Preserving the African Elephant for Future Generations

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South African Institute of International Affairs

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ABSTRACT

African elephants face an escalating poaching crisis due to an explosion in demand for ivory, mostly in China. Over 100 000 elephants were killed illegally between 2010 and 2012. This paper synthesises the relevant economic literature on elephant conservation, which informs the construction of a game theoretic model. The model is designed to demonstrate which combination of strategies would yield the most efficient allocation of capital for conservation efforts. Three main strategic governance options are available. The first is effective demand reduction. Demand reduction is not a simple matter of running a uniform awareness campaign. It requires a differentiated marketing approach directed at three markedly different groups of consumers. Shifting the demand curve inwards, where the marginal utility of consumption is highest, will have the largest effects on price reduction, thereby disincentivising poaching. In order to secure supply-side credibility for such campaigns, range states should put their domestic stockpiles beyond commercial use immediately and simultaneously. Demand-side efforts should also consider how to compensate potential economic losers. This entails ensuring that sufficient alternative economic value is bestowed on elephants to incentivise societies in developing countries to invest in their preservation.

Second, poaching in range states must be substantially and rapidly curtailed. Reducing poaching is not solely about protecting borders, employing better technology and arresting more poachers. It also requires elephant range states to co-ordinate on a number of levels. Third, banning domestic trades is an important complement to the first two priorities, especially for the sake of lowering the transaction costs of law enforcement to prevent the trafficking and laundering of illegal ivory. The model indicates that employing the first two strategies first may be optimal, as these have the greatest immediate probability of success. Efforts to ban domestic trades should follow, as the scale of the problem will presumably become smaller, ensuring higher returns on the capital invested in enforcing such a ban.

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ABBREVIATIONS AND ACRONYMS

AEAP	African Elephant Action Plan
CITES	Convention on International Trade in Endangered Species of Wild Fauna and Flora
COP	Conference of Parties
EPI	Elephant Protection Initiative
PA	protected area
PES	payment for ecosystem services
UNEP	UN Environment Programme

INTRODUCTION

African elephants face an insecure future. A 2013 UN Environment Programme (UNEP) report indicated a 'pronounced upward trend in both the poaching of African elephants and the illicit trade in ivory'[1] since 2007. Illicit ivory trade and the weight of illegally traded ivory have more than tripled since 1998.[2] Approximately 100 000 elephants were killed illegally between 2010 and 2012, at an average of 33 630 (6.8% of the total population) a year.[3] Figure 1 illustrates that the poaching rate over the last five years exceeds the population replacement rate.

Figure 1: Percentage of elephants killed illegally in Africa*, 2002–2011
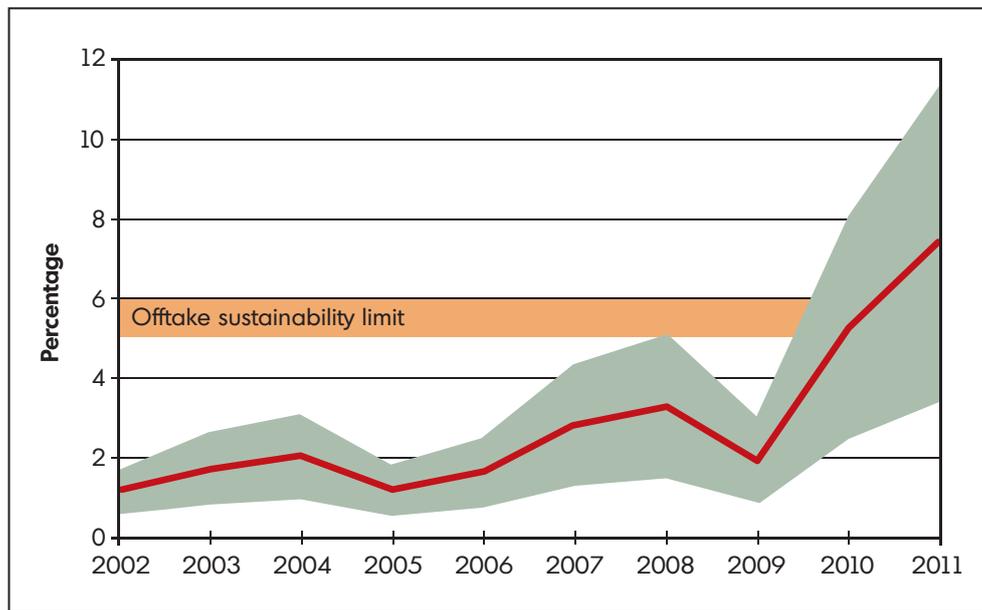
* at reporting Monitoring the Illegal Killing of Elephanta (MIKE) sites

Source: CITES (Convention on International Trade in Endangered Species of Wild Fauna and Flora), Monitoring the Illegal Killing of Elephants, 2012, http://www.grida.no/graphicslib/detail/percentage-of-elephants-illegally-killed-in-africa_fd31, accessed 25 June 2015

Combined with elephants' natural mortality rate, this trajectory means that the minimum viable population of African elephants is under threat. Across the 12 Monitoring the Illegal Killing of Elephants (MIKE) sites, elephant numbers have decreased by 7% a year on average over the last decade. Numbers were mostly rising until 2009 (a year in which natural mortality spiked due to environmental disasters). The reversal of that trend requires an urgent policy response. The UNEP report estimates that the total continental population of remaining elephants is between 420 000 and 650 000. Elephant populations grow at approximately 4.2% per year in the absence of poaching. Therefore, 'offtake currently exceeds the intrinsic growth capacity of the species'.[4] Figure 2 demonstrates these trends even more clearly when juxtaposed with the recorded price of ivory (in China).

Figure 2a: Estimated natural mortality and illegal killing rates, contrasted with local ivory prices (in Kenya)
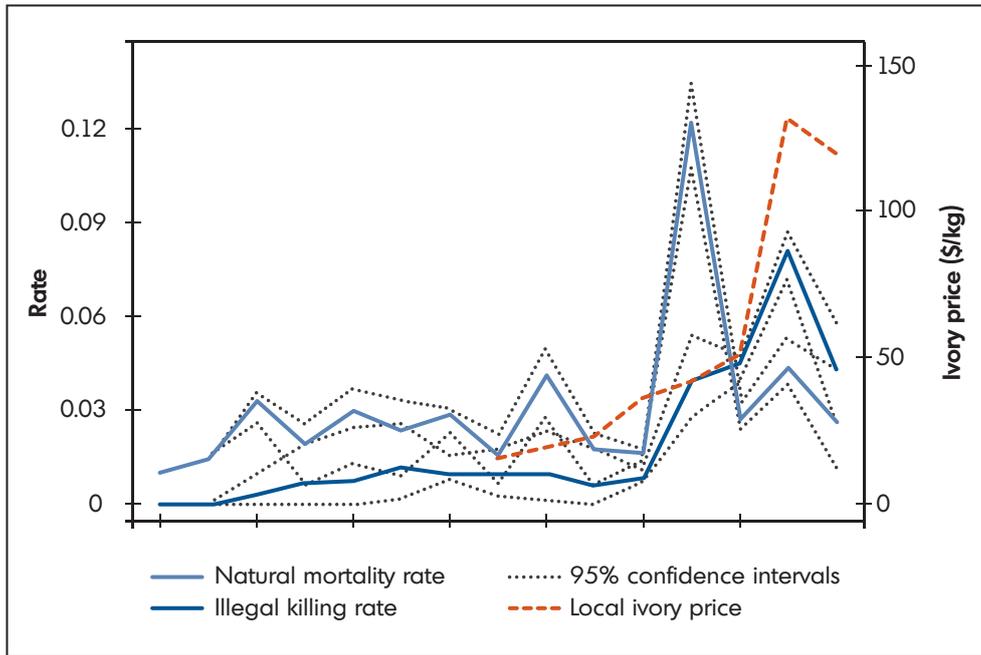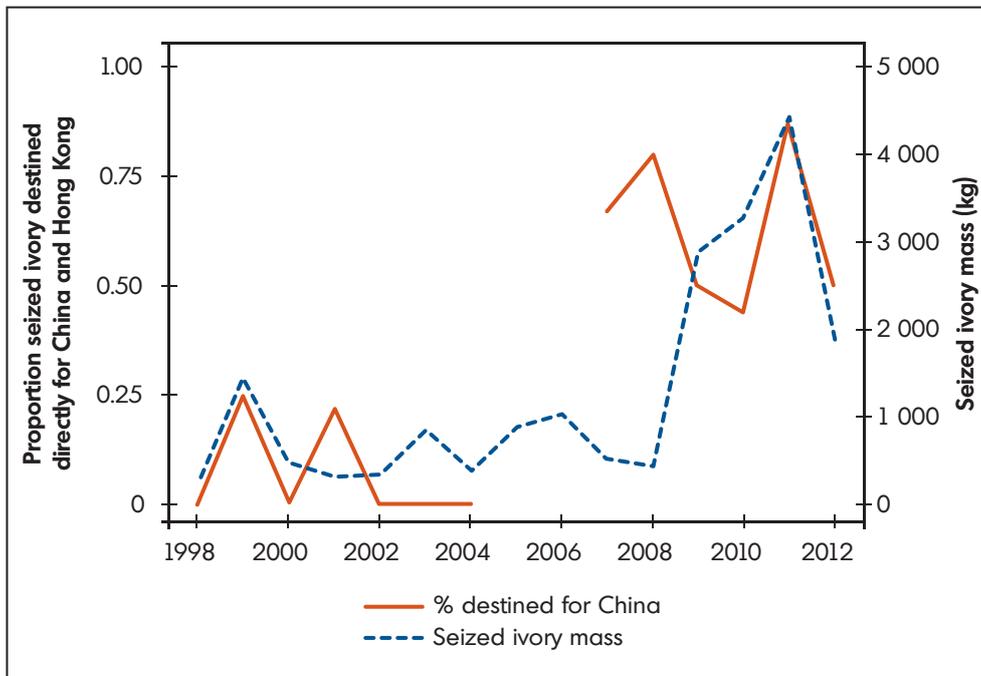

Figure 2b: Mass of annual ivory seizures in Kenya, and the proportion of seizures destined for China (including Hong Kong)


Source: Wittemyer G *et al.*, 'Illegal killing for ivory drives global decline in African elephants', *Proceedings of the National Academy of Sciences*, 111, 36, 2014, p. 13118

Conservation biologist Peter Leimgruber, commenting on the Wittemyer study, noted that elephant populations declined by nearly 60 to 70% every 10 years.[5]

Botswana, South Africa, Tanzania and Zimbabwe account for more than 50% of the remaining population. The extinction threat is thus more acute in some range states[6] than others. As Figure 3 indicates, West and Central Africa are worst affected by illegal killing, and lost upward of 65% of their elephants between 2002 and 2013.

