

## Legal Trade of Africa's Rhino Horns

Duan Biggs,<sup>1\*</sup> Franck Courchamp,<sup>2</sup> Rowan Martin,<sup>3</sup> Hugh P. Possingham<sup>1</sup>

**A**frica's western black rhino *Diceros bicornis longipes* was declared extinct by the International Union for the Conservation of Nature (IUCN) in 2011. Africa's other rhino populations are also under siege. South Africa is home to more than 90% of the world's 20,000 white rhino *Ceratotherium simum*, and 40% (more than 80% together with its neighbor Namibia), of the 5000 remaining black rhino (1–3). Yet, poaching in South Africa has, on average, more than doubled each year over the past 5 years (see the chart). If poaching continues to accelerate, Africa's remaining rhino populations may become extinct in the wild within 20 years (4, 5).

Because of the CITES (Convention on the Trade of Endangered Species) ban on the trade of rhino horn, in place since 1977, demand can only be met through the illegal market, which primarily relies on the killing of rhinos by poachers for their horns (6). The ban is failing because it artificially restricts supply in the face of persistent and growing demand (4, 7). The only remaining option is a carefully regulated legal trade based on the humane and renewable harvesting of horn from live white rhinos. Provincial conservation agencies in South Africa and southern African rhino management groups have asked the South African government to put forward a proposal for regulated international trade in rhino horn at the 16th CITES Conference of the Parties (COP-16), held 3 to 14 March 2013.

### Why the Trade Ban Has Failed

Skyrocketing poaching levels are driven by tremendous growth in the retail price of rhino horn, from around \$4,700 per kilogram in 1993 (8) to around \$65,000 per kilogram in 2012 (9). Rhino horn is now worth more, per unit weight, than gold, dia-

monds, or cocaine. Robberies of horns from museum specimens across Europe have taken place (10). Even dehorning rhinos to reduce the incentive to poach has proven ineffective without the provision of additional security, because of the value of the remaining horn stubs (11).

Rhino horn is used for dagger handles in Yemen and has been used in Chinese traditional medicine for millennia as a presumed cure for a wide range of ailments (10). Rapid economic growth in east and southeast Asia is assumed to be the primary factor driving the increased demand for horn (12). The tremendous financial rewards have led poachers to use increasingly sophisticated technologies, including helicopters and immobilization darts. The protection of rhinos has therefore become increasingly expensive not only in financial terms but in human lives (13). The increased militarization of rhino protection

**A trade ban limits supply, therefore raising prices and driving black market poaching.**

Stronger enforcement efforts will be further hampered by the cooption of corruptible government officials by crime syndicates in a very lucrative illegal trade (17, 19). Furthermore, as wildlife products, such as rhino horn, become rarer, their prices soar, which pushes them ever further into an economic supply-and-demand extinction vortex (10, 17, 20).

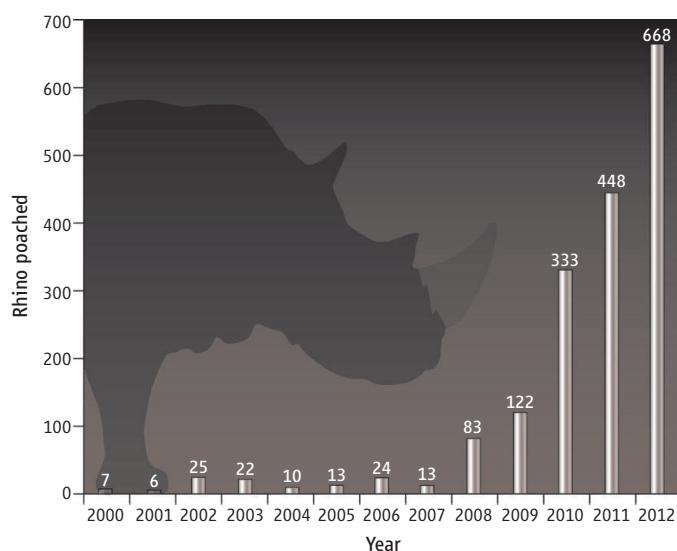
### Humane, Renewable Harvest and Legal Trade

