

# Rhino Horn: Are there viable alternatives?

Stacey Higgs (MA, BSc, PGCE)  
University of Derby / Derby College

## Highlights

- Alternative methods identified
- Education is key for the consumer and the trader
- Protecting private game owners
- Legalising the trade
- Government corruption

## Abstract

The number of rhinos being poached on private and national game reserves in Africa annually is unsustainable. The demand for rhino horn is having a detrimental effect on rhino populations with extirpations occurring throughout Africa. Traditional Chinese medicine and commercial art material are at the forefront of the problem with large syndicates poaching rhino and selling this product on the illegal black market in Asia, with high sales being documented in Vietnam. Alternative methods need to be considered and implemented to prevent extinction of an iconic megafauna species which has the potential to alter the biodiversity system in the Savannah regions if this species disappears *in situ*. Dehorning, legalising the trade (both nationally and internationally) and education are key areas which need to be addressed. However, it is vital to note that these alternatives only have the potential to be successful if implemented together and with the support from the traders, the consumers, but also from the government. It is imperative that all governments enforce current legislation on the trade and provide monetary and conservation backing to those individuals protecting their current rhino populations.

## Key words

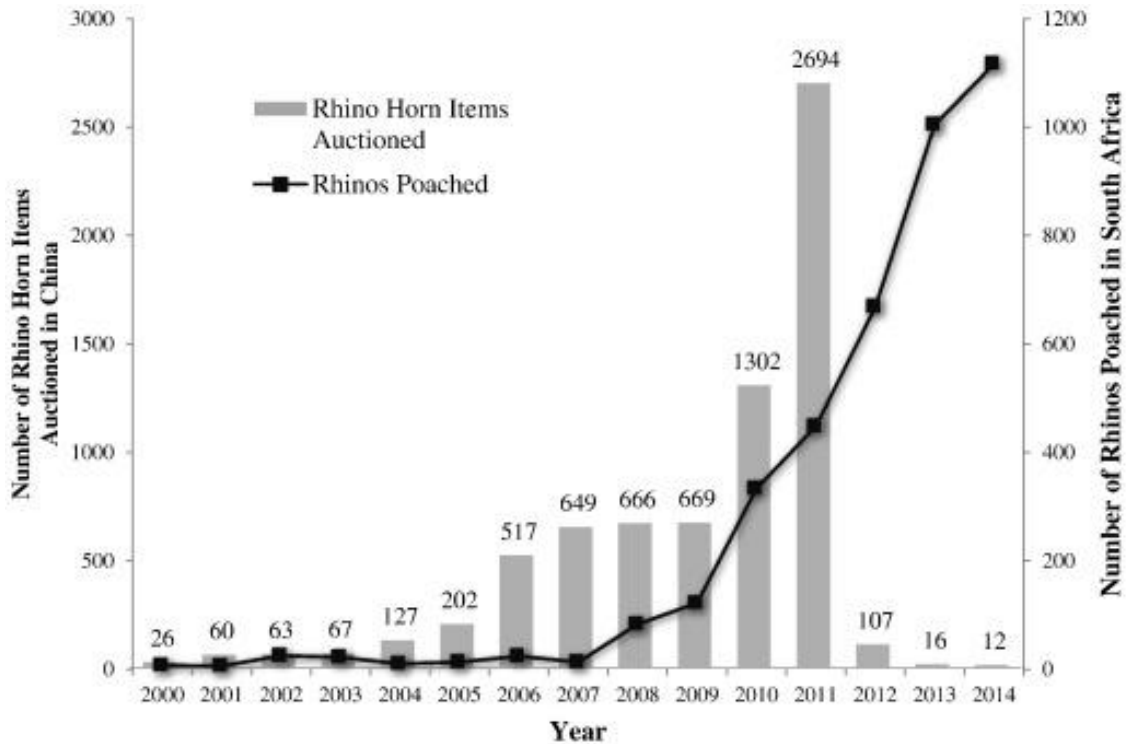
Rhinoceros; *Ceratotherium*; *Diceros*; Trade; Dehorn; Poaching; Wildlife management; Alternative methods

34  
35  
36  
37  
38  
39  
40  
41  
42  
43  
44  
45  
46  
47  
48  
49  
50  
51  
52  
53  
54  
55  
56  
57  
58  
59  
60  
61  
62  
63  
64  
65  
66

## 1.0 Introduction

Focus is predominantly on two species of rhino; white (*Ceratotherium simum*) and black (*Diceros bicornis*) found across 12 range states in Africa (Emslie *et al.*, 2013). Both species are listed in Appendix I in the Convention of International Trade in Endangered Species (CITES) (But *et al.*, 1990) due to their endangered status triggered by humans regarding all non-human animals as a resource for their tradable products and parts (Ayling, 2013). Both have their own distinguishing features, but their common similarity is their horn; made entirely of keratin fibres (Ryder, 1962). Their horn has properties similar to that of horses, birds (Heironymous, *et al.*, 2006); porcupine quills and Lincoln wool (Gillespie and Inglis, 1965) and therefore eludes that a potential alternative could be produced through similarities in their tissue structures; papillary cornfield epidermis. In Eastern culture rhino horn is considered for use in traditional medicine (29%), art (40%) and collectables (75%); however, in western culture 84% is deemed for medicinal value (Gao *et al.*, 2016). Vietnam is considered the primary consumer in rhino horn trade (Milliken and Shaw, 2012) and therefore alternatives need to be considered and implemented aimed at the source of the problem to prevent the rhino from going extinct within the next 20 years (Biggs *et al.*, 2013).

