

INCENTIVIZING RHINOCEROS CONSERVATION AMONG PRIVATE LANDOWNERS  
IN SOUTH AFRICA

By

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A DISSERTATION PRESENTED TO THE GRADUATE SCHOOL  
OF THE UNIVERSITY OF FLORIDA IN PARTIAL FULFILLMENT  
OF THE REQUIREMENTS FOR THE DEGREE OF  
DOCTOR OF PHILOSOPHY

UNIVERSITY OF FLORIDA

2018

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To my parents

## ACKNOWLEDGMENTS

I thank my parents, brothers, and Candy for their unlimited support and patience. I also thank Dr. Elizabeth Pienaar, Dr. Damian Adams, Dr. Lyn Branch, Dr. Brian Child, Dr. Tom Frazer, and Dr. Christina Romagosa for their valuable guidance and willingness to teach me throughout this journey. I am also grateful to all of my interview and survey participants, as well as the University of Florida's School of Natural Resources and the Environment and the Dallas Safari Club Foundation for funding my research.

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Abstract of Dissertation Presented to the Graduate School  
of the University of Florida in Partial Fulfillment of the  
Requirements for the Degree of Doctor of Philosophy

INCENTIVIZING RHINOCEROS CONSERVATION AMONG PRIVATE LANDOWNERS  
IN SOUTH AFRICA

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May 2018

Chair: Elizabeth Pienaar

Major: Interdisciplinary Ecology

South Africa is home to the majority of the world's rhinoceroses and its private wildlife ranching sector currently owns approximately one third of the country's rhinoceroses, contributing significantly to rhinoceros conservation. However, escalated poaching driven by Asian demand for rhinoceros horn threatens how rhinoceroses are valued by private ranchers within the 'sustainable use' paradigm to wildlife conservation. I used a conceptual framework to explore how poaching affects private sector rhinoceros owners and how potential conservation solutions (e.g., global horn trade legalization) may affect private sector rhinoceros conservation. Based on this framework, it is clear that financial revenues are not the sole motivation for private rhinoceros owners. I used semi-structured interviews to investigate this decision-making behind private landowners' decisions to own rhinoceroses. Private rhinoceros owners are primarily motivated by the non-financial benefits associated with rhinoceros ownership (e.g., emotional attachment), although respondents noted that financial assistance, in the form of legalized horn trade, would be helpful. I employed a quantitative survey disseminated to private wildlife ranchers to measure industry support for horn trade legalization on a larger scale. Results from the survey indicated strong, broad support for horn trade legalization, and also provided insights into the characteristics and industry activities of private rhinoceros owners. On average, these

rhinoceros owners were wealthier, had larger landholdings, and generated more income from high-value game species breeding than their non-rhinoceros owning rancher counterparts. This survey also included a series of best-worst choice experiments to elicit respondents' preferences regarding various potential global horn trade market formats, including an array of market structures, payments per unit horn, and minimum land size requirements for participation in the market. Respondents preferred market structures of a central-selling organization managed by the well-known, industry organization Wildlife Ranching South Africa, or an auction style market. They also preferred payments per unit horn of at least R150,000 or greater, whereas minimum land size requirements were rarely significant. Results from this quantitative survey can be used to introduce policies that are likely to increase horn trade market participation and rhino conservation on private lands.

## CHAPTER 1 INTRODUCTION

Black rhinoceros (*Diceros bicornis*) and white rhinoceros (*Ceratotherium simum*) (hereafter, ‘rhinos’) populations across Africa continue to be threatened by poaching, which has been fueled by Asian demand for rhino horn (Ferreira et al., 2014b; Collins et al., 2016). Since 2008, rhino poaching has escalated yearly, where 262 rhinos were poached in 2008 and 1,342 were poached in 2015 (Rademeyer, 2016). It is believed that poaching rates began to outpace rhino births in 2014 (Hubschle, 2016), concerning conservationists over the future survival of these threatened and endangered species.

South Africa contains over 80% of the world’s rhino population (Saayman & Saayman, 2016), making the country crucial to rhino conservation efforts. The majority of rhino conservation takes place in state and provincial parks (Saayman & Saayman, 2016), but a significant portion (approximately 33%) of rhinos are conserved on private lands (Rademeyer, 2016). Private sector rhino conservation occurs within the context of private ownership of wildlife, which is referred to as the sustainable use approach to wildlife conservation (Kabiri & Child, 2014). Private landowners (wildlife ranchers) are able to generate income from wildlife on their land (e.g., through hunting, breeding/live sales, ecotourism, and game meat production), which results in direct financial incentives to engage in wildlife conservation (Kabiri & Child, 2014).

The following research aims to: 1) understand how significant poaching pressures affect rhino conservation within the private sector sustainable use paradigm and how potential solutions may be able to increase private sector rhino conservation; 2) determine the motivations for private rhino ownership and how these benefits compare against the costs of ownership; 3) measure private wildlife industry support for a legal global rhino horn trade; and determine

private wildlife ranchers' preferences regarding the format of a potential legal global rhino horn trade. By better understanding the challenges and needs of current and potential private rhino owners, we can develop policies that incentivize rhino conservation on private lands.

CHAPTER 2  
APPLYING A CONCEPTUAL FRAMEWORK TO RHINOCEROS CONSERVATION ON  
PRIVATE LANDS IN SOUTH AFRICA

**The Rhinoceros Poaching Crisis**

Black rhinoceros (*Diceros bicornis*) and white rhinoceros (*Ceratotherium simum*) (hereafter referred to as ‘rhinos’) populations in southern Africa are threatened by poaching. Poaching is motivated by international demand for rhino horns for medicinal uses and as status symbols (Hubschle, 2016). Rhino poaching first became a serious problem in the 1960s and early 1970s. A temporary lull in poaching from the mid-1990s to 2007 led many to believe the problem had been successfully contained (‘t Sas-Rolfes, 2011a). Only 120 rhinos were poached on private and public lands in South Africa between 2000 and 2007 (Hubschle, 2016). However, poaching has since escalated, driven by increased illegal demand for rhino horn (‘t Sas-Rolfes, 2011a). A total of 6102 rhinos were poached between 2008 and 2016 in South Africa, the number poached rising from 83 rhinos in 2008 (Hubschle, 2016) to 1054 rhinos in 2016 (Modise, 2017).

South Africa plays a critical role in rhino conservation. As of 2010, South Africa was home to 95% (~19 000) of Africa’s white rhino population and 40% (~1915) of its black rhino population (Emslie et al., 2016). Poaching levels in South Africa were sustainable until about 2014, when rhino deaths outpaced births (Hubschle, 2016). The decline of rhino populations has resulted in global concern for the future existence of rhinos. This concern has generally manifested itself in pressure from developed countries and conservation interest groups not to lift the international ban on rhino horn trade and to increase penalties for poaching. Unfortunately,

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opponents of alternative policies and actions to attain rhino conservation are failing to recognize the complexity of rhino conservation, and the limitations of current rhino conservation strategies. If rhinos are to be conserved, it is important to consider how the decisions and actions of key stakeholders (including private landowners and poaching syndicates) are—or may be—altered by different policies or actions. A conceptual framework helps decision-makers to think through such a problem where there is limited research, and to consider what suite of policies and programs are required to attain conservation outcomes.

### **Applying a Conceptual Framework to Rhino Conservation by Private Landowners in South Africa**

Conservation practitioners often struggle to design and implement effective conservation practices and policies because they must deal with complex systems consisting of both natural ecosystems and human societies (Salafsky et al., 2002). To improve their understanding of these coupled natural–human systems, practitioners can develop and utilize conceptual frameworks that simplify complex conservation issues to cognitively accessible problems. Conceptual frameworks provide a foundation that can be used to explore how different management actions may potentially change the system (Salafsky et al., 2002), and whether these actions may have unintended consequences.

Salafsky et al. (2002) outlined a general framework that can be applied to conservation problems. The framework consists of identifying a conservation target, determining the threats affecting the target, and incorporating actions that may be used to reach the targeted goal (Salafsky et al., 2002). Conceptual frameworks have been applied to a range of conservation challenges, including human–wildlife conflicts (Treves et al., 2009); wildlife tourism and recreation (Duffus & Dearden, 1990; Reynolds & Braithwaite, 2001); and integrating human needs with biodiversity conservation (Salafsky & Wollenberg, 2000). Our frame work for

understanding rhino conservation generally follows the framework suggested by Salafsky et al. (2002). To the best of our knowledge, this is the first application of a conceptual framework to rhino conservation or the illegal rhino horn trade.

We explicitly focus on rhino conservation by private landowners in South Africa because approximately a third of South Africa's rhinos are found on private lands (Rademeyer, 2016). Eighty percent of the land in South Africa is privately held and only 5% of land is publicly protected (Cousins et al., 2008), making private lands critical to long-term conservation and recovery of rhino populations in South Africa. Under South African law, private landowners may own the wildlife on their lands (Child et al., 2012; Taylor et al., 2015). Accordingly, South African landowners have a direct financial incentive to place land into wildlife management in order to generate wildlife-based income, including revenues from trophy hunting, meat hunting, game breeding, live animal sales, production of game byproducts, and photographic tourism. The general success of this system in attaining the conservation of game species is well documented (Reilly et al., 2003; van der Merwe et al., 2004, 2014; Bond & Cumming, 2006; Child et al., 2012; Lindsey et al., 2013). Recent estimates suggest that there are approximately 9000 private game ranches in South Africa that encompass over 17 million ha of land (Taylor et al., 2015). It is within this context that private landowners in South Africa decide to own and manage rhinos. Ferreira et al. (2014b) estimated that approximately 2 million ha of private lands are currently managed for rhinos. It should be noted that the South African model of wildlife ownership is diametrically opposite to the preservationist approach to conservation, applied in other rhino range states such as Kenya (Kabiri, 2010) and India (Mishra, 2000), which seeks to minimize consumptive use.



Our conceptual model seeks to illustrate rhino conservation and the poaching crisis as a financial problem within South Africa's wildlife ownership model. In a system where private landowners manage wildlife as a financially viable land use, species that are a significant financial liability are likely to be removed from the land, even if landowners value their existence, because the costs outweigh the benefits (financial and non-financial) of managing those species.

Our conceptual framework visually elucidates the complexity of rhino conservation on private lands in South Africa by (1) revealing how financial decision-making drives rhino conservation among private landowners; (2) assessing how poaching alters the financial viability of private rhino ownership, thus affecting how rhinos fit into the wildlife use paradigm of South Africa; and (3) showing the limitations of anti-poaching interventions. We use this framework to examine how domestic and international policy hinders private sector conservation of rhinos by both increasing poaching pressures (by raising black market horn prices through the elimination of competition from a legal market), and stripping landowners of their ability to generate alternative income from their rhinos (which is necessary to offset the costs of rhino conservation and management). We further use the framework to investigate how current and potential conservation solutions affect rhino poaching and conservation. Two important findings emerge. First, current conservation actions only influence discrete portions of the framework, and so are limited in their scope for attaining rhino conservation on private lands. Second, new policies and actions that incentivize rhino management and conservation on private lands are required.

## **A Conceptual Framework: Viewing Rhino Conservation as a Financial Cost-Benefit Analysis**

### **Target: Rhino Conservation**

Our conceptual framework begins with the fundamental target of rhino conservation through private ownership (Fig. 2-1). We simplify the decision to own rhinos to a financial cost-benefit analysis (see Tietenberg & Lewis, 2009), based on the notion that ownership is desirable if the benefits outweigh the costs. Although we recognize that there are non-financial costs (e.g. safety concerns for family and employees) and benefits (e.g. passion for the conservation of threatened and endangered species) associated with rhino ownership, we simplify the complex problem of rhino conservation to a purely financial decision as a first key step towards understanding the challenges of rhino conservation.

Because we are framing private rhino ownership as a financial cost-benefit analysis, the 2 factors contributing to the decision to own rhinos are the revenues generated by rhinos and the costs of rhino ownership (Fig. 2-1). When the revenue from rhinos exceeds the cost of owning and managing them, game ranchers are more likely to invest in rhinos and consider them an asset to their wildlife operations (resulting in increased rhino conservation). When the costs of ownership exceed the revenues generated from rhinos, ranchers will view rhinos as a financial liability and are more likely to disinvest, resulting in less private land available as rhino habitat and likely also reduced rhino populations on private lands.

### **Financial Revenue from Rhinos**

Currently, the only legal revenues that can be generated from rhinos are revenues from photographic tourism (ecotourism), trophy hunting, and live sales (Fig. 2-1) (Child, 2012). Estimates of the photographic tourism value of rhinos on private lands are scarce in the literature. Spenceley & Barnes (2005) attempted to value the presence of rhinos on one South African and

one Namibian private reserve. While guides at the reserves indicated that guests were interested in viewing rhinos, Spenceley & Barnes (2005) were unable to estimate the proportion of tourism revenues that were attributable to rhinos on these reserves. However, using data from a Namibian communal conservancy, they estimated that 7% of the tourism value of the area could be attributed to the presence of rhinos (Spenceley & Barnes, 2005). Recent research suggests that the photographic tourism revenues generated by Kruger National Park's rhino population between 2011 and 2013 ranged from 5.9 to 14.9 million US\$ per year (Saayman & Saayman, 2016). Inferring a similar value for photographic tourism on private lands may be misleading, however, because photographic tourism is generally not feasible on the marginal, unattractive lands of many game ranches. Large operations with scenic appeal and charismatic fauna are better suited to photographic tourism (Hutton & Leader-Williams, 2003).

The advent of rhino hunting provided a financial incentive for the private sector to invest in rhinos (t Sas-Rolfes, 2011a). Saayman & Saayman (2016) documented that 331 white rhinos and two black rhinos were hunted between 2010 and 2012. The average price to hunt a white rhino increased by 31% from 65 000 US\$ in 2010 to 85 000 US\$ in 2012. The average price to hunt a black rhino increased by 28% from 235 000 US\$ in 2010 to 300 000 US\$ in 2012. Between 2010 and 2012 over 26 million US\$ in revenues were generated by rhino hunting (~8.7 million US\$ annually) (Saayman & Saayman, 2016).

In general, higher trophy hunting prices translate into increased live sale prices for wildlife. Landowners bid to invest in trophy hunting species, and expected hunting returns from a species are reflected in the species' purchase price at auction. Despite increasing trophy hunting prices, auction data from 2001 through 2016 show that the number of rhinos sold and the average price per rhino have fluctuated since a market trough in 2005 (see Wildlife Auctions,

2017). This may be due to landowner uncertainties regarding poaching threats and/or whether rhino horn trade will be legalized. These fluctuations indicate that revenues from live rhino sales are unstable, thereby increasing financial risks for rhino owners. Based on available information, hunting currently appears to be the most profitable use of rhinos on private lands.

### **Financial Costs of Rhinos**

Hall (2012) documents several financial costs of rhino ownership, including the initial land purchase, fencing, infrastructure, veterinary services, maintenance costs, and labor costs. Similar costs apply to a game ranch with virtually any wildlife species, depending on the intensity of the management system (Taylor et al., 2015). For the purpose of this framework, we assume that landowners have already invested in land and rhinos, and their property functions as a private game ranch. Only those costs that are specific to managing rhinos are encompassed in our conceptual framework, including rhino veterinary costs, supplemental feed costs, anti-poaching enforcement, and the costs of permits (Fig. 2-1).

Rhino ownership results in significant additional anti-poaching security costs to private game ranchers (Fig. 2-1) (Martin, 2011; Ferreira et al., 2014b; Collins et al., 2016). These costs encompass investment in both labor (e.g. highly trained security guards who are willing to engage with armed poachers) and anti-poaching technology and infrastructure (e.g. drones, helicopters, security towers; Tab. 2-1). Anti-poaching security forces and poachers have become locked in a conservation-related arms race, where each side must continue to become more militarized, technologically sophisticated, and strategic (Lunstrum, 2014)—which in turn has resulted in escalating risks and anti-poaching costs for private landowners. Besides trying to kill rhinos, poachers now carry a range of weapons meant for targeting anti-poaching units, including AK-47s and rocket grenades (Lunstrum, 2014). In contrast to public lands, private game ranchers

do not receive government or NGO subsidies to offset their anti-poaching security expenses, so they must shoulder these considerable costs themselves (Child, 2012).

### **Threat: Commercial Poaching**

Understanding what drives commercial poaching is critical to planning suitable and successful rhino conservation actions. Rhino poaching has quickly evolved from a haphazard activity to a well-structured and organized criminal venture (Lunstrum, 2014). Poaching syndicates operate multinationally, and there is evidence that organized cartels that trade rhino horn are linked to the illegal trade of other natural resources (e.g. abalone and ivory), as well as other illicit activities (e.g. drug smuggling and vehicle theft) (Montesh, 2013).