Figure 3: Percentage of illegally killed elephants per sub-region, 2011
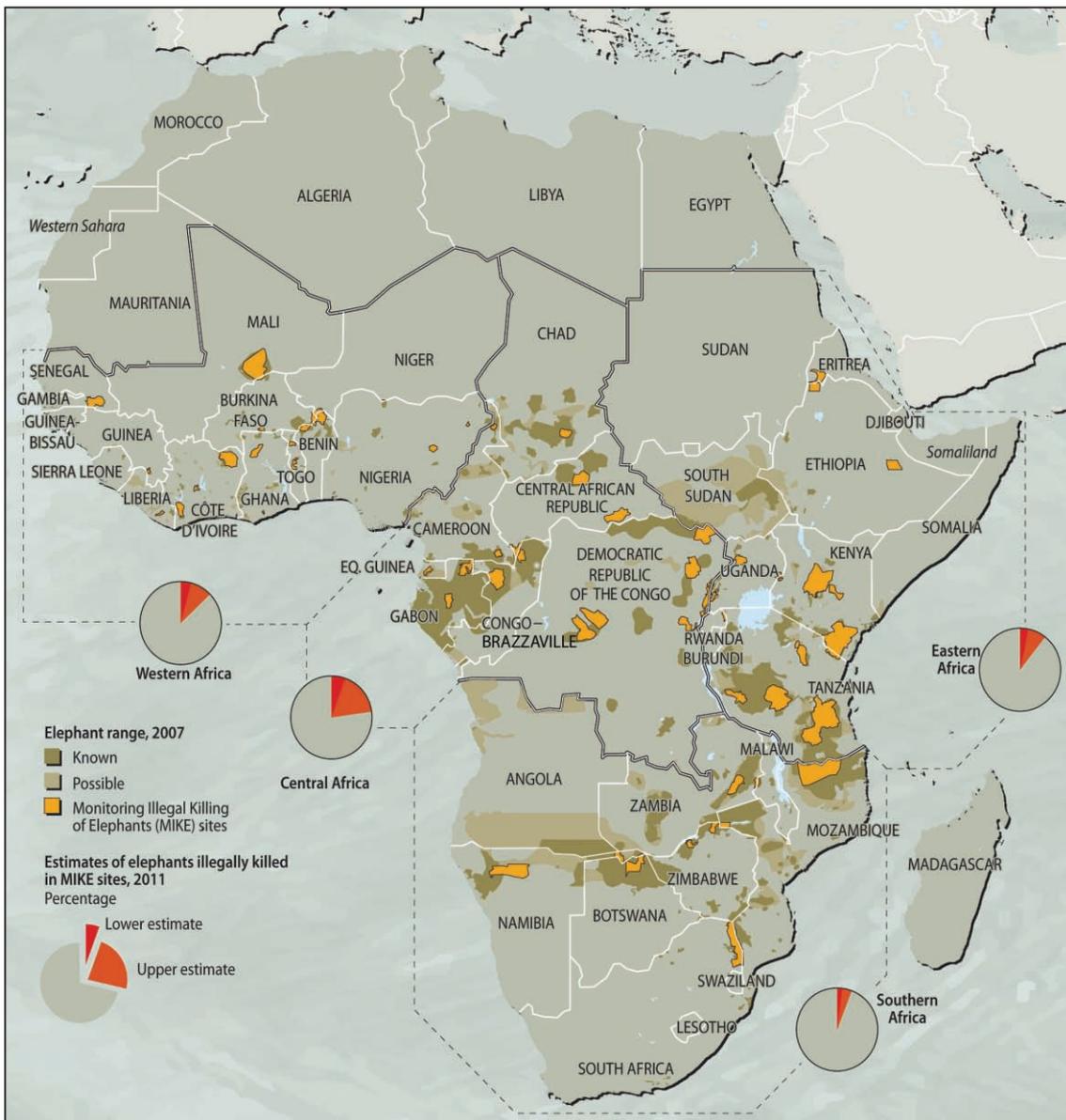
Source: GRID Arendal, 'Collection: Elephants in the dust – the African elephant crisis', http://www.grida.no/graphicslib/detail/percentage-of-illegally-killed-elephants-per-sub-region_333f, accessed 12 March 2015

However, the more stable populations in East and Southern Africa have also been declining at an unsustainable rate since 2009. If populations in West and Central Africa – far smaller than those in East and Southern Africa – become extinct, poaching syndicates are likely to channel their efforts towards the remaining populations, beginning with the weaker states among them.

There are three major components to the threat facing African elephants. First, rising demand for ivory in the rapidly growing economies of Asia, particularly China and Thailand, is driving up the price. Second, criminal syndicates exploit this demand, often sustained by ambiguous international legislation and the continued legality of domestic ivory trades. Syndicates are also able to keep supply constant and reliable. They are more efficient at poaching and smuggling than law enforcement is at anti-poaching and counter-smuggling. Third, developing country societies may place too little value on elephant conservation in the context of competing development pressures. According to the UNEP report, 'some models suggest that 29% of the existing elephant range is affected by infrastructure development, human population growth and rapid urban and agricultural expansion'.[7] This figure may increase to 63% by 2050, particularly in West, Central and East Africa, where human population pressures will be most acute.[8] Climate change is also likely to affect the future distribution of elephants as habitat and rainfall patterns change. 'In tropical or sub-tropical regions, longer dry periods are a threat to the elephant population in sub-Saharan Africa.'[9] Current rates of deforestation pose a threat to elephants directly, and indirectly through accelerating climate change.

Box 1: CITES explained

Established in 1975, the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) is the primary agreement governing the trade in endangered species. Currently there are 181 member states (parties) to the CITES Conference of the Parties (COP), meeting every three years. The 17th COP will take place in South Africa in 2016.

CITES lists species in two distinct categories. Appendix I classifies the most endangered and threatened species. Due to their vulnerability, no commercial trade is allowed in species classified in this category, except for non-commercial purposes such as scientific research and sport trophies. Appendix II classifies species not currently threatened by extinction but that may become so unless numbers are better controlled.

In 1989, due to a sharp decline in numbers, African elephants were listed in CITES Appendix I and a ban placed on the commercial trade of all international ivory. Although most range countries in Africa supported the ban on ivory trade, South Africa, Botswana, Namibia, Malawi and Zimbabwe opposed it. In June 1997, at the 10th COP meeting, signatories decided that elephant populations in Botswana, Namibia and Zimbabwe would be down-listed to Appendix II. South Africa's population was down-listed in 2000. Under this listing, two CITES-authorised one-off stockpile sales have taken place. In 1999, 49 tonnes of ivory were sold to Japan, at a price of $103/kg, resulting in revenue of $5.04 million.[10] In 2008, 105 tonnes were sold from Botswana, Namibia and South Africa

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to China and Japan (at estimated prices of $150/kg). Total revenue earned was in the order of $16 million. The 2008 sale was approved in 2002 but only occurred six years later due to the controversy surrounding it.

The 2002 decision was conditional on a nine-year moratorium on further ivory sales from Appendix II, in order to monitor the effect of the sale on elephant demographics. The question of future sales can therefore only be placed on the agenda again in the November 2017 meeting. As proposals can only be approved at CITES COPs, the next available opportunity for the approval of one-off sales would be the 18th COP in 2019. A total of 66% or more of CITES member parties must approve proposals for further sales.

This paper synthesises the economic literature on elephant conservation with a view to building a simple game theoretic model that sheds light on which governance efforts would yield the highest returns. Six specific issues will be interrogated in the paper. First, it is important to understand heterogeneity of demand if demand reduction campaigns are to be effective. Second, the structure of how international ivory syndicates operate is not yet well understood, which poses problems for anti-poaching and anti-trafficking efforts. Third, the political barriers to creating new formal rules are often high. In countries where the rule of law is weak, rule adherence cannot be taken for granted. Fourth, range states within Africa have divergent interests regarding the management of existing and future ivory stockpiles. An associated problem is that African elephants are listed differently in the CITES appendixes, sending ambiguous supply signals to consumer markets. Fifth, in the absence of any ivory sale revenue accruing to developing countries, competing development priorities may crowd out incentives for conservation. Policymakers should therefore give careful thought to how to increase the asset use value of elephants in these countries. Sixth, new technologies, available to both conservationists and syndicates, are changing the dynamics of conservation efforts considerably.

In the light of these considerations, the paper proposes a game-theoretic framework[11] for analysing the likely efficacy of conservation strategies. It closes with governance implications that proceed from the logic of the model.

DEMAND HETEROGENEITY

Within the body of literature on ivory trade economics, there is insufficient consideration of both demand elasticities[12] among different segments of the consumer market[13] and how quickly product differentiation is evolving.[14] 'Future demand for ivory is a crucial issue that lacks proper analysis.'[15] Ivory appears to be an unusual form of luxury good. Theoretically, demand for normal luxury goods is price-elastic (the quantity demanded is relatively sensitive to changes in the price). Empirically, however, there is considerable demand heterogeneity within major ivory markets.[16] Ivory is a differentiated product, appealing to different segments of the demand population. Price elasticity of demand is therefore likely to vary among different consumers.[17] The difference is largely a function

of the purpose of consumption, and can be understood to operate along a continuum with at least three distinct categories.

At the high end of the demand spectrum, consumers purchase ivory as an inflation-proof form of investment.[18]

> Ivory sellers talked of ivory as 'bao jia' (inflation-proof) and 'zeng zhi' (value appreciation) … Ivory is marketed as a good choice for those who can only afford to invest in artefacts at the relatively lower price range. It is believed that huge opportunity exists for value appreciation.

Ivory could potentially be understood among this portion of consumers as producing 'Giffen' behaviour[19] – where consumers purchase more in response to price increases, violating the common assumption that the opposite will occur.[20] There is robust economic rationale to treating ivory as an investment asset – its rarity increases its value, especially as elephants become more endangered or as trade restriction regulations are better enforced. This is especially true within the black market, and is unlikely to change unless cultural drivers of demand change. Moreover, the CITES convention is limited to governing trade in endangered species. Trade in the products of extinct species is thus permitted, which may raise syndicates' incentive to stockpile now in anticipation of potential extinction and higher future prices. Therefore, unless consumer tastes change, the future scarcity of ivory will maintain its future asset value and continue to fuel demand.

Slightly lower on the spectrum, consumers purchase ivory as a form of prestige and status. Ivory is more expensive in this category, but the consumer population is lower. The history of gift giving is deeply embedded in Asian culture, and apparently prominent among political elites. It 'involves "guanxi, renqing" and face, which are deemed important by Chinese for maintaining interpersonal relationship[s]'.[21] However, income elasticity plays a role, and a *Financial Times* article reported that average luxury spending in China between 2013 and 2014 fell by 15%, 'possibly due to the impact of anti-corruption initiatives and a slowdown in the economy'.[22] It added that 25% fewer people planned to give a gift of over $826 at Chinese New Year. Either way, this demand function would in all likelihood remain relatively price-inelastic, even if flattening slightly, especially if incomes started to rise again.

A major policy challenge for reducing trade in ivory is to shift demand within these two unusual consumer segments. Scarcity is the element that underpins demand and consequently incentivises higher rates of poaching.[23] These dynamics can produce a kind of 'race to the bottom', where each range state attempts to capitalise on potential gain from selling ivory illegally before other range states follow suit, if they believe that those states will follow the same strategy.

At the lower end of the demand spectrum are consumers who 'purchase ivory trinkets often simply because of ivory's beauty, and its relative affordability compared to other more luxurious products'.[24] This demand function could be understood as relatively price elastic, where ivory is treated as an aspirational luxury good that consumers would forego if incomes declined. This segment of the consumer market should be no less of a concern to conservationists than the other two. Rising real wages in China, combined with a structural economic shift away from export-led manufacturing towards increased consumption, mean that despite slowing economic growth, this segment of the demand

population is likely to grow. However, reducing the upward-sloping and price-inelastic demand first would have the greatest immediate downward price effect.

