

# Management strategies to curb rhino poaching: Alternative options using a cost–benefit approach

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The combination of increasing demand and high black market prices for rhino horn in Asian markets has fueled an escalation in rhino poaching since 2007, particularly in South Africa. This situation has in turn resulted in greatly increased rhino protection costs, loss in confidence by the private sector in rhinos, loss of revenue to conservation authorities and reduced rhino population growth rates. Within current CITES processes, management responses to threats posed by poaching to rhino persistence fall within a mixture of reactive responses of increased protection and law enforcement and some pro-active responses such as demand reduction tactics, along with a parallel call for opening a legal trade in horn. These rhino management strategies carry different risks and benefits in meeting several conservation objectives. An expert-based risk–benefit analysis of five different rhino management strategies was undertaken to assess their potential for delivering upon agreed rhino conservation objectives. The outcomes indicated that benefits may exceed risks for those strategies that in some or other format legally provided horn for meeting demand. Expert risk–benefit approaches are suggested to offer a rational, inclusive and consensus generating means of addressing complex issues such as rhino poaching and augmenting the information used within the CITES decision-making processes.

## Introduction

Poaching of Africa's rhinos has escalated exponentially from an average loss of 0.17 rhinos per day (a total of 62 rhinos) in 2007, to 2.04 rhinos per day (a total of 745 rhinos) in 2012.<sup>1</sup> This escalation has raised concerns amongst conservationists about the long-term survival of the species.<sup>2</sup> South Africa, with 82% (or 20 954 rhinos) of the continent's rhino population, has been most affected by poaching, losing 1805 (or 75%) of the 2387 rhino poached since 2006.<sup>3</sup> Of particular concern is the 1.75-fold ( $\pm 0.64$  s.d.;  $n=5$ ) increase in the annual rate of poaching, which accounts for 3.2% of the South African rhino population size in 2012. Although this loss is currently sustainable, it is predicted that South Africa's rhino population will start to decline by 2015–2016<sup>4,5</sup> if the increasing rate of poaching is not quickly addressed. Kenya and Zimbabwe lost 2.2% and 4.1%, respectively, of their rhino populations in 2012; Namibia was much lower amongst the four major African range states, with a loss of 0.04%.<sup>2</sup> The eight remaining minor rhino range states, which collectively conserve about 500 rhinos, had losses in 2012 ranging from 0% in Swaziland to 100% in Mozambique,<sup>3</sup> indicative that poaching is affecting the entire African continent.

The rapid rise in rhino poaching has been driven by an exponential increase in the illegal demand and black market price for rhino horn in south east Asia, especially Vietnam and China.<sup>5,6</sup> This increased demand for horn has not only come from the traditional Chinese medicine users, but has also been brought about by anecdotes of the unproven cancer reducing properties of rhino horn together with its newly found status symbol and general entrepreneurial uses, all supported by thriving regional economies with a higher disposable income than previously.<sup>2,7</sup> The inelastic relationship between the increasing demand and restricted supply influences the high black market prices for rhino horn,<sup>8</sup> making the product attractive to criminals and organised crime syndicates.<sup>7,9</sup> Increasing involvement by syndicated organised crime can have greater degrading effects on society at large.<sup>10</sup> Furthermore, it has been argued that trade bans, such as that over the sale of rhino horn,<sup>11</sup> exasperate the situation, driving up the black market prices for rhino horn even further and increasing pressure on wildlife populations.<sup>12,13</sup>

With the increasing value of rhinos, especially their horns, protection costs have soared, making rhinos a liability to state conservation authorities, private and communal landowners alike.<sup>14</sup> The private sector, which owns 24% of the South African rhino population on a further 2 million hectares of land, plays an integral role in conservation of the species<sup>15</sup> and wildlife habitat. No longer are the benefit streams from tourism, limited trophy hunting and live sales of rhinos sufficient to offset increased security costs for rhinos (especially in South Africa), and some private rhino owners are opting out of rhino conservation.<sup>1,12</sup> This situation is of major concern to rhino conservationists as it will lead to a lower carrying capacity for surplus rhinos, a reduction in the population growth, reduced essential revenue for the conservation authorities and a general devaluing of the important wildlife industry.<sup>1,16</sup>

Responses to escalating rhino poaching range from traditional increased law enforcement and protection (including conservation buffer zones) and demand reduction approaches<sup>17,18</sup> (such as targeted Asian awareness campaigns) to those advocating a regulated legal trade in horn.<sup>13,14</sup> If anything, these seemingly opposing strategies have tended to polarise the rhino debate,<sup>19</sup> with the pros and cons of alternative strategies in a logical, consensus building framework remaining unexplored. Approaches such as participatory risk–benefit analyses may facilitate consensus decisions and have been advocated as a way to evaluate various management strategies directed at curbing rhino poaching.<sup>17</sup>

