandestine manner*"
South African Department of Environmental Affairs, 2014.

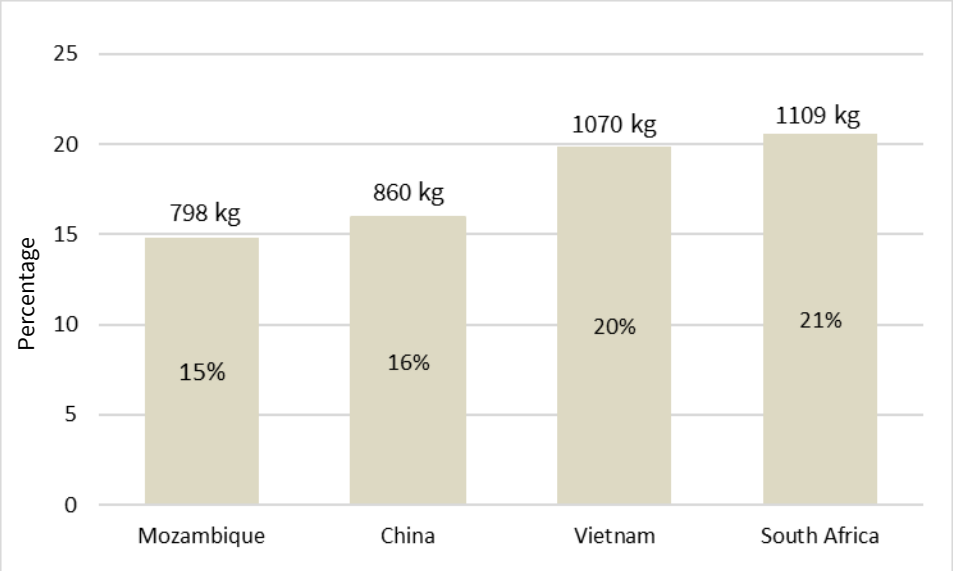


Figure 2. Rhino horn seizure for China, Vietnam, Mozambique and South Africa as percentages of the global total for 2010-2015. Data from Emslie 2016.

1,342 African rhinos died at the hand of poachers - the highest number since records began in 2006.

Rhino horn traffickers not only recruit professional poaching gangs, but hire marksmen with military backgrounds, equipped with silenced firearms, high calibre rifles or semi-automatic weapons, and sophisticated night vision equipment. Small helicopters that are able to fly below air traffic control radar, are sometimes employed to quickly move in and out of protected areas. In some cases, unprincipled wildlife veterinarians have leaked locations of unprotected rhinos or illegally provided M99, an immobilising drug without anaesthetic properties. Marksmen shoot the rhinos with darts containing M99 before the horns are hacked off with machetes or chainsaws - often while the animal is still alive. Rhinos injured in this way die of blood loss or shock after having suffered the most painful and brutal mutilations. A South African enforcement official who has been seen over six years of active service explains:

"Poachers do not care what animal they butcher to get to the horn. If they find a bull, so be it. If they find a cow, that will also work. Unfortunately, cows are very rarely alone and are normally accompanied by a calf or two. If he was to return to help his mother and the opportunity is there, they will not hesitate to kill or maim the calf. If the round does not kill, stun or at least incapacitate the rhino, they will not get what they want. If the animal is still alive but only stunned, they will hack it over the back with a panga [machete] to break the spine and render the rhino immobile, so they can proceed to hack off the horn. Then there is the psychological impact these poaching scenes have on the men - and women - who fight this onslaught on our heritage. It is heart-breaking, when you see grown men crying, overwhelmed by pity and despair, next to the bloodied body of a rhino."

Casualties of illegal trade. Photo: Hein Waschefort

Because of the unprecedented scale of rhino poaching and the exceptional violence and brutality involved the issue of illegal killing, trade and consumption of rhino horn has attracted widespread international attention. An internet search for "rhino poaching" brings up in excess of 70,000 media articles on the subject.

Rhino killed by poachers in Zimbabwe. Photo: Rhino Resource Centre

Rhino horn confiscated from poachers in South Africa. Photo: Allison Thomson

Criminal Networks

Besides posing a significant environmental threat, wildlife trafficking has also been associated with transnational security issues. Organized crime syndicates, armed groups, including terrorists, warlords, and insurgent entities, are involved in various aspects of international wildlife trade. According to a series of U.N. studies on illicit wildlife trafficking Chinese, Japanese, Italian, and Russian organized crime syndicates are "heavily involved in illegal wildlife trade" (ECOSOC, 2005, Sun Wyler & Sheik, 2013). Rhino crime related arrests have been made in the US, United Kingdom, Czech Republic, Germany, Italy, China, Thailand, Vietnam, India, Nepal, Kenya, South Africa, Namibia, Mozambique and Zimbabwe. These criminal networks, in collusion with wildlife or enforcement industry insiders (see Hübschle 2016 a,b) target wild rhinos as well as museums and similar facilities where rhino horn is stored (Emslie 2016). Consumption of rhino horn therefore bankrolls illegal activities.

White rhino mothers and their calves. Photos: Conservation Action Trust

South Africa opposed the ban on international trade in rhino horn when it was first proposed and has continued with its opposition ever since. The Kingdom of Swaziland, which hosts 76 white and 20 black rhinos, has tabled a proposal to legalize the international trade in white rhino horn at the CoP17 by amending the current annotation on the Appendix II listing of Swaziland's white rhinos to permit a "limited and regulated trade" in white rhino horn stockpiles collected from natural deaths or recovered from poachers, as well as horn to be harvested from a limited number of white rhino in the future (CITES 2016)

Rhino Economics

Dr Alejandro Nadal, is a Professor at the Centre for Economic Studies, El Colegio de Mexico and serves as Chair of the Theme on the Environment, Macroeconomics, Trade and Investment (TEMTI), with CEESP-IUCN. Since completing a review of 25 years' worth of literature relating to the wildlife trade, (Nadal A. & Aguayo 2014), Nadal has turned into a fervent critic of the economic arguments put forward by supporters of wildlife trade.