Because elephant poaching for ivory is primarily a demand-driven problem, the importance of understanding these different segments of demand cannot be overstated.[25] An immediate policy implication is that demand reduction campaigns should be specifically targeted at eroding the various drivers of demand. The most efficient allocation of capital in this respect would be to change consumer preferences within the 'Giffen' and most price-inelastic consumers, shifting the demand curve inwards and thereby reducing the price significantly. The corollary also holds, however. 'Even a small reduction in supply will lead to correspondingly larger increases in price',[26] unless the demand curve starts to flatten as it shifts inwards.

Many conservationists point to the success of the demand reduction campaign for shark fin soup[27] in China and suggest that it holds policy lessons for ivory. It is promising that consumer tastes can change in response to marketing campaigns. However, shark fin soup is not fully analogous with ivory. Ivory is non-perishable or durable, whereas shark fins are ultimately perishable. Shark fin soup is a delicacy, but is the only product derived from shark fins. On the contrary, ivory can be worked into various products along a value chain. Although it is no longer used for piano keys, buttons, billiard balls and chopsticks, worked ivory in the form of carvings is extensively sought. Unlike shark fin soup, which is essentially confined to the restaurant industry, ivory's value chain involves differentiated carved products. Worked ivory is part of the manufacturing industry and is therefore more heterogeneous than shark fin soup. Campaigns to reduce the demand for shark fins therefore entail fewer transaction costs than similar campaigns to reduce the demand for ivory.

Demand reduction campaigns should nonetheless spearhead the strategy to reverse the elephant crisis. They must, however, be properly targeted to appeal first to the most price-insensitive components of the consumer population. This should be complemented with other strategies such as abolishing all domestic trade in ivory. In isolation, the latter may be an ineffective use of capital. This is especially the case in markets where formal legal rules have little impact on influencing consumer tastes. Credible commitment from leaders, publicly urging the end of ivory consumption, is likely to make formal trade bans more effective. Demand reduction campaigns are therefore also likely to perform more effectively if they are supported by local political elites. It does appear, in this vein, that the Chinese government is committed to ending the practice of giving ivory as gifts, at least as a means of attaining political favour.[28]

A final point on understanding demand difficulties is that ivory and elephants are two distinct but inextricably related products. Elephant poaching is predominantly a consequence of the demand for ivory. Ivory constitutes an elephant's exchange value, which is often higher (or at least perceived as higher by near-park community members) than its use value.[29] As a recent paper exploring Hardin's classic 'tragedy of the commons' puts it:[30]

> In the absence of institutions supporting market exchange, herders would graze cattle only for their use value, thereby reducing pressure on the pasture … Note the implication that whether a commodity possesses exchange value or only use value depends substantially on the institutional setting and not simply on its scarcity.

A number of institutions, including cultural norms and illicit trade and distribution networks, sustain the current exchange value of elephants.

As a result, demand for ivory is exceeding the available supply. Population growth rates cannot satisfy demand, which portends extinction for some elephant species in vulnerable areas in the foreseeable future. Extinction in West or Central Africa would place significant pressure on stocks in Southern Africa, where poaching is already on the rise. Existing ivory stockpiles similarly cannot satisfy demand. Although the evidence is inconclusive, it is a feasible conjecture that one-off sales – desired by Appendix II states – send a confusing signal to the market that international ivory trade is again legitimate, thereby stimulating demand.[31] This combines with legal domestic trades to produce an interaction effect. If, however, demand for ivory were to be significantly and rapidly reduced, there is a potential risk that some range states would disinvest in elephants as assets[32] worth maintaining in their development portfolios.[33] In those countries that do not have a long-standing commitment to refrain from ivory sales, incentives to preserve elephants are often informed by expectations that revenue from future ivory stockpile sales, or hunting licences, will fund conservation efforts. Without that, competing pressures for land use may crowd out the incentive to invest in elephant preservation.[34] The latter is also a function of perceiving the use value of elephants exclusively in monetary terms, in isolation from their inherent value and the biodiversity value of their habitats. In Botswana, home to the world's single largest remaining elephant population, revenue accruing to communities from hunting has been foregone in the wake of a hunting ban, instituted in late 2012.[35] Communities that used to benefit directly from hunting, for instance, now have to plant crops. A combination of these dynamics can spur destructive human–elephant conflict. From a governance perspective, this points to the need to ensure that economic exchange value lost through the abolition of the ivory trade is replaced by greater use value, such as increased eco-tourism and game-viewing or photographic holidays. It is particularly important that this use value accrues to near-park communities, who are critical allies in the fight against poaching syndicates and habitat loss.[36]

Another caveat concludes this section. Use value demand for elephants is not always benign. For instance, news media reported that 35 elephant calves, forcibly separated from their mothers in Hwange Game Reserve in Zimbabwe, were awaiting export to China at the time of writing.[37] These elephants would likely be exploited for use in circuses or zoos. Forced separation of this nature is psychologically traumatic for elephants. It is likely to negatively affect future behaviour, and possibly reduce growth rates in affected populations.[38] Trauma may also impede reproductive fitness.[39] International campaigns attempting to prevent any trade in live elephants should harness both these elements.

Deeply embedded cultural practices, which inform consumer tastes, take time to change. Helping consumers make the connection between their purchases and the environmental consequences in a distant place is challenging psychological work. It must, however, be done if the current unsustainable trend is to be reversed.

SYNDICATES' STRATEGIES, ANTI-POACHING AND ANTI-TRAFFICKING

Reducing demand for ivory and dismantling the institutions that generate elephants' exchange value is a long-term objective. More immediately, poaching is escalating. 'Most elephant populations in Africa are already in decline or soon will be so, some of them dramatically.'[40] To save the remaining African forest elephants, for instance, 'illegal poaching for ivory and encroachment into core elephant habitat must be stopped'.[41]

Even if the trade in ivory were to be legalised – as some argue is necessary to save the species – the regulatory capacity to distinguish between legal and illegal ivory is often non-existent.[42] Moreover, there is no indication that prices would decline. Pro-traders tend to argue that a legalised trade would flood the market with increased supply, thus lowering the price and disincentivising poaching. However, legalising the trade would remove any stigma effect that may currently be in operation to reduce demand, and ignite demand among consumers who may otherwise have been reluctant to purchase a banned product. Previous consumer markets such as the US and Japan could flourish again. The resultant upward shift in the demand curve[43] would theoretically drive up the price by more than increased supply could reduce it. This would raise the poaching incentive and nullify the logic of trade legalisation. Moreover, the conjecture that supply would easily match demand under free market conditions ignores the slow rate at which tusks grow, and that they are not regenerative. Poaching rates would be unlikely to fall in the short term, irrespective of which trade scenario one supports. Therefore, on an immediate practical level, anti-poaching and anti-smuggling efforts require reinforcement.

Analysis of the organisational structure, efficacy and adaptive efficiency of criminal poaching syndicates is largely missing from the literature on elephant poaching. More thorough investigation into this topic is important, because syndicates are likely to counteract any strategic moves made by conservationists. If, for instance, range states agree to put their ivory stockpiles beyond commercial use[44] before demand has been eradicated, syndicates will have strong incentives to increase their current poaching efforts and (mis)appropriate ivory from existing stockpiles in advance of such disposal (assuming that states' intentions are communicated in advance). This would increase species decline, itself a driver of increased demand, especially for those consuming ivory as an inflation-proof investment vehicle. The value of ivory would increase exponentially if elephants became extinct. In this respect, syndicates can be viewed as speculators banking on extinction: 'With common stocks depleted, such investors may enjoy considerable market power and, by carefully restricting supply henceforth, may earn monopoly rents.'[45] Syndicates would thus have an incentive to create their own stockpiles from the limited remaining living stock.[46] As official ivory stockpiles grow over time, they evolve into a liability for conservationists, since they increase the profitability of syndicates' extinction strategies.[47]

> Insofar as current (international) trade in the species' commodities is banned by CITES, the trade ban might be lifted after extinction (as CITES only regulates trade in endangered species, not extinct ones). Relaxation of a trade ban would lead to increased demand, raising profits from banking [on extinction].

For this reason, collective range-state stockpile disposal is a necessary commitment device for conservationists to defeat syndicates.

One policy implication is that the risk of a 'banking on extinction' strategy can be attenuated through anti-poaching and anti-smuggling efforts that keep wild elephant populations sufficiently large to avoid the danger of extinction. This should not be done in isolation from demand reduction. Mason, Bulte and Horan show that as a result of the dynamics associated with banking on extinction, 'banning [ivory] trade while keeping demand unchecked creates the conditions for stockpiling of wildlife commodities'.[48] The most efficient means of removing the incentive to bank on extinction would therefore be to reduce demand for ivory both now and in the future. In the shorter term, syndicates can be undermined through improved anti-poaching and anti-trafficking efforts, raising their operating costs. This would be greatly aided by a proposal currently being considered by the British Natural History Museum: 'One mechanism to ban all ivory would be to make the mammoth the very first extinct species to be listed under CITES [Appendix I]; in other words, it would become illegal to trade its products.'[49] As mentioned above, CITES does not currently address the trade in the products of extinct species. If CITES approves such a proposal, it would remove the perverse incentive to bank on extinction.

Regarding poaching itself, syndicates are invariably more flexible, better resourced and adaptively efficient than conservationists. The latter are often ill equipped and generally under-resourced to deal with the threat posed by sophisticated syndicates. Amplifying the problem is that syndicates not only recruit for poaching but also control the market channels from park to market, often bypassing vigilant customs-control checkpoints by using less well-resourced intermediate countries.[50] Iain Douglas-Hamilton, founder of Save the Elephants, testified before the US Congress in 2012 that[51]

> in some cases, organised Asian criminal syndicates, which are now increasingly active in Africa, work with local economic and political elites to subvert control systems and operate with relatively impunity … Poachers who profit from killing elephants and harvesting illegal ivory may also have ties to criminal gangs and militias based in countries such as Sudan and Somalia.

To provide some idea of the sophisticated technology at the disposal of poachers, an incident from 15 March 2012 paints a vivid picture.[52]

> On that day, a foreign helicopter entered DRC [Democratic Republic of the Congo] airspace, and 22 elephants were killed by a marksman firing from the helicopter, killing the elephants with a single shot to the top of the head. While the actual slaughter was not witnessed, a Russian manufactured MI-17 troop-carrying helicopter was photographed in the vicinity at the same time. The helicopter was illegal and of unknown origin.

Syndicates target specific populations for intense exploitation, contradicting the dominant belief that traffickers follow a decentralised plan for procuring ivory stock as it becomes available.[53]

Syndicates are generally able to exploit community members with high-risk, low-reward poaching work. In order to minimise this ability to co-opt local elites and recruit poachers from near-park communities, innovative approaches are required to ensure that

communities reap greater financial benefits from protected areas, and that anti-poaching teams are better prepared and better resourced.

ENDOGENOUS MOTIVATION FOR RULE ADHERENCE

Banning domestic trades, especially in the largest consumer markets, is a necessary component of the strategy to secure elephants' future. However, it is likely to be most effective if used as a complement to demand-reduction and anti-poaching/trafficking strategies. It cannot be a substitute measure.

A ban would operate on a number of levels. First, it would raise the cost of transgression for traders and consumers. Second, it would reduce the opportunity for laundering illegal ivory through legal markets. Third, it would reduce the transaction costs of law enforcement – detecting and seizing all ivory is far more efficient than trying to distinguish between legal and illegal ivory. Fourth, the law communicates an ethical norm, which may produce a stigma effect among consumers and thus reduce ivory consumption. A few points of caution are, however, in order.