Rhino horn is composed entirely of keratin and regrows when cut. Sedating a rhino to shave its horn can be done for as little as \$20. The annual horn production of one white rhino averages 0.9 kg per year (11). The current speculative estimates of the demand for horn based on the illegal supply (21) could therefore be met by the 5000 white rhinos on private conservation land in South Africa alone. The natural death rate of rhinos of 2.6% would also provide hundreds of horns annually. The

income generated for conservation through a legal trade in rhino horn, accounting for the costs of dehorning and management, is substantial (4). In addition, with current technology, the risks to rhinos from dehorning are minimal, and there is limited evidence of significant behavioral change following dehorning (11). A legal trade could simultaneously supply horns, fund rhino protection, and provide an incentive for their sustainable use and long-term survival. The trade in crocodile skin is an example of how a legal market has reduced poaching pressure on wild populations (22).

Evidence from studies of other wildlife products [e.g., (23–28)] suggests that a legal trade can reduce the incentive for poaching if: (i) regulators can prevent the laundering of a threatening level of illegal supply under the cover of a legal trade; (ii) the legal supply can deliver the product (horn) more easily, reliably, and cost-effectively than the illegal trade; (iii) the demand does not escalate to dangerous levels as the stigma associated with the illegality of the product is removed; and (iv) legally harvested horns from live animals can substitute for horns obtained from wild, poached animals.

A highly regulated legal trade based on the renewable cropping of horns from rhinos is



Annual rhino poaching in South Africa since 2000. Data from (2, 3).

has resulted in a reallocation of conservation resources and is adversely affecting other conservation actions (14, 15).

Moreover, higher levels of militarized enforcement of a trade ban with harsher penalties may only serve to drive up prices further because supply is restricted in the face of inelastic and growing demand (4). This will create more profitable opportunities for crime syndicates and increase the incentives for poachers, as has been demonstrated in attempts to ban or control alcohol, illicit drugs, and other wildlife products (16–18).

<sup>1</sup>Australian Research Council Centre of Excellence for Environmental Decisions, Centre for Biodiversity and Conservation Science, University of Queensland, Brisbane, Queensland 4072, Australia.<sup>2</sup>Ecologie, Systématique et Evolution, Université Paris-Sud, UMR CNRS 8079, Orsay, France.<sup>3</sup>Independent Consultant, Harare, 00263, Zimbabwe.

\*Author for correspondence. E-mail: ancientantwren@gmail.com

likely to succeed if these conditions are met (7, 21, 23, 29). First, the technology exists to track the legality of individual horns through the selling chain to the end consumer to minimize laundering and the illegal trade (4). Each legal rhino horn traded can carry a small traceable transponder and have a recorded DNA signature (for less than \$200 per horn), which remains identifiable through the market chain to the buyer. (4). Second, accounting for land, management, and horn-harvesting costs, the cost-effectiveness, reduced risk, and lower transaction costs associated with a legal trade are likely to attract buyers away from the illegal market (4, 30). Third, an increase in demand for horn once it is legalized (23) would imply a success of the market. This demand could be met by an increase of the supply through a growing rhino population. White rhino populations increase at 8% per annum if provided with appropriate savannah habitat (31). Therefore, as a financially valuable umbrella species, an increase in land managed for white rhino will enable the conservation of accompanying biodiversity and will generate revenue for rural communities (4, 7).

### Central Selling Organization

One option for the implementation of a highly regulated trading system is through a Central Selling Organization (CSO). A CSO would negotiate and manage the selling of horns so that it is more attractive, reliable, and cost-effective for buyers to obtain the product legally than through illegal means (28). A CSO would be supported by and accountable to the white rhino range states, and the CITES COP (which includes governments of demand countries) for its performance. CITES is already in the process of evaluating a CSO for the management of ivory sales (28). It could be funded by a percentage from each horn sold and could ensure that the proceeds from rhino horn are channeled toward enforcement of the legal trade, that horn harvesting is humane and renewable, and that financial benefits are returned to landholders and communities where rhino occur.