Heavily armed antipoaching helicopter dog unit in South Africa. This level of security is unrealistic for many other rhino range states. Photo: Simon G

In what Nadal and Aguayo refer to "the basic pro-trade narrative" trade bans create scarcity, drive up prices and result in the formation of illegal markets to meet demand. Legal markets, on the other hand, would promise a stable supply, low prices, eliminate the incentive for poaching and out-compete illegal operators. But Nadal charges that governments, economists and conservationists who believe poaching can be stopped by selling rhino horn and ivory legally lack a basic understanding of macroeconomics. Pro-trade studies also fail to understand the sophistication of international wildlife trafficking cartels, which not only deal with different species but also work with many lines of production: illegal logging, narcotics, firearms, and human trafficking to spread their risk and, in a single market such as rhino horn or ivory, withstand price wars for longer than legal traders could (Nadal A. & Aguayo 2014, Nadal 2015 a,b). The absence of information about the structure and dynamics of illegal wildlife markets and the criminal organisations involved, says Nadal, makes it impossible to accurately assess or predict the potential impact of legal trade. Most pro-trade "claims are restricted to a very small and most likely irrelevant set of possible market configurations," and constitute a "brutal simplification of real-world economics (and) a serious assault on logic." (Nadal A. & Aguayo 2014).

Discussions about sustainable use of rhino horn and legal trade should differentiate between ecological and economic sustainability. The latter could provide a rationale for stockpiling but lead to the disappearance of wild rhino populations. Nadal warns that demand for ivory, rhino horn, and other products could be a "runaway market" for which legalization of trade acts as a catalyst (Nadal 2015b).

The Economist's perspective

Most pro-trade "*claims are restricted to a very small and most likely irrelevant set of possible market configurations," and constitute a "brutal simplification of real-world economics* (and) *a serious assault on logic."*
Dr Alejandro Nadal, Professor at the Centre for Economic Studies, El Colegio de Mexico and serves as Chair of the Theme on the Environment, Macroeconomics, Trade and Investment (TEMTI), with CEESP-IUCN.

Confiscated rhino horns and ivory about to be destroyed in Kenya. Photo: Mwangi-Kirubi

There are real life examples of legal trade in wildlife resulting in undesirable outcomes that are far removed from the "sustainable use idea" that generated them. One of these is the vicuña, a South American camelid with exceptionally fine and soft wool. Wildlife trade supporters like to refer to international trade in vicuña wool as a positive example of sustainable wildlife use (Jacobson 2012, DEA 2014). But despite these claims, illegal hunting is still the primary threat to the species (IUCN SSC GECS 2015) several decades after the experiment began (Parker & Ying 2009). Vicuña expert Christian Bonacic initially supported the both the concept of sustainable use and its application to vicuñas. But because legal trade in vicuña wool has led to an increase in poaching and trafficking of wool, he has since changed his mind (Nowak 2015). Bonacic sees parallels between the current rhino horn debate and vicuña conservation, which give rise to concerns that legal trade in rhino horn could end in extinction. "When you drive a magnificent animal away from its ecological relationships, you're taking away the whole meaning of wildlife conservation" (Nowak 2015). Evidence is mounting that wildlife farming is not the conservation panacea many want it to be. Dutton and colleagues (2011) identified a strong preference for wild products amongst Chinese bear bile consumers. So much so that "the introduction of farmed bear bile has either had little impact on demand for wild bear bile or in some circumstances increased it." A similar argument was posed in relation to farmed tigers as a means to persuade consumers to transfer their custom away from products obtained through poaching. Gratwicke et al. (2008) surveyed 1880 residents in six Chinese cites to learn about demand for products made from wild tigers. Of the 43% of respondents who admitted to having consumed tiger products, 71% expressed a preference for wild over farm-sourced products. The preference for wild sourced tiger products amongst consumers (Gratwicke et al. 2008) and the fact that farms are in the hands of a small number of producers are two factors that stand in the way of reducing poaching of wild tigers through farming (Kirkpatrick, R. C. & Emerton 2010). The authors conclude that "tiger farming is more likely to increase aggregate demand for tiger products and stimulate higher levels of poaching."

Wild beats farmed for traditional medicine consumers

Consumers of on bear bile, turtles, tigers and rhino horn have expressed a clear preference for products originating from the wild rather than from farms.

Assessing the Relationship between Supply and Demand

Whether a sustainable supply of rhino horn can meet and keep up with demand in Asia is pivotal to the success of legalized trade in horn (DEA 2014). Pro-trade advocates, which consist primarily of private rhino owners and some government conservation agencies in southern Africa are confident that South Africa's rhinos alone can match the demand of Asian consumers. Some pro-trade supporters vociferously hail legalized international trade in horn as the answer for rhino conservation *per se* and go as far as claiming that a steady flow of rhino horn from regular dehorning operations on privately owned white rhinos in South Africa can "flood the market."

We attempted to gauge the limitations of current rhino horn reservoirs from wild populations in relation to rhino horn trade by examining a series of supply and demand scenarios. We estimated horn mass (Pienaar et al. 1991, Bibhab Talukdar pers. comm.) of global and South African rhino populations (Emslie et al. 2016) (Tab.1) and apportioned the results to potential adult markets in Vietnam and China[1] (The World Bank 2015) via a range of rhino horn quantities that are commonly administered in traditional Asian medicine prescriptions (1 – 50 g, Appendix I). We also tested the results for larger quantities of rhino horn resulting from recently emerged non-traditional consumer markets (100 – 1000 g, Amman 2015b, Patton & Amman Amman 2016).

Global rhino populations and their associated horn mass estimates

Table 1. Global population abundance of the two African and three Asian species and the associated horn weights in gram. Sources: a) Population figures: White rhino (*Ceratotherium simum*) and Black rhino (*Diceros bicornis*): Knight 2016, IUCN African Rhino Specialist Group. Javan rhino (*Rhinoceros sondaicus*), Sumatran rhino (*Dicerorhinus sumatrensis*), Indian rhino (*Rhinoceros unicornis*): Emslie et al. 2016). b) Average horn weights: White and Black rhinos: Pienaar et al. 1991, Javan, Sumatran and Greater on-horned rhino: Bibhab Talukdar Chair, IUCN Asian Rhino Specialist Group, pers. comm. 2014.

Rhino Species	Horn Weight [g]	Population Size	Horn mass [g]
White rhino	5,880	20,378	119,822,640
Black rhino	2,655	5,250	13,938,750
Indian rhino	2,000	3557	6,528,000
Javan rhino	550	58	34,650
Sumatran rhino	700	100	53,200
Global total		**29,324**	**140,963,240**

Results

→ The estimated global population of 29,324 rhinos carries an estimated 140,963.24 kg of horn.

→ South Africa's 18,413 white and 1,893 black rhinos carry an approximate horn weight of 108,268.44 kg and 5,026.91 kg respectively with a combined total of 113,294.35 kg.