Dynamic ivory markets are subject to path-dependence, deeply embedded in historical cultural informants of taste, which are not easily shaken. This long history has shaped mutually consistent expectations between sellers and buyers that enable co-ordination without centralised direction.[54] Domestic trade bans may thus push the existing ivory markets deeper underground. In this context, new laws are often ineffective agents of change. Therefore, in both range states and consumer markets, endogenous motivation for rule adherence should be more overtly considered in policy decisions. Changing the formal rules may not sufficiently change the payoffs that drive the trade. Moreover, even if a domestic trade ban produced sufficient stigma and disincentive effects to change tastes and behaviour, it could take a considerable amount of time, given the potential political barriers.

In countries where the rule of law is well established, it is reasonable to expect that laws will influence consumer tastes and behaviour. This is part of the explanation for why the initial CITES 1989 ban on international trade in ivory was successful. Major consumer markets at the time had relatively strong legal institutions, political will and resources with which to enforce the ban. In the growing consumer markets of Asia at present, the same assumptions cannot be made:[55]

> The [CITES] treaty may not be capable of preventing the continued importation of illegal ivory into China. CITES has never before dealt with such a sudden increase in demand for any endangered animal product … Neither CITES nor the Chinese regulators are capable of battling the domestic ivory trade because of China's unique spike in demand.

Vandegrift concludes that because China will not be able to regulate the market meeting new demand, it should ban the domestic trade in ivory. In order to ensure the success of a ban, Fischer rightly notes that it should effectively split demand, removing law-abiding consumers and leaving only the illicit market. Law-abiding behaviour is thus to be encouraged, for instance, through ensuring easy availability of substitutes and amplifying the stigma effect.[56]

Some prominent authors[57] in the New Institutional Economics literature argue that in contexts where the rule of law cannot be assumed, researchers and policymakers should aim to comprehend the endogenous motivation that drives particular players to either obey or rebel against the formal rules. Rational choice theory suggests that if the expected utility from bribery, for instance, outweighs the expected utility from conforming to the rules, bribery will become institutionalised. In situations where well-functioning and transparent enforcement institutions exist, and the rules (both formal and informal) are easy to observe, one can reasonably expect that they will translate into affecting human preferences and behaviour. If these conditions are not met, however, it should not be assumed that formal rules would produce such a direct translation. In such cases, how the rules are enforced and why they would be followed require explanation. In other words, motivation for rule adherence should be treated endogenously and not taken as an external given. Motivation is likely to be generated by beliefs, norms and expectations, in addition to being a product of strategic interplay between various players. 'The key to institutional change, from this perspective, is not just changing rules, but changing players' motivations and patterns of behaviour in a self-enforcing way.'[58]

In this respect, if ivory traders are also politically powerful, conservationists should not assume that a formal declaration of a banned domestic trade would result in the intended outcome in the short run. This problem is even more pronounced in range states, where syndicates operate with relative impunity. Institutional arrangements are often weak, and elephant preservation is a low development priority for political elites,[59] unless they have a vested interest in tourism enterprises.[60] Combined with pervasive poverty in many communities bordering national parks, syndicates have the relatively easy job of providing poaching employment[61] to local community members. Furthermore, those rangers working on the front line of conservation are often poorly compensated for their high-risk work. Syndicates are thus often able to co-opt these rangers to turn a blind eye to their activities:[62]

> Effective management is particularly susceptible to subversion by corrupt officials because most wildlife officials are very poorly paid. This encourages bribes, especially when dealing with wildlife products of high value. This is especially the case in countries such as Cameroon, where rangers sometimes do not receive their salaries for months at a stretch. Inspections at any point in the trade chain can be a mechanism for eliciting bribes, rather than an effective regulatory tool. In those circumstances, increasing the numbers of enforcement officers merely results in the need to pay more bribes.

However, even if rangers were relatively well paid, such payment is diffused across a large staff, whereas a bribe is targeted at a small number of individuals. To place the matter in stark income terms, 'Even if ivory sold at a relatively low price, as it did at the start of the 1970s, poachers in the 1960s and 1970s could earn more selling a single elephant's tusks than they could earn for a year's salary doing another job.'[63] Weak enforcement institutions – from incoherent laws to corrupt customs officials to co-opted rangers – essentially generate open access to elephants. Overharvesting will occur rapidly, well beyond the species' ability to reproduce. As will be shown, however, this ought not to lead to the conclusion that simply paying rangers more money, or bonuses for detecting and preventing poaching, is the correct solution. Rangers' monetary rewards from selling tusks

can be high even in a low-price scenario, but this does not mean that demand reduction efforts are futile. Monetary reward is unlikely to account for the primary motivation in why people become rangers in the first instance.

Too many academic articles treat the ivory trade as an isolated problem and do not consider the incentive structures and payoffs that are particular to all players in the game. Elephant poaching is not only a difficult supply and demand issue; it is also a matter of understanding the endogenous motivation driving the strategies of both syndicates and conservationists.[64] For conservation management, this is especially important. Rules are meaningless without compliance, which cannot be taken for granted. Without enforcement, compliance will not be forthcoming, but enforcement entails large transaction costs. 'For example, enforcement activities can erode trust between local people and conservation authorities and undermine traditional systems of resource management.'[65] Trust is an important dimension of transaction costs, but not the only one. Enforcement activities such as patrols are relatively diffuse (unless informed by cogent intelligence regarding the geographic location of poaching), whereas poaching activities tend to be more strategically concentrated and thus efficient in terms of where scarce resources are allocated. In this respect, poachers appear to have an advantage in terms of transaction cost asymmetry.

However, with repeated interactions, game theoretic models have shown that increasing the reward enforcers (conservationists) receive for catching criminals does not reduce the incidence of poaching, 'and might increase it because enforcers can maximise their profit by monitoring less, reducing their costs and encouraging a greater number of offences and bonuses'.[66] Evidence of success shows that careful thought needs to be given to how anti-poaching incentives are constructed. Building trust between communities and enforcement authorities is a crucial first step – far more valuable than simply paying rangers a better salary.[67] Because of these difficulties, the game theory model shows that efforts to increase anti-poaching enforcement can be countered in equal terms by syndicates. Challender and MacMillan, of the Durrell Institute of Conservation and Ecology, conclude that the powerful market dynamics of illegal products and the role that poverty plays in driving the trade may overwhelm attempts to enforce CITES regulations. Conservationists should therefore rather 'focus more on policies and strategies that reduce the price of illegal wildlife products and increase the opportunity costs of poaching by contributing to the eradication of rural poverty'.[68]

STOCKPILE MANAGEMENT AS A COLLECTIVE ACTION PROBLEM

Within the primary game between syndicates and conservationists is a nested game[69] between range states best understood as a prisoner's dilemma.[70] Some range states want to be allowed to sell their stockpiled ivory (purportedly to fund conservation initiatives), whereas others are committed to the destruction thereof.

In West and Central Africa, institutional mechanisms for conservation are weak and conservation agents have limited resources and capacity to fight poaching. They thus have a strong incentive to keep their elephants on Appendix I. At present elephant poaching is geographically concentrated in these countries.[71] Relatively open access to the resource

for poachers quickens the route to extinction (for those particular elephant populations), inviting more stringent policy responses than in better-managed areas in the south.

In South Africa, Botswana, Namibia and Zimbabwe, stocks have been better managed. As a result, these countries successfully lobbied to have their elephants downgraded to Appendix II, where they are permitted to sell their stockpiled ivory in one-off sales, or under a quota system, subject to the approval of CITES. Botswana has, however, signed the Elephant Protection Initiative (EPI) and committed not to seek to sell ivory for a minimum of 10 years. Zimbabwe's stocks are decidedly less well managed now than in 1997, when the listing changed. Kenya and Ethiopia are taking the lead in stockpile destruction, which is to be commended.[72] As the game theory model suggests, however, co-ordinating these actions across range states would have a stronger effect in terms of signalling to the market that the trade is truly over.

A potential revenue substitute for official ivory stockpile sales – philanthropic offerings[73] – are arguably a tiny fraction of the revenue these countries could generate from selling stockpiled ivory in the current market. As a snapshot of what the market yields may currently be, 'middleman raw ivory prices' have been recorded in Table 1.

Table 1: Middleman raw ivory prices*, \$, 1999–2014

Country	Year	Weight (kg)	Price/kg (\$)	Year	Weight (kg)	Price/kg (\$)
Cameroon	1999	1–5	38–53	2010	1–5	43
Cameroon	1999	>5	42–70	2010	>5	53–128
DRC	1999	1–5	42–70	2010	1–5	32–53
DRC	1999	>5	>70	2010	>5	64–160
China	2002	1–5	155–220	2014	1–4	2,100
China	2011	1–5	471–777	2014	>5	660–1,100
China	2011	>5	930	2014	>5	484–613
Japan	2002	>5	181–311	2009	>5	302–362
Thailand	2002	1–5	30–236	2008	1–5	387

* Pre-2014 prices have been converted to 2013 \$ to take into account inflation using the 'real price' conversion for a commodity available from http://www.measuringworth.com

Source: 't Sas-Rolfes M, Moyle B & D Stiles, 'The complex policy issue of elephant ivory stockpile management', *Pachyderm*, 2014, 55, pp. 62–77

Southern African states, ironically, are also the countries that stand to benefit the most from tourism, as their tourism services sectors are relatively well developed. Despite the apparently vast amounts of money to be made from selling stockpiled ivory, tourism revenue dwarfs these amounts over the lifetime of an elephant.[74]

Researchers representing an array of institutions show that[75]

> [p]roceeds of a sale of Tanzania's 90 tons and Zambia's 22 tons of ivory are likely to be on the order of $14 million and $3.5 million, respectively, depending on ivory price at auction [~$150/kg at average values achieved in 2008 sales]. This represents less than 1% of annual tourism revenues for Tanzania. Ivory sales could jeopardize those revenues, either from tourist sanctions or by triggering widespread poaching.

This same *Science* article contends that no further 'one-off' ivory sales should therefore be approved, as it sends an ambiguous signal to the market. The split appendix listing of a single species, against which CITES itself cautions, similarly produces market confusion. Moreover, it creates challenges for law enforcement, possibly facilitating laundering.

These disparate interests of range states, and their differing development priorities, create a collective action problem: it would make overall strategic sense for conservationists to act uniformly and ensure Appendix I listing for all African elephants. But stronger range states believe they have an incentive to defect from co-operation and maintain their Appendix II listing. Unless this collective action problem is resolved and strategic co-ordination properly incentivised, the expected utility from defection may exceed the expected utility from co-operation.[76] This problem is equally applicable to the question of maintaining domestic trade in ivory in both range states and consumer markets. Syndicates are aware of these dynamics and may exploit them in an effort to drive a wedge between range states and retain legitimate domestic trade. Any form of legitimate domestic ivory trade remains a useful conduit for the laundering of illegal ivory.