In 2008 a modest 83 rhinos were poached in Africa, this number rose dramatically to 1,215 in 2014 (Koen, *et al.*, 2017) with emphasis being implied that the poaching crisis was not apparent as it was now considered 'common news' as opposed to having an impact on news bulletins worldwide. However, demand had reduced in 2015 with 1,175 rhinos being recorded as poached on the African continent (Savethehino, 2017) demonstrating that current conservation work is having a positive impact on the decline on poached rhinos, however minimal. The black rhino saw a decline of 96% in just 25 years to only 2,410 black rhinos *in situ* in 1975, however due to positive conservation work there are currently 5,040 now *in situ*. This corresponds with figure one, published by Gao, *et al.*, 2016, that the number of rhinos poached has increased, but the number of rhino horns being auctioned has decreased radically between 2012 and 2014 with just 12 being auctioned. Thus demonstrating that current conservation efforts and alternatives such as education are having a positive impact on the survival of the species with a reduction in consumer purchases at the source; however, Gao, *et al.*, 2016 does go on to state that this data should be taken with caution and may not provide a true representation of the trade in rhino horn; stating other factors such as lack of data and income within China will have huge influences.



67  
68

69 Figure 1: The number of rhino horn items auctioned in China and Rhinos poached in South Africa  
70 from 2000 to 2014 (Gao *et al.*, 2016)

71

72 Rhino horn had a value of \$5,000/kg in 2009; \$10,000/kg in 2010 and \$20,000/kg in 2011; with a  
73 whole rhino carcass being valued between \$60,000 - \$80,000 (Child, 2012). With Truong *et al.*, 2016,  
74 estimating the horns' value at \$65,000/kg in 2012. Gao, *et al.*, 2016 correlate with these values  
75 stating that uncarved items have a lesser monetary value per gram than those that had been carved.  
76 The monetary commercial elements need to be addressed as this is a tying point for people in the  
77 illegal trade (Douglas and Alie, 2014). The illegal trade in rhino horn has been linked to fuelling  
78 terrorism, political campaigns and the purchasing of weapons (Wyatt, 2013 and Duffy, 2016). Any  
79 alternatives that are put forward need to not only be beneficial for the conservation of the rhino,  
80 but to ensure the survival of the people that are working within this illegal trade. Corruption within  
81 Africa, and further afield, needs to be addressed first before any alternatives are implemented to  
82 ensure that all money is re-invested back into conservation and not into political wars (Douglas and  
83 Ali, 2014 and Duffy, 2016).

84

85 **2.0 What is rhino horn?**

86 Rhino horn, made of keratin fibres, is widely used within Chinese medicine; considered to be a  
87 psychosomatic approach to self-healing (Hughes, 1995). Still, 2003, states "that rhino horn is used

88 for alleviating fever, the skin to treat skin disease, the penis as an aphrodisiac, the bone to treat  
89 bone disorders and the blood to treat women with menstrual problems". It is strongly believed in  
90 Chinese culture that that the black rhino horn has a higher efficacy value than that of the white rhino  
91 horn (Still, 2003) due to its' smaller size and therefore higher concentration of medicinal properties;  
92 therefore, causing an increase in black rhino poaching and a greater decline in their numbers (Biggs  
93 *et al.*, 2013). However, Gottlieb, 1993, has found that there has been no scientific evidence to  
94 support this claim with Mainka and Mills, 1995, concerned that there is underreporting of countries  
95 supplying the horn for medicinal and art purposes.

96

## 97 **2.1 Traditional Chinese Medicine**

98 Traditional Chinese medicine (zoo therapy (Costa-Neto, 2005)) dates back to over 5,000 years  
99 (Mainka and Mills, 1995) with Still, 2003, stating rhino horn has been used within Chinese medicine  
100 for the last 2,000 years with only 13% of the products used within traditional Chinese medicine  
101 found to be animal-based. Traditional history and focus is from tales of animals using plants to heal  
102 themselves; Mainka and Mills, 1995, make use of a clear example of a snake consuming weeds to  
103 heal its wounds caused from an attack by a local farmer. The local farmer described the snake  
104 eating the weed *Panax notoginseng* (Himalayan Ginseng) and its' wounds becoming healed, the  
105 same weed which is still used today for anti-haemorrhagic treatments in humans. Animal products  
106 are rarely used alone, and are consumed with plant based products, leading onto the potential for  
107 an alternative of the 'animal-based product' being used. When rhino horn is used for its antipyretic  
108 effects, it is mixed with turpentine oil, a plant based medicinal product (But and Tam, 1990), this in  
109 turn leads for the potential of using less rhino horn mixed with plant based products until the rhino  
110 horn can be filtered out completely.