[1] For the purpose of this study 'adult population' is defined as citizens older than 15 years of age because this was the only available demographic breakdown available for both countries. Source: World Bank Development Database

South Africa's rhino population and associated horn mass estimates

Table 2 South Africa population abundance of White and Black rhinos and associated horn weights in gram. Sources: Population figures: White rhino (*Ceratotherium simum*) and Black rhino (*Diceros bicornis*): Knight 2016, IUCN African Rhino Specialist Group. Average horn weights: White and Black rhinos: Pienaar et al. 1991.

Species	Population Size	Individual Horn Mass [kg]	Combined Horn Mass [kg]
White Rhinos	18,413	5.880	108,268
Black Rhinos	1,893	2.655	5,027
Total	20,306		113,294

→ Global rhino population: The consumption of a single prescription of 1 – 3 gram of rhino horn by 11.58 – 3.86% of adults in Vietnam and China would use up all the horn of all the world's rhinos. Taken over the recommended three days, this figure drops to 3.86 – 1.29% of adults. Rhino horn ingested by 0.23% of adults in China and Vietnam for 10 – 14 days or shorter periods in slightly higher doses amounting to a total of 50 g per prescription would have the same obliterating effect.

Maximum estimated market reach of rhino horn mass amongst adults in China and Vietnam

Table 3. The relationship between rhino horn supply and demand presented as the percentage of adults in China and Vietnam that could be provided with traditional Asian medicine prescriptions containing rhino horn in a variety of dosages or treatment durations.

Amount of rhino horn used in gram	1 g	3 g	9 g	50 g	100 g	1 kg
	Market reach amongst adults in China and Vietnam [%]					
Global rhino population	11.58	3.86	1.29	0.23	0.12	0.012
South African black and white rhino population	9.31	3.10	1.03	0.19	0.09	0.009
South African white rhino population in private ownership	2.90	0.97	0.32	0.06	0.03	0.003
South African white rhino population in participating private ownership	2.32	0.77	0.26	0.05	0.02	0.002
Annual horn regrowth of white rhinos in private ownership in South Africa	0.4	0.12	0.04	0.007	0.004	0.0004
Annual horn regrowth of white rhinos in private ownership/owners interested in trade	0.29	0.10	0.03	0.006	0.003	0.0003

→ South Africa's rhino population: The ingestion of a single prescription of 1 – 3 gram of rhino horn by 9.31 – 3.10% of adults in Vietnam and China would require the horn of South Africa's entire rhino population. Taken over the recommended three days this figure drops to 3.1 – 1.03% of adults. Rhino horn ingested by 0.19% of adults in China and Vietnam for 10 – 14 days or shorter periods in slightly higher doses amounting to a total of 50 g per prescription would have the same effect.

A question of scale

The dosage of rhino horn in traditional Asian medicine ranges from 1.5 – 180 g per prescription. Our estimates are based on lower end dosages of 1 -50g.

→ White rhinos in private ownership in South Africa: The consumption of a single prescription of 1 – 3 gram of rhino horn by 2.90 – 0.97% of adults in Vietnam and China would require the horn of South Africa's entire privately owned white rhino population. Taken over the recommended three days this figure drops to 0.97 - 0.32% of adults. Rhino horn ingested by 0.06% of adults in China and Vietnam for 10 – 14 days or shorter periods in slightly higher doses amounting to a total of 50 g per prescription would have the same effect.

→ White rhinos owned by South African farmers interested in participating in legalized international trade (80%, Knight 2016): The consumption of a single prescription of 1 – 3 gram of rhino horn by 2.32 – 0.77% of adults in Vietnam and China would require the horn of South Africa's entire privately owned white rhino population. Taken over the recommended three days this figure drops to 0.77 - 0.26% of adults. Rhino horn ingested by 0.05% of adults in China and Vietnam for 10 – 14 days or shorter periods in slightly higher doses amounting to a total of 50 g per prescription would have the same effect.

Sumatran rhino mothers and calf resting together. Photo: International Rhino Foundation

Estimated annual horn growth of South Africa's privately owned white rhinos

Table 4. Number of White Rhinos (*Ceratotherium simum*) in private ownership in South Africa (N-6014, sex ratio 1:1.512) and estimated annual horn regrowth in kilogram (600g/year for females and 1000 g/year for males). Data from Knight 2016.

Species	Number of Rhinos	Annual Horn Regrowth [kg]	Annual Horn Regrowth Potential Trade Participators [kg]
White Rhino Females	3,978	2,386	1,909
White Rhino Males	2,036	2,036	1,629
Total	6,014	4,423	3,538

Photo: Pexel

→ Dehorning of South Africa's white rhino population: Horn obtained through regular collection of regrowth from South Africa's privately owned white rhino population (600 g for females, 1 kg for males, Knight 2016, Hanks in Crone 2015) could supply an estimated 0.36 – 0.12% of adults in Vietnam and China with a single prescription of 1 – 3 gram. Taken over the recommended three days this figure is reduced to 0.12 - 0.04% of adults. Rhino horn consumed in slightly higher doses or taken for 10 -14 days, amounting to a total of 50 g per prescription, could supply 0.007% of adults in China and Vietnam.

→ Dehorning of white rhinos owned by South African farmers interested in participating in legalized international trade (80%, Knight 2016): Horn obtained through regular collection of regrowth from South Africa's privately owned white rhino population (600 g for females, 1 kg for males, Knight 2016) could supply an estimated 0.29 – 0.10% of adults in Vietnam and China with a single prescription of 1 – 3 gram. Taken over the recommended three days this figure is reduced to 0.03 - 0.006% of adults. Rhino horn consumed in slightly higher doses or taken for 10 -14 days amounting to a total of 50 g per prescription would supply 0.003% of adults in China and Vietnam.

→ Bulk purchasers of 1 kg of rhino horn for traditional or non-traditional medicinal purposes, as investments, gifts or to demonstrate status by 0.012% of adults in China and Vietnam would consume the horn of all of the world rhinos. This figure is reduced to 0.009% for South Africa's rhino population, 0.003% of privately owned rhinos in South Africa, 0.002% for rhino owners who indicated interest in participating in legal trade, and 0.0003 - 0.0004% for horn originating from annual dehorning operations for all private facilities and those who expressed interest in participating in legal trade respectively.

White rhino calf Photo: Wikimedia

We used a conservative dose of 1 - 3 g of rhino horn for our calculations, either as a single or a three-day treatment (Appendix I). The latter is a common minimum treatment period in traditional Chinese medicine (Lan pers. comm.). We also used upper estimates for horn weight, regrowth and rhino population size. Our estimates of horn yield and potential demand therefore represent a conservative best case scenario. Our results about the quantitative relationship between rhino horn supply and its potential market reach in China and Vietnam are therefore all the more alarming.