Local men from South Africa and Mozambique are contracted by crime syndicates to poach rhinos. These poachers usually only receive 1,000 to 9,000 US\$/kg horn (compared to an estimated \$65,000/kg for end-users), but there are always willing participants. Ground-level poachers are generally poor, and they rarely have access to job opportunities that provide comparable earnings (Lunstrum, 2014). These poachers are at greatest risk of capture, injury, or death (Lunstrum, 2014), which appears to be of little concern to the international poaching syndicates. Syndicates can easily replace and recruit ground-level poachers because of their ample supply (Martin, 2011).

South African middlemen collect horns from the ground-level poachers, as well as from members of the private sector who are engaged in illegal trade (e.g. game ranchers who sell horn from dehorning or professional hunters who acquire horn through the guise of trophy hunting) (Montesh, 2013). At the highest level of the supply chain are leaders of the crime syndicates who control the movement of horn from South Africa to Asian consumer markets (Montesh, 2013).

While the individuals involved in the illegal rhino horn trade are heterogeneous, we assume that they are all profit-maximizers (see also 't Sas-Rolfes, 2012; Collins et al., 2016).

The correlation between the increasing price of horn and the increase in the frequency of poaching (Hubschle, 2016; Saayman & Saayman, 2016) supports this assumption. For the remainder of this paper, we will focus primarily on ground-level poachers because we are most interested in poaching activity that directly affects private rhino owners. However, we will discuss other members of the illegal supply chain when relevant to rhino conservation by private landowners. Assuming profit-maximizing behavior, we argue that poachers are incentivized by high potential profits. The profit from poaching equals the revenue from poaching less the costs of poaching (Fig. 2-1).

### **Revenue from Poaching**

Revenues from poaching depend on both the amount of horn poached and the price of the horn, although prices received are different for on-the-ground poachers versus high-level syndicate members dealing with the end market (Fig. 2-1). The (inherently black market) price of rhino horn is a reflection of the demand for horn and the lack of competition from a legal market (Fig. 2-1). We postulate that the price of horn stimulates poaching activity (Hubschle, 2016; Saayman & Saayman, 2016), although the link between the black market price for horn and the quantity of horn poached has not been explicitly tested.

Demand for rhino horn has existed for thousands of years (Martin, 2011). Asian markets dominate the demand (Hubschle, 2016), particularly Vietnam and China (Ferreira et al., 2014b). The horn is used in traditional medicine to treat a spectrum of ailments ranging from insomnia to paralysis (Cheung, 1995). It is also viewed as a status symbol and is used as criminal currency (Hubschle, 2016).

The absence of competition from a legal market has allowed criminal syndicates to create an oligopoly in rhino horn trade and charge inflated prices ('t Sas-Rolfes, 2012). Increasing scarcity of rhino horn as the rhino population declines or anti-poaching enforcement improves

should further increase the price of horn, *ceteris paribus*<sup>1</sup>. Despite these high prices and the fact that rhino horn is contraband, the Asian market for rhino horn persists, suggesting that the demand for horn is *price inelastic* or insensitive to price changes<sup>2</sup> (‘t Sas-Rolfes, 2012; see also Crookes & Blignaut, 2015).

Price inelasticity of rhino horn demand means that the percentage decrease in demand for rhino horn will be less than the percentage increase in prices as horn becomes more scarce. However, price inelasticity of demand should also mean that a decrease in the price of rhino horn (e.g. owing to competition from legal trade) should not greatly stimulate demand for horn. This is an important point. If opposition to the legal trade in rhino horn is based on the assumption that lowering the price of rhino horn will substantially increase demand for horn, then better understanding of the price elasticity of rhino horn demand is required. The income elasticity of rhino horn demand also needs to be better understood. Crookes & Blignaut (2015) recently confirmed Milner-Gulland’s (1993) finding that rhino horn is a luxury good, which suggests that demand for rhino horn is income elastic<sup>3</sup>. However, there is insufficient evidence on the

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<sup>1</sup> *Ceteris paribus* is a Latin phrase that is used by economists to denote ‘all other things being equal’ or ‘other things held constant’.

<sup>2</sup> Price elasticity of demand measures how demand for a good changes as the price of the good changes, *ceteris paribus*. Demand for a good is price inelastic when a 1% increase in the price of a good results in less than 1% decrease in demand for the good. Similarly, a 1% decrease in the price of the good will increase demand by less than 1%.

<sup>3</sup> Income elasticity of demand measures how demand for a good changes as the income of consumers increases, *ceteris paribus*. It is calculated as the ratio of the percentage change in quantity demanded to the percentage change in consumers’ income. For most goods, a 1% increase in income results in less than a 1% increase in demand for the good, i.e. the income elasticity of demand is less than 1. However, the income elasticity of demand for a luxury good is greater than 1, i.e. a 1% increase in income results in greater than 1% increase in demand for the good.

elasticity of the demand for rhino horn. This means that we cannot determine the degree to which demand for rhino horn will change as the price of horn or the incomes of end consumers change.

Despite an imperfect understanding of the demand for rhino horn, price data demonstrates that rhino horn is currently worth more than gold, diamonds, or cocaine per kilogram (Biggs et al., 2013). Hubschle's (2016) fieldwork in Vietnam indicated that rhino horn could sell for as much as \$65,000/kg to the end-users. At that price, the horn on a single white rhino is worth nearly \$500,000 (Hubschle, 2016). Other estimates place the price as high as \$100,000/kg to end-users (Saayman & Saayman, 2016). At these prices, it is unsurprising that poaching has escalated and that professional organized syndicates have entered the market ('t Sas-Rolfes, 2011a). Poaching syndicates can profit even more by stockpiling poached horn in expectation of higher prices in the future as horn becomes scarcer (Brown & Layton, 2001; Mason et al., 2012).

### **Cost of Poaching**

The cost of poaching consists of direct costs (e.g. vehicles, weapons), as well as the risk cost (Fig. 2-1). Risk cost is a function of the probability of detection, capture, and punishment, and the severity of the punishment (Fig. 2-1) ('t Sas-Rolfes, 2011b). Anti-poaching security on private lands has a direct impact on the probabilities of detection and capture of on-the-ground poachers (Fig. 2-1). The probability and severity of punishment are consequences of the legal system's enforcement post-capture (Fig. 2-1). The 4 components of the risk cost function are interdependent (Fig. 2-1). The probability of capture would be slim if there were no probability of detection. Punishment would be impossible without capture. In South Africa, the probability of punishment and the severity of punishment are jointly linked because stronger evidence is required to prosecute cases that carry heavier fines and prison sentences ('t Sas-Rolfes, 2012). Therefore, as the severity of punishment for poachers increases, the probability of prosecution



declines. We explore the implications of this inverse relationship between the severity and probability of punishment later in this paper. We postulate that the cost of poaching is likely capitalized into the black market price of horn (Fig. 2-1).

### **Rhino Conservation as Government and Market Failures**

Even in its simplified form, the conceptual framework illustrates that rhino conservation is a multifaceted problem. Another important insight from the conceptual framework is that financial decision-making drives rhino conservation among private landowners. Cost-benefit analysis suggests that rhino conservation on private lands depends on the revenues from rhinos outweighing the costs. This is a cause for concern, since currently the costs to private landowners from managing rhinos significantly outweigh the revenues generated by rhinos – in large part owing to the costs of anti-poaching measures.

Before examining some of the solutions intended to enhance rhino conservation on private lands, it is critical to understand the policy context in which the conceptual framework lies. The Convention on International Trade in Endangered Species (CITES) banned the international trade of rhinos and rhino parts in the mid-1970s (De Alessi, 2000), which has had unintended, perverse consequences for rhino conservation, which we explore below.

#### **The CITES Trade Ban as a Government Failure**

Poorly structured policies create perverse incentives that result in sub-optimal outcomes (Tietenberg & Lewis, 2009). The CITES trade ban is based on the assumption that making the trade of rhino horn illegal will stop people from trading horn, but this does not hold in practice. Not only has the trade ban proven to be unsuccessful in reducing poaching, its implementation has actually created a problematic feedback loop for rhino conservation by ignoring the ban's perverse role in incentivizing poaching.

By restricting the legal supply of rhino horn (and associated supply-side competition), the CITES trade ban may have increased the black market price of horn, thereby increasing the financial incentive to poach (Biggs et al., 2013). Increased enforcement and higher penalties may also fail to raise the costs of poaching to the point that there is reduced incentive to poach. Given the price inelastic demand for horn, syndicates may pass on the costs of poaching (in the form of increased risks) to end consumers by increasing the price of rhino horn. Increased black market horn prices enhance revenues from poaching and generate an even greater financial incentive to poach rhinos (Fig. 2-1) (Biggs et al., 2013).

### **The CITES Trade Ban as a Market Failure**

The current CITES trade ban on global rhino horn trade has created a significant market failure that jeopardizes rhino conservation on private lands by limiting legal revenues to be earned from rhinos. Well-defined property rights are (1) exclusive, where all benefits and costs from a resource accrue only to the owner; (2) transferable, so that all property rights can be voluntarily transferred from one owner to another; (3) secure, so that other people, firms, or the government cannot involuntarily seize one's resources; and (4) comprehensively assigned, where all assets of a resource are owned (Hanley et al., 2007). Strong, well-defined property rights result in the incentive for the owner of a resource to use, improve, and conserve the resource under his or her control (Hanley et al., 2007; Tietenberg & Lewis, 2009).

The rhino horn trade ban has created a market failure of incomplete property rights. Rights are not comprehensively assigned because landowners are not permitted to earn income from the horns of their rhinos. As such, the trade ban artificially reduces the value of rhinos on the legal market, distorting economic signals (Child, 2012). Incomplete property rights are directly linked to another market failure—missing (legal) markets (Krug, 2001). High black market horn prices solely benefit actors within the illegal supply chain. Conversely, law-abiding

game ranchers do not capture full benefits of rhino conservation, but carry the entire financial burden of rhino ownership (Child, 2012). If landowners do not receive all the benefits or potential financial returns associated with rhino conservation, they will engage in lower levels of conservation than is optimal (i.e. the number of rhinos conserved on private lands, and the amount of habitat managed for rhinos will be lower than if landowners are able to earn higher payments for their conservation efforts).

### **The Conservation Impact of these Failures: Poaching and Rhino Divestment**

When the costs of protecting rhinos were low, the benefits from photographic tourism, hunting, and live sales covered the costs of ownership (Child, 2012). These income streams are now insufficient to offset the costs of security needed to protect rhinos from poaching threats. As a result, many private landowners are opting out of rhino conservation (Knight, 2011; Ferreira et al., 2014b). It is estimated that as of 2016, 70 of the approximate 400 private rhino owners in South Africa have removed rhinos from their lands, amounting to a loss of about 200,000 ha of land available for rhino conservation (CITES Management Authority 2016). Disinvestment at this scale will likely lead to a lower carrying capacity for surplus rhinos that need to be moved from public lands (Knight, 2011, Ferreira et al., 2014b).

### **Adding Actions: Potential Solutions**

Several conservation actions have been tested in an attempt to increase rhino protection and reduce poaching, but with little demonstrated success. Fig. 2-2 illustrates how current and potential conservation actions fit into the framework of rhino conservation on private lands in South Africa. It is important to recognize that all of these conservation actions occur within the context of the over-arching CITES rhino horn trade ban.

## **Reducing Demand**

Demand reduction through public awareness and education campaigns is a commonly proffered solution to decrease revenues from poaching (Fig. 2-2), but it has seen little success so far (Martin, 2011; Biggs et al., 2013; Ferreira et al., 2014b). While education campaigns may eventually reduce demand for rhino horn (Cheung, 1995), Asian medical communities still adhere to traditional customs (Cheung, 1995; Martin, 2011). Rhino horn is considered an essential medicine that has no substitute (Brown & Layton, 2001). It was assumed that increasing Westernization of Asian cultures would reduce demand for rhino horn (‘t Sas-Rolfes, 2012), but the significant cultural value of rhino horn (Martin, 2011) and the fact that horn may be a luxury good (Milner-Gulland, 1993; Crookes & Blignaut, 2015) have proven this false. Laws against rhino horn use in both China and Vietnam have not eliminated demand for the product (‘t Sas-Rolfes, 2012).

Demand reduction is also inconsistent with attaining increased private rhino conservation through sustainable harvesting of rhino horn. Rhino conservation has the potential to be the highest-valued land use for ranchers if trade is legalized (Martin, 2014). Because South Africa’s wildlife ownership model is profit based, rhino conservation must remain a profitable land use, whether through hunting, tourism, live sales, or horn trade.

## **Dehorning**

Rhino horn is composed of keratin, and horns can be cut off and will regrow without harm to the rhino (Biggs et al., 2013). Currently, dehorning is used to reduce the profits from poaching by removing the majority of the horn and leaving a stub on the animal—which does not adversely affect the rhino (Fig. 2-2). However, even the horn stub is valuable enough to attract poachers (Lindsey & Taylor, 2011), which undermines the effectiveness of this strategy. Dehorned rhinos may also be poached (1) to increase the price of stockpiled horn, (2) as a

message to rhino owners that dehorning is ineffective, or (3) so poachers can avoid tracking the same animal again (De Alessi, 2000). Dehorning in the absence of effective anti-poaching security has failed to reduce poaching (Lindsey & Taylor, 2011).

### **Poisoning Rhino Horn**

Poisoning rhino horn, or infusing the horn with an anti-tick treatment and dye, has been suggested as a way to decrease the revenue associated with poaching. The logic is that by poisoning the horn, it will become harmful to humans, thereby rendering the horn worthless on the black market (Fig. 2-2) (Ferreira et al., 2014a). In addition to multiple technical and practical issues associated with injecting the treatment and dye into the horn of a live animal (see Ferreira et al., 2014a), the greatest problem with this strategy is that poachers are not the end-users of rhino horn. Unless poachers are concerned about the health and safety of consumers (which seems highly unlikely), they will simply sell the treated horn, especially if the dye is not visible (Ferreira et al., 2014a). Not only has this method been ineffective in its ability to alter the horn in any significant way that would deter poaching (see Ferreira et al., 2014a), the morality of poisoning horns potentially destined for human consumption is questionable.

### **Improving Anti-Poaching Technology to Increase Security**

Several current conservation actions focus on increasing the cost of poaching by influencing different aspects of the risk cost function (Fig. 2-2). Evidence suggests that on-the-ground poachers focus on immediate potential profits and heavily discount the future ('t Sas-Rolfes, 2012). As a result, increasing the probability of detecting and capturing poachers before they kill a rhino is the risk cost factor that is most likely to alter a poacher's perception of expected profit (Milner-Gulland & Leader-Williams, 1992; 't Sas-Rolfes, 2012). Measures that preemptively detect poachers are a better deterrent to poaching and are also more beneficial as they actually protect rhinos while they are still alive (Martin, 2011; 't Sas-Rolfes, 2011b, 2012).

Improved technology can ultimately lead to increased probabilities of detection and capture of on-the-ground poachers (although it does not directly affect other players in the illegal supply chain) (Fig. 2-2). Increased security through improved anti-poaching technology should result in increased costs for poachers—whether in time, effort, or risk associated with poaching—which may reduce their incentives to poach. However, the incentive to poach will likely not be eliminated if on-the-ground poachers have minimal or no access to comparable income earning opportunities (Fig. 2-2). As technology improves, it may become cheaper, potentially leading to decreased security costs for private landowners (Fig. 2-2). Decreasing the costs associated with improved anti-poaching technology should result in better *in situ* rhino protection.

New advances such as remotely piloted aircraft systems and heat sensing planes can be used to detect animals and humans on the ground, and mobile biological sensors can detect abnormalities in rhino movements (Mukwazvure & Magadza, 2014). Acoustic traps can monitor areas for unusual sounds, and radio collars that transmit GPS data are common for rhino protection (UNEP, 2014). Technologies also empower the public. New mobile phone applications encourage the public to report illegal wildlife activities (UNEP, 2014). However, it is important to remember that as anti-poaching security forces seek to improve technology, so do syndicate-backed poachers, resulting in a continuous arms race (Lunstrum, 2014).

### **Increasing Enforcement through Heavier Sentences, Shoot-to-Kill Policies, and Increased Prosecution Rates**

Conservation actions also target the remaining 2 aspects of poachers' risk cost functions by increasing the likelihood and severity of punishment if poachers are arrested (Fig. 2-2). However, these components appear not to significantly alter poachers' decision-making. Middlemen have been known to pay the fines imposed on ground-level poachers, so increased

finer do not serve as a deterrent to ground-level poachers ('t Sas-Rolfes, 2011b). Long prison sentences, the death penalty and shoot-to-kill policies are insufficient to deter poaching because of how highly impoverished ground-level poachers discount the future ('t Sas-Rolfes, 2012). Sanctioned killing of poachers also raises moral issues in terms of placing animal lives above human lives, punishing the impoverished, and lack of due process. For example, relations between Kruger National Park and nearby South African and Mozambican villages are strained because villagers view rangers as killers who value rhinos more highly than humans (Rademeyer, 2016).