A CSO can be structured to manage the uncertainties and risks that may emerge from a legal trade in four ways (4, 28). First, the CSO should be the only authority that can legally sell horns to registered buyers. Buyer's stockpiles should be subject to regular audits, and they should commit to processing all horn themselves. As proposed for the ivory CSO, a short and closely monitored market chain can be more effectively controlled, so as to limit the incentives for speculation and hoarding and to reduce the risk of corruption, because it will

be difficult to circumvent the controls (28). Second, at the onset of a legal market, sales of the 15 to 20 tons of stockpiled horns held in South Africa (13) could be used to attract buyers to the legal trade and away from the black market. Later sales can be used to dampen the price of horn should it escalate dangerously. Third, the CSO should work in partnership with the governments of demand countries to ensure that strong penalties are enforced for any buyers who operate outside of the legal market. Fourth, a monitoring system, funded by the CSO, is required to develop an understanding of the market for horn. This will enable the adaptive management of the CSO and the trade. There is currently limited data on the market for horn because of the trade ban, and through monitoring and studying a legal trade, an understanding of the market characteristics will emerge (4). If a legal trade in horn leads to an unexpected and dangerous upsurge in poaching, the legal trade can be restructured or closed down. With these safeguards, a carefully regulated, adaptively managed legal trade is more likely to lead to the successful conservation of Africa's rhino than the current trade ban.

Opponents of a legal trade in rhino horn argue that the bulk sales of ivory by countries in southern Africa lead to increased poaching elsewhere on the continent (32). Yet, there is no conclusive empirical evidence that supports this (28, 33). Moreover, the ivory sales take place too infrequently and unpredictably to attract buyers away from the illegal market and to reduce poaching pressure (28).

Attempts to suppress the supply of horns through the CITES trade ban are failing in Africa (7). A legal trade in rhino horn was first proposed two decades ago but rejected at COP-8 as premature on the grounds that the problem lay with insatiable demand from importing countries (33–35). Yet, education, enforcement, protection, and awareness efforts aimed at reducing the use of horn have all demonstrably failed to turn the tide of this rising demand (4, 10). Legitimizing the market for horn may be morally repugnant to some, but it is probably the only way to prevent extinction of Africa's remaining rhino, as demonstrated by the successful legal trade in crocodile skin (21). As primary custodian of Africa's rhino, the South African and Namibian governments should take leadership to enable serious consideration of a highly regulated legal trade as soon as possible.