111

112 Rhino horn has been claimed to be beneficial for a variety of purposes; reducing high fevers,  
113 poisoning, snake bites, influenza and abscesses to name a few (Hsu *et al.*, 1986, Costa-Neto, 2005)  
114 but with limited research conducted on the efficacy of the medicinal products used (Costa-Neto,  
115 2005). It has been found that the human culture regards themselves highly over non-human animals  
116 and therefore sustainability has not been factored into the use of animals as zoo therapy. In the  
117 16<sup>th</sup> century a pharmacist, Li Shih Chen, published that rhino horn did have medicinal benefits, this  
118 same book is still used today in the 21<sup>st</sup> century in seemingly resolving the same ailments (Costa-  
119 Neo, 2005). It has also been noted in literature that rhino horn is widely used in Buddhist holistic  
120 medicine (Hughes and Keown, 1995). Without a change in education and traditions, alternatives  
121 would not be viable and the species will remain endangered and in decline.

122 Plant materials have been scientifically proven to have significant effects on the reduction in a range  
123 of ailments and medicinal problems (fever, heart disease, malaria) (Ellis, 2005). Chinese medicine is  
124 still very much reliant on the use of plant and animal parts in medicine, whereas the western culture  
125 has moved on to whole animal medicinal testing (Ellis, 2005). This western culture, although  
126 controversial in aspects, could be an alternative way forward to move away from using endangered  
127 animal products and parts, towards the use of stable populations of animals that are readily bred in  
128 laboratories for medicinal purposes. Movements in the western culture are also considering the  
129 alternative of lab grown meat and organs. Goodwin and Shoulders, 2013, identify success in  
130 growing viable organs in laboratories; this could be a clear starting point to eliminate the use of wild  
131 and / or captive animals in any form of medical testing and to eradicate the use of non-human  
132 animals and their products in traditional and current medicine.

133

## 134 **2.2 Antipyretic and cardiotoxic effects**

135 Following on from medicinal uses, it has been widely published in literature that rhino horn is used  
136 for its antipyretic and cardiotoxic purposes (But *et al.*, 1991). Mainka and Mills, 1995, published that  
137 rhino horn does have an antipyretic effect on rats but only when used at extremely high doses.  
138 Research from Mainka and Mills, 1995 and Kong, 1987, have suggested that water buffalo (*Bubalus*  
139 *bubalis*) horn can be a viable alternative with similar medicinal effects, however, ten times more  
140 water buffalo horn would be required for the same effect and would therefore have short and  
141 ultimately long term implications on the survival of the water buffalo as a species, potentially leading  
142 to a similar scenario as the decline of the rhino. But and Tam, 1990, also found that whilst water  
143 buffalo horn does have a reduction effect at 5g/ml, there is no significant effect when a reduced  
144 quantity is applied. Mainka and Mills, 1995 correspond with But and Tam, 1990, finding an  
145 alternative medicine in Saiga antelope (*Saiga tatarica*) horn. They found Saiga horn causes a  
146 significant drop in fever when used at 1g/ml; the same quantity used as rhino horn, therefore  
147 providing a viable sustainable alternative if these were able to be bred successfully in captive or wild  
148 populations.

149

## 150 **3.0 Alternative medicines**

151 Subsequently there are around 5,040 black rhinos, 3,500 greater one-horned rhinos (*Rhino*  
152 *unicornis*), 100 Sumatran rhino (*Dicerorhinus sumatrensis*), 61 Javan rhino (*Rhinoceros sondaicus*)  
153 and 19,666 white rhino found *in situ* (Gao *et al.*, 2006). The rhino has become even further  
154 endangered since the ban in the trade of rhino horn in 1977 by CITES (Messer, 2010) with no  
155 evidence this ban has slowed poaching rates, but in fact had the opposite effect of creating a

156 demand for this product (Gao, *et al.*, 2016). Following the CITES CoP17 conference in October 2016  
157 held in Johannesburg and the ban on the trade in rhino horn remaining in place until consideration  
158 at CoP18 in a further three years, it is now imperative viable alternatives are sought to ensure the  
159 survival and to prevent extinction of this species. However, it is paramount to note that whilst  
160 medicinal medicine books, in particular that of Li Shih Chen, are still being used in current medicine,  
161 any animal alternative used has the potential to have the same fate as that of the rhino.

162

### 163 **3.1 Legalise the trade**

164 There is vast amount of literature published regarding legalising the trade in rhino horn (Crookes and  
165 Blignaut, 2015) both nationally throughout southern Africa, and internationally. Legalising the trade  
166 is a controversial issue, but an issue that needs considerable thought nonetheless. Biggs *et al.*, 2013,  
167 comments that legal trade could work, however, this is dependent on the legal trade not already  
168 fuelling an ever growing market. Biggs *et al.*, 2013, does also go on to state that legalising the trade  
169 needs to be carefully conducted, alongside other alternatives such as education, and not as a  
170 standalone alternative.