The challenge is that these evaluations cannot be made using only biological information; there is a need to move beyond traditional debates and decisions<sup>11,20</sup> that have to date only considered two strategies: (1) no trade in raw rhino horn with an associated intense law enforcement campaign and (2) unrestricted trade in raw rhino horn. We report on the outcome of a workshop involving a variety of experts to collectively identify and evaluate alternative strategies, focusing on rhino horn as a commodity, and making use of a basic conceptual model

of drivers influencing demand and supply.<sup>17</sup> The aims of the exercise were to (1) achieve a consensus understanding regarding potential drivers of rhino poaching by considering common economic theories and opinions, (2) identify a suite of alternative management strategies, irrespective of present legal constraints, by collating existing proposals and adapting or proposing new ones, (3) evaluate the risks and benefits of each management strategy for rhino persistence within South Africa, Africa and Asia, as well as for other conservation values, economic values and societal expectations and (4) recommend consensus<sup>21</sup> best-practice management strategies.

## Material and methods

### Workshop participation

A total of 45 experts were invited, of whom 30 participated. The participants had expert interest and experience across a broad spectrum of fields including traditional ( $n=1$ ) and resource economics (3), law (2), enforcement and compliance (9), conservation science (11) and ethics (4). In addition, the attendees had a common interest in rhinos and were representative of various value systems associated with conservation (10), animal welfare (2), animal rights (2), national (7) and provincial government (4) and private rhino ownership (5). We provided a brief overview on rhino conservation status<sup>1</sup> as well as an introduction to the requirements for innovative thinking,<sup>17</sup> given that present approaches have apparently had limited success in curbing the incentives for rhino poaching.<sup>4</sup> To ensure that we had a wide spectrum of viewpoints represented, we asked participants to express their expectations from the workshop and categorised these into 19 categories. The authors remained independent in facilitating the process of the assessment.

### Developing understanding of poaching drivers

Following a participatory objective setting process,<sup>22</sup> participants collectively agreed on a list of rhino conservation objectives, along with their expected challenges and costs. Differential effects can only be evaluated within a common understanding of how various factors may interact and influence rhino poaching.

Participants were introduced to risk–benefit approaches for evaluating various management strategies<sup>23,24</sup> (Box 1). Traditional risk methodology<sup>23</sup> focuses on describing all events or outcomes associated with a strategy

as risks, whether these have positive or negative consequences. This approach is challenging in participatory workshop processes and discussions tend to provide clarity when participants have a reference framework of risks and benefits. Our approach thus accommodated this aspect. The group agreed to use the integrated framework approach<sup>17</sup> in understanding the complexities associated with the relationship between the supply and demand for rhino horn, and aimed to develop a common understanding of how this relationship potentially influenced the price of horn and the incentive to poach rhinos.

In order to potentially meet the agreed rhino conservation objectives, participants proposed a number of alternative management strategies. These strategies were grouped into those that primarily attempted to reduce the demand for rhino horn, affect the supply of rhino horn or both. This approach allowed strategically aligned strategies to be identified and grouped and then evaluated through a risk–benefit analysis.

### Risk–benefit analysis

Potential outcomes or developments (such as an increase in poaching or an increase in the number of populations) associated with each objective were identified by participants in a participatory manner as being either a risk or benefit in delivering on the objectives. Each outcome or development was assessed in a spreadsheet model in terms of its possible impact, likelihood of occurrence and certainty of happening, following the scoring shown in Table 1. The 30 participants collectively listed various outcomes or developments for a specific scenario and then, following a discussion, a consensus was reached and scores assigned. Impact relates to the extent of an outcome's perceived effect on the objective. Likelihood provides a scoring for the possibility that the outcome or development will occur, while the certainty provides an indication of the confidence of it actually occurring. Risks were assessed in relation to the negative outcomes, while benefits focused on the positive outcomes. Participants defined the relative importance of each objective, used in weighting components, at the end of the risk–benefit analyses of the various management strategies following the same collective discussion approach as for scoring risks and benefits. As part of the analyses, each strategy was assessed for its logistical costs (challenges) and benefits (opportunities). In addition, the relative financial resources required for or generated in delivering on a specific strategy were also estimated by the group (see Box 1 for details).

#### Box 1: Risk–benefit analyses

Different rhino conservation objectives ( $i$ ) may carry different importance ( $w_i$ ) for different stakeholders and experts. An event or outcome that occurs in association with the implementation of a specific strategy may carry risks ( $r$ ), benefits ( $b$ ) or both. Risks for event  $j$  are defined as the product of the impact or effect ( $e_{r,i,j}$ ) it will have on objective  $i$  and the likelihood ( $p_{r,i,j}$ ) that event  $j$  will actually realise.<sup>23</sup> Similarly, benefits associated with event  $j$  are defined as the product of the impact or effect ( $e_{b,i,j}$ ) it will have on objective  $i$  and the likelihood ( $p_{b,i,j}$ ) that event  $j$  will actually realise. The total consequence for objective  $i$  of an event  $j$  is scaled by the importance of objective  $i$ . For risks and benefits, that is,  $w_i e_{r,i,j}$  and  $w_i e_{b,i,j}$  respectively.