### References and Notes

- IUCN, IUCN Red List of Threatened Species (IUCN, Gland, Switzerland, 2011).
- F. Mketeni, South Africa Department of Environmental Affairs: Rhino Poaching—Government interventions presentation, public hearing on 26 January 2012; [www.pmg.org.za/report/20120126-public-hearings-solutions-rhino-poaching-culling-old-bull-elephants-k](http://www.pmg.org.za/report/20120126-public-hearings-solutions-rhino-poaching-culling-old-bull-elephants-k).
- Department of Environmental Affairs, South Africa; [www.environment.gov.za/?q=content/rhino\\_poaching\\_statistics](http://www.environment.gov.za/?q=content/rhino_poaching_statistics).
- R. Martin, *A Legal Trade in Rhino Horn: Hobson's Choice* (Rhino Survival Trust, Johannesburg, South Africa, 2012).
- S. M. Ferreira et al., *PLoS ONE* **7**, e45989 (2012).
- N. Leader-Williams, *World Trade in Rhino Horn: A Review* (TRAFFIC International, Cambridge, 1992).
- B. Child, *S. Afr. J. Sci.* **108**, 21 (2012).
- J. Loh, K. Loh, *TRAFFIC Bull.* **14**, 55 (1994).
- L. Marshall, *Newswatch*, 11 December 2012; <http://newswatch.nationalgeographic.com/2012/12/11/record-618-south-african-rhinos-poached-for-horns-in-2012-so-far/> (2012).
- K. Nowell, *Species Trade and Conservation: Rhinoceroses: Assessment of Rhino Horn as a Traditional Medicine* (CITES Secretariat, on behalf of TRAFFIC, Geneva, 2012).
- P. A. Lindsay, A. Taylor, A study on the dehorning of African Rhinoceroses as a tool to reduce the risk of poaching (Endangered Wildlife Trust and the South African Department of Environmental Affairs, Johannesburg, South Africa, 2011).
- CITES, Conservation of and trade in African and Asian Rhinoceroses—61st meeting of the standing committee, Geneva, 15 to 19 August 2011.
- T. Milliken, J. Shaw, The South Africa–Viet Nam rhino trade nexus: A deadly combination of institutional lapses, corrupt wildlife industry professionals and Asian crime syndicates (TRAFFIC, Johannesburg, 2012).
- S. Ferreira, B. Okita-Ouma, *Pachyderm* **51**, 52 (2012).
- South African National Parks Annual Report 2011–12, [www.sanparks.org/assets/docs/general/annual-report-2012.pdf](http://www.sanparks.org/assets/docs/general/annual-report-2012.pdf).
- P. Rivalan et al., *Nature* **447**, 529 (2007).
- M. Cussen, W. Block, *Am. J. Econ. Sociol.* **59**, 525 (2000).
- B. G. Daly et al., Perspectives on dehorning and legalised trade in rhino horn as tools to combat rhino poaching (Endangered Wildlife Trust, Johannesburg, South Africa, 2011).
- R. J. Smith et al., *Nature* **426**, 67 (2003).
- F. Courchamp et al., *PLoS Biol.* **4**, e415 (2006).
- T. Milliken, R. H. Emslie, B. Talukdar, African and Asian rhinoceroses—Status, conservation and trade (CoP15 Doc. 45.1 Annex, IUCN Species Survival Commission, Gland, Switzerland, 2009).
- J. Hutton, G. Webb, in *Crocodiles: Proceedings of the 16th Working Meeting of the Crocodile Specialist Group*, IUCN—The World Conservation Union, Gland, Switzerland, and Cambridge, UK (IUCN, Gland, Switzerland, 2002), pp. 1–10.
- C. Fischer, *J. Environ. Econ. Manage.* **48**, 926 (2004).
- E. H. Bulte, R. Damania, *Conserv. Biol.* **19**, 1222 (2005).
- C. Fischer, *Rev. Environ. Econ. Policy* **4**, 103 (2010).
- R. Damania, E. H. Bulte, *Ecol. Econ.* **62**, 461 (2007).
- C. Costello et al., *Nature* **481**, 139 (2012).
- R. B. Martin, D. H. M. Cumming, G. C. Craig, S. C. Gibson, D. A. Peake, Decision-making mechanisms and necessary conditions for a future trade in African elephant ivory (SC62 Doc. 46.4, Annex, CITES, Geneva, 2012).
- G. Brown, D. Layton, in *Protecting Endangered Species in the United States: Biological Needs, Political Realities, and Economic Choices*, J. F. Shogren, J. Tschirhart, Eds. (Cambridge Univ. Press, Cambridge, 2001), pp. 32–50.
- V. Ruggiero, N. South, I. Taylor, Eds., *The New European Criminology: Crime and Social Order in Europe* (Routledge, London, 1998).
- R. B. Martin, White Rhino Conservation Strategy for Namibia: Background Study (Ministry of Environment and Tourism, Windhoek, Namibia, 2010).
- S. Wasser et al., *Science* **327**, 1331 (2010).
- R. W. Burn et al., *PLoS ONE* **6**, e24165 (2011).
- E. J. Milner-Gulland et al., *Proc. Biol. Sci.* **249**, 83 (1992).
- CITES, Eighth meeting of the COP, Kyoto, Japan, 2 to 13 March 1992, Prop. 16–18.

**Acknowledgments:** M. 't Sas-Rolfes and E. J. Milner-Gulland reviewed an earlier draft. S. Ferreira and D. Pienaar, from South African National Parks, and C. Harper and R. Loon provided valuable insights.

10.1126/science.1229998

Tackling a  
grand puzzle

1170

700 new  
neurons a day

1180



LETTERS | BOOKS | POLICY FORUM | EDUCATION FORUM | PERSPECTIVES

## LETTERS

edited by Jennifer Sills

## Rhino Poaching: Supply and Demand Uncertain

IN THEIR POLICY FORUM "LEGAL TRADE OF AFRICA'S RHINO HORNS" (1 MARCH, p. 1038), D. Biggs *et al.* point out that the trade ban on rhino horn has not been successful in reducing rhino poaching, which reached a record high of 668 in 2012. They argue that trade bans support illegal organizations, whereas a regulated legal market could reduce poaching effort and provide much-needed income for conservation. In making their case, Biggs *et al.* overlook a few important points.