Nearly a third (6.014) of South Africa's 20,306 rhinos live on privately owned land or on so called farms. In contrast to integrated biodiversity conservation approaches. many of these facilities keep rhinos at unnaturally high densities, heavily skewed sex ratios (about 1:1.5) (Warren 2015, Knight 2016, DEA 2014) and dependent on supplementary food (Warren 2015). Photo: Ann & Steve Toon

Our estimate of horn mass resulting from annual dehorning operation on private land (3,538 kg) exceeds the estimate of the South African Department of Environmental Affair's (approx. 2,500 kg) (DEA 2014). The difference between is due to the smaller proportion of rhino owners that have signalled they would participate in legal trade in 2014 (50% vs. 80%, Knight 2016).

TCM shop in Tsim Sha Tsui, Kowloon, Hong Kong. Photo: Wikimedia

Several market surveys offer indications about the scale of current and latent rhino horn consumption amongst different demographics in Vietnam. These studies provide useful points of reference for the findings of this study. A survey of 800 educated, urban, traditional medicine users in Vietnam with an average monthly income of US$292 revealed that 59% (475) had either purchased or used rhino horn, or expressed an interest in doing so in the future (Hanley et al. 2016). 16% (130) of participants had either used or purchased rhino horn in the past five years. Consumer choice was significantly influenced by income, with wealthier participants more likely to have purchased rhino horn in the past. The survey also revealed a notable preference for wild sourced horn and the willingness to pay more for horn from poached rhinos (Hanley 2016). An earlier survey by TRAFFIC (2013) in Hanoi and Ho Chi Minh City found that 5% of the study group had purchased or consumed rhino horn or were doing so now, and that 16% of those who were not using horn at the time, were intending to do so in the future. Of the 720 individuals questioned 35% of expressed they would neither purchase nor consume rhino horn. Due to different demographics, TRAFFIC's and Hanley's estimates for active rhino horn consumers of 5% and 16% are not directly comparable. However, the difference might indicate a worrying rise in demand, particularly amongst young, urban professionals.

A possible demand of 16% to 59% (Hanley 2016) and 5% also with a sizeable latent market (TRAFFIC 2013), exceed the capacity of the world's wild rhino populations to accommodate even a one off prescription of rhino horn. The obvious disparity between demand and the possible supply of horn from South Africa and from the country's privately owned rhinos further illustrates that sustainable legal international trade in rhino horn is highly improbable. The omission of rhino horn from natural mortalities and break offs in our calculations have no sizeable effect on the order of magnitude differences between supply and demand suggested by this study.

The link between consumption and affluence identified by Hanley (2016) provides further support for the notion that the size of Vietnam's market is likely to expand. Vietnam's per capita income has grown from around US $100 in 1986 to US $2,100 by the end of 2015 (The World Bank 2016). Its per capita GDP growth has been among the fastest in the world in recent years, averaging 6.4% a year in the 2000s. As affluence grows, demand for rhino horn and other wildlife products is likely to surge unless effective demand reduction initiatives are undertaken. Rhino horn trade enthusiast Michael Eustace (2016) shares the belief in potential market expansion. "All the poached horn sold from Africa is consumed by about 1-million people in the Far East but there could be 500-million people that would buy horn at lower prices." In contrast to his peers, trade advocate John Hanks cautions that legalized rhino horn trade won't put a stop to poaching, nor could it operate as planned in the face of corruption or without significantly enhanced field security (Crone 2016, see also Christy 2016). In addition, all illegal activities would have to cease. It is unlikely that either, not to mention all of these conditions will be met anytime soon.

Rhino horns, rhino feet and traditional medicines confiscated in the United States. Photos: USFWS

Conclusion

The potential impact of the Asian traditional medicine market on wild species was demonstrated in the 1990s when conservation groups encouraged the use of Saiga antelope as a substitute for rhino horn. By 2003, this well-intentioned plan decimated over one million Saiga to fewer than 30,000 individuals, largely due to poaching for use in TCM. Saiga antelope were subsequently included in the IUCN Red List Endangered Species in 2002, and TCM practitioners are now actively discouraged from using their horn. Instead, the horns of water buffalo and cows are commonly promoted as alternatives to rhino horn. This example highlights the potential impact of the traditional Asian medicine market.

Pro-trade proponents have suggested that if things go wrong and poaching escalates further as a result of lifting the ban, rhino horn trade could either be "closed down or restructured" after three or four years. Such plans are both unhelpful and impractical, firstly because it risks setting off an illegal buying and poaching rush to exploit a potentially limited window of opportunity as soon as trade is permitted. Secondly, experience from rising exports of rhino horn as hunting trophies from so called "pseudo hunts" in South Africa has shown that it can take seven years (2003-2009) to recognise and address such problems.

Northern white rhinos once ranged across Uganda, South Sudan, the Central African Republic and the Democratic Republic of the Congo. Around 2,000 survived in the wild in 1960. Now they are down to the last three survivors. Forty-three-year-old Sudan is the last male of his kind. He lives in Kenya in the company of armed rangers who guard him around the clock. Sudan is probably the most famous and most photographed rhino on earth - an example of how we pay attention to what's rare and how we are touched by loss and lost opportunities.

Sudan is the last male Northern White Rhino in the world. He lives in Kenya and is protected by armed rangers around the clock. Photo: Amy Vitale

Saving rhinos will involve a host of urgent initiatives in both range states and consumer countries. Addressing issues of social justice and marginalization amongst disenfranchised communities near protected areas is one of the priorities. But besides providing vital ecosystem services, protected areas also generate an estimated US$ 600 billion a year in direct in-country expenditure and US $250 billion a year in consumer surplus (Balmford et al. 2015). Yet just US $8 billion are spent on them in return. Reinvesting some of these funds to maintain protected areas and support the local communities who live in their vicinity will go some way towards solving the problem. But resolving poverty in South Africa cannot be contingent on international trade in rhino horn – or ivory for that matter. To suggest that it is, is at best misguided and at worst a cynical attempt to distract from the underlying causes of inequality that persist in South Africa (Hübschle 2016 a). The promise of quick and easy cash to lift disadvantaged communities out of poverty through rhino horn trade is likely to successfully rally the desired pro-trade support amongst those communities and rouse anger against those who oppose it. But taking this route is a dangerous game because, as the experience in Zimbabwe has shown, once these unrealistic expectations are thwarted, the resulting anger and frustration is likely to turn once again against protected areas and wildlife.