The overall consequences of the risks and benefits on several events is the average consequence of events  $j$  on objective  $i$  defined as

$$\bullet \text{ Risk} = w_i \sum_{n=1}^{n=j} \frac{e_{r,i,j} P_{r,i,j}}{n_j}$$

$$\bullet \text{ Benefit} = w_i \sum_{n=1}^{n=j} \frac{e_{b,i,j} P_{b,i,j}}{n_j}$$

The complete risk–benefit profile associated with events  $j$  influencing objective  $i$  then reduces to an estimate  $k_j$  where

$$\bullet K_j = w_i \sum_{n=1}^{n=j} \frac{e_{b,i,j} P_{b,i,j}}{n_j} - w_i \sum_{n=1}^{n=j} \frac{e_{r,i,j} P_{r,i,j}}{n_j}$$

Operational elements ( $z_a$ ), usually comprising costs and logistics, use a similar structure

$$\bullet \text{ Costs: } Z_a = w_a \sum_{n=1}^{n=j} \frac{e_{g,a,j} P_{g,a,j}}{n_j} - w_a \sum_{n=1}^{n=j} \frac{e_{l,a,j} P_{l,a,j}}{n_j} \text{ with } g \text{ referring to events that lead to gains and/or to those that lead to losses.}$$

$$\bullet \text{ Logistics: } Z_a = w_a \sum_{n=1}^{n=j} \frac{e_{o,a,j} P_{o,a,j}}{n_j} - w_a \sum_{n=1}^{n=j} \frac{e_{c,a,j} P_{c,a,j}}{n_j} \text{ with } o \text{ referring to events that provide opportunities and } c \text{ to those that lead to challenges.}$$

The complete risk–benefit–logistic–cost profile of a management strategy collapses to

$$\bullet Q_m = \frac{\sum_{n=1}^{n=k} k_j}{n_k} + \frac{\sum_{n=1}^{n=a} z_a}{n_a}$$

Strategies are prioritised so that  $Q_1 > Q_2 > Q_3 > Q_4 > \dots > Q_m$ .

**Table 1.** Scores used by participants in the risk–benefit analyses of various management strategies

| Score assigned | Impact    | Likelihood | Certainty        | Value     | Availability |
|----------------|-----------|------------|------------------|-----------|--------------|
| 1              | Very low  | Negligible | Uncertain        | Very low  | Very low     |
| 2              | Low       | Unlikely   | Some uncertainty | Low       | Low          |
| 3              | High      | Likely     | Some certainty   | High      | High         |
| 4              | Very high | Definite   | Certain          | Very high | Very high    |

## Results

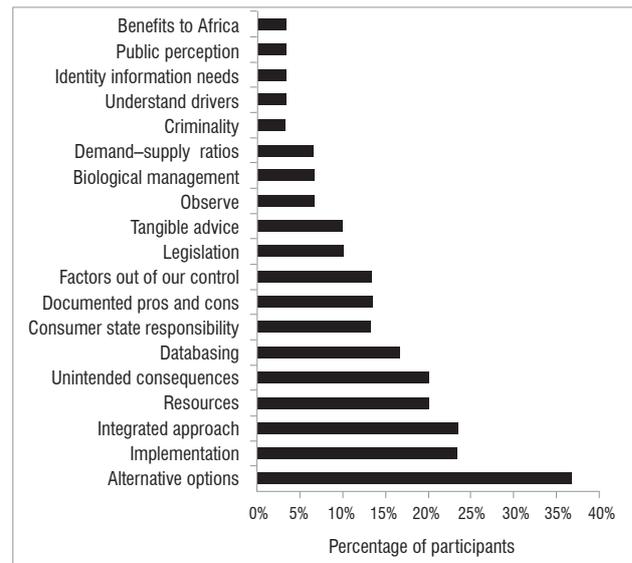
### Workshop participation and expectations

Participants ( $n=30$ ) had a broad diversity of expectations in relation to addressing current rhino management issues. Importantly, 37% of participants appreciated the need to explore alternative rhino conservation strategies, with 24% advocating the need for an integrated approach (Figure 1).