Biggs *et al.* write that legal trade can only work if, among other things, "the demand does not escalate to dangerous levels as the stigma associated with the illegality of the product is removed." It is unclear whether any stigma is associated with rhino horn usage in eastern countries, but the phenomenally high price for the horn, along with rising real income and population growth in the major consumer markets, is likely to indicate rising demand.

Biggs *et al.* point out that the technology to profile rhino DNA is now affordable. In the past, illegal buyers have been unable to determine easily whether they are using real or fake products. With affordable DNA profiling, however, the supply of fake rhino horns [which is, by some accounts, extensive (*1*)] will diminish, thus further increasing demand pressure for the genuine horn.

On the supply side, there is currently insufficient evidence as to whether farmed rhinos would breed at the same rate as in the wild. An additional concern is that South Africa's white rhino population is based on a very small gene pool. After nearly being hunted to extinction in the 19th century, with only a small number of white rhinos surviving in one South African park (Hluhluwe-Umfolozi), the population grew to 840 in 1960 (*2*). These white rhinos were used to populate national and private game reserves. Intensive breeding programs would thus have to consider this potential genetic weakness.

According to the Africa Guide (*3*), the gestation period of a rhino is 15 to 16 months and the calf stays with the cow for 2 to 3 years in the case of the white rhino and 2.5 to 4 years for the black rhino. It thus would take up to 5 years for an adult rhino population to produce a generation sufficiently mature for regular harvesting of horn.

Biggs *et al.* acknowledge that there are well-resourced criminal syndicates currently engaged in illegal horn trade. However, they fail to take into account the reaction of illegal traders to the establishment of legal suppliers. The extent to which illegal organizations will retaliate is contingent on the effectiveness of auction releases in reducing horn price. If prices remain high, illegal suppliers will remain in business and vigorous turf wars are likely to emerge (*4*). It is unlikely that such criminal syndicates will respond passively; rather, they would seek to interrupt the regulated supply chain through acts of sabotage and even stronger poaching effort.



The characterization of the supply chain as a single body—the Central Selling Organization (CSO)—is oversimplified. In practice, the supply side consists of a disparate mix of public and private "providers" with different objectives and motives. Regulation and management are unlikely to be simple, as a CSO represents only one stage of the supply chain. More research is needed in terms of what such a CSO would do. For example, would it be able to provide adequate enforcement and incentives to prevent private suppliers from selling outside the legal market?

ALAN COLLINS,<sup>1,2</sup> GAVIN FRASER,<sup>1</sup>  
JEN SNOWBALL<sup>1\*</sup>

<sup>1</sup>Department of Economics and Economic History, Rhodes University, Grahamstown, 6140, South Africa. <sup>2</sup>Economics and Finance, Portsmouth Business School, University of Portsmouth, Portsmouth PO1 3DE, UK.

\*Corresponding author. E-mail: j.snowball@ru.ac.za

## References

1. T. Milliken, J. Shaw, "The South Africa–Viet Nam rhino horn trade nexus: A deadly combination of institutional lapses, corrupt wildlife industry professionals and Asian crime syndicates" (TRAFFIC, Johannesburg, South Africa, 2012).
2. M. 't Sas-Rolfes, "Saving African rhinos: A market success story" (PERC Case Studies, Bozeman, MT, 2010); <http://perc.org/sites/default/files/Saving%20African%20Rhinos%20final.pdf>.
3. The Africa Guide, Rhinoceros ([www.africaguide.com/wildlife/rhino.htm](http://www.africaguide.com/wildlife/rhino.htm)).
4. A. C. Carpenter, *Conflict Resolution Quart.* **27**, 401 (2010).

Rhino Poaching:  
Unique Challenges

IN THEIR POLICY FORUM "LEGAL TRADE OF Africa's rhino horns" (1 March, p. 1038), D. Biggs *et al.* advocate legalizing trade in rhino horn through harvesting horns of 5000 white rhinos in South Africa as the panacea to the current rhino poaching crisis. Their arguments were based on the law of supply and demand and supported by the example of crocodile farming.