171

172 Demand for rhino horn since 2015 has been on a slow decline (Gao *et al.*, 2016) with Collins *et al.*,  
173 2013 stating that the positive decline, caused by an anthropogenic allee effect, will be detrimental  
174 towards rhino populations if the trade was to become legalised. Prins and Okita-Ouma, 2013, agree  
175 with Biggs *et al.*, 2013, reservations writing that it is unknown of the stigma in Eastern countries, but  
176 it does allude to that of high consumer markets for medicinal and commercial art purposes. Smith *et*  
177 *al.*, 2013, writes that a quarter of the white rhinos found within Africa are on private game reserves,  
178 18% of South Africa's land (Hoven, 2014), and therefore private game owners should have a say in  
179 the legalising of the trade, in particular that nationally, many of who are wanting the legal trade to  
180 be implemented. Private game owners generate revenue from live sales and tourism of these  
181 megafauna species (Entwistle and Dunstone, 2000), however, a white rhino is currently worth more  
182 dead than it is alive (Hoven, 2014).

183

184 Minin *et al.*, 2014, conducted a study to determine if legal trade would benefit and facilitate rhino  
185 protection. Under present management, it was agreed with Biggs *et al.*, 2013, that the white rhino  
186 would become extinct *in situ* within 20 years. Minin *et al.*, 2014, was reserved to state that current  
187 anti-poaching efforts are costing \$147,000,000 per annum; whereas legalising the rhino horn could  
188 provide a profit of \$717,000,000 per annum; a clear increase in money that can be put back into the  
189 conservation of these iconic species. However, Minin *et al.*, 2014, end their report corresponding

190 with Biggs *et al.*, 2013, article stating that 2.6% of the natural death rate of rhino *in situ* would  
191 provide hundreds of surplus tradeable horns on an annual basis. However, does go on to suggest  
192 that the legalising of rhino horn should not be approved unless the money generated from the trade  
193 is solely put back into the conservation of the rhino and not used elsewhere.

194

195 There is a clear emphasis from literature that whilst legalising the trade could become a viable  
196 alternative; it is not a standalone solution. The legal trade in rhino horn needs to be closely  
197 monitored with revenue generated reinvested back into the protection of these species (Minin *et al.*,  
198 2014). Smith *et al.*, 2013, confirms that poaching increased 4.3% in 2013, before the decline of  
199 poached rhinos in 2015, and therefore has a strong emphasis that money generated has to be  
200 reinvested into the 11,600 (Hoven, 2014) private game reserves to ensure they continue to protect  
201 and conserve this iconic species.

202

### 203 **3.2 Rhino farming**

204 Private game reserves play a huge role in the successful breeding of rhino. Rhino farming can be  
205 considered as a viable alternative in reducing the trade in rhino horn, however this would only be  
206 successful if the legal trade was sanctioned nationally, but most importantly internationally to flood  
207 the market with a sustainable supply of horn, therefore causing the monetary value of the horn to  
208 fall. Roberts *et al.*, 1999 is cautious regarding the farming of species writing that the promotion of  
209 captive farmed species has the potential to stimulate market demand further therefore potentially  
210 resulting in increased poaching. Private game reserves farming rhinos and conservation  
211 organisations would need to work alongside educational awareness bodies and the legalising of the  
212 trade to ensure a sustainable supply of horn was available long term in order for this alternative to  
213 be successful.

214

215 Prins and Okita-Ouma, 2013, discuss that it is unknown if farmed rhinos would breed as well and as  
216 successfully as captive bred rhinos, however Smith *et al.*, 2013 dismisses this by claiming a 130%  
217 increase in rhino population numbers on farmed rhinos on private game reserves alone in Africa.  
218 This correlates back to Biggs *et al.*, 2013, that whilst legalising can work, and using farmed rhinos to  
219 support the demand of the trade, this alternative has to be used alongside other alternative  
220 methods such as education to support and lead to a decline in demand.

221

222 Damania and Bult, 2007, are also cautious regarding the farming of rhino horn; “farmed varieties  
223 perhaps lacking the potency of wild products”, suggesting those who use rhino horn as a medicinal

224 product would not buy in to using a farmed product if the wild variety were to be considered much  
225 better for curing medical ailments. Damania and Bult, 2007, also correlate with Roberts *et al.*, 1999,  
226 that a farmed rhino may stimulate market demand further from new consumers buying into this  
227 commodity and therefore pose a high detrimental threat to the species. Whilst farmed rhinos does  
228 have the potential to supply a trade that is currently in high demand, this alternative has to be used  
229 cautiously, and alongside other methods to eliminate the trade, before the rhino themselves  
230 become extinct *in situ*.

231

### 232 **3.3 Education**

233 As stated previously in all sections when considering any alternative method, education is key and at  
234 the heart of the survival of the rhino. Education is required to educate those using rhino horn as a  
235 medicinal product to find suitable sustainable alternatives before they are forced into this option.  
236 There is only a finite supply of rhino horn available, as discussed previously, and therefore  
237 alternative methods need to be sought to ensure the survival of this species before they become  
238 extinct. Effective conservation can only occur when education is also implemented into the plan  
239 (Salafsky *et al.*, 2002).