Future sales of ivory would undermine the success of policy recommendations currently on the table, such as demand reduction. Any talk of further sales introduces a finite round to the game, which will be modelled below. By backward induction, players reason that the trade will again become legitimate at a future date. This generates an incentive for syndicates to poach, not only to supply the market in the short run but also to stockpile supply for some future date when the trade opens again. Part of any strategy therefore has to be to compel countries with apparently divergent interests to dispose of existing and naturally accruing stockpiles continuously and simultaneously. Stockpile disposal is one of the credible commitment devices required for conservationists to demonstrate to syndicates and consumers that the trade in ivory actually is over.[77]

Simple co-ordination failure also characterises the interaction between range states. Range states could greatly benefit from acting in unison with one another. First, pooling conservation resources could reduce poaching by generating incentives for united action. For instance, if South Africa shared some of its anti-poaching resources with Mozambique, the anti-poaching efforts in the Kruger Park could be substantially more efficient than at present. Second, it would be in the interests of all range states to put their ivory stockpiles beyond commercial use simultaneously. If each is staggered, and syndicates figure out which countries will be putting their stockpiles beyond use (and when), they can strategise accordingly by attempting to access those stockpiles in advance. Each respective disposal drives up the price of ivory, creating an incentive for riskier behaviour by syndicates and undermining demand-reduction efforts. However, if each country disposes of its ivory simultaneously and continuously, syndicates will increase their efforts towards killing living stock that is most vulnerable. But conservationists can anticipate this in advance

and direct anti-poaching resources towards those elephant populations. This strategy is only likely to work if demand reduction campaigns are working to reduce the price at the same time. The reality is often different to what game theoretic models suggest, but range states must consider how to use their scarce resources more efficiently. One study[78] shows that the CITES ban on international trade has been generally successful, but high degrees of country variation call for more co-ordinated action. It focuses on the importance of closing all unregulated domestic ivory markets simultaneously in target or near-target countries, 'otherwise the poached ivory will continue to be transported to where it can easily be sold'.[79]

Co-ordinated action is therefore required on three levels. First, range state countries should all be in agreement to place their elephants on Appendix I. Second, they need to take collective and simultaneous action in placing their official stockpiles beyond commercial use. Third, they should act together to close all domestic ivory markets at the same time.

These dynamics show just how complex the issue of securing a future with elephants can be. Each policy decision on one variable has an impact on a number of other equilibria, none of which can be considered in isolation.

COMPETING DEVELOPMENT PRIORITIES

If ivory stockpiles are to be obliterated, demand for ivory reduced and domestic trades banned, the exchange value of elephants will essentially move towards zero. Therefore, it is imperative that policymakers consider how to increase the use value of elephants. This involves complex thinking around opportunity costs of land use, and compensation for those who previously benefited from hunting and/or poaching. New methods of community participation in the use value should also be considered.

One possible means of overcoming the collective action problem mentioned above is to ensure that range states are sufficiently compensated for the (perceived) losses associated with Appendix I listing of their elephants and disposal of their ivory stockpiles. In governance terms, banning domestic ivory trades, reducing demand, disposing of stockpiles and improving anti-poaching initiatives are unlikely to solve the problem entirely (even if strongly advised). At the same time, policymakers should work to increase the economic use value of elephants. Range state societies could conceivably choose to invest in alternative land-use activities that compete with elephant conservation. Under current conditions, conservation (through tourism, game viewing and photographic safaris) may be insufficiently lucrative to compensate those who are most likely to lose economically – and politically – from elephants' exchange value being driven to zero. These are often the same people who are susceptible to being co-opted by syndicates or who kill elephants that raid their crops.

Human–elephant conflict often arises as a result of having to choose between crop survival and elephant conservation. In Botswana, for instance, some communities that used to benefit from hunting revenues have had to return to growing crops, as hunting occurred in different geographic locations to where photographic safaris now operate. The returns on investing in elephant preservation may therefore be perceived as lower than the returns on activities such as agriculture or poaching. This is especially the case in the

context of growing population pressures in areas such as the Okavango Delta, and the concomitant increased demand for agricultural produce. Although there are clearly ways in which this apparent zero-sum scenario can be navigated for the benefit of elephants and communities, their implementation requires skill and dedication.

Oxford economist Timothy Swanson contends that societies select a portfolio of assets from which they derive a flow of benefits. 'These resources are assets (stocks which generate flows) simply by virtue of being biological in nature.'[80] Of course, societies are not uniform, homogeneous entities that make unified decisions. Developing country societies are faced with difficult trade-offs between environmental imperatives and development objectives. As such, one can conceptualise societies' collective 'decision-making' as choosing a particular asset portfolio. An important aspect of this portfolio is the set of biological resources on which survival is dependent. In the development process, given capital constraints, societies may choose to disinvest in some stocks and invest the receipts elsewhere. In some instances, natural capital will be converted to man-made capital such as machinery. In other instances, biological assets may be converted into different forms, yet remain fundamentally biological; for instance, growing crops on land that would otherwise be utilised as an elephant migratory corridor. There are a number of means by which such conversions may occur, but the[81]

> fundamental force driving species decline is always the relative rate of investment by the human species. It is the human choice of another asset, over a given biological asset, which results in the inevitable decline of that species. Extinctions, whether of specific breeds or of general diversity, are the result of their non-inclusion in the human asset portfolio.

While this may be oversimplifying the case, it provides a useful model for understanding the dynamics particular to developing countries.

Slow-growing resources (such as elephants) are at risk of extinction because of the time it takes to reach a competitive marginal rate of return in competition with other assets:[82]

> There are incentives for the conversion of the entire stock of this asset to other, more productive forms of capital in order to achieve a better return … Resources, even biological resources, must be competitive as productive assets if there is to be a force for their retention in a world of scarce resources … The fundamental cause of extinction is that a species will be seen as an inferior asset, and thus be excluded from the human portfolio of assets.

If elephants are unable to grow as quickly as competing assets, they are theoretically at risk of having their habitats converted. The exclusion decision subsequently affects the stock level of an asset through three main theoretical channels.

The first is direct stock disinvestment, which involves selling off the asset and reinvesting the receipts in other competing assets. Second, and perhaps most important in some African countries, is base resource re-allocation – land, water and food are allocated to economic activities that compete with the preservation of elephants and their habitats (a partial generator of tourism revenue). Third, management services are allocated away from elephant conservation towards more competitive assets. The policy implication is that inadvertent exchange value destruction, unless complemented by policies that raise

the use value of elephants, may destroy the marginal rate of return to that asset. This opens a path to extinction, aided by investment in competing assets such as agriculture. Naturally, such a binary conception seems unnecessarily restrictive, but competition over land use is likely to be an increasingly pressing policy problem in developing countries.

The answer is to create conditions under which communities view the resource to be preserved as an appreciating asset. Policymakers should also be aware of discounting, especially in the context of poverty: 'Gains in the distant future are likely to be heavily discounted, generating few positive incentives for collective action.'[83] Part of the policy solution must therefore also lie in changing affected societies' discount rates by ensuring that elephants' use value accrues to local communities, who may view themselves as being in land-use competition with elephants and their habitats.

Generating more value from tourism is one obvious but only partial answer to this problem. However, tourism is not a low-hanging fruit. It requires improved infrastructure and services to many areas that are at present effectively devoid of any such infrastructure. Generating more revenue from tourism and allocating it towards conservation is also not a straightforward task – ring-fencing any revenue is typically fraught with political economy problems. Vested interests in the system fight over who gets the resources and how these are allocated. It is not clear that elephants will necessarily survive unless a proportion of tourism profits are transparently redistributed towards elephant conservation. By implication, this means that some of the revenue must be distributed to both near-park communities and conservation authorities. But transferring resources also will not happen overnight, which raises the policy question of how compensation should work in the intermediate period. Finally, whatever policy position is advanced in this respect should be incentive-compatible with the distribution of political power in any given jurisdiction.[84] For instance, if a politically important constituency is likely to lose materially from a greater focus on conservation tourism at the expense of other activities such as cattle grazing or hunting, the promotion of increased tourism should be aware of these dynamics.[85]

Finally, the diverse array of players who have a stake in domestic ivory trades may not be able to transfer easily into other modes of employment. They may therefore have a strong incentive to lobby for continued legal domestic trades. Whether they are politically powerful is an empirical question that requires further investigation. Either way, part of the demand-reduction campaign should incorporate potential compensation for those who would lose if demand for ivory products were successfully eliminated. The potential losers are often a powerful political lobby group for maintaining the status quo.[86]

Policymakers should ensure that relevant stakeholders place sufficient economic use value on elephants so as to incentivise their inclusion in development portfolios. This is a necessary but insufficient condition to guarantee the survival of the species. There is a danger that the use value of elephants would only be conceived of in terms of the tourism revenue they could generate. 'In many cases, conservation-related tourism generates largely private and unevenly distributed benefits.'[87] Focusing on tourism exclusively would therefore be myopic, given that elephant conservation is also integral to enhancing food and water security on which other species and human communities depend. Raising awareness of, and encouraging communities to partake in, the non-pecuniary value of elephants and their habitats would therefore constitute a possible sufficient condition for survival. Elephants, for instance, convert woodland to shrub land, improving the

availability of browsing for impalas and black rhinos. Incorrectly understood as destructive for ecosystems if 'overpopulated', elephants contribute to improved habitat complexity through damaging trees; benefiting lizards, for instance. They also open otherwise impenetrable thickets, easing access to prey for large predators. Finally, African elephants are indispensable seed dispersers over long distances.[88] The value that elephants add to the habitats in which they dwell cannot be overstated.

The recognition of latent economic value in preserving elephants' habitats is largely dependent on the success of protected area (PA) management. 'If effectively managed and equitably governed, PAs can operate as economic institutions, providing monetary and non-monetary benefits to support Africa's development priorities.'[89] A key innovation in this respect is the use of economic instruments to conserve and pay for ecosystem services (PES).[90] 'The total economic value associated with managing ecosystems more sustainably or protecting them entirely is often higher than the value associated with the conversion of the ecosystem through farming, clear-cut logging or other intensive uses.'[91] These ecosystem services go largely unmeasured by traditional economic indicators and yet are widely utilised. Policymakers need to incorporate both market and non-market benefits into their development choices. This will help attract additional investment to conservation rather than into alternative uses such as trade in wildlife products. Accurately valuing the natural services and functions associated with ecosystems helps local authorities and conservation managers to justify species and habitat conservation in economic terms. This demonstrates their link, directly and indirectly, to generating income for communities. Once this link between natural assets and development gains has been established, decision makers can incorporate PA management strategies and objectives into cross-sectorial planning and priority frameworks at all scales. For example, ecosystem services from dedicated conservation zones need to be embedded in national regulatory frameworks and mainstreamed into economic planning and development policy. Integrating these approaches will improve coherence with other development goals and help to avoid unwise trade-offs, especially with competing sectors such as agriculture and biofuel production. This is especially true for preserving African elephants and the biodiversity contained in their migratory habitats. Although elephants occur in a number of PAs, up to 80% of their range is believed to lie outside PAs.[92] Efforts to reduce human–elephant conflict are therefore crucial and should continue in order to gain more widespread support.

An important caution in terms of PES must, however, be heeded. The offer of payments to those who might value other assets over elephants is often presumed to be sufficient to the task. However, payments can only be sufficient if they are preceded by new beliefs about the inherent value of preserving elephants and their habitats. If money is merely a cue, then new temporary behaviours might emerge. Money may induce new mechanical habits, but is incapable of forging new beliefs.[93]

> Too often, once the payment stops, those new temporary behaviours are generally the first casualty. When the cue is gone, the response also goes … Constructive or destructive environmental behaviours very often arise because of a flawed economic environment within which rural households are situated. Individuals are often powerless to modify their behaviour even with the promise of particular rewards for doing so.