The law of supply and demand only applies to commodities for which supply is independent of demand. It does not apply specifically to white rhino horn because the mar-

## Letters to the Editor

Letters (~300 words) discuss material published in *Science* in the past 3 months or matters of general interest. Letters are not acknowledged upon receipt. Whether published in full or in part, Letters are subject to editing for clarity and space. Letters submitted, published, or posted elsewhere, in print or online, will be disqualified. To submit a Letter, go to [www.submit2science.org](http://www.submit2science.org).

ket does not differentiate between horns of the five extant rhinoceros species, and therefore the supply exceeds the quantity of horns of the white rhino alone. Because the rhino horn has no medicinal properties (1, 2), drug producers can dilute it at will, making the price formation normally dictated by the law of supply and demand unpredictable. Furthermore, legal access to rhino horn risks reawakening demand in older markets, such as Taiwan, Japan, Singapore, and Yemen, where demand for rhino horn was prevalent in the 1970s and 1980s and has since decreased (3). If demand grows again in these markets, indiscriminate poaching may increase accordingly, putting look-alike black, Indian, Javan, northern white, and Sumatran rhinoceros species at even higher risk. The costs of securing horns for the proposed Central Selling Organization for legal trade might make poaching even more lucrative.

The comparison with the crocodile skin market is unjustified. Farmed crocodiles occur in millions, whereas the five rhino species number about 30,000 animals and reproduce much more slowly. Crocodile-skin trade involves processing and was established in well-regulated industries; rhino horn is used unprocessed in China and Vietnam (3, 4), known for weak control of their drugs industries. Unlike rhino horn, crocodile skin has substitutes, is not consumed, and is not believed to have medicinal or religious applications.

The Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) upheld the ban on trade in rhino horn by enacting tighter controls in March 2013 (5). We propose education, awareness, and diplomacy (5, 6) for squashing horn demands in China and Vietnam that continue to destabilize rhino conservation globally and undermine national security (7) in source countries.

**HERBERT H. T. PRINS<sup>1</sup> AND BENSON OKITA-OUMA<sup>2,\*</sup>**

<sup>1</sup>Resource Ecology Group, Wageningen University, Droevedaalsesteeg 3a, 6708 PB Wageningen, Netherlands.

<sup>2</sup>Kenya Wildlife Service, P.O. Box 40241-00100, Nairobi, Kenya.

\*Author for correspondence. E-mail: bokita@kws.go.ke

#### References

- R. Sham loul, *J. Sexual Med.* **7**, 39 (2009).
- H. P. Laburn, D. Mitchell, *J. Basic Clin. Physiol. Pharmacol.* **8**, 1 (2011).
- T. Milliken, J. Shaw, "The South Africa-Viet Nam rhino horn trade nexus: A deadly combination of institutional lapses, corrupt wildlife industry professionals and Asian crime syndicates" (TRAFFIC, Johannesburg, South Africa, 2012).
- D. Graham-Rowe, *Nature* **480**, S101 (2011).
- CITES, "Rhinoceroses: Draft decisions of the Conferences of the Parties" (16th meeting of the Conference of the Parties, Bangkok, Thailand, 2013); [www.cites.org/common/cop/16/com/E-CoP16-Com-II-24.pdf](http://www.cites.org/common/cop/16/com/E-CoP16-Com-II-24.pdf).
- S. M. Ferreira, B. Okita-Ouma, *Pachyderm* **51**, 52 (2012).
- J. Ayling, *J. Int. Wildlife Law Pol.* **16**, 57 (2013).

## Rhino Poaching: Apply Conservation Psychology

THERE IS NO DOUBT THAT THE ILLEGAL TRADE in rhino horns is a lucrative industry and is contributing to their extinction in the wild ("Legal trade of Africa's rhino horns," D. Biggs *et al.*, Policy Forum, 1 March, p. 1038). Conservation psychology can play a role in preventing people from consuming rhino horn (1). Psychological principles of persuasion, attitude, and behavior change have been used effectively for many decades, but they have been largely ignored or underutilized within biodiversity conservation (2).

Investigation of consumer behavior must not be restricted to economic theory of market and individual demands, but rather should recognize human psychology in all its complexity. First, we must understand rhino horn consumption patterns in east and Southeast Asia, and possibly elsewhere, given that rhino horn is used for different purposes. Exploring the "dark side" of rhino horn consumption is necessary (consumption of illegal products may be considered "cool"). Global and country-specific public marketing campaigns can

raise awareness about the negative impacts of illegal (or perhaps one day, legal) trade in rhino horns and debunk the myth of their healing properties. The most effective communicators about rhino conservation may be children, naturalists, specialist tour guides, field assistants, trackers, religious leaders, or even ex-poachers or ex-hunters. Saving rhinos is the responsibility of everyone, and effective conservation is based on moral values as well as economic ones.