240

241 It is highly recognised that education in the media can influence the human perception on wildlife  
242 trade, in particular that of the plight of the rhino (Ellis, 2005 and Ferreira and Okita-Ouma, 2012).  
243 Education and awareness on the impact of poaching and the consumption of rhino horn on this  
244 species needs to be delivered to the target audience; the consumers. There is much emphasis on  
245 key personnel such as Prince Harry raising awareness in western society, becoming the patron of  
246 rhino conservation in 2017 (Samhan, 2017), but it will only become effective if this is fully  
247 implemented into eastern societies and culture; Gao *et al.*, 2016, reiterates that there is a lack of  
248 true information on the demand and end-use market which in turn effects what information is  
249 published in the sector. If the information published is not true, and propaganda is used only on the  
250 medicinal use of the rhino horn, then the end use market will remain for art: ornaments and other  
251 alternatives of the product, therefore leading to the extinction of the species as full awareness has  
252 not been made available to the appropriate traders and consumers.

253

254 Whilst it is imperative to target education at the consumers and the reason for the demand, it is also  
255 crucial to ensure 'middle-men sellers' (Milliken and Shaw, 2012) are fully aware of the effect they  
256 are having on the rhino. Many traders are either unaware of the implication they are having, or do  
257 not have any alternative work and reside in a third world country such as South Africa, this to them



258 is a viable way in which they can provide for their families. It has been claimed many sellers are  
259 unaware of the scientific names of rhino, however, if a rhino can be proven to originate from India  
260 or China than their sale price increases than that of a horn from Africa (Milliken and Shaw, 2012).  
261 Education is key here to ensure the sellers are fully aware of the impact they are having on the  
262 decline in the rhino.

263

264 As a megafauna species, if this species were to go extinct then there would be huge implications for  
265 biodiversity within their habitat (Ayling, 2013). Poaching is an issue that effects many species, not  
266 just the rhino alone. A meat hunter will enter a reserve for meat, usually to feed his family, but is  
267 not particular in the antelope choice, this will impact on breeding herds and grass consumption, but  
268 ultimately due to the random identification will not have lasting implications on the grazing of the  
269 land. A white rhino grazes on Savannah land, if this herbivorous species was removed from an area,  
270 Waldram *et al.*, 2008, found that grass sward height increased significantly. Waldram *et al.*, 2008  
271 goes on to state that other grazers, except those found in semi-arid areas, were unable to maintain  
272 short grass. This has lasting implications for the increased risk of fire spreading throughout a game  
273 reserve, but also for animals that consume the shorter grass which contains higher nutritional  
274 values.

275

### 276 **3.4 Dehorning**

277 Biggs *et al.*, 2013, is clear to state that current dehorning methods have minimal risks to the non-  
278 human animal; and currently, although there is limited published literature on this, highlights that  
279 there are no significant behavioural changes within the dehorned rhino. Dehorning, however, can  
280 lead to stress within the species as *in situ* this is a process that needs to be conducted between 1.16  
281 and 1.51 years (Berger and Cunningham, 1994 and Rachlow and Berger, 1997). Berger and  
282 Cunningham, 1994, also express concerns that the dehorning process leaves mothers unable to  
283 defend their calves, having the potential for the breeding of the species to be halted; however, both  
284 authors do go on to state that this is anecdotal with limited published literature.

285

286 Literature published by Milner-Gulland *et al.*, 1994, although prior to the millennium, states the cost  
287 to dehorn a rhino varies between \$350 and \$1,800 (estimated \$1,000 in 2016, SavetheRhino, 2017b)  
288 with the horn being valued at around \$2,000 in 1994, a small would-be profit made for farmers,  
289 however they are unable to sell the product in to the international trade. Milner-Gulland *et al.*,  
290 1994, also went on to state that poachers were still poaching rhinos at 1.3 years after dehorning;  
291 going against Rachlow and Berger, 1997, who suggest that farmers will leave their rhinos for several

292 months more before dehorning again. This makes evident that before the rhino had chance to be  
293 dehorned again, they were poached for their small portion of horn, correlating with Berger and  
294 Cunningham, 1994, that poachers prefer to obtain a smaller horn than larger horns, and therefore  
295 eluding that this is not a viable alternative. However, Kagande and Musarurwa, 2014, counteract  
296 this claim by stating that if dehorning is conducted on a regular basis there will be a reduction in  
297 large rhino horn specimens on the market, therefore depressing the trade. Milner-Gulland *et al.*,  
298 1992, suggests that dehorning is required to be conducted on an annual basis as an effective and  
299 sustainable alternative, however due to costs, this is not always feasible. Dying and GPS trackers  
300 have been considered alternatives, but have minimal to no chance of success or efficacy in reducing  
301 poaching (Lee and Roberts, 2016).