Although seeking heavier sentences in court may reduce the probability of a conviction in South Africa ('t Sas-Rolfes, 2012), the greater problem seems to be that poaching-related arrests have not increased at the same rate as poaching incidents (Collins et al., 2016). In addition, in 2015, 83% of the poaching-related arrests in South Africa were not prosecuted (Verwoerd, 2016).

Unlike increasing the probability of detection, these reactionary and punitive enforcement strategies are suboptimal because a rhino was poached before the 'success' of punishing the poacher was attained (Martin, 2011). Additionally, catching or killing poachers does not actually end the threat. Ground-level poachers are replaceable within the syndicate (Martin, 2011). The enforcement system has also been undermined by pervasive bribery and corruption (Martin, 2011; 't Sas-Rolfes, 2011b; Rademeyer, 2016). If local, impoverished communities are engaging in poaching because they have limited means to meet their survival needs, then poverty alleviation programs may be more effective in reducing poaching than punitive actions (see Douglas & Alie, 2014; Haas & Ferreira, 2016). Wildlife management in South Africa is highly lucrative, and may have generated a 'resource curse' in terms of socioeconomic inequality,

corruption, and social conflict (Douglas & Alie, 2014). Policies and programs that promote poverty alleviation should be combined with anti-poaching enforcement and efforts to dismantle criminal syndicate networks (Haas & Ferreira, 2016).

### **Subsidizing Security Costs**

One potential conservation action that has not been implemented to date is to establish government subsidies to defray security costs associated with rhino conservation (Fig. 2-2) (Child, 2012). Just as the US government offers programs that provide financial assistance to individuals engaged in conservation efforts on private lands (Sorice et al., 2011), government subsidies to offset security costs may provide South African private landowners with an incentive to invest in rhino conservation.

Realistically, however, it is unlikely that the South African government is able to provide this support to private landowners because public conservation lands already suffer from inadequate funding and declining budgets (Krug, 2001). Other public spending programs (such as health and education) may also take priority over rhino conservation (Rademeyer, 2016). Finally, government programs that undermine the self-sufficiency of ranchers (who currently must generate sufficient revenues to cover the costs of their land management) may generate perverse outcomes in terms of landowner reliance on government subsidies, and reduced efficiency in their land management practices.

### **Legalizing Horn Trade**

Legalizing the horn trade would help to correct the market failures associated with the CITES trade ban. Legalizing horn trade would permit the sale of horns from dehorned rhinos and horn stockpiles that have been generated from natural deaths of rhinos on private and state lands (Ferreira et al., 2014b). Several authors discuss the advantages and disadvantages of this potential conservation action in detail (see Martin, 2011; 't Sas-Rolfes, 2012; Biggs et al., 2013;



Ferreira et al., 2014b; Collins et al., 2016), and we will only summarize some of the main arguments.

Proponents of legalizing rhino horn trade commonly point to 2 significant potential conservation outcomes of this action. First, legal trade would increase the supply of horn available on the market, creating competition for the black market and removing the black market's ability to charge inflated prices ('t Sas-Rolfes, 2012). Decreased black market profits may reduce the incentive to poach, *ceteris paribus* (Fig. 2-2) ('t Sas-Rolfes, 2012; Biggs et al., 2013; Ferreira et al., 2014b), although it should be recognized that illegal trade exists for items with legal markets. Nonetheless, population increases of crocodiles, ostriches, and vicuna are cited as evidence that legalized trade reduces poaching pressures (Eustace, 2012). Similar arguments have been made when considering the creation of a legal market for cocaine, heroin, and other illicit drugs (Miron, 2003).

A legal market would also allow for monitoring of consumer demand, which is currently extremely challenging because all trade takes place illegally ('t Sas-Rolfes, 2012). While it is likely that black market trade would still occur even if a legal market were established, the legal market may attract consumers away from the black market, especially if the legal product is cheaper, of guaranteed quality, and/or lower risk than the illegal product (Martin, 2011; Biggs et al., 2013).

The second key argument for legalization of horn trade is that it would provide an additional, renewable source of income for rhino owners, increasing the revenue of live rhinos and thereby incentivizing rhino ownership and long-term conservation on private lands (Fig. 2-2) (Child, 2012; 't Sas-Rolfes, 2012; Biggs et al., 2013). This new revenue stream could be

reinvested in anti-poaching security (‘t Sas-Rolfes, 2012), which should reduce the amount of horn available to poachers (Fig. 2-2).

Arguments against legal trade in rhino horn center on ethical concerns about commercially exploiting wildlife (‘t Sas-Rolfes, 2012) and the uncertain consequences of removing the CITES trade ban (Ferreira et al., 2014b). Of particular concern is the potential of a ‘reverse stigma effect’, where demand increases because previously law-abiding consumers now enter the market (‘t Sas-Rolfes, 2012). The counter argument is that an increase in demand for rhino horn would translate into a long-run increase in the number of rhinos conserved on private lands to meet this demand (Biggs et al., 2013), i.e. private landowners will invest in valuable rhinos.

There is significant debate surrounding regulated trade as a conservation strategy that extends beyond rhino conservation to include many endangered species that are poached and trafficked (Fischer, 2010; Santos et al., 2011; Conrad, 2012). Some authors assert that ‘naïve’ models that do not realistically capture markets for wildlife are common in pro-trade literature (Fischer, 2004; Bulte & Damania, 2005). However, more complex models also generate uncertain predictions regarding the success of trade bans versus regulated trade. The model predictions depend on which assumptions are made about market competition (Bulte & Damania, 2005) and the presence of illegal horn laundering (Fischer, 2004).

Although our conceptual framework suggests that legal trade is a necessary component of rhino conservation on private lands in South Africa, the fact remains that policymakers should be careful when implementing legal trade (Bulte & Damania, 2005) in order to ensure that a legal market has a net positive conservation effect. This is not inconsistent with South Africa’s game ranching system. Landowners are required to fence their land in accordance with government

regulations in order to be allowed to earn hunting revenues throughout the year (Taylor et al., 2015). Landowners are also required to obtain permits related to wildlife on their land, and in order to move or transport wildlife to other locations (Taylor et al., 2015). The permit system provides an opportunity to require that landowners manage sufficient habitat to support rhinos before they would be allowed to engage in legal trade.

Significant effort will be required to create a well-regulated horn market (Biggs et al., 2013; Ferreira et al., 2014b; Collins et al., 2016). There is now urgent need to determine how legal rhino horn trade should be structured. In February 2017, South Africa's Minister of Environmental Affairs published a government gazette, 'Draft Regulations for the Domestic Trade in Rhinoceros Horn, or a Part, Product or Derivative of Rhinoceros Horn' (DEA, 2017). As a result, the Private Rhino Owners Association (PROA) of South Africa has been drafting a domestic trade proposal (PROA, 2017).

Current indications are that a central selling organization (CSO) will be instituted to regulate and monitor the legal rhino horn trade within South Africa. The CSO would be the only authority that could legally sell horns to registered buyers. It has also been suggested that the CSO would use technology (e.g. microchips) to track individual horns through the legal selling chain to the end consumer (Biggs et al., 2013). By regulating the supply chain, a CSO could effectively minimize the risk of corruption and speculation through rhino horn stockpiling (Biggs et al., 2013). Additionally, a CSO may stop the legal trade of rhino horn if the legal market proves ineffective in incentivizing rhino conservation (Martin, 2011; Biggs et al., 2013).

It is important to note that the draft regulation is for domestic horn trade only and the export of horn is permitted only for personal (i.e. non-commercial) use. Because the demand for rhino horn is driven by Asian consumers, in the absence of legal exports of rhino horn for

commercial purposes, it is likely that the draft regulations will still restrict potential profits from rhino horn trade. This will limit financial incentives for rhino conservation by private landowners.

### **Discussion**

Our conceptual model demonstrates 2 important points. First, each current rhino conservation action is targeted at only one part of the larger problem of protecting rhinos (with the exception of improving anti-poaching technology). Practitioners need to use multiple tools to counter different and diverse rhino conservation threats (Salafsky et al., 2002). Although all the current strategies to conserve rhinos likely play a role in reducing rhino poaching, there is mounting evidence that they are insufficient to ensure the conservation and recovery of the rhino. After nearly a decade of drastic and increasing poaching pressure, a more comprehensive strategy (or set of strategies) that targets multiple threats to rhino conservation (including rhino disinvestment by private landowners) is needed.

The second insight from the conceptual framework is that current conservation actions completely overlook half of private landowners' cost-benefit function. Not a single strategy focuses on increasing legal revenues from rhinos, which would directly benefit landowners and allow them to cover the costs of managing and protecting rhinos. Instead, the vast majority of conservation actions are dedicated to altering poachers' cost-benefit functions, which may reduce poaching pressures but does not directly influence the benefits that private landowners derive from rhino management. A truly comprehensive strategy should increase revenues from rhinos because financial benefits are central to the South African wildlife use model. Direct, transparent incentives to own and protect rhinos (in the form of sustainable revenues from harvesting horn) may increase rhino conservation on private lands.

While economic solutions are needed to conserve rhinos on private lands, we recognize that care should be taken in implementing a legal market for rhino horn. Research underpinned by an adaptive management approach (see Salafsky et al., 2002) should be conducted to ensure the market attains conservation outcomes. First, rigorous initial research regarding the design and structure of the market is needed to prevent perverse or unintended outcomes. As noted by Collins et al. (2013), there is little understanding about how the legal horn market should be structured or regulated. Research into different market structures (including a CSO) and how they may influence the legal price and supply of rhino horn is vital to increasing rhino conservation on private lands.

In the event that a legal market is created, the impacts of legal trade should be monitored to assess whether (1) rhino owners have the ability to meet horn demand, (2) legal trade stimulates demand for horn, and (3) legal trade reduces black market prices for horn (‘t Sas-Rolfes, 2012; Collins et al., 2013; Ferreira et al., 2014b). Research into how legal trade affects poaching activities will also be needed (‘t Sas-Rolfes, 2012; Biggs et al., 2013; Ferreira et al., 2014b) and whether measures are needed to prevent laundering of illegal horn into the legal supply (see Fischer, 2004).

Conservationists are so alarmed by the state of rhino poaching in South Africa that plans are underway to transport rhinos to Australia (Hayward et al., 2017) and Texas, USA (Forsyth, 2015) for safekeeping. Hayward et al. (2017) catalog a series of concerns related to projects aimed at establishing extra-limital populations, including the fact that they divert funding and expertise from *in situ* conservation efforts, may result in unknown ecological consequences, and exploit Africa’s resources by removing biological assets. Despite the fact that efforts are already being taken to remove rhinos from their natural habitat in the name of conservation,

conservationists have yet to fully explore all available options that may improve *in situ* conservation. While some conservationists question the morality of horn trade legalization and commoditizing wildlife, the morality of shipping rhinos out of Africa is also debatable. It seems prudent to exhaust all potential strategies that may promote *in situ* conservation of rhinos before they are sent to other continents to be protected.

Table 2-1. Examples of anti-poaching security costs. Adapted from Collins et al. (2016).

Anti-poaching expenditure	Price in ZAR (price in 2016 USD)
Rhino dehorning	R6,000 - R10,000 per rhino (~\$423 - \$706)
Fitting rhino with transmitter devices	R8,000 - R10,000 per rhino (~\$564 - \$706)
Entry level personnel	R4,000 per month (~\$282)
Experienced/weapons-trained personnel	R6,000 per month (~\$423)
Vehicle operation	R6,000 per month (~\$423)
Helicopter support	R400 per flight hour (~\$28)
Handheld thermal imagery cameras	R68,000 per camera (~\$4,798)
Bullet-proof vest	R4,000 per vest (~\$282)
Night vision binoculars	R17,000 per pair (~\$1,200)

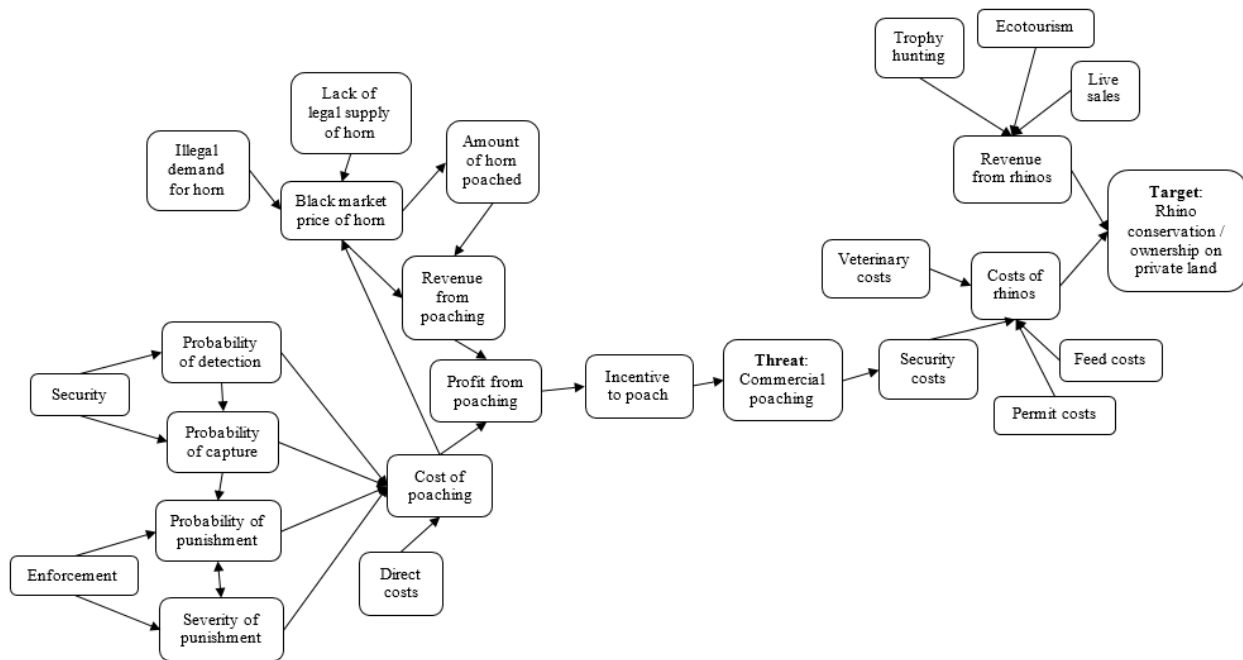


Figure 2-1. Framework for understanding private rhino conservation and the threat of poaching.

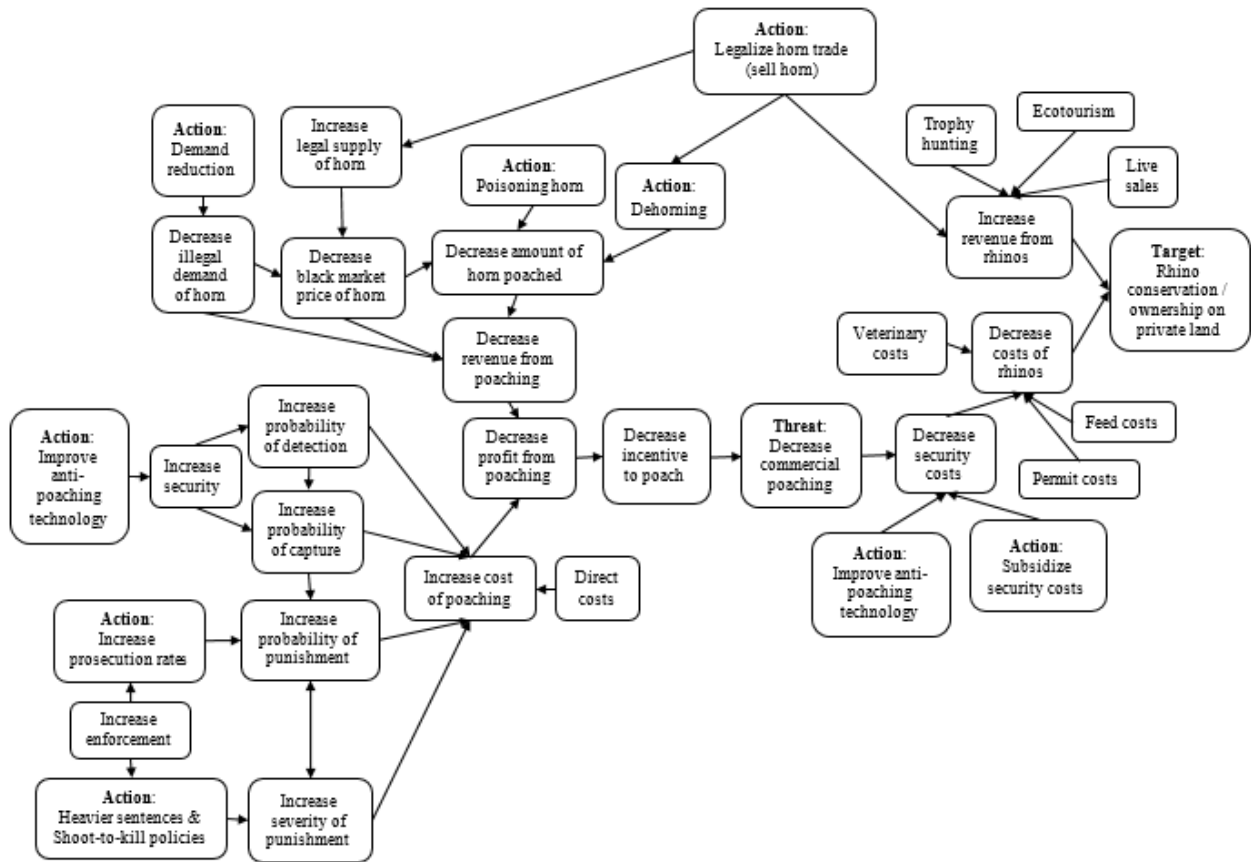


Figure 2-2. How current and potential conservation actions are meant to result in achieving the conservation target.