**CARLA A. LITCHFIELD**

School of Psychology, Social Work, and Social Policy, University of South Australia, Magill, Adelaide, SA 5172, Australia. E-mail: carla.litchfield@unisa.edu.au

#### References

- S. D. Clayton, *The Oxford Handbook of Environmental and Conservation Psychology* (Oxford Univ. Press, Oxford, 2012).
- S. K. Jacobson, *Communication Skills for Conservation Professionals* (Island Press, Washington, DC, ed. 2, 2009).

## Response

COLLINS *ET AL.* AGREE WITH OUR OBSERVATION that the trade ban has failed and that a legal trade in Africa's rhino horn will be an important contributor to tackling the current poaching crisis. A skillfully regulated legal trade, in which horn is harvested renewably from live animals, will offer financial incentives for the conservation of rhinos and deliver benefits to local communities. Moreover, we concur with Collins *et al.* that the institutional and market arrangements for the management for a legal trade require in-depth discussion and evaluation. This deliberation is particularly important as the South African government has indicated that it is seriously exploring this contentious issue in the build-up to the next CITES Conference of Parties in 2016 (1, 2).

We acknowledged the uncertainties inherent in estimating demand under a trade ban and in the functioning of a legal trade. We discussed how risks can be minimized and explained that the trade must be monitored closely and managed adaptively, with possible restructuring required over time. Under a well-enforced legal trade, the demand for horn more broadly will be met in a sustainable way. In addition, more resources should be available for stronger enforcement against illegal trade in horn of all rhino species. As we wrote in our Policy Forum, technology exists to track horns from the source through the market chain to the buyer (3). The presence of fake horn, which appears to originate in Asia (4), is unlikely to have an impact on a well-regulated and enforced legal trade, nor on the illegal killing of rhinos in Africa.

Collins *et al.* raise the critical issue of the structure of a legal trade. A Central

## CORRECTIONS AND CLARIFICATIONS

**New Focus:** "Hubs aim to reinvent DOE research culture" by A. Cho (24 May, p. 914). The caption for the photograph on page 918 incorrectly identifies the leaders of the five Department of Energy–funded hubs. They are, from left to right, Douglas Kothe of CASL, Nathan Lewis of JCAP, Henry Foley of EEB, George Crabtree of JCESR, and Alexander King of CMI. The HTML and PDF versions online have been corrected.

**Reports:** "A reconciled estimate of glacier contributions to sea level rise: 2003 to 2009" by A. S. Gardner (17 May, p. 857). In the last paragraph of the text, the first sentence should have included "( $2.50 \pm 0.54 \text{ mm year}^{-1}$ )" after the phrase "the observed sea-level rise." The last sentence of the text should read as follows (total numbers have been changed): "To avoid double counting, we subtracted our estimates for peripheral glacier mass loss from this total to obtain a total ice-sheet mass budget of  $-290 \pm 50 \text{ Gt year}^{-1}$  (11) and a total land ice (all glaciers + ice sheets) mass budget of  $-549 \pm 57 \text{ Gt year}^{-1}$ , amounting to a sea-level rise of  $1.51 \pm 0.16 \text{ mm of SLE year}^{-1}$  which is  $61 \pm 19\%$  of the total global sea-level rise (11)." The HTML and PDF versions online have been corrected.

**Editorial:** "Improving education standards" by J. Coffey and B. Alberts (1 February, p. 489). The doi was incorrect. It is 10.1126/science.1235590. The HTML and PDF versions online have been corrected.

Selling Organization (CSO) is one option for institutionalizing a legal trade; the costs and benefits of alternative structures need to be evaluated. It is critical that the governments of the main demand countries, including Vietnam and China, support and actively police the legal trade. In particular, Vietnam has been criticized for its lack of enforcement of the current trade ban (5). The strong actions by China and Vietnam against the illegal drug trade (6) suggest that if these governments actively support a legal trade in horn, they may be capable of enforcing compliance. The inception of a legal trade would imply international acknowledgment and respect for the long history of use of rhino horn in their societies. This may be an important factor in gaining their active participation and cooperation in designing a workable market structure at the outset. Some of the potential risks can be informed by research and scientific input; others, such as managing possible turf wars with illegal horn traders, require input from security experts and the use of tools such as scenario analyses (7, 8).