302

### 303 **3.5 Biomechanical / lab grown horn**

304 Laboratory grown horn has a potential has a viable alternative, however, if conducted incorrectly,  
305 may have the same fate as the use of dye or GPS trackers in their failed attempt at reducing demand  
306 and poaching (Lee and Roberts, 2016). Rhino horn is considered a high commodity amongst eastern  
307 culture and has strong links to generations of cultural traditions using this product in traditional  
308 Chinese medicine (Still, 2003). A new alternative emerging is that rhino horn could be synthetically  
309 replaced on the market by synthetic analogues (Still, 2003), however Graham-Rowe, 2011, states  
310 that the value of synthetic rhino horn amongst consumers is much less as the quality of the horn is  
311 reduced. If this reduction in quality and similarity is noticed by the consumers, the horn will not be a  
312 viable alternative.

313

314 Rhino horn alternatives have been used from Saiga antelope and domesticated water buffalo, but no  
315 significant effect was shown in the decline of illegal rhino horn (Milliken, 2014 and Broad and  
316 Burgess, 2016) in carved products. A key point by Broad and Burgess, 2016, is that the synthetic  
317 rhino horn must not be distinguished from the natural horn. Ultimately, if the synthetic horn was  
318 found to have a distinguishing differentiating feature from natural rhino horn, this would lead to a  
319 rise in price in the natural rhino horn and have a strong potential to lead to increased poaching for  
320 higher monetary gain in the sale of real rhino horn for syndicate groups. Nevertheless, Philips, 1983,  
321 was confident in his report that Gresham's Law theory would be applied, leading to the true value  
322 being lowered as differentiation would not be possible immediately and consumers would not be  
323 willing to take that risk when purchasing such high value products.

324

325 Broad and Burgess, 2016, go on to state that 3D printing could be involved in flooding the market  
326 alongside the current illegal trade, however, this does have implications in legal settings in terms of  
327 how the horn can be incorporated into the market both in the national and international trade  
328 systems, with enough distinguishing features for this trade to be allowed. Mason, *et al.*, 2012, goes  
329 on to state that if a product was restricted then the speed of poaching increases, falling back that  
330 legalising the trade with an alternative supply has the potential to be successful in reducing demand  
331 from wild rhino. Meecham, 1997, is clear that “If the animal becomes extinct, those stockpiles  
332 become infinitely valuable” with Mason, *et al.*, 2012, agreeing with Milliken, 2014, that synthetic  
333 products could be utilised but is more confident in the use of farmed products from other  
334 sustainable species as an alternative source for the reduction in demand of rhino horn.  
335

335

#### 336 **4.0 Conclusion**

337 The rhino horn is a high commodity product and of enormous value within the illegal black market  
338 trade (Truong *et al.*, 2016). It is therefore imperative that an alternative is found to prevent  
339 extinction of the species (Biggs *et al.*, 2013). Extirpation has already occurred in certain states and is  
340 becoming more widespread as private and national game reserves are unable to cope with the  
341 numbers of rhinos being poached on an annual basis (Truong *et al.*, 2016). Several alternatives have  
342 been discussed in this report, however it has been highlighted that no alternative is stand alone. All  
343 alternative methods fall back to education being at the centre starting point, ensuring that both the  
344 traders and consumers are informed on the effect they are having on this species (Milliken and  
345 Shaw, 2012). It is imperative that education regarding the use of the rhino horns’ medicinal  
346 properties is disseminated to those that fall back on rhino horn as a traditional medicine (Mainka  
347 and Mills, 1995) and those of high wealth that use the horn as a product of art (Salafsky *et al.*, 2002).  
348

348

349 Many alternatives rely on the government working with local communities to find sustainable  
350 methods of farming rhino to increase their numbers, but in also raising awareness and providing  
351 funds to conduct sufficient anti-poaching patrols (Douglas and Ali, 2014). Alternative methods also  
352 rely on the government enforcing legislation and prosecuting those at the top of the syndicate to  
353 eradicate the supply of this product. The government in all affected countries, predominantly Africa  
354 and Asia, need to work together to stop the illegal trade and work towards a legal trade system that  
355 alongside education will prevent the extinction of such an iconic species (Biggs *et al.*, 2013, Wyatt,  
356 2013 and Duffy, 2016).  
357