### CHAPTER 3 UNDERSTANDING SOUTH AFRICAN PRIVATE LANDOWNER DECISIONS TO MANAGE RHINOCEROSSES

The continued existence of black (*Diceros bicornis*) and white (*Ceratotherium simum*) rhinoceroses (hereafter referred to as “rhinos”) in Africa is threatened by commercial poaching for their horns (Collins et al., 2016). South Africa is critical to rhino conservation because it is home to over 80% of the world’s rhino population (Saayman & Saayman, 2016). Although most rhino conservation takes place within national and provincial parks (Saayman & Saayman, 2016), only 5% of the land in South Africa is publicly protected (Cousins et al., 2008). By contrast, 80% of land is privately owned (Cousins et al., 2008), and these private lands are increasingly important to rhino conservation in South Africa. Recent estimates suggest that approximately 33% of the country’s rhino population is privately owned (Rademeyer, 2016).

Rhino management by South African landowners occurs within the context of private ownership of wildlife – commonly referred to as the sustainable use approach to wildlife conservation (see Kabiri & Child, 2014). Private landowners in South Africa (hereafter referred to as “game ranchers” or “ranchers”) who comply with government regulations (e.g., fencing their property) own the wildlife on their land and may utilize this wildlife throughout the year to generate income, such as through hunting and photographic tourism (Pienaar et al., 2017). Private ownership of wildlife generates a direct financial incentive for ranchers to manage and conserve wildlife on their land, hence the designation of the South African approach to wildlife management as a sustainable use model. This market-based approach to wildlife management

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has been credited with increasing game populations and the amount of land allocated to wildlife management in South Africa (Child, 2012; Pienaar et al., 2017).

Prior to significant poaching pressures that began in 2008 (Rademeyer, 2016), income streams available from rhinos (photographic tourism, hunting, and live sales) were sufficient to generate profits for ranchers from owning rhinos, which in turn provided a clear financial incentive to own rhinos. However, escalating poaching efforts have increased the anti-poaching security (hereafter, “security”) costs associated with owning rhinos. Debut (2016) estimated that security costs have reached as high as \$170,000 per month for some ranchers. Without a commensurate increase in the revenues to be earned from rhinos, rising security costs will reduce or eliminate the financial returns from rhino ownership (Child, 2012). This poses a threat to rhino conservation because ranchers can remove rhinos from their lands if the costs of rhino ownership become excessive (Collins et al., 2016). Rhino conservation on public lands is expected to continue, despite relatively higher poaching pressures compared to private lands (Rademeyer, 2016), because conservation on these lands is government-mandated. However, the facts remain that (a) public lands only account for a small percentage of the total land area of South Africa and (b) private lands provide important habitat for the rhino.

Given that South Africa’s model of wildlife management is largely profit-driven, it would be reasonable to expect that the significant costs associated with rhino ownership would result in ranchers removing rhinos from their land. In fact, evidence suggests that the number of ranchers engaging in rhino conservation is declining (CITES Management Authority, 2016). As of 2016, it was estimated that 70 of 400 South African private rhino owners had removed rhinos from their lands. This represented a loss of approximately 200,000 ha of privately owned habitat (CITES Management Authority, 2016).

Nonetheless, despite the substantial costs associated with owning rhinos, approximately 83% of private landowners have retained their rhino herds (CITES Management Authority, 2016). In a system where wildlife conservation is driven by financial returns, this decision to keep rhinos appears irrational. The seeming irrationality of this decision is further highlighted when the nonfinancial costs of rhino ownership are factored into rancher decisions to keep rhinos. Recent research has demonstrated that the militarization of rhino conservation places park rangers in physical danger and also results in adverse psychological and social effects induced by war-like conditions (Neme, 2014; Lunstrum, 2014; Humphreys & Smith, 2014; Duffy, 2014; Buscher & Ramutsindela, 2015; Annecke & Masubelele, 2016). Rhino conservation may also force the reallocation of finances, labor, and resources from other important conservation activities (Humphreys & Smith, 2014; Buscher & Ramutsindela, 2015; Annecke & Masubelele, 2016), which may have long-term, detrimental impacts for both wildlife and habitat conservation on private and public lands. Why then do ranchers in South Africa continue to own rhinos?

One possible explanation is that ranchers anticipate future profits from the sale of rhino horn (i.e., ranchers may have speculated on the removal of CITES and domestic trade bans). Indeed, in April 2017, domestic commercial trade of rhino horn within South Africa was legalized for the first time since 2009. There are plans to establish a national trading desk and depository to facilitate regulated horn trade (Jones, 2017b). Although representatives for the game ranching community have been largely supportive of legalizing the trade in rhino horn, it is unclear to what degree domestic trade will benefit rhino owners. Given that Asian consumers chiefly drive demand for horn (Collins et al., 2016), legalizing only domestic horn trade may not

provide sufficient revenue to offset security costs for rhino owners. With domestic trade in its infancy, rhinos are likely to remain a financial liability for the foreseeable future.

Given the uncertainties associated with rhino ownership, continued private ownership of rhinos suggests that South African game ranchers' decision-making is not purely financial. As part of the "Big 5," rhinos are often associated with tourist satisfaction (Maciejewski & Kerley, 2014), which should translate into tourism-based financial returns from owning rhinos. However, the environmental sociology and psychology literatures provide insights into important nonfinancial motivations that may be driving rhino ownership. For example, rancher decisions to keep rhinos on their land may be driven by their level of environmental knowledge or concern, the behavioral and physical characteristics of rhinos, their past and present interactions with rhinos (Kotchen & Reiling, 2000; Schultz, 2000; Martín-Lopez et al., 2007), or an emotional attachment to rhinos, such as in the theory of emotional affinity (Kals et al., 1999) and attachment theory (Archer, 1997; Sable, 1995). Alternatively, ranchers may feel a moral obligation to contribute to rhino conservation, as posited by Schwartz's (1977) norm-activation model. Specifically, ranchers may recognize that action must be taken to conserve rhinos (awareness of need) or may consider themselves responsible for engaging in rhino conservation (awareness of responsibility).

Using the environmental economics, sociology, and psychology literatures, we sought to explore the financial and nonfinancial considerations that game ranchers include in their decisions to own rhinos. Using the economics constructs of utility (an individual's level of satisfaction from engaging in an action) and cost–benefit analysis, we framed rancher decisions to own rhinos as an example of utility maximization (Hanley & Shogren, 2005), rather than profit maximization. This framing allowed us to investigate both financial (e.g., security costs)

and nonfinancial (e.g., emotional attachment) costs and benefits associated with rhino ownership. To investigate these considerations, we conducted semi-structured interviews with rhino owners and managers in South Africa in 2015 and 2016.

## **Methods**

### **Data Collection**

Qualitative research methods were utilized because they allow researchers to capture experiences and perspectives, which are often too abstract to be measured quantitatively (Berg, 2001). Semi-structured interviews were used for eliciting information that respondents identified as important (Bryman, 2001). Semi-structured interviews use initial, predetermined questions to elicit information, but also allow respondents to introduce new material, providing further insights and encouraging the exploration of additional topics (Berg, 2001; Bryman, 2001).

We conducted 19 interviews in total. All interviews were conducted in English, audio recorded, and transcribed, with each interview averaging over 65 minutes. Fourteen respondents were owners of private game ranches, meaning that they own the wildlife on their land and manage their properties to generate wildlife-based income. These ranchers primarily engaged in the game breeding, trophy hunting, and biltong (game meat) hunting of various species, although a subset of ranchers also engaged in ecotourism. The remaining five respondents were managers of privately owned reserves that border Kruger National Park. These reserves form part of the Associated Private Nature Reserves and, as such, are governed by certain rules regarding how wildlife and habitat are managed.

The interviews were conducted in two distinct sets: 9 interviews were completed in July and August of 2015, and 10 interviews were completed in October and November of 2016. Data from both sets of interviews were used in our analysis. The first set of interviews (2015), which were conducted by both authors, was part of a larger study on management activities by South

African game ranchers. The interviews were guided by broad questions regarding ranchers' wildlife and land management activities (e.g., do you have a management plan for any of the species on your ranch?). These interviews were not specific to rhino ownership, but respondents organically raised the issue of rhinos, including different ways rhino ownership affected their ranch management, finances, and families. These respondents were derived from a random sample of Wildlife Ranching South Africa members.

Respondents for our second set of interviews (2016), conducted by the first author, were identified using referral-based (i.e., snowball) sampling from the first set of respondents. Referral-based sampling utilizes personal connections to reach new respondents, and is well suited to researching sensitive topics (Biernacki & Waldorf, 1981). This method was appropriate because ranchers may be reluctant to share that they have rhinos with unknown researchers for fear of poachers gaining this information (Wright et al., 2016). These interviews were guided by questions specific to the challenges and motivations of rhino ownership (e.g., why do you continue to keep rhinos on your property?).

### **Data Analysis**

We independently analyzed transcripts from the first set of interviews. We both independently identified themes and categories (e.g., “dehorning,” “poaching problems”) that emerged and checked how we reached these findings as a form of verification (Berg, 2001). We then compared and discussed these initial findings to confirm that they were consistent, an intercoder reliability check suggested by Berg (2001).

After this initial data analysis, we refined our interview questions for the second set of interviews. These questions were specific to rhino ownership and were meant to further investigate key concepts that arose during the first set of interviews. The same coding scheme from the first set of interviews was applied to the second set of interviews, although additions

were made as necessary to account for new information. Data collection ended after 19 interviews when saturation of concepts that arose from both sets of interviews was reached, which is consistent with findings that the frequency of new concepts and results diminish after approximately 20 interviews (Tashakkori & Teddlie, 2003).

## **Results**

Respondents confirmed that they factor both financial and nonfinancial costs and benefits into their decision to own rhinos. All respondents noted that, although the financial costs of rhino ownership exceeded financial returns, the sum of all (financial and nonfinancial) benefits from owning rhinos were sufficient to offset the various costs of rhino ownership. Direct quotes from respondents are used for supporting important findings.

### **Financial Costs: Security Costs**

Our interviews with rhino owners and reserve managers suggest that security costs vary across ranches and reserves, depending on the size of the property and how much owners are willing or able to invest in security measures. Most private ranchers who were interviewed estimated their monthly security costs to be between ZAR 20,000 and ZAR 50,000 (2017 USD \$1500–3700), with one large rhino breeder spending ZAR 3 million (~\$227,000) per month on security. Reserve managers in our study were not willing to share exact amounts, but they all indicated that security costs account for 30–60% of their budgets. As one respondent noted, “There is no wildlife reserve in the world where the amount of money spent on rhino protection is financially sustainable.”

Nearly all respondents indicated their main security expense was paying for the salaries and accommodations of around-the-clock security teams with the appropriate training and firearms experience to prevent poaching. According to respondents, rhino security is almost exclusively conducted by armed guards with extensive firearms training who are expensive to

employ. Some ranchers in our study contracted with external security companies because it simplified the process for them. Others preferred internal security teams because they trust their own employees and believe that hiring external companies leads to information leaks and increased threats of poaching. Other respondents used a combination of internal and external security teams as a way of “one jackal watching the other.” Liability insurance associated with having armed personnel on the property (e.g., in the case of firearm fights with poachers) was a related security expense. Ranchers with internal security teams paid their own insurance fees, whereas those with external teams stated that these fees are built into the security contracts.

Most respondents also noted that fencing costs may be extremely expensive if the perimeter of the ranch is very long or if fences are electrified (which is more effective at deterring poachers from entering the ranch). All respondents checked their fences at least daily because fences are the first line of defense against poachers. Respondents used cameras to monitor their fences, and they stated that high-tech equipment was a major expense of rhino ownership. Respondents also paid for the following equipment as part of their security expenses: vehicles and fuel, firearms, cameras and spotlights for in the bush and on roads, radio collars and GPS tags for rhinos, and night vision goggles and night sights for rifles. Many respondents paid for verifiable intelligence about potential poaching threats. It was noted this can be expensive, depending on how often they were contacted by informants.

However, as respondents noted, the one benefit of such intensive security efforts is that snare poaching, or poaching by locals for bush meat, is virtually eliminated. As one respondent said, “If someone claims they are protecting rhinos on their land, but they are having a problem with snare poaching, then they definitely have a problem.”

Despite these anti-poaching efforts, nearly every respondent had at least one of their rhinos poached since 2008. Respondents who did not experience significant poaching attributed it to the fact that their property is isolated from major roads, there are minimal access points to the property, and/or that the property is surrounded by other ranches. One rancher explained his poaching problems are because his property is adjacent to a main highway and there is a cell tower on the property, which provides easy access to his property and communication by poachers when on his ranch.

### **Financial Costs: Managing Rhinos**

At the time of the second set of interviews, South Africa was suffering from a drought, so supplemental feed costs were substantial for all respondents except for the managers of a few large reserves. Even in non-drought years, many ranchers in our study said that they engage in supplemental feeding because they keep their rhinos in smaller camps<sup>1</sup>, rather than letting them roam across the ranch. The choice to keep rhinos in these smaller camps was motivated by the fact that high-level security is more cost-effective for a single camp than for the entire property. However, smaller camps may not provide sufficient feed to support the rhinos, and so supplemental feeding is necessary to maintain the rhinos and habitat in the camps.

There was no clear consensus regarding dehorning costs. All respondents with smaller ranches (<1000 ha) considered dehorning costs to be substantial, but most respondents with larger operations (>2000 ha) considered dehorning costs insignificant compared to security and supplemental feed costs. Based on information provided by respondents, there are economies of scale associated with dehorning, such that dehorning more rhinos per event reduces the cost per

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<sup>1</sup> The term “camp” may be misleading to individuals who are not familiar with South Africa’s game ranching system. These camps may be sufficiently large to allow for dense bush and may not allow for the darting of rhinos using motor vehicles.



rhino. According to respondents, the two major dehorning expenses are (a) the cost of the veterinarian and (b) the cost of hiring a helicopter and pilot, to locate the rhinos in the bush so the veterinarian can tranquilize the animals using a dart gun. Both veterinarians and helicopter pilots are paid by the hour. Respondents also pointed out that they must pay for the indefinite storage of the horn offsite because the sale of horn was not legal. Many respondents used banks to store horns, although one respondent noted that fewer banks are willing to take on this responsibility because of the security risks involved. Most ranchers and managers we interviewed engaged in dehorning, although a few respondents admitted they do not like the practice for aesthetic reasons. One rancher explained that before he began dehorning, he was able to offer rhino hunting, but because hunters do not want a rhino without a horn, he is no longer able to benefit from that income stream.

Purchasing insurance on individual rhinos is an available option for owners. However, only one rancher we interviewed bought annual insurance for his individual animals, and another rancher buys insurance for when he transports rhinos. Several respondents indicated that rather than paying high insurance premiums, they choose not to insure their rhinos and instead allocate that money to security costs. Given these multiple costs of rhino ownership, respondents frequently described their rhinos as a “financial liability” or the cause of “economic strain.” For example, “[Expenses are] always in the back of my mind because if I sell [my rhinos] the farm won’t have all these problems, we can go on profitably ... Rhinos are crippling us.”

### **Tradeoffs and Opportunity Costs**

Nearly all respondents said that they routinely sacrifice funding for other land management and business activities to pay for their rhino-related costs. Examples included less spending on burning programs, fence maintenance, and marketing for their businesses, as well as monitoring and research programs on larger reserves. Example quotes included:

On a financial side, having rhinos ... I've never been in such a bad financial situation as I am now because every single cent that I have goes to the rhinos. And if I have a few extra bucks at the end of the month, I buy a [trail] camera.

I was supposed to start growing lucerne. I just haven't had enough money to buy the seeds. We had to redo the piping in one section of the farm. There hasn't been enough money to do it.

A few ranchers in our study stated they have made financial sacrifices in their personal lives to pay the costs of rhino ownership, including working a second job and selling their car. Only two ranchers noted that, although rhino-related expenditures do not reduce funds available for other ranching activities, their profits have decreased in line with rising costs of rhino ownership.