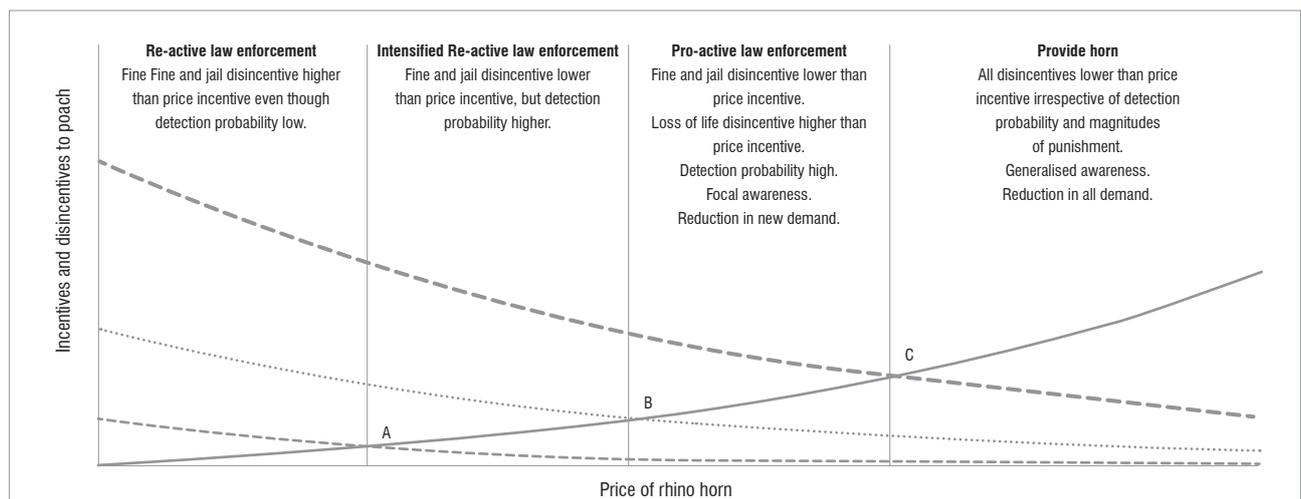
### Drivers of rhino poaching incentives

The integrated framework<sup>17</sup> and supply–demand relationships that influence the price of horn provided an understanding of the main drivers affecting the relationship between the demand and supply of rhino horn. These relationships indicated the complex nature that different management strategies may potentially have in affecting the price of horn and the incentive to poach rhinos. The central proposition of this framework was that the demand for horn is driven primarily by traditional and new uses, while the supply of horn is affected by attempts to restrict (or eliminate) or provide horn via legal means. It was assumed that if supply is increased, a reduction in price may result and the incentive to poach should decrease. However, the nature of that relationship may differ substantially depending on the specific use, the consumer country

being considered and the elasticity of the demand for horn. Participants expected that, at least in some consumer countries, an increase in the supply of rhino horn should lead to a substantial decline in the price of that commodity. Incentives to poach rhinos were also expected to increase in a non-linear positive relationship between the price of horn and the risk of detection. This risk which acts as a disinvestment to poach consists of two elements: the fear of being detected and arrested, and the magnitude of the punishment.<sup>25</sup> It was suggested that critical thresholds would exist in this relationship, which apply to increased protection, increased judicial sentences, shoot-to-kill protection, increased demand reduction strategies and provision of horn (Figure 2). When the incentives created by the increasing price of horn outweigh disincentives to poach, an escalation in poaching results and the need to change approaches arises.<sup>26</sup>



**Figure 1.** A summary of the expectations and issues that the 30 participants expressed at the workshop, some of which fell into more than one category.



**Figure 2.** Expected relationships between incentives as well as disincentives to poach and the price of rhino horn. Participants expected non-linear increases in poaching incentives (solid line) with an increase in the price of rhino horn. Disincentives to poach varied – re-active law enforcement (lower dashed line) as was the case until recently, relied on jail sentences and fines as sufficient deterrents to poach. When incentives to poach exceed re-active law enforcement disincentives (A), then intensified re-active law enforcement (dotted line) increases detection probabilities and serves as a disincentive. When price increases to such an extent that incentives to poach exceed intensified re-active law enforcement disincentives (B), authorities may impose pro-active law enforcement (upper dashed line) with high probabilities of detection and additional risks such as loss of life as sufficient deterrents to poach. Such activities can be complimented by focal awareness programmes directed at reducing demand. A significant critical threshold is reached when price is so high that the incentive to poach exceeds all disincentives (C). At this threshold, authorities are best placed to change tack completely and provide rhino horn in parallel with aggressive awareness campaigns.

### Objectives and alternative management strategies

Participants identified six objectives that should be achieved through management strategies (Table 2). Four of these objectives have strong conservation outcomes; one gives recognition to economic values associated with rhinos from the direct and indirect values attributed to both the horn and live rhino markets; and the last considers the values of stakeholders both in range as well as in consumer states. The group weighted the objectives with regard to their perceived relative importance.