Moreover, Hardin's 'tragedy of the commons' and the assumption that private property rights will overcome incentives to degrade are often misplaced.[94] Hiedanpää and Bromley suggest, for instance, that deforestation sometimes occurs because national governments have their reasons for allowing it, regardless of whether private property rights would incentivise protection.[95] Applying this reasoning to elephant conservation, one can see that some governments hope to earn significant foreign exchange revenue from selling their stockpiled ivory (or live elephants), and it may be politically expedient for them to relieve landlessness by moving poor farmers to areas previously inhabited by elephants.

NEW TECHNOLOGY

New technologies can possibly truncate the trajectory toward species extinction, especially in the anti-poaching and anti-trafficking domains. In this respect, the Executive Secretary of the UNEP Convention on Migratory Species of Wild Animals, Bradnee Chambers, wrote an interesting article in May 2014.[96] He highlighted the potential use of unmanned aerial vehicles for monitoring animal populations and scouting for poachers. Douglas-Hamilton also provides some instructive testimony in this respect, showing that the use of new technologies can serve conservationists well.[97]

> Tracking of elephants by GPS and satellites was pioneered by 'Save the Elephants' in Kenya, Mali, Central Africa and South Africa, and has now proved to be useful in greatly improving elephant security. This is one of several high tech solutions proposed. 'Save the Elephants' is also developing algorithms to detect wounding and mortality and organizing patrols according to alerts that are generated automatically. If the resources of the US agency DARPA [Defense Advanced Research Projects Agency] were made available it would greatly promote these high technology solutions. We would like to develop a new high tech collar incorporating more sensors that can give information of tactical use, such as gunshot detectors and accelerometers to measure fine movements. Thinking outside the box is needed to defeat the poaching and the use of remote sensors, gunshot indicators and drones would help to give an edge over well armed and highly motivated criminal gangs.

Drone technology (relatively inexpensive) is of course also likely to be used by poaching syndicates to respond to the increased intelligence that conservationists would possess if Douglas-Hamilton's call were heeded. Much more thought needs to be given to how to successfully use technology to aid conservation efforts, and equip law enforcement agencies to identify, arrest and imprison trafficking kingpins.

GAME THEORETIC MODEL

A game theoretic model provides a strategic lens through which to assess where conservationists' capital can most efficiently be allocated in light of expected rational responses from syndicates. Conservationists are essentially trying to outsmart syndicates.

Elephant preservation strategies are complex because they are characterised by players acting in anticipation of each other's actions. This is demonstrated below by a

simple two-player river-crossing game.[98] Player 1 is the conservationist, representing all stakeholders committed to sustaining Africa's elephant population. Player 2 is the syndicate, representing all players committed to stalling the efforts of player 1 in order to maintain the stream of rents from the ivory trade or the trade in live elephants.

In order to successfully cross the river, and take elephants to safety, the conservationist must cross three bridges, but each crossing is characterised by different payoffs, and need not occur simultaneously. The syndicate will try to anticipate the conservationist's strategic moves and respond accordingly. Conservationists must decide where to allocate scarce capital and in what order, to be of highest return. Under current circumstances, player 1 needs to:

- eradicate global demand for ivory products, especially in East Asia, and simultaneously increase elephants' use value in developing range states;
- prevent further elephant poaching and trafficking, especially in weak states verging on open access to elephants, and dispose of all official ivory stockpiles continuously and simultaneously; and
- successfully ban domestic ivory trades in range states and consumer markets.

Player 2 attempts to undermine each of these strategies. These dynamics are best modelled as a simultaneous-move game, as opposed to a sequential game, as each player's moves are not necessarily revealed in advance. However, each player is aware of the strategies available to his/her opponent. As such, the matrix for the game appears as illustrated in Figure 4.

Figure 4: Game theory matrix

		(1) Conservationists		
		Demand reduction	Prevent poaching	Ban domestic ivory trade
(2) Syndicates	Demand increase	0.5 ; 0.5	0 ; 1	1 ; 0
	Upscale poaching	0 ; 1	0.5 ; 0.5	1 ; 0
	Keep domestic trade legal	0 ; 1	0 ; 1	0.5 ; 0.5

Source: Author compilation

The payoffs for the row player are listed first, and payoffs for the column player second. Considering each block in turn from the top left, moving clockwise, we observe the following:

- If conservationists (the column player) succeed in reducing demand considerably, they receive a payoff of 0.5. The numbers are ordinal, signifying a binary of winning (1) or losing (0) respectively. Syndicates (the row player) will counter by attempting to increase demand, especially among high-end consumers for whom ivory produces Giffen behaviour or is highly price-inelastic. The probability of success is a different matter altogether. As mentioned earlier, conservationists' demand-reduction strategies must be specifically targeted to effect preference switches in the differentiated consumer market, especially to shift in demand where the marginal utility of consumption is highest. However, in isolation from other simultaneous strategies, syndicates could technically counteract demand-reduction campaigns with equal probability of success, also receiving a payoff of 0.5. The payoffs in row 1 and column 1 are thus equally shared.

- If conservationists attempt to limit poaching, but demand for ivory continues to rise, syndicates will attempt to source ivory from existing stockpiles. However, if conservationists, anticipating this move, simultaneously dispose of existing official stockpiles, syndicates are left without any strategic options other than to increase their poaching efforts of living stock. The existence of demand becomes immaterial in the short run. In this scenario (row 1, column 2), syndicates would receive a payoff of 0, and conservationists 1. But the probability of success against poaching is contingent on solving the nested prisoner's dilemma between range states. At present, the dominant strategy of Southern African conservationists is to maintain their elephants' Appendix II listing. Subject to CITES permission, this would allow further one-off ivory sales from naturally accruing ivory. However, it would come at the expense of costly stockpile maintenance, risky as that might be. The dominant strategy of West and Central African states, on the contrary, is to keep their Appendix I listing. If these countries co-operated and unanimously sought Appendix I listing, African elephants would stand a better chance of survival as it would avoid sending ambiguous signals to the market. Moreover, if elephants become extinct in West and Central Africa, syndicates will direct their attention eastwards (as has already started to happen) and then southwards.

- The resolution of the dilemma requires a focal point around which to change the payoffs to produce an assurance game. An assurance game ensures a mutually beneficial outcome if each player credibly commits to the focal point. If, for instance, the divided range states signed up to an initiative such as the EPI,[99] a mutually beneficial outcome could be attained. Southern states are unlikely to dispose of their stockpiles unless they are assured of other means with which to invest in managing what is currently a risky asset of medium value and intermediate growth rates. The EPI recognises that range states require urgent and sustained financial and technical support to compensate for potentially foregone revenue. It proposes to provide this funding for all range states that commit to implementing the African Elephant Action Plan (AEAP). Built-in incentives for timely implementation include incremental payments linked to growth in elephant populations.

- In row 1 and column 3, conservationists attempt to ban domestic ivory trades, a strategy also incentivised by the EPI, and syndicates attempt to create a larger black market (through increasing illicit demand). A strategy to change domestic laws to abolish an extensive trade is likely to work better if demand reduction is simultaneously (or even

ex ante) successful, as this would reduce the scale of the problem that law enforcement agencies have to deal with. However, given the likely connections between syndicates and political elites, banning domestic trades would likely face significant political barriers. The Chinese government recently announced a one-year ban on domestic trade, which is largely symbolic and functionally meaningless. If conservationists were to focus on banning domestic trade in isolation (not a likely strategy), it would leave them with 0, and syndicates with 1, as it would be capital inefficiently allocated. The possibility is included here for the sake of completeness for the model.

- In row 2 and column 1, we observe that it would be futile for syndicates to respond to successful wide-scale demand reduction with increased poaching efforts. The risk–reward ratio is too low. In this scenario, syndicates receive 0 and conservationists 1.

- If conservationists attempt to eradicate poaching, and syndicates respond by increasing their efforts (row 2 and column 2), the payoff would technically be equally shared at 0.5 each. At present, syndicates are empirically winning this game. They have better intelligence than conservationists, are able to exploit poverty-stricken on-site communities, and can easily co-opt members of national park conservation teams. Where borders are poorly patrolled, open access gives syndicates free poaching rein. There are, however – as mentioned above – some promising anti-poaching success stories that can be replicated and scaled up.

- In row 2 and column 3, banning domestic trade could be a relatively successful strategy against increased trafficking efforts, as it removes the transaction costs for law enforcement officials who currently have to try to distinguish between legal and illegal ivory. Laundering would thereby be reduced. However, a large part of the current market in China is already illicit. Syndicates would still poach to supply this demand, and use similar distribution routes to their current ones. For law enforcement officials, it may be less about transaction costs than about political will. For instance, if the expected utility from bribing exceeds the expected utility from a seizure of illegal ivory, formally banning domestic trades may render the conservationists' strategy futile. Again, banning domestic trade is only likely to be effective if demand reduction is successful and law enforcement officials have an incentive to stop accepting bribes. In this scenario, syndicates receive 1 and conservationists 0.

- In row 3 and column 1, when conservationists attempt to reduce demand and syndicates respond by lobbying to maintain legal domestic trades, the payoffs are 1 and 0 respectively. This outcome is contingent on the assumption that the demand reduction strategy is well directed, and does not necessarily depend on banning domestic trades. Given the difficulty associated with endogenous motivation for rule adherence in developing countries, it is strategically superior for conservationists to appeal to a universal morality rather than a legal paradigm to effect demand reduction. Similarly, syndicate efficiency would presumably be greater from creating a large illicit market than from actively trying to maintain trade legitimacy.

- Similarly, if conservationists were successful at preventing poaching, syndicates would be allocating capital inefficiently to keep domestic trades legal (row 3, column 2). Here, conservationists receive 1 and syndicates 0.

- Finally (row 3, column 3), the technical outcome is an equal payoff to both players. The ideal scenario would be for the eradication of domestic trades to result from a cogent demand-reduction campaign. In this case, syndicates would find it difficult

to supply to an organically shrinking black market. Reducing the size of the demand problem would increase the efficiency of capital subsequently directed towards banning domestic trade. In this scenario, with less syndicate capital available to pay bribes, anti-trafficking efforts may produce higher levels of expected utility for law enforcement agents, thus overcoming some of the problems mentioned above.

A mixed strategy is clearly best, with initial capital most effectively directed towards demand reduction and anti-poaching efforts. Capital directed towards banning domestic trades, aiding anti-trafficking efforts in the process, will be most efficient in the wake of the first two strategies being successful.

GOVERNANCE IMPLICATIONS

This analysis has accomplished two important goals. It has provided an overview of the economic literature on the conservation of elephants with a view to identifying six important criteria to inform game-theoretic modelling of the interaction between syndicates and conservationists. The question of maintaining a minimal viable population of elephants is of course more complex than a model with only two players. An extensive range of stakeholders is involved, from transit countries, range states and consumer markets to near-park communities, conservation agencies, international lobbyists, etc. These players all have differing interests and are therefore motivated by different incentives. However, reducing a complex system into a plausible model can help to discern where preservation efforts may be most proficiently employed. This is especially the case if the two players each approximate the incentives of the groups they represent. A systematic diagnosis of the salient problems is necessary if the correct governance interventions are to be derived. Decisions made in isolation can affect multiple equilibria. The probability of creating many unintended negative consequences is thus high.