357

358

359 **5.0 References**

- 360 AYLING, J., 2013, What sustains wildlife crime? Rhino horn trading and the resilience of criminal  
361 networks, **Journal of International Wildlife and Law Policy**, 16, 57-80
- 362 BERGER, J., and CUNNINGHAM, C., 1994, Active intervention and conservation: Africa's Pachyderm  
363 Problem, **Science**, 263(5151), 1240-1242
- 364 BIGGS, D., COURCHAMP, F., MARTIN, R., and POSSINGHAM, H, P., 2013, Legal trade of Africa's Rhino  
365 Horn, **Science**, 339 (6123), 1038-1039
- 366 BROAD, S., and BURGESS, G., 2016, Synthetic biology, product substitution and the battle against  
367 illegal wildlife trade, **TRAFFIC International**, 28 (1), 22-27
- 368 BUT, P, P., LUNG, L., and TAM, Y-K., 1990, Ethnopharmacology of rhinoceros horn: Antipyretic effects  
369 of rhinoceros horn and other animal horns, **Journal of Ethnopharmacology**, 30, 157 – 168
- 370 BUT, P, P., YAN-KIT, T., and LAI-CHING, L., 1991, Ethnopharmacology of rhinoceros horn II:  
371 antipyretic effects of prescriptions containing rhinoceros horn or water buffalo horn, **Journal of**  
372 **Ethnopharmacology**, 33(1-2) 45-50
- 373 COSTA-NETO, E, M., 2005, Animal-based medicines: biological prospection and the sustainable use  
374 of zoo therapeutic resources, **Anais da Academia Brasileira de Ciencias**, 77(1) 33-43
- 375 CHILD, B., 2012, The sustainable use approach could save South Africa's rhinos, **South African**  
376 **Journal of Science**, 101(7-8) 1-4
- 377 CROOKES, D, J., and BLIGNAUT, J, N., 2015, Debunking the myth that a legal trade will solve the rhino  
378 horn crisis: A system dynamics model for market demand, **Journal for Natural Conservation**, 28, 111  
379 – 18
- 380 DAMANIA, R., and BULT, E, H., 2007, The economics of wildlife farming and endangered species  
381 conservation, **Ecological Economics**, 62(3-4), 461-472
- 382 DOUGLAS, L, R., and ALIE, K., 2014, High-value natural resources: linking wildlife conservation to  
383 international conflict, insecurity, and development concerns, **Biological Conservation**, 171, 270-277
- 384 DUFFY, R., 2016, War, by conservation, **Geoforum**, 69, 238-248
- 385 ELLIS, R., 2005, Tiger Bone and Rhino Horn, **Nature**, 71-79
- 386 EMSLIE, R., MILIKEN, T., and TALUKDAR, B., 2013, African and Asian Rhinoceros – Status,  
387 Conservation and Trade. A report from the IUCN Species Survival Commission African and Asian  
388 Rhino Specialist Groups and TRAFFIC to the CITES Secretariat pursuant to the Resolution Conference  
389 9.14 (Rev CoP15)
- 390 ENTWISTLE, A., and DUNSTONE, N., 2000, Priorities for the conservation of mammalian diversity:  
391 Has the panda had its day?, UK: Cambridge University Press, 58-62
- 392 GAO, Y., STONER, K, J., LEE, A, T, L., CLARK, S, G., 2016, Rhino horn trade in China: An analysis of the  
393 art and antiques market, **Biological Conservation**, 201, 343-347
- 394 GILLESPIE, J, M., and INGLIS, A, S., 1965, A comparative study of high-sulphur proteins from a-  
395 keratins, **Comparative Biochemistry Physiology**, 15, 175 – 185

- 396 GOODWIN, J. N., and SHOULDERS, C. W., 2013, The future of meat: A qualitative analysis of cultured  
397 meat media coverage, **Meat Science**, 95(3), 445-450
- 398 GOTTLIEB, A., 1993, Sex, drugs and aphrodisiacs, UK: London: 20<sup>th</sup> Century Alchemist, 89
- 399 GRAHAM-ROWE, D., 2011, Biodiversity: endangered and in demand, **Nature**, 480, 101-103
- 400 HIERONYMUS, T. L., WITMER, L. M., and RIDGELY, R. C., 2006, Structure of white rhinoceros  
401 (*Ceratotherium simum*) horn investigated by x-ray computed tomography and histology with  
402 implications for growth and external form
- 403 HOVEN, W. V., 2014, Private game reserves in Southern Africa, **Institutional arrangements for  
404 conservation, development and tourism in eastern and southern Africa**, USA: Springer, 101-102
- 405 HSU, H. Y., CHEN, Y. P., SHEN, S. G., HSU, C. S., CHEN, C. C., and CHANG, H. C., 1986, Oriental  
406 material: A concise guide, USA: Oriental Healing Arts Institute, Long Beach
- 407 HUGHES, J. J., and KEOWN, D., 1995, Buddhism and medical ethics: A bibliographic introduction,  
408 **Journal of Buddhist Ethics**, 2, 105 – 124
- 409 KAGANDE, S. M., and MUSARURWA, L. K., 2014, Conserving the African rhinoceros, **Biodiversity and  
410 Conservation**, 23(2), 497-502
- 411 KOEN, H., VILLIERS DE, J. P., ROODT, H., and WAAL DE, A., 2017, An expert-driven causal model of  
412 the rhino poaching problem, **Ecological Model**, 347, 29-39
- 413 KONG, Y. C., 1987, Animal Drugs in Chinese Medicine, **PROC. AAZV**, 450-451
- 414 LEE, T. E., and ROBERTS, D. L., 2016, Devaluing rhino horns as a theoretical game, **Ecological  
415 Modelling**, 337 (73-78)
- 416 MAINKA, S. A., and MILLS, J. A., 1995, Wildlife and traditional Chinese medicine – supply and  
417 demand for wildlife species, **Journal of Zoo and Wildlife Medicine**, 26(2), 193-200
- 418 MASON, C. F., BULTE, E. H., and HORAN, R. D., 2012, Banking on extinction: endangered species and  
419 speculation, **Oxford Review of Economic Policy**, 28(1) 180-192
- 420 MEECHAM, C. J., 1997, Hoe the tiger lost its stripes: USA: New York Harcourt Brace, 134
- 421 MESSER, K. D., 2010, Protecting endangered species: When are shoot-on-sight policies the only  
422 viable option to stop poaching?, **Ecological Economics**, 69(12), 2334-2340
- 423 MILLIKEN, T., AND SHAW, J., 2012, The South Africa – Vietnam Rhino horn trade nexus: A deadly  
424 combination of institutional lapses, corrupt wildlife industry professionals and Asian crime  
425 syndicates, **TRAFFIC South Africa, Johannesburg**, 1-173
- 426 MILLIKEN, T., 2014, Illegal trade in ivory and rhino horn: an assessment report to improve law  
427 enforcement under the wildlife TRAPS project, **TRAFFIC International**, UK: Cambridge
- 428 MILNER-GULLAND, E. J., BEDDINGTON, J. R., and LEADER-WILLIAMS, N., 1992, Dehorning African  
429 Rhinos: a model of optimal frequency and profitability, **Proceedings of the Royal Society: Biological  
430 Sciences**, 249 (1324)
- 431 MILNER-GULLAND, E. J., LEADER-WILLIAMS, N., and BEDDINGTON, J. R., 1994, Is dehorning African  
432 rhinos worthwhile?, **Pachyderm**, 18, 52-58