Regulating legal trade without substantial quantities of illegally obtained horn leaking onto the market is not within our grasp due to significant and persistent governance issues in range states and consumer countries (see Amman 2013a, Anonymous 2015, Hübschle 2016 a,b). The Sixteenth Session of the Conference of the Parties (COP16) of CITES (Convention on the International Trade in Endangered Species of Wild Fauna and Flora) required member countries implicated in the rhino horn trade, to “develop and implement long-term demand reduction strategies or programmes and immediate actions aimed at reducing the illegal movement and consumption of rhino horn products” (COP 16; Decision 16.85). Since then thousands of rhinos have died for their horn.

Change is possible. But we have to really want it and commit to it. Demand reduction initiatives for shark fin soup in China have been extremely successful in a comparatively short time and are said to have cut consumption by an estimated 70% (Wu 2015). The crippling practice of foot binding came to an end in the middle part of the last century and panda bears, once the target of relentless hunting, are finally making a comeback.

Two white rhinos. Photo: Andamanse

The size of the market for rhino horn in Vietnam and China and the sophisticated global criminal cartels that supply it mean that there can be no such thing as “regulated and limited trade” when it comes to rhino horn. Nor will South Africa’s private rhino owners or the country’s entire rhino population be able to “flood the market” with “harvested” horn. Instead, legal trade in rhino horn would flood the whole of Africa with mutilated rhino corpses. Our results have shown that there simply are not enough rhinos left anywhere to satisfy demand. Legalising trade would vastly outstrip supply, because illegal rhino horn would continue to be laundered into legal flows, exacerbated by the likelihood of a continued market for rhino horn sourced from wild populations due to expressed consumer preferences. Thus, lifting the ban will hasten the demise of rhinos across all 14 range states. We therefore urge all South Africans, including local communities, to consider the likely impact of legalized rhino horn trade on their own rhinos and on those that live beyond their borders. We also appeal to the delegates of the 17th Conference of the Parties to CITES and the citizens of rhino range states and consumer nations to unite on behalf of the world’s beleaguered rhinos and send a strong message that rhino horn consumption and trade have had their day

Appendix I

Examples of doses for rhino horn in traditional Asian and allied medicines either as a single ingredient or as part of compound prescriptions.

Dosage	Comments	Literature Source
0.05 g/kg	Dependent on patient's body weight	But et al. 1990, Tsai 1995, Liu et al. 2011
0.5 - 1	Daily dose. Vietnam	Do et al. 2006
1 - 2		Jennes F. & Flaws B. 2006
1-3	Daily dose	椑璟 嘆諭苗 D 旄嬭 业内相关 嘆諭书籍 图书 嘆條 ⌐嘆药方剂 隣諭 諭騁盪癮 专栏 杂集
1.5 – 3		Anonymous 2016b, Chinese Herb Academy, Anonymous 2016a, Jiao Shu-De 3003, Hempen C-H. 2009
1.5 – 6		Anonymous 2012
2 - 6		Anonymous 2016d
2.5 - 10	Asian rhino horn	Anonymous 2016c
2.5 - 10	decocted	Chinese Herb Academy, Anonymous 2016a
3		Liu et al. 2004, Joe Hing kwok 2013, Nowell 2012
3 - 4	Daily dose. Vietnam	Do et al. 2006
3 -5	Daily for two weeks	Hübschle 2016a p 355
3 - 9	decocted	Jiao Shu-De 2003
3 - 9		Liu et al. 2004
6	Twice daily	Joiner 2001
2.5 - 10	Asian rhino horn	Anonymous 2016c
6 - 24		Liu et al. 2004
9	Cancer, 3 x daily	Joiner 2001
9 - 15	decocted	Hempen C-H. 2009
6 - 15	decocted	Gonzalez C.J. 2005
30 - 60	Veterinary use, 2 x daily	Center for Acupuncture and Herbal Medicine, P.A.
5-75		Xie H. 2010
1 - 80	Korea	Song & Milliken 1991
30 - 150		Chinese Acupuncture & Wellness
180		Liu et al. 2004

Bibliography

Amel A. (2014) Rhinos face extinction by 2020, wildlife experts warn. Aljazeera, April 14, 2014.

Amman, K. (2013a) Hanoi connection: The rhino horn mafia. (2 April 2013) https://www.youtube.com/watch?v=1WhTj_50KMo

Amman, K. (2015a) Characteristics of rhino horn trade along Vietnam's northern borders: Conservation Action Trust (15 April 2015)

Amman K. (2015b) The rhino horn story at the consumer end. Karl Amman. http://www.karlammann.com/rhino-horn.php

Anonymous (2012) Rhinoceros horn (Xijiao). Pharmacognogy Accesses 6/25/2012: http://www.epharmacognosy.com/2012/06/rhinoceros-horn-xijiao.html>

Anonymous (2012) South Africa vets & hunters involved in rhino poaching. Wildlife Extra: http://www.wildlifeextra.com/go/news/rhino-m99.html#cr

Anonymous (2015) A solution to South Africa's wildlife crisis? John Hanks quoted in University of Capetown news, 29 May 2015.

Anonymous (2015) Decision over sale of stockpile rhino horn set for 2016. Sapa, Mail & Guardian, 10 Feb 2015. http://mg.co.za/article/2015-02-10-stockpiled-rhino-horns-sale-decision-will-be-made-in-2016

Anonymous (2016a) Chinese Herbs Healing: Complete guide to proven herbal remedies, Rhinoceros Horn (Xi Jiao) Accessed: 15 August 2016 http://www.chineseherbshealing.com/rhinoceros-horn

Anonymous (2016b) The Prescription of Xijiao Dihuang Tang. TCM Wiki is a wiki site of Traditional Chinese Medicine. Accessed: 15 August 2016 http://old.tcmwiki.com/wiki/the-prescription-of-xijiao-dihuang-tang

Anonymous (2016c) Xi Jiao 丨ブ, Rhinoceros Horn, Cornu Rhinocerotis Asiatici, Horn of Asiatic rhinoceros, TCM Wiki a wiki site of Traditional Chinese Medicine. http://old.tcmwiki.com/wiki/xi-jiao Accessed 7 September 2016

Anonymous (2016d) Rhinoceros indicus, R. unicornis, R. sondaicus 丨ブ Xī jiāo Rhinoceros Horn. Inner Path http://www.innerpath.com.au/matmed/herbs/Rhinoceros~indicus.htm