**Table 2.** Objectives and their importance weighting of different management strategies

| Importance      | Objective   |
|-----------------|---|
| Essential       | Conservation of rhinos in South Africa, including their population size and range.<br>Conservation of other biodiversity components associated with the protected areas/properties rhinos occur on. |
| Most important  | Conservation of rhinos elsewhere in Africa, including their population size and range.<br>Sustained direct and indirect economic values of both African rhino species.                              |
| Important       | Conservation of rhino in Asia, including their population size and range.   |
| Some importance | Expectations of and benefits to stakeholders within range as well as consumer states.   |

A total of 17 possible management strategies for curbing rhino poaching in South Africa were identified (Table 3). These possibilities were grouped into three strategic themes that focused on reducing supply, reducing demand and increasing supply. These strategies were then further grouped into eight strategic management categories. The consumer response category focused on increased diplomatic pressure on the consumer states as well as increased domestic trade restrictions, while the international awareness category addressed demand reduction.

**Table 3.** Categorisation of the 17 proposed alternative detailed rhino management strategies

| Strategic theme | Strategic management category | Detailed management strategy  |
|-----------------|-------------------------------|---|
| Reduce demand   | Consumer state responses      | Diplomatic pressure and legal actions<br>Strict domestic measures in consumer states  |
|                 | International awareness       | <b>Consumer state public awareness programmes</b>   |
| Reduce supply   | Indirect disincentives        | Creating and providing rhino horn substitutes<br>Breeding or surgical creation of hornless rhinos<br>Dehorning rhinos   |
|                 | Direct disincentives          | <b>Law enforcement and compliance – status quo</b><br>Destroy all stockpiles<br>No hunting and no national trade in live rhino and rhino horn                             |
| Increase supply | Horn stock donation           | Buy all horn stock and donate to consumer states  |
|                 | Provision of live rhinos      | Trade in live animals to establish out of range populations for horn harvesting<br><b>Lease of live animals to establish out of range populations for horn harvesting</b> |
|                 | Restricted trade              | <b>Trade in horn nationally</b><br>Medicinal horns traded nationally in powdered or whole form<br>Medicinal horns traded internationally in powdered or whole form        |
|                 | Unrestricted trade of horn    | <b>Trade in horn internationally from stockpiles and natural mortality</b><br><b>Trade in horn internationally from harvested horn</b>                                    |

Strategies evaluated in the cost–benefit analysis are shown in bold.

A total of six suggested detailed strategies were more focused on restricting the supply of horn to the illegal market. Half of these were more directed at providing for disincentives to criminal involvement in the trade in horn, such as through enhanced law enforcement, while the remaining three – such as the creation of rhino horn alternatives or dehorning animals – were considered indirect approaches aimed at restricting the supply of horn.

Eight detailed strategies were focused on increasing the supply of rhino horn to the market, through direct donations, provision of live rhinos, and restricted or unrestricted trade in rhino horn.

A total of five different detailed strategies from across the spectrum of management categories were selected for the analysis. Each strategy, along with the mechanism through which it was thought to work, is described below.

- 1. Direct disincentives to poaching through increased local law enforcement (the status quo):** This strategy is maintaining the current status quo in which the ban on the trade in horn nationally and internationally is retained and for which there are slightly improved law enforcement and anti-poaching efforts and associated intelligence gathering in the range states. The primary focus of this strategy is to curb poaching through disrupting criminal syndicates and providing direct disincentives for poaching. This approach is the basis for numerous current fundraising initiatives. The strategy is suggested to reduce the availability of rhino horn through local law enforcement and intense anti-poaching programmes. It aims to discourage poaching by increasing the risk of being arrested and prosecuted. With a restriction on supply of horn, but no concomitant reduction in demand in the consumer states, the price of rhino horn is expected to rise, increasing further poaching pressure.
- 2. Increased international awareness (demand reduction):** This strategy is the same as the above status quo situation, but includes an intensification of awareness and government law enforcement interventions in consumer states to reduce the use of rhino horn. This approach also targets conduit states through diplomatic awareness. Substitution with alternative products and increased enforcement in consumer states may form part of this approach,

but were considered to be relatively minor components. This strategy was suggested to reduce the demand for rhino horn, and along with a shrinkage in supply, there would be a reduction in the price of horn and a subsequent reduction in the incentive to poach. There was some uncertainty as to whether differential rates in the shrinkage of supply and reduction in demand may affect the price of horn and the incentive to poach. This strategy is currently being widely advocated.