Three reserve managers we interviewed estimated that habitat management previously accounted for 40% of their total budgets, but due to the costs of security, only 5–10% of their budgets are currently being allocated to habitat management. One reserve manager expressed concern about rhinos receiving such a disproportionate amount of funding, worrying that the conservation of other species and ecosystem services is being neglected:

[Reserves and parks are] skewing their budget to rhino protection and things as unglamorous as pollinators, bees, or dung beetles, whatever, are just not getting the due that they should be. Or eradication of alien vegetation, those sorts of unsexy things are tending to go by the wayside.

Many ranchers and managers in our study agreed that private operations are currently facing tradeoffs between hiring ecologists or game managers and recruiting security experts because most operations cannot afford both.

### **The Costs of Securing Human Safety**

Nearly all respondents stated that their security staff risk their lives on the job, but were of the opinion that their guests and clients are not in danger from poachers, although one rancher stated his guests seem wary of staying on his ranch due to perceived risks. Another rancher noted

that he no longer offers ecotourism on the part of the ranch with rhinos because clients were uneasy about seeing armed guards. Many respondents were most concerned about the potential safety risks to their families, particularly when loved ones help with ranch activities (e.g., helping to patrol the fences at night). For example:

The biggest impact is on my family. I put my whole family's lives at risk by bringing these animals onto the farm.

I've noticed my son ... he used to be very comfortable wandering anywhere around the ranch. Now there are certain parts where he won't go without me. He used to be just fine.

Dehorning was mentioned by respondents as a strategy to protect both rhinos and humans because it may discourage poachers from targeting properties with dehorned animals, provided that poachers did not believe there is still horn available on the property. However, many respondents also believed that applying for dehorning permits increases the risk of poaching because it creates the opportunity for government officials to pass information about the location of rhinos and dehorning events to poaching syndicates. As a safety precaution, all respondents who dehorn said they immediately transport horn to an external storage facility after the dehorning event so no horn is kept on the ranch overnight. One rancher recalled having poachers break into his house searching for horn, whereas another said a similar situation happened to a friend. Some respondents also post signs throughout their properties displaying that they do not keep horn on the premises.

Many respondents also engage in other measures to protect staff who may be targeted by poachers. Although cleaning and custodial staff are unlikely to be put at risk from poaching, one reserve manager noted that senior management and their families were being repeatedly targeted at his reserve, where poachers would try to locate and break into their homes to find stored rhino horn. He now posts security guards around their houses and has installed panic buttons in their

homes. Another rancher employs night-time security guards outside her house. The majority of respondents also said they carry firearms and provide their families and other at-risk employees with firearms. For example:

I have now applied for three new firearms because I don't feel safe walking on the farm on my own. One of them is an AK-47. It's not a normal thing for anybody, let alone a woman, to go and buy an AK-47.

Every single family member of mine who is above 18 [years old] has a firearm that is carried on them all the time, ready for trouble at all times.

### **Psychological Stress**

Continuous stress due to concerns about the safety of rhinos, family members, and employees was repeatedly mentioned by respondents as one of the important challenges of rhino ownership. Respondents characterized their daily life as “war-like” with “no break.” Most respondents also stated that rhino ownership creates strain on their families, with multiple respondents citing an increase in divorce rates among their colleagues as evidence of this strain.

Some of the statements made by respondents included:

Every aspect of my life has changed. From being a normal civilian ... Your whole mindset has changed. You have to think in militaristic ways.

We're in a war, that's one way you can describe it.

We're up all hours, watching the ranch for any poaching activity.

Respondents also indicated that there are other, more subtle strains associated with rhino ownership. Most respondents stated that their job as a rancher or land manager has changed since rhino poaching escalated. These respondents pointed out that they entered game ranching to be outside in nature, but now they spend most of their time dealing with issues of security and related administrative work. For example:

In the days before [poaching] was a really big problem, we had a lot more time to spend out in the bush, which is of course what our passion is for.

We are conservationists who are now being forced into the role of securing and protecting a species. It creates quite a bit of problems.

As a result of this shift in job duties and the stress associated with anti-poaching efforts, many respondents stated that their former colleagues have exited the game industry.

### **Lack of External Financial Support**

Although both public and private lands are being targeted by poachers, ranchers we interviewed expressed a strong sense of isolation because they do not receive financial or in-kind support from the government and conservation-related nongovernmental organizations (NGOs). All respondents noted that their financial costs are paid entirely out-of-pocket. In contrast, the government and NGOs subsidize anti-poaching enforcement on public lands. Respondents pointed out that they pay twice (i.e., double-billing) for anti-poaching enforcement, first as a taxpayer and second as a rhino owner. Most respondents argued that government and NGO funding should also be available to the private sector because they are performing the same conservation service as public parks: “We don’t see a single penny of that [NGO donation]. I guess it goes to Kruger (i.e., the largest national park in the country). But what people don’t get is that we’re fighting the same battle.” One respondent specifically suggested government rebates per animal or lower tax rates to assist private rhino owners.

### **Ideological Conflicts**

Most ranchers in our study were also frustrated by the anti-horn trade sentiments of NGOs. These ranchers claimed that anti-trade NGOs are perpetuating poaching by lobbying against trade legalization, which ranchers perceive as simultaneously exacerbating their poaching problems and preventing them from earning additional income from rhinos that could be used to offset security costs. They argued that these organizations exploit public emotions, using graphic images and stories of poaching to raise funds, but then do little for on-the-ground conservation.

Respondents stated that as long as rhino poaching continues NGOs will benefit from increased donations, which support NGO staff salaries rather than financing conservation efforts like their own. Example quotes included:

It's a multi-billion dollar business – being an anti-trader and getting all [these] “save the rhino” [donations and merchandise] ... They're making the money, these guys running campaigns against us.

The problem is that as soon as rhino can start paying for themselves, the funding and the sensationalism behind the “save the rhino” organizations is going to disappear. So they will no longer make a profit.

Some ranchers we interviewed also expressed feelings of resentment and anger because they had been labeled as “greedy” and maligned on social media for being in favor of legalizing horn trade. These ranchers said that rather than being applauded for their self-funded conservation efforts, the international public (mainly Americans) shames them for earning income from wildlife. Ranchers in our study described this characterization of their business as “unfair criticism” because it is inconsistent with the sustainable use model of South Africa. These ranchers voiced frustration that the tangible conservation benefits they provide are disregarded by people on social media, most of whom “have never set foot in Africa.” Most of these ranchers were also of the opinion that the international public needs to recognize the significant contributions that the private sector makes to rhino conservation.

### **Financial Benefits of Rhino Ownership**

Many owners of hunting and tourism-based ranches and all reserve managers who we interviewed noted that having rhinos on the property (especially as part of the Big 5) helps differentiate an operation from competitors' ranches, thereby attracting tourists and increasing revenues. Four ranchers originally bought rhinos for breeding to generate revenues from live sales, although these ranchers have since sold most of their herd and keep only a few rhinos they can more easily protect. Only one rancher mentioned offering rhino hunting in the past. In all

cases, respondents stated that additional revenues generated from rhinos were insufficient to cover security costs.

All ranchers in our sample indicated that if horn trade were legalized they would be eager to participate, in large part because it would provide an additional source of income that could be used for covering security costs. One rancher noted that he originally did not think trade legalization was a prudent idea, but has since decided it is the only way to conserve rhinos. All other ranchers were strongly in favor of a well-regulated horn trade, as demonstrated by the following quotes:

If you encourage it to be bred commercially and it pays, it will stay. The rhino is not currently paying its way and therefore it will not stay.

[Income from horn trade] would just go back to rhinos. And then it wouldn't be such a cost to people. They might actually want rhinos again.

Most reserve managers we interviewed were pro-trade, although they noted that the decision to participate in horn trade would not be made by them. One reserve manager noted that, as an individual, he was against legalizing trade, but as a reserve manager, he saw merit in participating and acknowledged that trade legalization would provide an additional income stream for the reserve that could be used for security costs.

At the time of the interviews, the domestic trade moratorium was still in place and respondents were undecided about the potential effect of domestic legalization. One rancher we interviewed was confident that domestic trade would be helpful. He cited the sizeable Chinese population in South Africa and he was of the opinion that if he could sell horns to the domestic Chinese population then he could afford to protect his rhinos. Several other ranchers in our sample were more skeptical. These respondents were of the opinion that there would only be significant demand if the horn that is traded domestically is smuggled out of the country to Asia.

## **The Responsibility to Conserve Rhinos**

All reserve managers in our study mentioned that they felt a responsibility to nature and the environment to conserve rhinos because rhinos are imperiled. These managers cited the directives of their reserves which mandate: (a) the reintroduction of all species that are native to the area and (b) the maintenance of well-functioning ecosystems. Most managers sampled noted that white rhinos fill an ecological niche as productive grazers.

Nearly all ranchers we interviewed tended to focus more on their responsibility to their children and grandchildren. For these ranchers, doing their part to conserve rhinos was their way of doing “the right thing” for future generations, as demonstrated by the following quotes:

[I keep rhinos] because I feel that it is my responsibility so that my grandchildren can one day see rhinos. I have taken on this responsibility and I have made the choice and I have to do it.

You want your grandchildren and everyone else to see a rhino. So we’ve got to keep the rhinos alive.

## **Emotional Attachment to Rhinos**

Most ranchers in our study spoke about a strong emotional attachment to rhinos, stating that rhinos have “the best personalities” and characterizing rhinos as “majestic” and “gentle.” One respondent used the term “underdog” to describe rhinos, and many owners stated their relationship with rhinos is unique because rhinos need the protection of landowners to survive. This attachment to the rhino is epitomized by the following quotes:

But rhino is a passion of ours. And we believe that we have to protect them.

You know these things need your help more than anything else. You know you need to protect them.

Given that they viewed rhinos as persecuted and in need of special care, many respondents mentioned they have a strong attachment to their rhinos that they do not have with other species on the land. Rhinos were often referred to as “part of the family.” For example:



My rhinos have names. I've seen them born. I know their characters. I know their personalities.

Losing a rhino – it's like losing a family member. I'm 73 years old and I cried more than 10 days when I had a loss from rhino poaching. It's very emotional.

Multiple ranchers in our sample commented that they believe that if rhinos are able to be saved from extinction it will be due to the efforts of the private sector.

### **Discussion**

Our intention in conducting this study was to identify the financial and nonfinancial considerations that drive private landowner decision-making with regards to rhino ownership. To date, our respondents have kept rhinos on their lands, largely due to nonfinancial considerations, in particular a sense of responsibility for the protection of rhinos, concerns about the continued existence of rhinos, the desire to protect rhinos for future generations, and an emotional affinity for rhinos. However, all respondents also stressed the need for additional financial returns from rhinos to finance the continued protection of these species on their lands. Respondents placed particular emphasis on the need for legalized trade in rhino horn, which would provide considerable revenues and would not harm rhinos, according to those interviewed.

Child (2012) previously documented the limited financial benefits currently available to rhino owners, which include: trophy hunting, live sales, and ecotourism. None of our respondents currently offered rhino hunting and those who invested in rhinos for live sales purposes had reduced their rhino herds (given the significant costs of protecting them). Although rhino ecotourism was not considered profitable, many ranchers and all reserve managers believed the presence of rhinos, particularly as part of the Big 5, attracted additional tourism to their operations. This finding is consistent with Maciejewski and Kerley (2014), although they cautioned against the introduction of species outside of their natural ranges for tourism purposes.

Respondents' protection of rhinos is consistent with findings that conservation behavior can be motivated by feelings of personal and moral responsibility to protect a species or the environment (Hines et al., 1987; Kaiser & Shimoda, 1999). Based on our findings, there were multiple nonfinancial motivations for respondents' protection of rhinos, including (a) their level of environmental concern (which was particularly apparent during interviews with reserve managers who were typically trained ecologists), (b) the behavioral and physical characteristics of rhinos (which was apparent in how respondents described the characteristics of rhinos), (c) an emotional attachment to rhinos (which manifested itself in statements that rhinos are like members of the family), and (d) an awareness of the need and responsibility for protecting the rhino (which tended to be expressed as the need to protect the rhino because it is an underdog). Furthermore, ranchers in our study stated that it was important to them to protect rhinos for their children and grandchildren, which is consistent with the economic concept of bequest value, the value of ensuring rhinos will be protected for future generations (Laurila-Pant et al., 2015).

During interviews, respondents stressed the multiple costs of rhino ownership. We infer that this was an attempt to demonstrate the level of commitment respondents have made in owning and conserving rhinos (i.e., they were trying to emphasize how much value they place on the continued existence of rhinos). These costs are both financial and nonfinancial in nature, and the safety threats associated with rhino ownership were emphasized by respondents.

Although the financial costs of rhino ownership in terms of anti-poaching enforcement have been previously established (Ferreira et al., 2014b; Collins et al., 2016, ranch-scale estimates of security costs are typically missing from the literature. Our respondents estimated that they spend between ZAR 20,000 and ZAR 50,000 (2017 USD \$1500–3700) per month on security costs, although one larger rancher estimated his costs considerably higher at ZAR 3

million per month. Payments for security personnel, firearms, cameras, fences, and other equipment form a large part of these security expenses (see also Collins et al., 2016), but respondents also pay for intelligence about poaching threats, a strategy that has also been adopted by Kruger National Park officials (Buscher & Ramutsindela, 2015). The costs of dehorning rhinos and securing horns off-site were also raised by respondents. As noted by Lindsay and Taylor (2011), dehorning costs can range from \$125 to \$1600 per event, depending on the scale of the operation. Despite multiple measures to protect rhinos on their lands, all respondents had experienced at least one rhino poaching event, and they characterized these events as traumatic precisely because they have such a strong attachment to their rhino herds.

Consistent with Wright et al. (2016), we found that respondents were also concerned about safety threats to their families from the presence of rhinos on their property. This psychological stress is exacerbated by the physical dangers that both ranchers and reserve managers bear when protecting rhinos from poaching threats (see also Duffy, 2014; Humphreys & Smith, 2014; Lunstrum, 2014; Buscher & Ramutsindela, 2015). Annecke and Masubelele (2016) and Neme (2014) have previously documented the psychological trauma associated with protecting rhinos from poaching threats on public lands, and the majority of our respondents described similar stresses, noting that these psychological and emotional stresses have resulted in divorce or exit from the game ranching industry.

Based on our interviews, it would appear that these stresses are further compounded by ranchers' frustration with how the legalized trade in horn and their support for this trade is characterized by the international public. Similar to legalizing the trade in drugs (see Miron, 2003), legalizing the trade in rhino horn is heavily debated (see Ferreira & Okita-Ouma, 2012; Biggs et al., 2013; Di Minin et al., 2014). Ranchers in our sample viewed opposition to the legal

trade in horn as emotive and based on inaccurate and misleading information. In particular, they expressed frustration and anger with international NGOs that they perceive to be financially exploiting the poaching crisis rather than promoting pragmatic approaches to conservation (see also Wright et al., 2016). Respondents were further frustrated by the fact that although they are helping to conserve rhinos they receive no financial assistance with anti-poaching enforcement and are vilified on social media. Respondents viewed the legalization of rhino horn trade as a means to earn sustainable revenue streams that could be used to finance security costs (Child, 2012; Biggs et al., 2013), not as a means for exploiting rhinos.

As noted by our respondents, the considerable costs of managing and protecting rhinos not only directly affect the financial viability of game ranches and reserves, but these costs also indirectly affect other wildlife and habitat. According to one reserve manager, allocating such a large share of financial resources to rhinos siphons both funding and time away from alternative conservation actions (see also Humphreys & Smith, 2014; Buscher & Ramutsindela, 2015). As documented by Annecke and Masubelele (2016), Kruger National Park rangers spend up to 90% of their time on security, leaving only 10% for conservation activities, which may have a long-term impact on habitat, biodiversity, and ecosystem services.

### **Limitations**

Although our findings help to extend the existing literature by providing additional insights into private rhino owners' decision-making, we recognize several limitations of our study. For example, the long timeframe of data collection may have influenced our results from the different sets of interviews. Additionally, similar to many exploratory qualitative studies, our small sample size means that we must caution against using our findings to make inferences for the larger population of game ranchers in South Africa as our results may not be generalizable

(Berg, 2001). Larger-scale, quantitative research is required to understand the motivations and decision-making by private game ranchers in South Africa specific to rhinos.

We also recognize the potential for bias in the data collection and data analysis processes. Our interview questions were pretested with methodological experts and our study population, which is a strategy to reduce bias in questions and ensure the validity of the interview instrument (Berg, 2001). Nonetheless, there is potential for bias in qualitative analysis, which we attempted to minimize through comparisons of findings to test for intercoder reliability (Berg, 2001).