433 MININ, E. D., LAITILA, J., MONTESINO-POUZOLS, F., LEADER-WILLIAMS, N., SLOTOW, R., GOODMAN,  
434 P, S., CONWAY, A, J., and MOILANEN, A., 2014, Identification of policies for a sustainable legal trade  
435 in rhinoceros horn based on population projection and socioeconomic models, **Conservation**  
436 **Biology**, 29(2) 545-555

437 PHILIPS, L., 1983, The economics of price discrimination, UK: Cambridge University Press, 287

438 PRINS, H, H., and OKITA-OUMA, B., 2013, Rhino Poaching: Unique Challenges, **Science**, 7(340), 1167-  
439 1168

440 RACHLOW, J, L., and BERGER, J., 1997, Conservation implications of patterns of horn regeneration in  
441 dehorned white rhinos, **Conservation Biology**, 11(1), 84-91

442 ROBERTS, A, M., GRACE GE, G., and ROBINSON, J., 1999, Dying to heal: The use of animals in  
443 traditional medicine, **The Animals Agenda Westport**, 19(3) 30-31

444 RYDER, M, L., 1962, Structure of Rhinoceros Horn, **Nature**

445 SALAFSKY, N., MARGOLUIS, R., REDFORD, K., and ROBINSON, J, G., 2002, Improving the practice of  
446 conservation: a conceptual framework and research agenda for conservation science, **Conservation**  
447 **Biology**, 16(6), 1469-1479

448 SAMHAN, J., 2017, Prince Harry named new patron of rhino conservation Botswana, **Royal Central**,  
449 19<sup>th</sup> January 2017 [[http://royalcentral.co.uk/uk/princeharry/prince-harry-named-new-patron-of-](http://royalcentral.co.uk/uk/princeharry/prince-harry-named-new-patron-of-rhino-conservation-botswana-75281)  
450 [rhino-conservation-botswana-75281](http://royalcentral.co.uk/uk/princeharry/prince-harry-named-new-patron-of-rhino-conservation-botswana-75281)]

451 SAVETHERHINO, 2017, Poaching statistics,  
452 [[https://www.savetherhino.org/rhino\\_info/poaching\\_statistics](https://www.savetherhino.org/rhino_info/poaching_statistics)]

453 SAVETHERHINO, 2017b, De-horning,  
454 [[https://www.savetherhino.org/rhino\\_info/issues\\_for\\_debate/de-horning](https://www.savetherhino.org/rhino_info/issues_for_debate/de-horning)]

455 SMITH, R, J., ROBERTS, D, L., DUFFY, R., and St JOHN, F., 2013, New rhino conservation project in  
456 south Africa to understand landowner decision-making, **Oryx**, 47(03), 323

457 STILL, J., 2003, Use of animal products in Chinese medicine: environmental impact and health  
458 hazards, **Complementary Therapies in Medicine**, 11(2), 118-122

459 TRUONG, V, D., DANG, N, V, H, and HALL, C, M., 2016, The marketplace management of illegal elixirs:  
460 illicit consumption of rhino horn, **Consumption Markets and Culture**, 19(4), 353-369

461 WALDRAM, M, S., BOND, W, J., and STOCK, W, D., 2008, Ecological engineering by a mega-grazer:  
462 white rhino impacts on a south African savannah, **Ecosystems**, 11(1), 101-112

463 WYATT, T., 2013, Wildlife Tracking: A deconstruction of the crime, the victims and the offenders, UK:  
464 Palgrave MacMillan, Basingstoke

465

466

467