Anonymous (2015) Corruption behind Tanzania's increasing wildlife poaching incidents: report. China Daily, Mar 10,2015: http://www.shanghaidaily.com/article/article_xinhua.aspx?id=271561

Balmford A, Green JMH, Anderson M, Beresford J, Huang C, et al. (2015) Walk on the Wild Side: Estimating the Global Magnitude of Visits to Protected Areas. PLoS Biol 13(2): e1002074. doi: 10.1371/journal.pbio.1002074

Bloch S. (2015) Cop caught with rhino horns gets R500 bail. Times Live. http://www.timeslive.co.za/thetimes/2015/01/16/cop-caught-with-rhino-horns-gets-r500-bail

But P.H.H., Lung L.C., Tan Y.K. (1990) Ethnopharmacology of rhinoceros horn. I: Antipyretic effects of rhinoceros horn and other animal horns. J Ethnopharmacol; 30: 157-168

Center for Acupuncture and Herbal Medicine P.A. http://www.acupunctureandherbalmedicine.com/document/link_herbal_formulas.pdf Accesses 6/25/2012:

Chinese Acupuncture & Wellness (2016) Chapter 9 开窍剂 Formulae opening orifices.

Chinese Herb Academy: Chinese Herb Academy Database. http://chineseherbacademy.org/databases/hb-db/rhino.html Accessed: 15 August 2016

Christy B. (2016) Special Investigation: Inside the Deadly Rhino Horn Trade: Here's how a pair of South Africans could undermine the international efforts to protect the vulnerable animals. National Geographic, October 2016, National Geographic magazine. http://www.nationalgeographic.com/magazine/2016/10/dark-world-of-the-rhino-horn-trade/

CITES (2013) CoP16 Doc. 54.2 (Rev. 1) 16th meeting of the Conference of the Parties, Interpretation and implementation of the Convention, Species trade and conservation Rhinoceroses, REPORT OF THE SECRETARIAT http://www.cites.org/eng/cop/16/doc/E-CoP16-54-02.pdf

CITES (2016) Swaziland, CoP17 Prop. 7: Consideration of Proposals for Amendment Of Appendices I And I Seventeenth meeting of the Conference of the Parties Johannesburg (South Africa), 24 September – 5 October 2016 https://cites.org/sites/default/files/eng/cop/17/prop/060216/E-CoP17-Prop-07.pdf

Columbia University 2009, Issues and Trends in China's Demographic History, http://afe.easia.columbia.edu/special/china_1950_population.htm

Crone A. (2015) Will Clarity on Rhinos Help Save Other Species? Africa Geographic http://magazine.africageographic.com/wp-content/uploads/2015/07/Issue-54-Africa-Geographic-Magazine.pdf

DEA/Taylor, A., Brebner, K. Coetzee, R. Mostert, Lindsey, P., Shaw, J. & 'T Sas-Rolfes (2014) The viability of legalising trade in horn in South Africa, Authors: H. Department of Environmental Affairs

Do, H.B., Dang, Q.C., Bui, X.C. et al. (2006). Medicinal plants and animals in Vietnam, Volume II. Publishing House for Science and Technology, Ha Noi.

Dutton A.J., Hepburn C. & Macdonald D.W. (2011) A Stated Preference Investigation into the Chinese Demand for Farmed vs. Wild Bear Bile. PLoS ONE 6(7): e21243. doi:10.1371/journal.pone.0021243

ECOSOC (2005) United Nations Economic and Social Council (ECOSOC), reports of the Secretary-General, Progress Made in the Implementation of Economic and Social Council Resolution 2001/12 on Illicit Trafficking in Protected Species of Wild Flora and Fauna E/CN.15/2002/7, Feb. 26, 2002, Illicit Trafficking in Protected Species

Emslie H.E., Milliken T., Talukdar B., Ellis S., Adcock K. & Knight HM.K. (2016) African and Asian Rhinoceroses – Staus, Conservation and Trade. IUCN SSC African and Asian Rhino Specialist Groups and Traffic to the CITES Secretariat pursuant to Reolution Conf. 9.14 (Rev. CoP15), Cop17 Doc 68 Annex 5

Emslie R. & Brooks M. (1999) African Rhino. Status Survey and Conservation Action Plan. IUCN/SSC African Rhino Specialist Group.

Emslie R. (2011) Diceros bicornis, IUCN Red List of Threatened Species. Version 2012.1.

Eustace M (2016) letter: CITES secretariat does not understand where rhino-poaching risk lies. Business Day Live, 24 September 2016. http://www.bdlive.co.za/opinion/letters/2016/09/14/letter-cites-secretariat-does-not-understand-where-rhino-poaching-

Ferreira S.M, Greaver, C., Knight, G.A., Knight, M.H., Smit,I.P.J., Izak P. J. & Pienaar D. (2015) Disruption of Rhino Demography by Poachers May Lead to Population Declines in Kruger National Park, South Africa. PLOS ONE. http://dx.doi.org/10.1371/journal.pone.0127783

French H. (2014), China's Second Continent: How a Million Migrants Are Building a New Empire in Africa. Knopf, 304 pp

Gonzalez C.J. (2005) An.Illustrated.Chinese.Materia.Medica. Oxford University Press https://archive.org/details/An.illustrated.chinese.materia.medicaPdfBook

Gratwicke B, Mills J, Dutton A, Gabriel G, Long B, et al. (2008) Attitudes Toward Consumption and Conservation of Tigers in China. PLoS ONE 3(7): e2544. doi:10.1371/journal.pone.0002544. http://journals.plos.org/plosone/article/asset?id=10.1371/journal.pone.0002544.PDF

Hanley N., Sheremet O., Bozzola M, Kasterine A& MacMillan D.C. (2016) Consumer Demand for Rhino Horn in Vietnam: insights from a choice experiment. University of St Andrews, Discussion papers in Environmental Economics. http://www.st-andrews.ac.uk/media/dept-of-geography-and-sustainable-development/pdf-s/DP%202016-10%20Hanley%20et%20al.pdf

Haryono M. et al. (2015) Monitoring of the Javan rhino population in Ujung Kulon National Park, Java. Pachyderm 56: 82–86.

Hempen C-H. (2009) A Materia Medica for Chinese Medicine: Plants, Minerals, and Animal Products. Churchill Livingstone, 1016 pp http://www.shanghaidaily.com/article/article_xinhua.aspx?id=271561

Huang (2014) Rhino horn is no medicine. New Scientist, April 2014

Huang, L. (2011) "Statement opposing the use of rhino horn in medicines by the American College of Traditional Chinese Medicine and Council of Colleges of Acupuncture and Oriental Medicine."