### **Conclusion**

South Africa's sustainable use paradigm is a prime example of market-based conservation (i.e., wildlife remains on private lands if it is profitable). But, explaining rhino ownership as merely a financial cost-benefit analysis is clearly an oversimplification. Ranchers continue to keep rhinos on their land, despite the considerable costs and risks associated with rhino ownership. According to a purely financial analysis, this decision is irrational and should not occur. Yet, our findings show that the decision to own rhinos is not irrational. In economics parlance, rhino owners are utility-maximizing in that they have considered all of the financial and nonfinancial costs and benefits associated with rhino ownership, and they continue to engage in rhino conservation because they derive net benefits from rhino ownership. Our findings suggest that the benefits of rhino ownership are primarily nonfinancial and are strongly grounded in an emotional attachment to rhinos and a sense of responsibility for the continued existence of rhinos. Although we acknowledge that ranchers may also own rhinos because they anticipate considerable earnings from the legalization of the rhino horn trade (i.e., rhino owners may be speculating on future returns from selling rhino horn), our research was conducted prior to the legalization of the domestic trade in rhino horn. At the time that we conducted this research, the

potential financial returns from rhino ownership were insufficient to cover the costs of rhino ownership (see also Child, 2012).

Understanding private rhino owners' motivations for owning rhinos, and the financial and nonfinancial constraints and obstacles they face is important for designing appropriate policies and programs to support rhino conservation in South Africa. As already discussed, private lands are critical to continued rhino conservation. Although our results are not generalizable to the larger population of game ranchers in South Africa, our findings suggest that rhino owners would value financial assistance with anti-poaching efforts. Furthermore, our results indicate that rhino owners would value recognition of the role they play in rhino conservation efforts, and that these individuals and their families may require support to address the psychological and emotional stresses of protecting rhinos.

CHAPTER 4  
RHINOCEROS OWNERSHIP AND ATTITUDES TOWARDS GLOBAL HORN TRADE  
LEGALIZATION WITHIN SOUTH AFRICA’S PRIVATE WILDLIFE SECTOR

Black (*Diceros bicornis*) and white (*Ceratotherium simum*) rhinoceros (hereafter, ‘rhino’) populations across Africa continue to be threatened by poaching, which has been fueled by Asian demand for rhino horn (Ferreira et al., 2014b; Collins et al., 2016). Increased poaching has stimulated debate about the efficacy of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) global rhino horn trade ban in protecting rhinos, and whether the trade ban should be overturned (see Biggs et al., 2013; Ferreira et al., 2014b). Much of this debate has been abstract. The opinions of private wildlife ranchers, and their willingness to participate in horn trade, have been largely overlooked despite the fact that these individuals protect a third of the remaining South African rhino population on their properties (Rademeyer, 2016). This information is critical to designing effective and appropriate policies to conserve rhinos.

South Africa’s private wildlife ranching sector, grounded in the ‘sustainable use approach’ to wildlife management, has been vital to rhino conservation efforts (see Child, 2012). However, increased poaching pressures have resulted in escalating costs of rhino ownership, in particular security costs to protect rhinos from poaching threats (Ferreira et al., 2014b; Collins et al., 2016). It has been asserted that these costs outweigh the financial returns of rhino ownership (Child, 2012), thereby forcing wildlife ranchers to remove rhinos from their lands (Ferreira et al., 2014b)—which in turn undermines rhino conservation in South Africa.

In April 2017, private rhino owners were granted the right to commercially trade horn within South Africa (Jones, 2017b) – a policy decision that is consistent with the sustainable use paradigm in South Africa. The intention is that private rhino owners may earn sufficient revenue from domestic trade in rhino horn to offset the security and management costs associated with

rhino ownership (Jones, 2017a) – thereby allowing private ranchers to continue financing rhino conservation on their lands. Whether the domestic trade will be sufficient to offset the costs of rhino ownership remains unclear because the demand for horn primarily stems from Asia, and international trade in rhino horn is still banned under CITES (Ferreira et al., 2014b). As a result, the Private Rhino Owners Association (PROA) has advocated for the implementation of global horn trade (Jones, 2017a,b).

There is little peer-reviewed evidence on private ranchers' attitudes towards rhino conservation, and how they might be assisted in conserving rhinos. There is also little evidence on the costs of rhino ownership, despite claims that the costs of rhino ownership exceed the revenues that can be earned. To the best of our knowledge, two qualitative studies of rhino owners and land managers (Wright et al., 2016; Rubino & Pienaar, 2018) are the only peer-reviewed papers that address these issues. The lack of research into the realities of private rhino ownership likely stems from private ranchers' distrust of conservation organizations (see Wright et al., 2016) and their unwillingness to share sensitive rhino-related data for fear of information leaks and associated poaching threats (Davies-Mostert, 2014). Moreover, the private wildlife ranching community in South Africa tends to avoid scientific research in favor of its autonomy (Davies-Mostert, 2014), despite the potential benefits of such research to their livelihoods and conservation on their lands. As a result, there have been relatively few attempts to investigate the degree to which the private wildlife ranching sector engages in conservation and stewardship activities, and their motivations for stewardship (see van der Waal & Dekker, 2000; Lindsey et al., 2006; Cousins et al., 2008; Taylor et al., 2015; Pienaar et al., 2017).

To fill these gaps in the literature and to better understand whether legalizing the horn trade might be expected to incentivize rhino conservation on private lands, we implemented a



quantitative survey. The objectives of this research were to: (1) obtain a better understanding of ranchers' motivations for owning rhinos, (2) investigate how rhino ownership affects ranchers' income and operations, and (3) explore wildlife industry members' attitudes towards the legalization of global horn trade.

## **Methodology**

### **Survey Design**

An electronic survey was administered to members of the South African private wildlife ranching industry from February through April 2017. The survey was designed to elicit respondents' opinions about how the legalisation of global trade in rhino horn might impact rhino conservation. One of the major objections to removing the CITES ban on global horn trade is that this would result in intensive rhino farming, which is inconsistent with rhino conservation on extensive areas of native habitat (Wright et al., 2016). Accordingly, we asked respondents their opinion about intensive rhino farming and whether ranchers who participate in the trade of rhino horn should be required to own a minimum amount of land per rhino. Respondents were also asked a series of questions related to their wildlife operation, including the activities in which they participate (e.g., hunting, wildlife breeding, photographic tourism, wildlife meat production) and the amount and location of the land they manage.

Questions that might be considered sensitive were placed after these initial questions to reduce respondents' skepticism about the motivations for the survey (see de Leeuw et al., 2008). We asked respondents if they currently own rhinos, to which they could provide three responses: 'yes', 'no', or 'I prefer not to answer'. This latter option was included because rhino ownership is a sensitive topic (Davies-Mostert, 2014; Wright et al., 2016), and we wanted to encourage participants to answer truthfully so as not to bias our results (see de Leeuw et al., 2008). Rhino owners were asked about expenses and risks associated with rhino ownership, as well as the

reasons they choose to own rhinos. Non-rhino owners and respondents who preferred not to state whether they own rhinos were asked to state their concerns related to rhino ownership, and whether they owned rhinos in the past. All respondents were asked about their trust in South Africa's Department of Environmental Affairs (DEA) and provincial environmental departments. These government agencies are directly relevant to rhino management and the trade in rhino horn and qualitative interviews with rhino owners (that were conducted as part of the survey design process) indicated concerns that interactions with government agencies (e.g., applying for dehorning permits) may lead to poaching incidents. Respondents were also asked whether they are concerned that land reform will negatively affect their wildlife operations. We included these questions because social trust and government policies may affect wildlife ranchers' decision-making (see Davies-Mostert, 2014). The survey was approved by the University of Florida Institutional Review Board (IRB201601671).

### **Survey Implementation**

Our study population included any individual who participates in a private wildlife-based operation in South Africa. We pre-tested our survey using cognitive testing (Alaimo et al., 1999) at the January 2017 Dallas Safari Club (DSC) convention with members of the study population, specifically South African professional hunters and wildlife ranchers. The survey, which was available in both English and Afrikaans, was distributed through several channels:

- We attended the Safari Club International (SCI) convention to meet with hunting outfitters and hand out flyers about the survey. We generated a list of these outfitters and sent them an email invitation to take the survey after the convention.
- The Professional Hunters' Association of South Africa (PHASA) and the South African Hunters and Game Conservation Association (SAHGCA) included a link to the survey in their newsletters.
- We directly contacted members of PHASA, based on an online membership list.

- We cultivated our own list of potential respondents by conducting an Internet search using keywords such as ‘wildlife ranching’, ‘game ranching’, and ‘game hunting’ for each of the nine South African provinces. We used advertisements in recent issues of the Wildlife Ranching South Africa (WRSA) magazine to identify additional respondents.
- Finally, respondents reached out to us suggesting we contact their colleagues in the wildlife industry who would be interested in our research. This referral-based sampling (Biernacki & Waldorf, 1981) increased our total number of completed surveys.

We made follow-up phone calls to all individuals who were initially contacted via email if their phone numbers were publicly available. The majority of responses were collected online via Qualtrics Survey Software, but some respondents preferred to complete the survey over the phone or in-person.

### **Data Analysis**

To determine if rhino owners had differing demographic characteristics, concerns, and opinions from non-owners, we analyzed responses based on individuals’ current rhino ownership status. We compared the answers of rhino owners and non-owners (excluding respondents who preferred not to disclose their rhino ownership status because we could not determine whether they were rhino owners). For comparisons of nominal variables, we used Fisher’s exact test, which corrects for small sample sizes (McDonald, 2009). We also tested for differences in mean responses to statements between rhino owner and non-rhino owner groups (see McDonald, 2009).

## **Results**

### **Response Rate**

We received completed surveys from 171 respondents. We achieved a 100% response rate during pre-testing and among referrals. Response rates from the SCI convention (18.4%), PHASA membership list (16.4%), and our cultivated list (12.2%) were lower. Response rates

from the two newsletters cannot be calculated because it is unclear how many potential respondents actually received the link to the survey.

### **Characteristics of the Sample**

Nearly all respondents (95.3%) were male and the median age of respondents was between 46 and 55 years old. There was no statistical difference between rhino owners and non-rhino owners with regards to their gender (Fisher's exact test,  $p = 0.619$ ) or age ( $p = 0.324$ ).

The majority of respondents offered at least one form of hunting on their ranches (86.6% trophy hunting; 57.3% biltong hunting) (Tab. 4-1). Approximately half of all respondents engaged in at least one form of live wildlife sales (53.0% sale of plains game; 48.5% sale of rare species and/or color variants). Nearly 40% of respondents engaged in photographic tourism and wildlife meat production. Respondents derived the largest share of their wildlife-based income from trophy hunting activities (46.7%). When comparing rhino owners to non-owners, non-owners derived a larger share of their wildlife-based income from trophy hunting ( $t = -2.71$ ,  $p = 0.008$ ), whereas rhino owners derived a larger share of their income from live sales of rare species and color variants ( $t = 3.50$ ,  $p = 0.001$ ; Tab. 4-1).

The distribution of annual, pre-tax incomes for respondents was approximately U-shaped with 24.9% of all respondents (including respondents who preferred not to state whether they own rhinos) earning less than ZAR 1 million in pre-tax income and 20.1% of all respondents earning in excess of ZAR 7 million in pre-tax income (Fig. 4-1). Rhino owners had significantly higher incomes than non-rhino owners (Fisher's exact test,  $p = 0.002$ ).

Nearly a third (32.0%) of all respondents owned, leased, and/or managed more than 5,000 hectares of land, whereas 18.3% owned 1,001 to 2,000 ha., 11.2% owned 2,001 to 3,000 ha., and 11.2% owned 3,001 to 4,000 ha. Rhino owners owned significantly more land than non-rhino owners (Fisher's exact test,  $p = 0.020$ ).

The majority (52.7%) of all respondents owned, leased, and/or managed land in Limpopo province. The percentage of respondents who owned, leased, and/or managed land in other provinces ranged from 17.5% (Eastern Cape) to 2.3% (Mpumalanga). A subset of respondents owned, leased, or managed land in multiple provinces.

### **Decisions about Rhino Ownership**

Thirty-three respondents (19.3%) stated that they currently own rhinos. Best estimates suggest there were approximately 330 private rhino owners in South Africa in 2016 (CITES Management Authority, 2016), indicating that we received responses from at least 10% of this population (not accounting for the 24 individuals who preferred not to state if they own rhinos). A total of 20 rhino owners (over 60% of owners surveyed) currently dehorn their rhinos.

Both rhino security costs (e.g. salaries and accommodations for guards, equipment) and management costs (e.g., supplemental feed, dehorning, insurance, management plan/consulting, and permit costs) were sizeable monthly expenditures. Security costs tended to exceed management costs (Fig. 4-2). Median monthly security costs among respondents were in the range of R50,001 to R100,000 (~2017 USD \$3,700 - \$7,300) and median monthly management costs were less than R50,000. Aggregate expenditures across respondents indicated that surveyed rhino owners spend at least R3,600,023 (~\$275,000) per month on security costs and R2,900,016 (~\$222,000) per month on management costs. On average, surveyed rhino owners incurred approximately R109,100 (~\$8,000) per month in security costs and R87,900 (~\$6,400) per month in management costs (Fig. 4-2). There was no significant relationship between land size and security (Fisher's exact test = 0.944) or management costs (Fisher's exact test = 0.580) (Tab. 2-2).

The majority of rhino owners indicated that their financial costs always (69.7%) or almost always (15.2%) exceed the revenues generated from rhinos. Fewer owners stated that

their financial costs sometimes (9.1%) or rarely (6.1%), exceed revenues generated from rhinos. No owners stated that these costs never exceed revenues.

Rhino owners were further asked to indicate their level of concern about risks associated with rhino ownership (scale of 1 to 4; 1=not at all concerned, 4=very concerned). Their median responses were that they are ‘very concerned’ about rhinos being poached, government decisions related to rhino ownership, and the safety of their family and employees (Tab. 4-3).

As a result of the substantial expenses and risks associated with rhino ownership, the majority of rhino owners admitted that they either frequently (54.6%) or occasionally (24.2%) consider removing rhinos from their lands. Only a small portion of rhino owners stated that they rarely (9.1%) or never (12.1%) consider removing their rhinos. When asked why they continue to keep rhinos, owners largely cited a passion for rhino conservation (94.0%). Other key reasons for rhino ownership included that rhinos are attractive to visitors (57.6%), that respondents want to have all of the native species possible on their lands (45.5%), and that respondents consider rhino horn to be a potentially valuable investment (45.5%). Less common reasons for rhino ownership included that respondents wanted to have the Big 5 on their land (27.3%), that rhinos serve as good grazers and/or browsers for the land (24.2%), and that respondents offer rhino hunting (24.2%).

Respondents who did not own rhinos (n=112) or preferred not to state whether they own rhinos (n=24) were asked their level of concern about rhino ownership (Tab. 4-3). The median response by these respondents indicated that they were ‘very concerned’ about rhinos being poached, government decisions related to rhinos, and safety risks to their families. Of these 136 respondents, 33 had owned rhinos in the past. When asked why they no longer own rhinos, these

respondents primarily cited the dangers of poaching (39.4%), past poaching events (33.3%), and the high financial cost of rhino ownership (18.2%).

### **Respondents' Attitudes towards Government**

The majority of respondents thought that interacting with the DEA either definitely (51.8%) or probably (25.9%) increases the risk of poaching events. Beliefs about provincial government were similar, with most respondents stating that interacting with their provincial environmental department definitely (46.1%) or probably (27.5%) increases the risk of poaching. Other respondents were unsure of this linkage, with 14.5% and 18.0% of respondents believing that interacting with the DEA or their provincial department, respectively, may increase the risk of poaching. Only 7.8% and 8.4% of respondents believed the interacting with the DEA and their provincial environmental department, respectively, probably or definitely does not increase the risk of poaching. When comparing the responses of rhino owners and non-rhino owners (excluding respondents who preferred not to disclose their current rhino ownership status), there was no statistical difference between rhino owners and non-owners with regards to their beliefs about the risks of interacting with the DEA (Fisher's exact test,  $p = 0.451$ ) or provincial environmental departments ( $p = 0.327$ ).

Respondents were also asked how concerned they were that land reform may negatively impact their wildlife operations (scale of 1-4; 1=not at all concerned, 4=very concerned). The median level of concern was 4 and the mean level of concern was 3.39 ( $SD=0.90$ ). There was no significant difference in the mean level of concern between rhino owners ( $M=3.21$ ,  $SD=0.96$ ) and non-owners ( $M=3.46$ ,  $SD=0.85$ ) ( $t= -1.37$ ,  $p=0.173$ ).

### **Respondents' Attitudes towards Global Horn Trade Legalization**

The majority of respondents strongly agreed that legalizing the global rhino horn trade will: benefit rhino owners (81.9%); benefit rhino conservation (81.3%); and reduce rhino

poaching (63.2%) (Tab. 4-4). Although the majority of respondents (62.6%) strongly agreed that it would be acceptable if horn trade legalization led to intensive rhino farming, they also agreed (36.3%) or strongly agreed (42.7%) that there should be a minimum land size requirement for participation in the horn trade market to incentivize habitat conservation. We found a significant difference between rhino owners and non-owners with regards to their beliefs that legalization will benefit rhino owners (Fisher's exact test,  $p = 0.006$ ) and rhino conservation ( $p = 0.011$ ) – with rhino owners showing more support for both of these statements (Tab. 4-4).