The river-crossing game demonstrates where strategic efforts would gain the highest returns. Any strategy where conservationists win (gain a payoff of 1) in the majority of cases should be their dominant strategy. In the scenario modelled above, there is no clear winner. However, conservationists win two out of three times and draw once. The wins occur in following a demand-reduction and poaching prevention strategy. It therefore follows that it would be most efficient to allocate capital and effort towards both these strategies simultaneously. As this paper has been at pains to point out, however, there are extensive caveats.

First, campaigns to reduce the demand for ivory should not simplistically replicate other demand-reduction campaigns, nor should they be confused with mere awareness or information campaigns. The latter have had limited results in changing consumer behaviour. Ivory is not a uniform product and price elasticity differs among a heterogeneous consumer market population. Policymakers can, however, learn from the likes of the shark fin soup campaign in their appeal to universal morality. Helping consumers to make the connection between their consumptive behaviour and elephant population viability is vital. However, the campaign should be individually tailored to the specific segments of demand that have been identified. In a world of scarce resources, far more capital should be spent in this direction than on trying to ban domestic ivory trades.

Over-reliance on legal mechanisms as a primary strategy would likely be doomed to fail in a developing country context where the rule of law is weak.

Second, successful poaching prevention depends on overcoming the prisoner's dilemma that results from a collective action problem among range states. For as long as syndicates can divide and rule by driving a wedge between African countries, poaching prevention will fail. The question of what to do with existing ivory stockpiles and naturally accruing ivory in the future (from well-managed elephant populations) is not easily answerable. Just as the Spanish conqueror Hernando Cortez decided to burn his ships when landing in Mexico (as a signal to the local inhabitants and his soldiers that return was impossible), so African governments should agree to dispose of their stockpiles in a manner that puts them beyond commercial use. For as long as stockpiles exist, syndicates can find ways of accessing them. Demand-reduction campaigns are unlikely to gain traction if unaccompanied by credible commitment to stockpile disposal. Maintaining stockpiles entails a number of opportunity costs, largely through diverting scarce capital away from anti-poaching and anti-trafficking efforts. Most importantly, though, it sends an ambiguous signal to the market about whether the commitment to banning the trade is credible. African governments with well-managed elephant stocks are understandably reluctant to sacrifice the potential income, and so careful thought must be given to compensation. However, as soon as stockpile disposal occurs, syndicates are incentivised to increase poaching efforts to create their own stockpiles from remaining living stock. Conservationists should be prepared in advance for these likely responses. Moreover, the liability of maintaining a costly stockpile may exceed any future equities that governments may derive, as illegally seized ivory in the stockpile may not be traded under CITES in any event.

In closing, this paper contends that conservationists should combine their efforts towards effectively reducing demand and improving their anti-poaching and anti-smuggling efforts. Better co-ordination has been achieved in recent years, especially through the creation of the EPI and its associated AEAP. Banning domestic trades, especially in markets such as China, remains an important strategy, although the probability of success is likely to be higher if preceded by significant demand reduction. Simultaneously, because the mixed strategy from the model moves elephants' exchange value towards zero, conservationists must be united in their approach to sufficiently increase elephants' use value through PES schemes, tourism and so forth. Unless the latter is accomplished, through careful consultation with local near-park communities, competing development priorities may crowd out imperatives for elephant conservation.

ENDNOTES

1   UNEP (UN Environment Programme), CITES (Convention on International Trade in Endangered Species), IUCN (International Union for Conservation of Nature) & TRAFFIC (Wildlife Trade Monitoring Network), 'Elephants in the Dust: The African Elephant Crisis', 2013.

2   *Ibid.*

3   Wittemyer G *et al.*, 'Illegal killing for ivory drives global decline in African elephants', *Proceedings of the National Academy of Sciences*, 111, 36, 2014, p. 13118.

4   *Ibid.*

5   Geggel L, 'Poachers killed more than 100,000 elephants in 3 years', *Live Science*, 18 August 2014, http://www.livescience.com/47420-african-elephant-poaching.html, accessed 12 March 2015.

6   There are an estimated 38 range states in sub-Saharan Africa. The term refers to the countries that elephants cover across their migratory routes (their geographic range).

7   UNEP, CITES, IUCN & TRAFFIC, *op. cit.*, p. 7.

8   *Ibid.*

9   Omann I, Stocker A & J Jäger, 'Climate change as a threat to biodiversity: An application of the DPSIR approach', *Ecological Economics*, 69, 2009, p. 27.

10   Bulte EH, Damania R & GC van Kooten, 'The effects of one-off ivory sales on elephant mortality', *Journal of Wildlife Management*, 71, 2, 2007, pp. 613–618.

11   Very few academic papers attempt to model elephant conservation in game theoretic terms. For one example, see Colyvan M, Justus J & H Regan, 'The conservation game', *Biological Conservation*, 144, 2011, pp. 1246–1253.

12   Elasticity generally refers to the sensitivity of consumer demand response to changes in price. There are different types of elasticities. Policymakers should be particularly interested in the empirical price elasticity of demand for different types of ivory products. If a product is price-inelastic (the quantity demanded is relatively insensitive to changes in price), and changed consumer preferences shift the demand curve inwards, the price will drop relatively more steeply than for more price-elastic products. For this reason, demand reduction campaigns should be primarily targeted towards that segment of demand with the steepest demand curve, or even an upward sloping one.

13   In the formal academic literature, only eight papers appear that even mention elasticities.

14   For an idea of why elasticities are so crucial to the question of conservation, see Nadal A & F Aguayo, *Leonardo's Sailors: A Review of the Economic Analysis of Wildlife Trade* (No. 6). Manchester: Leverhulme Centre for the Study of Value, 2014.

15   't Sas-Rolfes M, Moyle B & D Stiles, 'The complex policy issue of elephant ivory stockpile management', *Pachyderm*, 55, 2014, pp. 62–77.

16   See, for instance, Gao Y & S Clark, 'Elephant ivory trade in China: Trends and drivers', *Biological Conservation*, 180, 2014, pp. 23–21.

17   This is a difficult point to establish empirically because the international ivory trade is currently banned. However, reasonable inference can be drawn (built on solid economic theory) as to how different consumers will respond to changes in price.

18   Gao Y & S Clark, *op. cit.*, pp. 27–28.

19   A substitution effect would usually account for such behaviour. For instance, bread substitutes become so expensive that people whose incomes are low or declining would choose to purchase more bread, although the price of bread is also increasing. It remains unclear whether similar dynamics characterise the purchase of ivory. One could imagine a story where alternative forms of investment (eg, shares in Apple) become so expensive that one purchases ivory investments as a substitute, although they are also increasing in price.

20   There is very little empirical evidence for the existence of Giffen goods. As yet, only Jensen R & N Miller, 'Giffen behavior: theory and evidence', NBER (National Bureau of Economic Research), Working Paper Series, 2007, have found evidence for Giffen behaviour among the poor (for rice and wheat). More reliable empirical information for ivory is clearly required.

21   Gao Y & S Clark, *op. cit.*, p. 27.

22 Waldmeir P, 'Austerity drive crimps gift-giving by China's rich', *Financial Times*, 16 January 2014, http://www.ft.com/intl/cms/s/0/a29b9164-7e5e-11e3-95dd-00144feabdc0.html?siteedition=intl#slide0, accessed 17 April 2015.

23 See Mason CF, Bulte EH & RD Horan, 'Banking on extinction: Endangered species and speculation', *Oxford Review of Economic Policy*, 28, 1, 2012, pp. 180–192.

24 Gao Y & S Clark, *op. cit*., pp. 27–28.

25 See Fischer C, 'The complex interactions of markets for endangered species products', *Journal of Environmental Economics and Management*, 48, 2004, pp. 926–953. She writes that '[r]ecognizing that products like ivory are durable and storable is also likely to be important for price dynamics'.

26 't Sas-Rolfes M, Moyle B & D Stiles, *op. cit*., pp. 62–77.

27 On attempts to reduce shark finning, see Dell'Apa A, Chad Smith M & MY Kaneshiro-Pineiro, 'The influence of culture on the international management of shark finning', *Environmental Management*, 54, 2014, pp. 151–161.

28 Waldmeir P, *op. cit*.

29 An important caveat is that this is not uniformly true across range states. Where tourism value is high, the equation does not necessarily hold. However, tourism revenue is diffuse whereas benefits from illicit ivory sales can be very targeted, often generating greater value for communities (in which poachers are contracted by syndicates) than tourism does.

30 Cole DH, Epstein G & MD Mcginnis, 'Digging deeper into Hardin's pasture: The complex institutional structure of "the tragedy of the commons"', *Journal of Institutional Economics*, 10, 2014, p. 364 & footnote 12.

31 Gabriel G, Huang N & J Wang, 'Making a Killing: A 2011 Survey of Ivory Markets in China', International Foundation of Animal Welfare, 2012.

32 The use of this phrase is not intended to suggest that the author agrees with the paradigm of viewing wildlife as economic assets per se (rather than sentient beings with inalienable rights), but merely an acknowledgement that this is the dominant worldview when it comes to biodiversity governance.

33 See Swanson T, *op. cit*. It must also be noted that societies are not uniform, homogeneous entities. There are different stakeholders, often with conflicting interests. Increasingly, near-park communities are becoming the most important stakeholders in wildlife conservation. Without their commitment, governments' best intentions for conservation can be nullified through non-co-operation.

34 See Hiedanpää J & DW Bromley, 'Payments for ecosystem services: Durable habits, dubious nudges, and doubtful efficacy', *Journal of Institutional Economics*, 10, 2, 2014, pp. 175–195.

35 This information was attained through interviews that the author conducted in the Shakawe and Seronga areas of Botswana's Okavango Delta. Conservationists and tour operators (on separate occasions) voiced a concern that poaching had increased in the wake of the hunting ban.

36 The section that deals with competing development goals will investigate these difficulties more substantially.

37 Teagle A, 'Zimbabwe plans to sell baby elephants to global buyers', *The Guardian*, 15 January 2015, http://www.theguardian.com/world/2015/jan/15/-sp-zimbabwe-sell-62-baby-elephants-global-buyers, accessed 16 January 2015.

38 Growth rates are highly varied and circumstance-dependent. See, for instance, Foley CH & LJ Faust, 'Rapid population growth in an elephant *Loxodonta africana* population recovering

from poaching in Tarangire National Park, Tanzania', *Oryx*, 44, 2, 2010, pp. 205–212; Wittemyer G, Daballen D & I Douglas-Hamilton, 'Comparative demography of an at-risk African elephant population', *PLoS ONE*, 8, 1, 2013.

39   Shannon G *et al.*, 'Effects of social disruption in elephants persist decades after culling', *Frontiers in Zoology*, 10, 1, 2013, pp. 1–11.

40   US Senate, Testimony of Iain DouglasHamilton, founder and CEO of Save the Elephants, 'Ivory and Insecurity: The Global Implications of Poaching in Africa', to the Committee on Foreign Relations.

41   Maisels F *et al.*, 'Devastating decline of forest elephants in Central Africa', *PLoS ONE*, 8, 3, 2013.

42   Fischer C, 'Does trade help or hinder the conservation of natural resources?', *Review of Environmental Economics and Policy*, 4, 1, 2009, pp. 103–121.

43   There is some controversy over this point, as we do not know whether it would simply be a matter of increased quantity demanded (which would reduce the price) or whether it would be a matter of changed consumer preferences shifting the entire curve upwards. This paper contends that the latter is more likely.