3. **Provision of live rhinos to consumer states to breed for horn:** This strategy involves providing live rhinos to consumer states through international trade. Harvesting of horns from these ex-situ rhino populations would be permitted. It also includes the status quo scenario plus a ban on both domestic and international trade in rhino horn in range states. It envisages the trade being compliant with current CITES (the Convention on International Trade in Endangered Species of Wild Fauna and Flora) restrictions, but with consumer states allowing domestic trade in horn products derived from local harvesting. The strategy proposed here assumes a leasing agreement for the rhinos (i.e. involves a financial return to the lessor) and benefit sharing (50:50) between range and consumer states. To avoid genetic contamination of South African rhino populations, no progeny would be allowed to return to South Africa. Effectively this strategy provides for parts of the rhino horn market. With a greater reliable supply of horn to the market, the price is expected to decline, thus reducing the incentive to poach. The associated harvesting of horn may not be able to provide for certain markets because of cultural preference of horn originating from free-ranging rhino, thereby limiting impact on demand–supply dynamics. This strategy also carries considerable uncertainty regarding the possible effects of achieving the conservation objectives.
4. **Restricted trade in rhino horn:** In this scenario the national moratorium on the trade in horn in South Africa would be lifted, allowing only for domestic trade. This strategy is expected to lead to the stockpiling of rhino horn. Participants essentially considered

this strategy as a stepping stone to international trade. The strategy envisages a well-regulated and controlled internal trade with appropriate database management and reporting being in place. Effectively this strategy provides for parts of the rhino horn market, albeit only locally in South Africa. Sales and expansion of the rhino range in South Africa were expected. This strategy is anticipated to have limited positive impact on the global demand–supply dynamics, and thus limited influence on the price of rhino horn and hence incentives to reduce poaching.

5. **Unrestricted trade in rhino horn:** This strategy allows for the international trade in rhino horn. The approach includes the situation described in the status quo strategy above, plus a well-regulated domestic trade in rhino horn within South Africa along with the required law enforcement and compliance mechanisms. Harvested horn from dehorned rhino plus stockpiled horn from natural deaths in both private and state populations would be allowed to be sold. The approach requires a legitimate trading partner, as well as compliance with CITES and international systems for tracking and monitoring of the rhino horn to reduce laundering of illegally obtained horn. A central selling organisation was advocated as the trading mechanism based on free market principles with certified buyers. Effectively this strategy provides for all components of the rhino horn market. It is envisaged that the demand–supply ratio should lead to a drop in the price of horn and a reduction in the incentives for poaching. There was uncertainty around the reduction in the price of horn possibly stimulating further demand from a growing, wealthier Asian middle class, thus maintaining demand and poaching incentives.

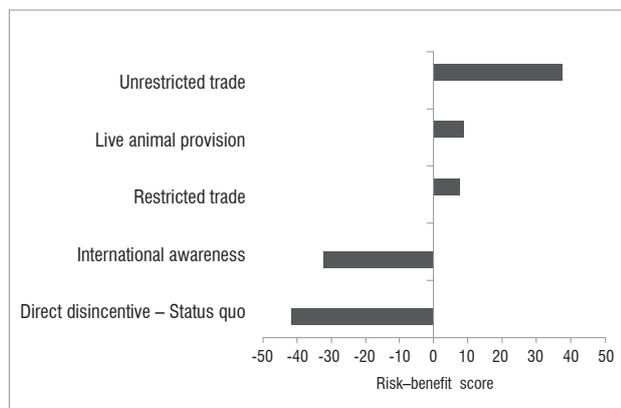
#### Risk–benefit analyses

The potential mechanisms by which the six conservation objectives are met and, in turn, affect the demand and supply of rhino horn to the market for each of the five management strategies are described in Table 4. The descriptions include each strategy’s logistical challenges and opportunities, and relative financial costs and revenue generation

**Table 4.** Summary of the risks and benefits associated with five management strategies to curb rhino poaching in South Africa

| Strategy   | Detailed risk–benefit analysis   |
|--|--|
| Direct disincentives (status quo)                              | Overall, risks were dominated by an expected general degradation of all conservation values with some measure of certainty. Negative consequences for economic values were highlighted, but participants were relatively uncertain about their impacts and the likelihood of them materialising. The strategy, however, carries some certainty regarding risks to the public perception and conservation reputation, including some costly logistical challenges. Overall, risks substantially exceeded benefits (Figure 3).   |
| International awareness (demand reduction)                     | It was acknowledged with some uncertainty that declines in poaching rates and enhanced conservation effects may result from this strategy. Degradation of conservation values were thought to be more likely, but also with considerable uncertainty. There was also some uncertainty about what the consequences might be for the economic value of rhinos. This strategy carried some logistical challenges with considerable costs, but benefits to South Africa’s reputation were anticipated. Overall, the strategy carried more risks than benefits (Figure 3).  |
| Provision of live animals to consumer states to breed for horn | Direct poaching effects on rhinos may diminish, but indirect effects were identified as having potentially high negative impacts on the conservation values of rhinos in South Africa. There was general uncertainty about other conservation consequences, although some were perceived to be beneficial. The effect on the value of live rhinos was thought to be high in the short term, and to diminish over time. It was anticipated, although with some uncertainty, that there may be risks associated with animal welfare, ethics and South Africa’s conservation reputation, but that benefits would more than likely accrue from consumer states being appreciative of the recognition of their traditional values. A large number of logistical challenges were envisaged. It was anticipated that revenue could be generated, creating further opportunities. This option carried more perceived benefits than risks (Figure 3). |
| Restricted trade in horn                                       | Several consequences associated with horn stockpiling were identified. It was imagined that rhino owners may want to have the option to sell their rhino horn stockpiles, because at present holding rhino horn is a security risk. It was envisaged that this management option would open the possibility to locally perfect the trading mechanism with its checks and balances for later roll-out to the international market. Generally the risk to conservation objectives remained, with much uncertainty and additional expectations of high logistical challenges associated with innovative criminal activities and stockpile management. Some opportunities associated with a number of anticipated conservation incentives were noted, in addition to the increased economic value of live rhinos through hunting opportunities. Overall this approach carried nearly equal risks and benefits (Figure 3).                        |
| Unrestricted trade in rhino horn                               | Because of an anticipated reduction in poaching incentives, several benefits were identified for conservation and economic value objectives. These assessments, however, only carried some certainty. Enhancement of South Africa’s conservation reputation was anticipated, even though there were some risks associated with South Africa’s support of medicinal uses that may have limited value. The strategy was perceived to carry considerable challenges associated with establishing a legitimate trading partner, regulated trade procedures, as well as high costs associated with lobbying internationally to achieve CITES compliance, although these costs were anticipated to be offset by increased financial gains. Generally this strategy had substantially more benefits than risks (Figure 3).  |