### **Discussion**

Similar to Taylor et al. (2015), we relied on multiple modes to recruit survey participants because of new privacy laws protecting government and industry organization membership lists. Our response rates were similar to those achieved by Lindsey et al. (2006) and van der Waal and Dekker (2000). We expected difficulties in recruiting respondents given the sensitive subject of our survey (Davies-Mostert, 2014; Wright et al., 2016). Surveys on sensitive topics tend to suffer from higher levels of nonresponse bias (de Leeuw et al., 2008).

Although our sample size of 33 rhino owners is small, this accounts for approximately 10% of rhino owners in the country (CITES Management Authority, 2016). Compared to non-owners, we found that rhino owners have significantly higher incomes and landholdings. They also derive less of their income from trophy hunting and more of their income from the live sales of valuable game species. The breeding of high value species (rare species and color variants) may provide rhino owners with the income needed to finance rhino ownership as prices of high value species may reach hundreds of thousands of dollars (Taylor et al., 2015).

While studies reference the substantial financial burden of anti-poaching security costs for private landowners (Ferreira et al., 2014b; Collins et al., 2016), estimates of these costs are missing from the literature. Rhino owners in our sample spend approximately R109,100 per



month on security costs and R87,900 per month on management costs related to their rhinos. We note that dehorning costs (which were included in management costs for this study) could be considered security costs. As such, our estimates of security costs are likely an underestimate of the true financial costs of protecting rhinos.

The size of these monthly expenditures provides insight into why 69.7% of owners stated that rhino-related costs exceed the revenues from owning rhinos. Wright et al. (2016) also found that rhino owners and land managers were concerned that the costs of protecting rhinos undermine the financial viability of their reserves. For our study, only 45% of owners considered rhinos to be a good future financial investment in terms of the value of their horn, although 58% stated that they were attractive to visitors – which may translate into higher tourism revenues. The prevailing reason for rhino ownership was a passion for rhino conservation, which is an inherently non-financial motivation for rhino ownership (see also Rubino & Pienaar, 2017).

All respondents, regardless of rhino ownership, provided identical ranking of the risks associated with owning rhinos. They expressed greatest concern about the risks of rhinos being poached and government decisions related to rhino ownership. This indicates that non-owners recognize the main risks of rhino ownership (as defined by rhino owners).

Respondents' concerns about poaching threats are consistent with our finding that previous owners removed rhinos from their land because it put their ranches in danger of poaching events. Our finding that both rhino owners and non-owners are concerned about how the presence of rhinos on their properties affects the safety of their families is consistent with the findings of Wright et al. (2016).

The majority of respondents believed interacting with the DEA (77.7%) and provincial environmental departments (73.7%) increased poaching risks. This is consistent with a few

documented cases of corruption of South African national and provincial conservation officials and members of the police force by the illegal rhino horn trade, and arrests of government employees related to rhino poaching (Montesh, 2013; Rademeyer, 2016). Lack of trust in government may be further reinforced by land reform in South Africa. Land reform is an emotional and uncertain political issue, and there are significant societal divisions regarding the implementation of land reform (Sebola & Tsheola, 2014).

Our respondents' positive attitudes towards the legalization of rhino horn trade are consistent with the minimal literature documenting the attitudes of rhino owners and other wildlife-industry stakeholders towards rhino horn trade. Nine of 10 rhino owners and 6 of 15 reserve managers interviewed by Wright et al. (2016) either strongly agreed or agreed that horn trade should be legalized. Similarly, a polling question by the Private Rhino Owners Association of South Africa found that 85% of its members supported horn trade legalization in 2015 (10% undecided and 5% anti trade) (Jones, 2017a).

We found that 97.7% of respondents either strongly agreed or agreed that legalizing the global rhino horn trade would benefit rhino owners. As a comparison, Wright et al. (2016) found that 84% of their 25 respondents believed that legalization would result in additional income to rhino owners and 60% believed it would increase the value of live rhinos. While 98.3% of our respondents either strongly agreed or agreed that legalization will benefit rhino conservation, only 64% of respondents of Wright et al. (2016) believed legalization will better protect rhinos, 56% believed it would result in an expanded rhino range, and 40% believed it would result in increased rhino populations. We also found that 92.4% of respondents strongly agreed or agreed that legalization will reduce rhino poaching, which is higher than the 20% of the respondents of Wright et al. (2016) who believed legalization would reduce the incentive to poach.

Interestingly, although 91.8% of our respondents strongly agreed or agreed that it would be acceptable if horn trade legalization led to intensive rhino farming, 79% of our respondents also strongly agreed or agreed that participation in the horn trade should require a minimum land size per rhino to ensure increased habitat conservation. This indicates that these two ideas are not mutually exclusive to respondents. This may be because respondents do not believe that legalizing the trade in horn will result in large-scale, intensive rhino farming. Additionally, rhino owners in our sample managed or owned larger areas of land than non-owners. Thus, respondents may be of the opinion that rhino owners (or potential rhino owners) likely have sufficient land to fulfill any minimum land requirement per rhino.

### **Conclusion and Policy Implications**

Understanding the perspectives of current and potential rhino owners about legalizing the trade in rhino horn is important because they will be directly affected by horn trade policy changes (Wright et al., 2016) and have a key role to play in rhino conservation as the stewards of a third of South Africa's rhino population (Rademeyer, 2016). However, to date there has been limited research on these individuals, their reasons for owning or not owning rhinos, and their level of support for legalization of the rhino horn trade. Our findings extend this limited literature, and provide support for some of the key findings of that literature with regards to wildlife industry member support for trade in rhino horn. However, given our small sample size, we would caution against using our results to make inferences for all rhino owners and the wildlife ranching community of South Africa.

Nonetheless, we were able to recruit sufficient participants to gain some useful insights into decision-making by rhino owners. By also surveying individuals who do not currently own or manage rhinos, we were able to explore how rhino owners differ from non-owners – which to the best of our knowledge has not been done to date. Understanding the characteristics of rhino

owners (e.g., higher income individuals, high-value species breeders, etc.) is important when generating policies to incentivize rhino conservation. Additionally, our estimates of ranch-scale security and management costs indicate that rhino owners are making a substantial financial contribution to rhino conservation, without receiving any government or conservation agency funding in return (Child, 2012). They are also bearing non-financial burdens in terms of concerns for the safety of their families and employees. Documenting the financial and non-financial costs that rhino owners bear is critical to understanding why they may support efforts to legalize the trade in rhino horn. Rancher support for horn trade legalization may be driven by the need to cover the costs of rhino security and management, in order to keep rhinos on private lands (Child, 2012; Biggs et al., 2013). Maintaining or increasing the number of rhinos on private lands (because the costs are offset by revenues from legal horn trade) is consistent with ensuring the future existence of the species.

Wildlife ranching industry members who do not own rhinos were also broadly supportive of global horn trade legalization. Understanding the perspectives of wildlife ranchers who do not own rhinos is important because these people, who are already invested in the wildlife industry, will likely be more easily incentivized to participate in rhino conservation. These individuals already have the required wildlife ranches and infrastructure, but they likely also need the assurance that they can earn sufficient income to cover the costs of rhino ownership. Their support of global horn trade legalization suggests that legalization may be an incentive needed to participate in rhino ownership and conservation. We also note that, while respondents were not opposed to intensive rhino farming, they were also largely supportive of minimum land requirements for rhino owners who wish to engage in horn trade. This indicates that there is

potential for trade in rhino horn to be a driver of conservation of habitat and other wildlife that coexists with rhinos.

While the outcomes of domestic horn trade legalization remain to be seen, our results suggest that this may be an important step towards keeping rhinos on private lands by allowing ranchers to defray the costs of rhino ownership. There has been opposition to horn trade legalization by conservation interest groups, who consider the horn trade to be unethical (Wright et al., 2016). Our paper is not intended to address those issues. Rather, we sought to better document the realities of rhino ownership on private lands, and why rhino owners and other wildlife industry members in South Africa support the trade. Understanding their opinions and constraints is important to policy design and debate about the legalization of rhino horn trade.

Table 4-1. The percentage (and number) of respondents engaged in different wildlife industry activities and the average percentage of income derived from these wildlife industry activities.

Industry Activity	Current Rhino Ownership Status						T-test Results (yes/no)	
	All Respondents <sup>a</sup>		Yes		No		t-statistic	p-value
	Mean	S.D	Mean	S.D.	Mean	S.D.		
Trophy Hunting 86.6% (148)	46.7%	32.67	33.6%	27.26	50.6%	32.64	-2.71	0.008*
Biltong Hunting 57.3% (98)	11.7%	17.01	8.8%	13.38	13.0%	18.17	-1.23	0.220
Live Sales Plains Game 53.0% (92)	9.3%	14.94	12.3%	17.25	7.8%	12.32	1.62	0.107
Live Sales Rare Species 48.5% (84)	17.0%	27.54	31.5%	34.91	12.8%	23.39	3.50	0.001*
Ecotourism 39.8% (68)	7.1%	15.38	6.6%	11.86	6.2%	13.45	0.17	0.865
Game Meat 37.4% (64)	2.9%	4.77	3.1%	3.81	3.1%	5.15	0.01	0.992

<sup>a</sup> Includes survey respondents who preferred not to state whether they own rhinos.

Table 4-2. Monthly security and management costs (in ZAR) by amount of land (in ha) owned and/or managed (by number of respondents).

Sec. Costs	<100	100-500	501-1000	1001-2000	2001-3000	3001-4000	4001-5000	> 5000
No funds	0	0	0	0	1	0	0	0
≤ 50 000	0	0	1	2	1	1	0	4
50 001-								
100 000	1	0	1	1	0	1	0	5
100 001-								
150 000	0	0	0	1	0	0	0	4
150 001-								
200 000	0	0	0	0	0	0	0	2
200 001-								
250 000	0	0	0	0	0	0	0	1
250 001-								
300 000	0	0	0	1	0	0	0	1
> 300 000	0	0	0	0	0	0	1	3
Manage. Costs								
No funds	0	0	1	0	0	0	0	1
≤ 50 000	0	0	1	2	2	2	0	8
50 001-								
100 000	0	0	0	3	0	0	0	2
100 001-								
150 000	0	0	0	0	0	0	1	2
150 001-								
200 000	1	0	0	0	0	0	0	4
200 001-								
250 000	0	0	0	0	0	0	0	0
250 001-								
300 000	0	0	0	0	0	0	0	1
> 300 000	0	0	0	0	0	0	0	2

Table 4-3. Respondents' level of concern about risks of rhino ownership (scale of 1-4).

Risk Factor	Not at all concerned	A Little Concerned	Concerned	Very Concerned	Median	Mean	SD
Rhino Owners							
Rhinos being poached	3.0%	0.0%	6.1%	90.9%	4	3.9	0.56
Govt. Decisions	0.0%	6.1%	18.2%	75.8%	4	3.7	0.58
Safety of Family	0.0%	6.1%	24.2%	69.7%	4	3.6	0.59
Safety of employees	9.1%	6.1%	12.1%	72.7%	4	3.5	0.96
Safety of guests	12.1%	33.3%	18.2%	36.4%	3	2.8	1.07
Other respondents							
Rhinos being poached	6.6%	2.2%	10.3%	80.9%	4	3.7	0.82
Govt. Decisions	10.3%	6.6%	18.4%	64.7%	4	3.4	0.99
Safety of Family	12.5%	9.6%	18.4%	59.6%	4	3.3	1.06
Safety of employees	16.9%	12.5%	24.3%	46.3%	3	3.0	1.12
Safety of guests	19.1%	11.8%	22.1%	47.1%	3	3.0	1.16

Table 4-4. Respondents' attitudes towards global horn trade legalization.

Statement	Answer	All Respondents	Current Rhino Ownership Status		Fisher's Exact Test p-value
			Yes	No	
I believe legalizing the global horn trade will benefit rhino owners	Strongly agree	81.9%	91.0%	77.7%	0.006*
	Agree	15.8%	3.0%	21.4%	
	Neither agree nor disagree	1.2%	3.0%	0.9%	
	Disagree	0.6%	3.0%	0.0%	
	Strongly Disagree	0.6%	0.0%	0.0%	
I believe legalizing the global horn trade will benefit rhino conservations	Strongly agree	81.3%	97.0%	75.9%	0.011*
	Agree	17.0%	3.0%	23.2%	
	Neither agree nor disagree	1.2%	0.0%	0.9%	
	Disagree	0.0%	0.0%	0.0%	
	Strongly Disagree	0.6%	0.0%	0.0%	
I believe legalizing the global horn trade will reduce rhino poaching	Strongly agree	63.2%	81.8%	56.3%	0.090
	Agree	29.2%	15.2%	33.9%	
	Neither agree nor disagree	3.5%	3.0%	4.5%	
	Disagree	2.9%	0.0%	4.5%	
	Strongly Disagree	1.2%	0.0%	0.9%	
It would be acceptable to me if global horn trade legalization led to intensive rhino farming	Strongly agree	62.6%	66.7%	58.0%	0.721
	Agree	29.2%	24.2%	33.9%	
	Neither agree nor disagree	2.3%	3.0%	2.7%	
	Disagree	4.7%	6.1%	5.4%	
	Strongly Disagree	1.2%	0.0%	0.0%	
I think that there should be a minimum land requirement to participate in a legal horn trade so that horn trade results in wildlife habitat conservation	Strongly agree	42.7%	45.5%	42.0%	0.906
	Agree	36.3%	36.4%	37.5%	
	Neither agree nor disagree	9.4%	9.1%	9.8%	
	Disagree	7.0%	3.0%	7.1%	
	Strongly Disagree	4.7%	6.1%	3.6%	

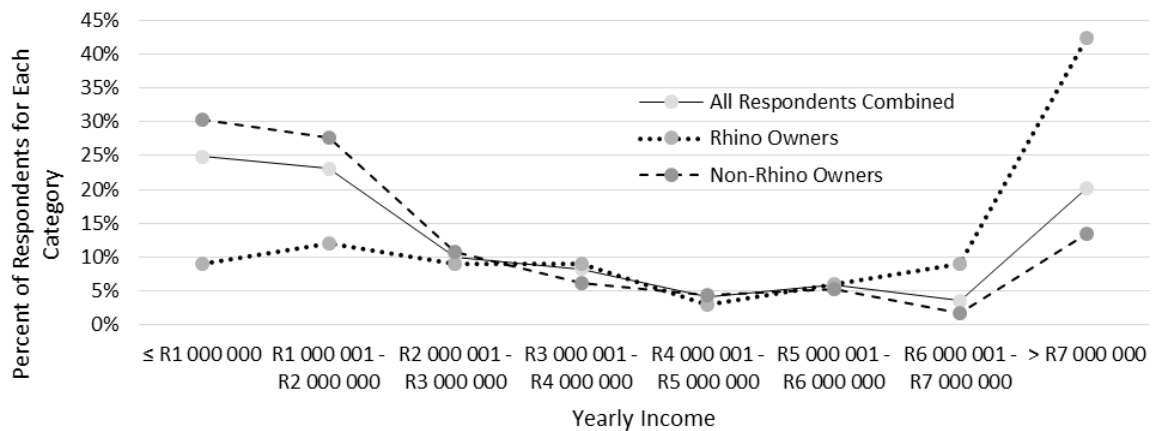


Figure 4-1. Respondents' yearly pre-tax income (1 ZAR ≈ 0.076 2017 USD).



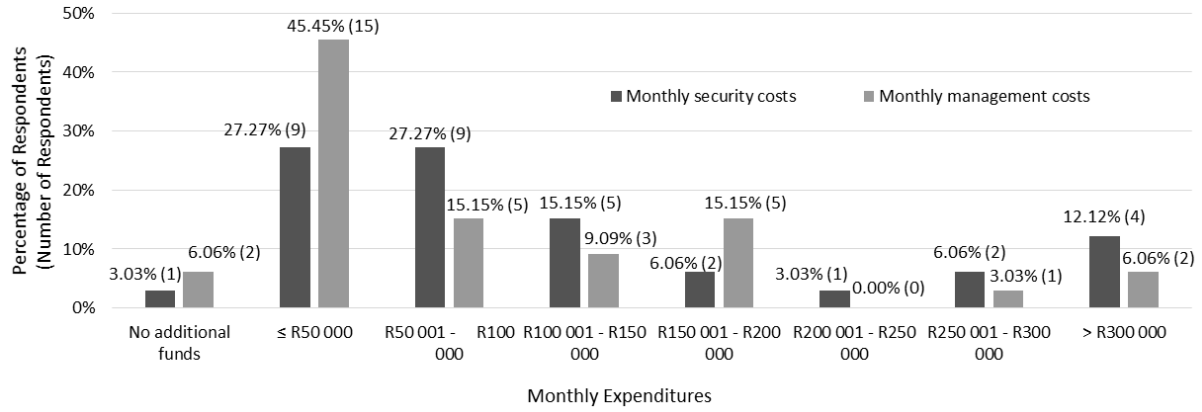


Figure 4-2. Monthly security and management costs associated with rhino ownership (1 ZAR ≈ 0.076 2017 USD).