Hübschle A. (2016a) A Game of Horns: Transnational Flows of Rhino Horn. Max Planck Research School on the Social and Political Constitution of the Economy, Cologne, ISBN: I978-3-946416-12-8, DOI: 10.17617/2.2218357 p 355, http://imprs.mpifg.de

Hübschle A. (2016b) Security coordination in an illegal market: the transnational trade in rhinoceros horn

Hume J (2015) Rhino Breeding Project J.F. Hume. PowerPoint presentation.

IRF (International Rhino Foundation) (2016) Greater One-horned Rhino, http://rhinos.org/species/greater-one-horned-rhino

IUCN Glossary Definitions, IUCN DEFINITIONS ─ ENGLISH: https://www.iucn.org/downloads/en_iucn__glossary_definitions.pdf

IUCN SSC GECS (2015) Poaching of Vicuña and the Illegal Commercialization of its Fiber: a Persisting Problem, South American Camelid Specialist Group,1-5. http://cmsdata.iucn.org/downloads/gecs_vicuna_poaching_en.pdf

Jacobsen T. (2012) Rhino and vicuna: a parallel, 9 pp. http://www.rhinoresourcecenter.com/pdf_files/133/1331765741.pdf

Jennes F. & Flaws B. (2006) Herb Toxicities & Drug Interactions: A Formula Approach. Blue Poppy Press 412 pp.

Jiao Shu-De (2003) Ten Lectures on the use of Medicinals from the personal experience of Jiao Shu-De (Jiao Clinical Chinese Medicine) Editor: Nigel Wiseman, Paradigm Press; Bilingual edition (11 Mar. 2003), 730 pp.

Joe Hing Kwok (2013) Chu Complementary and Alternative Healing University. Accessed: 15 August 2016

Joiner T. (2001) Chinese Herbal Medicine Made Easy: Natural and Effective Remedies for Common Illnesses. Hunter House, 432 pp.

Joris P. G. M. Cromsigt, J.P.G.M and te Beest, M. (2014) Restoration of a megaherbivore: landscape-level impacts of white rhinoceros in Kruger National Park, South Africa. J. Ecol. 102 (3) 566-575

Kirkpatrick, R. C. & Emerton, L. (2010) Killing Tigers to Save Them: Fallacies of the Farming Argument. Conservation Biology, 24: 655–659. doi:10.1111/j.1523-1739.2010.01468.x

Knight M. (2016) African Rhino Specialist Group report, Pachyderm 57: 12-42

Larson, R. (2010). Rhino Killings on the Rise: A troubling correlation between rhino killings and the spreading Chinese footprint in Southern Africa. Saving Rhinos LLC, San Francisco, USA.

Leader-Williams N. (1992) The World Trade in Rhino Horn: a review. A TRAFFIC Network report, 41 pp. file:///C:/Users/Barbara/Desktop/traffic_species_mammals45.pdf

Li Shizhen (2003) Compendium of Materia Medica (English) (Ming Dynasty) Beijing: Foreign Languages Press, 2003. Size: 187×258 mm; 4,456 pages.

Liu C., Tsen S. & Yang S. (2004) Chinese Herbal Medicine: Modern Applications of Traditional

Liu, R., Duan, A.J. Wang, M. et al. (2011). Analysis of active components of rhinoceros, water buffalo and yak horns using two-dimensional electrophoresis and ethnopharmacological evaluation. Journal of Separation Science 34(3): 354-362.

Milliken T. (2012) The final destination. Africa Geographic, April 2010: 40-43.

Milliken, T and & Shaw J. (2012), J. The South Africa – Viet Nam Rhino Horn Trade Nexus: A deadly combination of institutional lapses, corrupt wildlife industry professionals and Asian crime syndicates. Traffic report.

Nadal A. & Aguayo F. (2014) Leonardo's sailors: A review of the economic analysis of wildlife trade. The Leverhulme Centre for the Study of Value.

Nadal A. (2015a) The economics of legal wildlife trade: pitfalls and perspectives. Wildlife in Crisis: Markets, responses and solutions. University of Cape Town, Cape Town (19 May 2015).

Nadal A. (2015b) Submission to Committee of Inquiry into a Possible Trade in Rhino Horn. 30TH MAY 2015 - DEA WEBSITE

Nardelli F. (2014) The last chance for the Sumatran rhinoceros? Pachyderm 55: 43–53.rademay

News24, 23 December 2015. http://www.news24.com/SouthAfrica/News/exclusive-north-korean-diplomatexpelled-from-sa-for-rhino-horn-trafficking-20151223

Nowak K. (2015a) Legalizing Rhino Horn Trade Won't Save Species, Ecologist Argues: What can South Africa's rhino horn trade proponents learn from experiences with the South American vicuña? National Geographic, January 2015

Nowak K. (2015b) Rhinos and Elephants Are in Trouble—So Why Adopt Contradictory Emergency Measures? National Geographic, March 21, 2015.

Nowell, K. (2012) Species trade and conservation Rhinoceroses Assessment of Rhino Horn as a Traditional Medicine. TRAFFIC, 43 pp.

Nuwer R. (2015) Poaching Upsurge Threatens South America's Iconic Vicuña. Scientific American. November 24, 2015. http://www.scientificamerican.com/article/poaching-upsurge-threatens-south-america-s-iconic-vicuna/