potentials. A comparison of the five alternative management strategies (Figure 3) suggests that rhino poaching may be best addressed by management strategies that generate benefits at least equal to or higher than the associated risks involved in the supply of horn to the market. Overall, unrestricted international trade in rhino horn produced the best risk–benefit score, while the worst case scenario, in which risks substantially exceeded benefits, was provided by the status quo strategy.



**Figure 3.** Relative comparison of risks and benefits for five evaluated management strategies to curb rhino poaching in South Africa. Negative scores are indicative of risks outweighing benefits, while positive scores indicate strategies in which benefits outweigh risks.

## Discussion

Despite substantial efforts to curb rhino poaching, rhinos continue to be poached for their highly priced horns.<sup>1</sup> Alternative strategies thus need to be seriously considered to ensure the persistence of Africa's rhinos. We made use of an expert-based risk–benefit analysis in an attempt to tease out the cost–benefit relationships influenced by the main drivers of rhino poaching for horn in this complicated and complex international resource use industry. Moral complexity and factual uncertainty often derail such debates.<sup>27</sup>

A large part of factual uncertainty stems from opinions, expectations and assumptions not robustly tested by appropriate information. Curbing rhino poaching epitomises such challenges. In the absence of factual certainty, several approaches are used, most notably that of adaptive management.<sup>28</sup> In such instances, adaptive management proceeds with some opinion about how a system may be working and implements responses followed by processes allowing learning by doing. The opinions that workshop participants had about responses to curb rhino poaching were translated into predictions through discussions on what the outcomes might be. These discussions reflected many management strategies or options to meet desired outcomes,<sup>29</sup> as noted in the wide variety of expectations and options discussed by the workshop participants. The risk–benefit approach thus benefitted from this diversity of opinions towards the agreed central outcome of seeking solutions to curb the escalation in rhino poaching and the need for innovative thinking.

Although a potentially large number of management strategies were proposed, the five consolidated strategies that were assessed provided a diversity of approaches to achieving the agreed objectives. In addition, the risk–benefit approach had the value of enticing expert participants to collectively debate and decide upon various issues associated with each strategy,<sup>30</sup> thus drawing away from the limited polarised trade/no trade paradigm that has tended to dominate most previous deliberations.<sup>14,19</sup> Our results suggest that there were more benefits than risks associated with strategies that increase the supply of horn, but this outcome may be constrained by the limited expertise within the workshop on Asian culture and markets.

CITES processes are cumbersome at best<sup>7</sup> and often ignore ecological realities.<sup>31</sup> Although the provisions of CITES<sup>7</sup> are invaluable for achieving

sustainable international trade, they are vulnerable to lobbying tactics that distract focus from the conservation and sustainable use agenda. Given the international scope of the illegal trade in rhino horn,<sup>5,6</sup> and the dichotomy of conservation philosophies, it would be of value to repeat the risk–benefit approach used in the present study with other range states, and also with the Asian consumer states. The latter would be important in elucidating the understanding of local Asian trade in rhino horn and the international implications of the illegal trade. The importance of the risk–benefit approach would be its non-confrontational and consensus building nature that allows for a common understanding of the details and socio-ecological-economic linkages.<sup>32</sup> We envisage that such an approach could draw consumer states in as potential partners for finding a solution to the rhino poaching problem. Risk–benefit approaches may thus provide a useful basis for a participatory consultation process to inform CITES processes and decisions.