44   The difficulties of putting ivory beyond commercial use are discussed later in the paper. An important scientific argument in favour of doing so can be found in Wasser S *et al.*, 'Elephants, ivory, and trade', *Science*, 327, 2010, pp. 1331–1332.

45   Mason CF, Bulte EH & RD Horan, 'Banking on extinction: Endangered species and speculation', *Oxford Review of Economic Policy*, 28, 1, 2012, pp. 180–192.

46   Moyle B, 'The raw and the carved: Shipping costs and ivory smuggling', *Ecological Economics*, 107, 2014, pp. 259–265.

47   Mason CF, Bulte EH & RD Horan, *op. cit.*, p. 185.

48   *Ibid.*, p. 188.

49   Furness H, 'Listing mammoths as endangered would protect elephants, expert says', *The Telegraph*, 20 April 2015, http://www.telegraph.co.uk/news/earth/wildlife/11547222/Listing-Mammoths-as-endangered-would-protect-elephants-expert-says.html, accessed 20 April 2015.

50   UNEP, CITES, IUCN & TRAFFIC, *op. cit.*

51   US Senate, *op. cit.*, p. 5.

52   *Ibid.*, p. 6.

53   Wasser SK *et al.*, 'Combating the illegal trade in African elephant ivory with DNA forensics', *Conservation Biology*, 22, 4, 2008, pp. 1065–1071.

54   David PA, 'Why are institutions the "carriers of history"?: Path dependence and the evolution of conventions, organizations and institutions', *Structural Change and Economic Dynamics*, 5, 2, 1994, pp. 205–220.

55   Vandegrift J, 'Elephant poaching: CITES failure to combat the growth in Chinese demand for ivory', *Virginia Environmental Law Journal*, 31, 102, 2013, pp. 103–134.

56   Fischer C, *op. cit.*, 2009, pp. 116–117.

57   See, for instance, Greif A, *Institutions and the Path to the Modern Economy: Lessons from Medieval Trade*. New York: Cambridge University Press, 2006; Brousseau E, Garrouste P & E Raynaud, 'Institutional changes: Alternative theories and consequences for institutional design', *Journal of Economic Behavior and Organization*, 79, 2011, pp. 3–19; Greif A & C Kingston, 'Political economy of institutions, democracy and voting', in Schofield N & G Caballero (eds.), *Political Economy of Institutions, Democracy and Voting*. Heidelberg: Springer, pp. 13–43.

58 Greif A & C Kingston, 'Institutions: Rules or equilibria', in Schofield N & G Caballero (eds.), *op. cit.*, p. 40.

59 See Environmental Investigation Agency, 'Vanishing point: Criminality, corruption and the devastation of Tanzania's elephants', 2011, pp. 9–10.

60 During a research field trip to Botswana in September 2014, the author spoke to a number of environmentalists who privately expressed the view that conservation efforts in Botswana had only been successful because a sufficient number of political elites benefited economically from tourism ventures.

61 This is a complex issue. Perceptions of risk and reward are evidently not universal. In a poverty-stricken context, one could also envisage that the incentive to poach may be driven by a perceived low-risk, high-reward equation. Poaching may provide cash for livelihood sustainability in entire communities. See, for instance, Steinberg J, 'The Illicit Abalone Trade in South Africa', Institute for Security Studies, Paper, 105, April 2005, http://www.issafrica.org/pubs/papers/105/105.pdf, accessed 25 June 2015.

62 Bennett EL, 'Legal ivory trade in a corrupt world and its impact on African elephant populations', *Conservation Biology*, 29, 1, 2014, pp. 54–60.

63 Vandegrift J, *op. cit.*, p. 104.

64 The two terms – 'syndicates' and 'conservationists' – are used for the game theory model. They are necessarily reductionist for the sake of the game, but useful nonetheless given that all their constituent parts face the same incentives. For the sake of completeness, 'syndicates' incorporate poachers, buyers, traders and distributors. 'Conservationists' incorporate rangers, enforcement agencies such as Customs, and national departments of tourism and environmental affairs.

65 Keane A *et al.*, 'The sleeping policeman: Understanding issues of enforcement and compliance in conservation', *Animal Conservation*, 11, 2008, p. 76.

66 *Ibid.*, p. 77.

67 Lotter W & K Clark, 'Community involvement and joint operations aid effective anti-poaching in Tanzania', *Parks*, 20, 1, 2014, pp. 19–28.

68 Challender DWS & DC Macmillan, 'Poaching is more than an enforcement problem', *Conservation Letters*, 7, 5, 2014, p. 491.

69 A nested game is one that occurs within the broader game. For instance, the game that characterises the different interests of range states is distinct from the overall game between syndicates and conservationists, but still inextricably connected to it.

70 A prisoner's dilemma is a game in which each player's dominant strategy overrides his/her weaker strategy, even though playing the latter would result in the mutually beneficial outcome. The payoffs are structured such that each player is forced to play his/her dominant strategy.

71 The interesting caveat is that South Africa (a supposedly strong state) is currently unable to ameliorate the rhino-poaching pandemic. But this is admittedly complicated by Mozambique's lack of capacity to prevent poachers from accessing the Kruger Park. Better co-ordination would clearly benefit both countries.

72 Ethiopia burned its entire 6.1 tonnes ivory stockpile on 20 March 2015. Kenya burned 15 tonnes in the same month, and the president has promised that the rest will be burned before the end of the year.

73 See Jepson P & S Canney, 'Values-led conservation', *Global Ecology and Biogeography*, 12, 2003, pp. 271–274, for a discussion of this concept: 'The growth in public concern for nature and

the environment creates the possibility to raise substantial funds from public subscription, philanthropic and corporate donations and governments. Conservation agencies are adopting business techniques to capitalize on this opportunity …' (p. 273)

74 See iworry, 'Dead or alive? Valuing an elephant', 2014, http://iworry.org/wp-content/uploads/2013/09/Dead-or-Alive-Final-LR.pdf, accessed 20 April 2015. Over its lifetime, one elephant can contribute $1.6 million to tourism, whereas the average raw value of ivory that one elephant carries is only worth $21,000 on average.

75 Wasser S *et al.*, *op. cit.*, p. 1332.

76 The maths suggests that the perceptions pertaining to 'expected utility' are ill informed (if true that the tourism use value of an elephant far exceeds its ivory value).

77 For a thorough explanation of the importance of credible commitment in this kind of game, see Ross D, 'Game theory', in *Stanford Encyclopedia of Philosophy*, Stanford Center for the Study of Language and Information, 2014, http://plato.stanford.edu/entries/game-theory/#Mot: 'Long before game theory had come along to show analysts how to think about this sort of problem systematically, it had occurred to some actual military leaders and influenced their strategies. Thus the Spanish conqueror Cortez, when landing in Mexico with a small force who had good reason to fear their capacity to repel attack from the far more numerous Aztecs, removed the risk that his troops might think their way into a retreat by burning the ships on which they had landed. With retreat having thus been rendered physically impossible, the Spanish soldiers had no better course of action but to stand and fight – and, furthermore, to fight with as much determination as they could muster. Better still, from Cortez's point of view, his action had a discouraging effect on the motivation of the Aztecs. He took care to burn his ships very visibly, so that the Aztecs would be sure to see what he had done. They then reasoned as follows: Any commander who could be so confident as to wilfully destroy his own option to be prudent if the battle went badly for him must have good reasons for such extreme optimism. It cannot be wise to attack an opponent who has a good reason (whatever, exactly, it might be) for being sure that he can't lose. The Aztecs therefore retreated into the surrounding hills, and Cortez had his victory bloodlessly.'

78 Lemieux AM & RV Clarke, 'The international ban on ivory sales and its effects on elephant poaching in Africa', *British Journal of Criminology*, 49, 2009, pp. 451–471.

79 *Ibid.*, p. 464.

80 Swanson TM, 'The economics of extinction revisited and revised: A generalized framework for the analysis of the problems of endangered species and biodiversity losses', *Oxford Economic Papers*, 46, 1994, pp. 800–821.

81 *Ibid.*, p. 805.

82 *Ibid.*, pp. 807–809.

83 Cole DH, Epstein G & MD Mcginnis, *op. cit.*, p. 356.

84 For the economic theory underpinning this line of reasoning, see Acemoglu D & JA Robinson, 'Economics versus politics: Pitfalls of policy advice', *Journal of Economic Perspectives*, 27, 2, 2013, pp. 173–192.

85 Some stakeholders interviewed in Botswana speculated that elephant hunting had been banned not in the interests of conservation per se (which is how the idea was sold), but because the elite was frustrated that the profits were being repatriated out of the country. Communities who previously benefited from the ban are now susceptible to being used as poachers, but they are viewed as politically unimportant. These stakeholders speculated that part of the reason why the hunting ban was imposed was because elites had sufficient stakes in tourism ventures

to compensate for any losses (to themselves). This does not get around the problem of how to compensate communities, but it shows the unfortunate reality that often preservation is a function of how much vested interests elites have in revenue that may be generated from it. Another conflict ironically arises – in Botswana – between tourism and cattle grazing. The elite are also cattle owners, likely to allow cattle grazing into areas such as the delta.

86 Acemoglu D & JA Robinson, 'Political losers as a barrier to economic development', *The American Economic Review*, 90, 2, 2000, pp. 126–130.

87 Chevallier R & R Milburn, 'Value and Contribution of Protected Areas in Africa', SAIIA (South African Institute for International Affairs), Policy Briefing, 125, 2015. Johannesburg: SAIIA, pp. 1–4.

88 Ripple WJ *et al.*, 'Collapse of the world's largest herbivores', *Science Advances*, 1, 2015, pp. 1–12.

89 *Ibid.*, p. 1.

90 For more on PES, see Milder JC, Scherr SJ & C Bracer, 'Trends and future potential of payment for ecosystem services to alleviate rural poverty in developing countries', *Ecology and Society*, 15, 2, 2010: 'Payment for ecosystem services (PES) is an approach to environmental management that uses cash payments or other compensation to encourage ecosystem conservation and restoration. We define PES to include direct payments from ecosystem service beneficiaries to land stewards, as well as indirect payments earned through eco-certified production … PES is implemented through contingent agreements between land stewards and ecosystem service beneficiaries such as private businesses, communities, and society as a whole … As markets and compensation schemes for ecosystem services are established, low-income land stewards stand to benefit from the increased value placed on the services that these lands provide.'

91 Chevallier R & R Milburn, *op. cit.*, p. 3.

92 See Edge of Existence, 'African elephant (*Loxodonta Africana*)', http://www.edgeofexistence.org/mammals/species_info.php?id=77, accessed 2 April 2015, for further information.

93 Hiedanpää J & DW Bromley, *op. cit.*, p. 185.

94 Cole DH, Epstein G & MD Mcginnis, *op. cit.*

95 Hiedanpää J & DW Bromley, *op. cit.*

96 Chambers B, 'Cutting-edge conversation', *Project Syndicate*, 7 May 2014, http://www.project-syndicate.org/commentary/bradnee-chambers-shows-off-the-new-high-tech-tools-that-can-help-protect-endangered-species, accessed 15 January 2015.

97 US Senate, *op. cit.*, p. 9.

98 For a useful introduction to game theory, see Ross D, 'Game theory', in *Stanford Encyclopedia of Philosophy*, *op. cit.*, http://plato.stanford.edu/entries/game-theory/#Mot.

99 See Elephant Protection Initiative, http://www.elephantprotectioninitiative.org/about/, accessed 21 April 2015.