Prins and Okita-Ouma question our application of the law of supply and demand.

Basic economics dictates that the price of a product continually changes and is determined by the interaction of supply and demand, in addition to factors such as regulation (9). Our comparison with the crocodile trade was to show how a legal trade can usurp an illegal trade by enabling a more profitable, safer, and easier way to supply the market (10). Prins and Okita-Ouma claim we should try to reduce demand and crush the illegal markets. Litchfield argues that it is possible to convince people to stop consuming horn. However, the current poaching crisis affirms the persistent failure of these strategies (11). Evidence and logical argument suggest that Africa's rhinos are more likely to be conserved through instituting a skillfully regulated and enforced legal trade.

DUAN BIGGS,<sup>1\*</sup> FRANCK COURCHAMP<sup>2</sup>,  
ROWAN MARTIN,<sup>3</sup> HUGH P. POSSINGHAM<sup>1</sup>

<sup>1</sup>Australian Research Council Centre of Excellence for Environmental Decisions, Centre for Biodiversity and Conservation Science, University of Queensland, Brisbane, QLD 4072, Australia. <sup>2</sup>Ecologie, Systematique et Evolution, Université Paris-Sud, UMR CNRS 8079, Orsay, France. <sup>3</sup>Independent Consultant, Harare, 00263, Zimbabwe.

\*Author for correspondence. E-mail: ancientantwren@gmail.com

## References

- J. Rademeyer, "Environmental Affairs Minister Edna Molewa throws her weight behind controversial calls for the legalisation of trade in rhino horn," *Mail & Guardian* (22 March 2013).
- S. Blaine, "CITES meeting is SA's next step in setting up rhino horn trade," *Business Day* (29 March 2013).
- R. Martin, *A Legal Trade In Rhino Horn: Hobson's Choice* (Rhino Survival Trust, Johannesburg, South Africa, 2012).
- K. Nowell, "Species trade and conservation. Rhinoceroses: Assessment of rhino horn as a traditional medicine" (CITES and TRAFFIC, 2012); [www.cites.org/eng/com/sc/62/E62-47-02-A.pdf](http://www.cites.org/eng/com/sc/62/E62-47-02-A.pdf).
- CITES, "Interpretation and implementation of the Convention: Species trade and conservation: Rhinoceroses. Sixteenth meeting of the Conference of the Parties, Bangkok (Thailand), 3–14 March 2013" (CITES, 2013).
- W. Schabas, "The death penalty and drug offences" (NU Galway and the International Centre on Human Rights and Drug Policy, 2010); [www.humanrightsanddrugs.org/wp-content/uploads/2010/10/Prof-Schabas-Death-Penalty-for-Drug-Offences-Oct-2010-EN.pdf](http://www.humanrightsanddrugs.org/wp-content/uploads/2010/10/Prof-Schabas-Death-Penalty-for-Drug-Offences-Oct-2010-EN.pdf).
- N. Bunnefeld, E. Hoshino, E. J. Milner-Gulland, *Trends Ecol. Evol.* **26**, 441 (2011).
- G. D. Peterson, G. S. Cumming, S. R. Carpenter, *Conserv. Biol.* **17**, 358 (2003).
- G. N. Mankwi, *Principles of Economics* (South-Western Cengage Learning, Mason, OH, 2008).
- J. Hutton, G. Webb, in *Crocodiles: Proceedings of the 16th Working Meeting of the Crocodile Specialist Group, IUCN—The World Conservation Union, Gland, Switzerland and Cambridge UK* (IUCN, Gland, Switzerland, 2002), pp. 1–10.
- K. Conrad, *Trop. Conserv. Sci.* **5**, 245 (2012).

**Science Classic**

Digital Archives of Science 1880–1996

Fully integrated with Science Online (1997–Current Issue)

Recommend *Science Classic* to your institution's library.  
[ScienceOnline.org/recommend](http://ScienceOnline.org/recommend)

Science  
**Classic**  
AAAS

[ScienceClassic.org](http://ScienceClassic.org)

© 2012 Jupiterimages Corporation