Park Y.J & Ying A (2009) Chen (Recent Chinese Migrants in small Towns of Post-apartheid South Africa, Reveue Europeenne des Migrations Internationales, 25(1), p. 25-44 http://remi.revues.org/4878?lang=en#ftn14
Patton F. & Amman K. (2016) From health to wealth – understanding the trade in rhino horn in the age of affluence. Pachyderm, 57 (July 2015 – June 2016) 122-124.
Patton, F. (2011) Understanding Chinese medicine - the scourge of the rhino. Swara, Nairobi 2011(4), 38-40. http://www.rhinoresourcecenter.com/index.php?s=1&act=pdfviewer&id=1320466014&folder=132
Pflanz M. (2009) Chinese demand and financial crisis cause surge in Kenya elephant poaching, The Telegraph, 25 Feb 2009, http://www.telegraph.co.uk/news/worldnews/africaandindianocean/kenya/4807291/Chinese-demand-and-financial-crisis-cause-surge-in-Kenya-elephant-poaching.html
Pienaar D. J., A. J. Hall-Martin, P. M. Hitchens (1991) Horn growth rates of free-ranging white and black rhinoceros. In: Koedoe 34, 97–105.
Prothero, D. (1993) Fifty Million Years of Rhinoceros Evolution. Proceedings of the International Rhino Conference, San Diego Zoological Society. San Diego.
Pui-Hay But P. Yan-Kit Tam, Lai-Ching Lung (1991) Ethnopharmacology of rhinoceros horn. II: antipyretic effects of prescriptions containing rhinoceros horn or water buffalo horn. J. Ethnupharmaculogy, 33 (1991) 45-50, Elsevier Ltd., Ireland. http://www.rhinoresourcecenter.com/pdf_files/117/1178937442.pdf
Rademeyer J. (2012) Killing for profit: Exposing the illegal rhino horn trade. Cape Town,
Rademeyer J. (2015) North Korean diplomat expelled from SA for rhino horn trafficking.
Rademeyer J. (2016a) Tipping Point: Transnational organised crime and the 'war' on poaching. Part 2 of a 2-part investigation into rhino horn trafficking in Southern Africa. http://globalinitiative.net/wp-content/uploads/2016/07/Global-Initiative-Tipping-Point-Part1-July-2016.pdf
Rademeyer J. (2016b) Beyond Borders: Crime, conservation and criminal networks in the illicit rhino horn trade, Part 2 of a 2-part investigation into rhino horn trafficking in Southern Africa. http://globalinitiative.net/wp-content/uploads/2016/07/Global-Initiative-Beyond-Borders-Part2-July-2016-1.pdf
Ripple W.J., Newsome T. M., Wolf C., Dirzo R., Everatt K.T., Galetti M., Hayward M.W., Kerley G.I.H., Levi T., Lindsey P.A., Macdonald D.M., Malhi Y., Painter L.E., Sandom C.J., Terborgh J. & Van Valkenburgh B. (2015) Collapse of the world's largest herbivores. Science Advances: 1(4), e1400103, DOI: 10.1126/sciadv.1400103. http://advances.sciencemag.org/content/1/4/e1400103
Roane B. (2014) R104m horn heist biggest in SA, Crime & Courts. IOL, 22 April 2014. http://www.iol.co.za/news/crime-courts/r104m-horn-heist-biggest-in-sa-1678827
Robinson J. (2009) Healing without Harm: Working to Replace the Use of Animals in Traditional Chinese Medicines [report]. Animals Asia Foundation.
Rookmaaker K. (2011) Medicinal Use of Rhino Horn. Rhino Resource Centre, NEWSLETTER #25 p.4.
Sellar J. M. (2014a) Is this the best we can do? John Sellar's blog on LinkedIn. https://www.linkedin.com/pulse/article/20141016125602-185378273-is-this-reallythe-best-we-can-do
Sellar J. M. (2014b) Never mind the elephant – we need a policeman in the room. Linked In. https://www.linkedin.com/pulse/article/20140623085456-185378273-never-mindthe-elephant-we-need-a-policeman-in-the-room
Sellar J. M. (2014c) Policing the trafficking of wildlife: Is there anything to learn from law enforcement responses to drug and firearms trafficking? Geneva: The Global Initiative against Transnational Organized Crime.
Sellar John M. (2015) What's happening in Kruger is so much more than poaching. Linked In. https://www.linkedin.com/pulse/whats-happening-kruger-so-much-more-thanpoaching-sellar-obe-frgs?trk=hp-feed-article-title
Song C. & Milliken T. (1990) The Rhino Horn Trade in South Korea: Still Cause for Concern, Pachyderm 13, p 5 http://www.poachingfacts.com/docs/Pachyderm/pachy13.pdf#page=14
Sun Wyler, L. and Sheikh, P.A. (2013) International Illegal Trade in Wildlife: Threats and U.S. Policy . Congressional Research Service 7-5700, www.crs.gov , RL34395
The World Bank (2015) World Bank World Development Database http://databank.worldbank.org/data/reports.aspx?source=world-development-indicators#selectedDimension_DBList Accessed 15.7.2016.
The World Bank (2016) The World Bank Country overview: Vietnam. http://www.worldbank.org/en/country/vietnam/overview
TRAFFIC (2013) Rhino horn consumers: who are they? TRAFFIC Greater Mekong Region, Hanoi, Vietnam.
TRAFFIC (2013) TRAFFIC's Engagement on African Rhinoceros Conservation and the Global Trade in Rhinoceros Horn.
Tsai, F.J. (1995). Antipyretic Effect of Xi Jiao [Rhino horn] and Shuiniujiao [Water buffalo horn] in Children. Annual Report of Chinese Medicine and Pharmacy 329-337. Taipei, Taiwan.
UNEP-Interpol (2016) UNEP-INTERPOL Report: Value of Environmental Crime up 26%. Sat, Jun 4, 2016. http://www.unep.org/newscentre/default.aspx?DocumentID=27076&ArticleID=36202
Vigne L. & Martin E. (2008) The Influx of Chinese workers in Ethiopia is encouraging production of illegal ivory trinkets. Swara 31(3), 18-19. http://www.rhinoresourcecenter.com/pdf_files/130/1304636847.pdf
Vigne L. & Martin E. (2016) High rhino horn prices drive poaching. Swara, July-September 2016, 42-45.
Warren P. (2015) Conservation and Financial Benefit by Legalizing the Trade in Rhino Horn.
Wilson-Spaet A. (2016) Private army protects world's largest rhino farm. News24, 2.3. 2016. http://www.news24.com/Green/News/private-army-protects-worlds-largest-rhino-farm-20160302
Wu J. (2016) Online Illegal Wildlife Trade in East Asia. Traffic East Asia. https://aprigf2016.files.wordpress.com/2016/08/2016-online-sales-of-illegal-trade-in-endangered-species_taipei-joyce-wu.pdf
Wu Y.-S. (2015) Not beating around the bush: understanding China and South Africa's illegal wildlife trade. SAIIA, Foreign Policy Programme, Policy Insights 28, 12 pp.

Xie H. (2010) Xie's Chinese Veterinary Herbology. Editors: Huisheng Xie & Vanessa Preast, Wiley-Blackwell; 1 edition (May 18, 2010), 632 pp.

椑页 嘆諭苗 D 旄嬭 业内相关 嘆諭书籍 图书 嘆桍窏 嘆药方剂 隣諭 諭騁盪癙 专栏 杂邊: www. zysj.com.cn/yaocai_x/xijiao. Accessed 15.9.2016.

NABU International
Foundation for Nature

Charitéstraße 3, 10117 Berlin, www.nabu-international.de. Text: Barbara Maas
Photo credits: front cover Fiona Ayerst, back cover Jonathan Pledger