As many of the decisions dealing with the cause of rhino poaching rely upon an understanding of the economic drivers and processes, any risk–benefit analysis involving all range and consumer states must have a well-informed resource/economics presence in addition to other knowledge areas such as conservation, private rhino ownership, animal ethics, animal welfare, animal rights, law enforcement, Chinese traditional medicinal experts, market analysts, jurisprudence and diplomatic representation. It is clear from the South African workshop that the broader the base of expertise, the more informed the outcome.

Disregarding these shortcomings, the conceptual framework<sup>17</sup> adopted by participants highlighted three important realisations. Firstly, curbing rhino poaching requires a variety of responses that may have different levels of effectiveness depending on the incentive/disincentive interaction at a specific time. Rhino poaching is an illegal activity driven by the complex interaction between risks and rewards of committing a crime.<sup>25</sup> Incentives driven by the international price of rhino horn are relatively simple and tend to increase exponentially as the price of the commodity increases. However, the impacts of disincentives remain more elusive given their broad scope and the variability in their effectiveness at different prices of the commodity. A key challenge arises when the price of rhino horn reaches such high values that incentives outweigh all disincentives. Reactive responses such as enhanced law enforcement and dehorning focus on the symptoms of the problem and will be ineffective, as evidenced by the rhino poaching surge observed during recent years in South Africa.<sup>1</sup> In essence, more of the same law enforcement will be in vain. Conservation authorities must be adaptive and switch to more wide reaching solutions that focus on the cause of the problem, such as the demand for horn. Doing so does not mean that basic law enforcement and protection should be discarded.

Secondly, not all tools and strategies are available to conservationists to address the rhino poaching problem, which provides conservation authorities with particular challenges. The provision of rhino horn through international trade is not feasible in the foreseeable future given lengthy CITES processes.<sup>7</sup> An alternative response focusing on the cause of the problem is to consider strategies of providing horn that are not trade related,<sup>4</sup> and thus not constrained by CITES processes. The possible positive effects of this response would be negated given the ban on domestic trade in rhino horn in consumer states.<sup>33</sup>

The third realisation is that if rhino range states are to be effective in conserving their rhinos, they need to be decisive and flexible in changing their management approaches. In the short term, authorities are forced to be reactive and focus on the symptoms of rhino poaching in their management responses, which are progressively more demanding, expensive, technically advanced and complex, in an attempt to increase the risk to would-be poachers, a known significant deterrent for crime<sup>25</sup> below certain threshold prices for the commodity. The opportunity costs of redirecting such resources away from other conservation activities can be detrimental to other conservation outcomes. Collapsing (or undermining) organised crime links is part of this complexity, while focal awareness campaigns, particularly in Vietnam where new demands have reportedly surfaced,<sup>5</sup> can disrupt the exponential cascade of continual increases in rhino horn retail prices. Such disruption of the horn supply chains could provide important respite and allow time to fully explore

other broad-based systemic strategies and ways to provide rhino horn when price incentives outweigh all disincentives.

Being mindful that our results are dependent upon subjective assessments and understanding, as well as the persuasive powers of participants, the assessment is only indicative; yet it provides important insights to inform an adaptive management approach to addressing this subject. An important product of this process was the identification of potential information gaps, especially those with potentially major impacts for which there were a high degree of uncertainty. Some of these included the need to: (1) identify the potential opportunity costs to conservation associated with an increase in the supply and/or demand reduction strategies; (2) understand the potential threats and the magnitude of these threats associated with implementing different rhino management strategies on South Africa's reputation; (3) understand the animal rights and welfare issues with regard to live animal trade strategies; (4) understand the international and national legal implications of the different strategies; (5) assess the potential impact that increased supply and demand reduction may have on the potential to increase demand in consumer states; (6) assess the potential impact of local rhino management policies and actions on regional and continental rhino populations; and (7) understand detailed market linkages and drivers of rhino horn consumption in consumer states.

## Conclusions

Curbing rhino poaching requires integrated and flexible approaches. A restriction in the availability of strategies constrains authorities to respond effectively to the underlying causes of rhino poaching. Conservation authorities are thus forced to engage in progressively more aggressive and costly law enforcement activities to the detriment of other conservation values. Risks and costs of the present status quo management strategy substantially outweighed any benefits and any additional measures to enhance this strategy should be approached with caution. Even the simultaneous application of demand reduction strategies may not reduce the incentive enough to reduce the threat of poaching. South African conservation authorities will remain compromised if short-term pro-active law enforcement activities fail to disrupt organised crime syndicates to reduce poaching and if alternative management options to supply rhino horn within CITES processes do not become readily available.

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## Authors' contributions

S.M.F. was the project leader; S.M.F., M.H.K and M.P. were responsible for workshop design and facilitation; S.M.F. wrote the manuscript and M.H.K and M.P. provided conceptual contributions and manuscript revisions.

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