## CHAPTER 5 INCENTIVIZING SOUTH AFRICAN PRIVATE SECTOR PARTICIPATION IN A GLOBAL LEGAL RHINOCEROS HORN TRADE

Since 1977, the global trade of all rhinoceros (hereafter, ‘rhino’) parts, including the horn, has been banned by the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES). However, with the escalation of poaching events that began in 2008 (Biggs et al., 2013), there is renewed debate about the efficacy of the trade ban (see Biggs et al., 2013; Di Minin et al., 2014; Ferreira et al., 2014b; Crookes & Blignaut, 2015; Haas & Ferreira, 2016). In fact, recent steps have been made by African rhino range states to move towards horn trade legalization. Although it was denied, Swaziland proposed reversing the global trade ban for their rhino population at the CITES Conference of Parties in 2016 (CITES Management Authority, 2016). South Africa, which contains over 80% of the world’s rhino population (Rademeyer, 2016), reversed their domestic moratorium on rhino horn trade in April 2017. Domestic commercial trade of rhino horn is now legal in South Africa and the first domestic sale occurred in August 2017 (Du Toit, 2017).

Because global trade has been banned for 40 years, it is unclear what format legal trade should take. The existing peer-reviewed literature consistently fails to articulate the authors’ assumptions about trade, even while advocating for or against trade. For example, although studies discuss the potential implementation of central selling organizations (CSOs) to facilitate trade (Biggs et al., 2013; Ferreira et al., 2014b), the organization responsible for managing the CSO is routinely overlooked. Other studies simply refer to “trade”, without any explanation of how trade would occur (Crookes & Blignaut, 2015; Haas & Ferreira, 2016). We argue that empirical studies must be explicit about how horn trade is facilitated because the expected supply of horn depends on market structure.

Previous studies are likely not explicit about how trade in rhino horn would be facilitated because it is unclear how the market should be structured to maximize rhino conservation. Furthermore, no research has been conducted on stakeholders' preferences for how trade in rhino horn should be managed or the price per unit horn they require to enter the market. This paper seeks to fill the gap related to supply-side stakeholders' preferences for a global horn trade market. We use economic choice experiments to better understand the market format preferences of current and potential horn suppliers, specifically South African private wildlife ranchers.

Private ranchers are critical stakeholders in rhino conservation in South Africa as a third of rhinos are protected on private lands (Rademeyer, 2016). In fact, private ranchers are credited with the recovery of rhino populations from the brink of extinction in the early 1900s (Child, 2012). This is due to the stewardship incentive provided by South Africa's sustainable use approach to wildlife management, where private landowners are able to secure the user rights to wildlife on their lands (see Child, 2012). In this system, wildlife conservation serves as a source of revenue (e.g. through hunting or photographic tourism), thus incentivizing wildlife management as a land use. By engaging in wildlife conservation, private ranchers are 'supplying' wildlife. Thus, by exploring the market structure preferences of these on-the-ground horn trade stakeholders, we can determine the market structures that are most likely to elicit rancher participation and incentivize rhino conservation.

Choice experiments are stated preference questions that are commonly used in natural resource conservation settings to investigate peoples' preferences for programs or policies (e.g., Pienaar et al., 2014; Soto et al., 2016). In the field of rhino conservation, discrete choice experiments have only been employed twice: to study locals' preferences for rhino management in Nepalese parks (Adhikari et al., 2005), and tourists' preferences for rhino conservation

strategies on a private reserve in South Africa (Lee & Du Preez, 2015). In addition to contributing to the literature by exploring the market structure preferences of potential rhino horn suppliers, this study is a novel application of the best-worst choice experiment methodology in the context of wildlife trade, which affects species all over the world. Furthermore, this research can be applied to other settings where conservation efforts intersect with private property ownership.

## **Methods**

### **Best-Worst Choice Methodology**

To understand the horn trade market preferences of private wildlife industry stakeholders, we employed stated preference choice experiments. Unlike revealed preference methods which can be used to study real market behavior, stated preference methods are often used because real-world observations are not available (Freeman et al., 2014). In this case, the use of stated preference methods to explore a hypothetical global rhino horn market is required because the market does not yet exist.

We utilized a new development in choice experiments, the best-worst choice (BWC) methodology, for this study. The BWC methodology generates richer insights by combining best-worst scaling (BWS) methods with a traditional dichotomous choice experiment (DCE). The BWC methodology requires respondents to: 1) choose a best and worst attribute from a given policy profile (the BWS task); and 2) accept or reject participation in the described policy scenario (the DCE task).

The BWS task measures extremes in utility space, which is cognitively easier for respondents (Louviere & Islam, 2008) and generates more consistent measures than considering ‘middle ground’ rankings (Flynn et al., 2008). Best-worst scaling identifies where policy attributes fall on respondents’ underlying scale of utility, or preference (Lusk & Parker, 2009).

The importance of each policy attribute is placed on this ratio scale, allowing for direct comparisons where one attribute can be quantified as more/less important than another (Lusk & Briggeman, 2009; Lusk & Parker, 2009). This is not possible with DCE (Flynn et al. 2008). By requiring respondents to make tradeoffs between attributes, BWS measures conditional demand (Louviere & Islam, 2008; Lusk & Briggeman, 2009; Lusk & Parker, 2009), but the methodology does not provide information on the attractiveness of a policy relative to the respondent's status quo situation (Flynn et al., 2008). By including the DCE task, BWC can also estimate unconditional demand in that the dichotomous choice permits respondents to choose the status quo of not participating in the market (Flynn et al., 2008). The DCE task also allows the researcher to determine the reservation price at which an individual will enter a market, and how this reservation price varies according to market structure (see Pienaar et al., 2014).

The BWS and DCE tasks measure utility in complementary ways. The BWS task measures utility directly by asking individuals to state the degree of importance of attributes in the policy profile. The DCE task indirectly measures utility by analyzing respondents' decisions to accept or reject participation in the policy scenario as a whole (Louviere & Islam, 2008). Thus the best-worst choice combination of methods generates both direct and indirect measures of utility (Soto et al., 2016). Additionally, the DCE estimates can be compared to the BWS estimates for consistency (Flynn et al., 2008).

### **Survey Design**

We developed the BWC attributes and levels based on previous interviews with rhino horn trade stakeholders and by reviewing the academic literature on horn trade. The first required attribute was the market structure (Tab. 5-1). Central selling organizations (CSOs) are often discussed in the literature as a way to permit the trade of horn while still having a managing organization be responsible for regulating the market and ensuring transparency (Biggs et al.,

2013; Ferreira et al., 2014b). Central selling organization levels included: 1) South Africa's Department of Environmental Affairs (DEA); 2) Wildlife Ranching South Africa (WRSA), a prominent wildlife ranching industry organization; and 3) De Beers, a company well-known for its management of diamond trade in South Africa (as per Martin, 2011). These three organizations allowed us to compare preferences for government and non-government management of trade in rhino horn, and whether ranchers preferred management by a wildlife-related entity or an entity outside of the wildlife industry.

We also wanted to include unregulated market structures, namely an auction structure, which was recently used in South Africa's first domestic, commercial horn sale (Du Toit, 2017), and a completely open trading market, where horn could be sold among individuals like most other commodities (Tab. 5-1). In order to include the CSO market structure and the unregulated market structures, two separate choice experiments were created. This is because the levels of an attribute must be comparable so that respondents can trade off between them (Coast et al., 2006). In this case, three CSO management organization levels and two unregulated market structure levels cannot be considered different levels of the same attribute. To avoid this problem, we administered two choice experiments (the CSO Experiment and the Unregulated Market Experiment) to all respondents where the market structure attributes and levels differed, but the other attributes and levels were identical.

The second attribute was the payment per kilogram of horn, framed as either a buying price set by the CSO or the average expected price one could receive via an unregulated market structure. These attribute levels were determined using interviews with rhino horn trade experts. At the middle payment level of R150,000/kg, it was estimated that rhino owners would be able to cover their rhino-related costs and make a small profit. The extreme payment levels were chosen

to represent prices where rhino owners would definitely not be able to cover their costs (R15,000) and where rhino owners would be making a sizeable profit (R500,000, which is approximately the price of gold/kg). We intentionally kept this maximum level lower than the currently estimated black market price of horn (\$65,000/kg to the end-users; Hubschle, 2016) as it is unlikely the legal price would ever reach the black market price (which is artificially inflated due to a lack of legal competition).

The final attribute was the minimum amount of land required per rhino. This attribute was included in response to concerns that horn trade legalization may result in intensive rhino farming with limited conservation impact (Wright et al., 2016). The attribute levels were determined using interviews with rhino owners. Policy scenarios where there was no minimum land requirement represented an acceptance that horn trade legalization may result in intensive farming, whereas scenarios that required a minimum of 100 ha/rhino represented a strong effort to link horn trade legalization with the conservation of rhino habitat and management of rhinos on extensive properties.

We used optimal designs generated by SAS statistical software to maximize the information derived from the choice task while minimizing the length of the survey for respondents (per Soto et al., 2016). The optimal designs for both choice experiments (CSO Experiment D-efficiency = 92.76; Unregulated Market Experiment D-efficiency = 91.38) created ten choice tasks (i.e., policy scenarios) for each of the experiments. To reduce the length of the survey for each respondent, each choice experiment was split into two blocks, where respondents were given five policy scenarios of each experiment (i.e. five CSO policy scenarios and five unregulated market structure policy scenarios).

For each market scenario, respondents were asked to choose their most and least preferred attribute of the market and state whether they would enter the market (Fig. 5-1). We also provided several dissonance minimizing options to avoid hypothetical bias (i.e., to improve the accuracy of estimated participation) (Morrison & Brown, 2009). These dissonance minimizing response categories, which were coded as refusal to enter the market, allowed respondents to answer honestly that they would not want to participate, while still showing support for horn trade legalization.

Respondents were asked different follow-up questions for each market scenario depending on whether they agreed to participate in the market or not. If they rejected participation, respondents were asked why they did not want to participate. They could choose from response categories related to the policy scenario (e.g., ‘The price is not high enough’), rhino ownership (e.g., ‘I will never be interested in owning rhinos’), or they could write in their own response. These responses were used to identify potential protest responses during analysis (Freeman et al., 2014). If respondents agreed to participate, they were asked to rate their certainty that they would enter the market on a 10-point scale (with higher numbers indicating increasing certainty). We used the certainty-7 correction (where acceptances with a certainty of <7 are recoded as rejections, per Morrison & Brown, 2009) as an additional method to mitigate bias. Other questions included in the survey related to respondents’ attitudes towards horn trade legalization and the government, as well as demographic information. All questions were designed and ordered according to the best practices of Dillman et al. (2009).

### **Survey Implementation**

We defined our study population as individuals who participate in the private wildlife industry in South Africa because these are the individuals most likely to engage in rhino horn trade in the short- to medium-term. The survey was pretested (see Dillman et al., 2009) with



survey methodology experts and members of our study population. The survey was offered in both English and Afrikaans, and was primarily distributed online via Qualtrics Survey software, although some respondents preferred to take the survey by phone or in-person.

We used multiple distribution channels to reach a population that was large enough to result in an appropriate sample size. We cultivated email address and phone number lists of potential respondents by conducting internet searches of companies that were listed on the Professional Hunters' Association of South Africa (PHASA) membership website and companies that advertised in the Wildlife Ranching South Africa (WRSA) magazine. We also conducted general internet searches for other professional hunting, wildlife breeding, and photographic tourism companies in South Africa. A link to the survey was included in weekly newsletters to PHASA and the South African Hunters and Game Conservation Association (SAHGCA) members. We attended the Safari Club International convention to distribute flyers directing hunting outfitters to the online survey, and follow-up emails were sent with a direct link to the survey. Finally, some respondents were eager to share the survey with colleagues in the wildlife industry, so we also engaged in referral-based sampling (see Biernacki & Waldorf, 1981) to increase our sample size. When a phone number was available, we made follow up phone calls to all potential respondents who were initially contacted by email.

### **Econometric Analysis of the BWS Task**

We used different econometric models for the two BWS tasks: a random parameters logit (RPL, or mixed logit) model for the BWS task of choosing the best and worst policy attribute pair (Lusk & Briggeman, 2009), and a logit model for the binary choice task of choosing to participate or not participate in horn trade (Train, 2012).

Best-worst scaling analyses can be conducted as paired or marginal estimations at either the respondent or sample level (Flynn et al., 2007). We used the paired estimation at the

respondent level because marginal estimation is an approximation of the paired estimation (Flynn et al., 2007) and respondent-level analyses consider heterogeneity across respondents (Louviere et al., 2015). A multinomial logit (MNL) can be used for analysis, where each best-worst pair is a distinct choice outcome (Flynn et al., 2007). Thus, for our study with 3 items per policy scenario ( $J$ ), there were  $J(J - 1) = 6$  different best-worst combinations. As per Lusk and Briggeman (2009), if  $j$  and  $k$  are items and  $j$  is selected as best and  $k$  as worst, then  $\lambda_j$  and  $\lambda_k$  represent the locations of their respective values on individual  $i$ 's underlying utility scale.  $I_{ij} = \lambda_j + \varepsilon_{ij}$ , where  $\varepsilon_{ij}$  is a random error term, represents individual  $i$ 's latent unobserved level of utility. Best item  $j$  and worst item  $k$  represent the maximum difference between all possible  $J(J - 1)$  items on individual  $i$ 's underlying utility scale (Lusk & Briggeman, 2009). The probability that individual  $i$  selected  $j$  and  $k$  is represented as:  $\Pr[(I_{ij} - I_{ik}) > (I_{il} - I_{im})]$ , where  $l$  and  $m$  are all other possible best-worst pair combinations. The following MNL equation can be applied (assuming i.i.d. type I value errors):

$$\text{Prob}(j \text{ is selected as best, } k \text{ as worst}) = \frac{e^{\lambda_j - \lambda_k}}{\sum_{l=1}^J \sum_{m=1}^J e^{\lambda_l - \lambda_m}} \quad [5-1]$$

Maximum likelihood techniques can be applied to estimate the  $\lambda_j$  utility parameters. Each policy scenario (i.e., question) is expanded into  $J(J - 1)$  distinct outcomes, where the dependent choice variable takes a value of 1 if that best-worst pair was selected and 0 if not. Following Flynn et al. (2007), attribute impact variables were coded as 1 if the attribute (corresponding to the attribute level) was selected as best, -1 if worst, and 0 if otherwise. Similarly, level scale values were effects coded (Tab. 5-1), where one level is embedded as -1 and its coefficient is later recovered by calculating the negative sum of the coefficients of the other levels.

Parameter  $\lambda_j$  represents the location of item  $j$  on individual  $i$ 's underlying utility scale. As noted by Lusk and Briggeman (2009), this location is relative to another item that is omitted to

prevent the dummy variable trap. The omitted item is normalized to 0 on the utility scale, thus serving as a reference point for all other utility parameter estimates. As such, the signs and magnitudes of parameter estimates are relative to the reference point of 0 and the parameter estimates can be directly compared (Lusk & Briggeman, 2009; Lusk & Parker, 2009).

The MNL model suffers from several limitations, including the assumptions of preference homogeneity and independence of irrelevant alternatives (Train, 1998). To avoid these restrictions, we utilized the more flexible random parameters logit (RPL) model for our analysis. RPL allows for random variation in preferences of respondents. It is also not restricted by the independence of irrelevant alternative assumption (Train, 1998; Lusk & Briggeman, 2009). The RPL preference parameters are specific to individual  $i$ , and thus is specified as  $\tilde{\lambda}_{ij} = \tilde{\lambda}_j + \sigma_j \mu_{ij}$ , consisting of the mean ( $\tilde{\lambda}_j$ ) and standard deviation ( $\sigma_j$ ) of  $\lambda_j$  in the population and a normally distributed random error term with a mean of 0 ( $\mu_i$ ). The probability statement for this new specification implies normally distributed preferences for attribute levels (Lusk & Briggeman, 2009). Thus, parameter coefficients vary randomly over people and are no longer fixed. RPL models were estimated using the ‘mixlogit’ command in the STATA statistical software package.

### **Econometric Analysis of the DCE Task**

The dependent variable of the binary choice task was assigned 1 if the policy profile was accepted (“yes”) and 0 if it was not (including “no” responses and dissonance minimizing responses). We analyzed these data using different logit model specifications, where in some models all covariates were effects-coded and in others only the “payment” attribute was quantitatively coded to obtain mean reservation payment estimates (Pienaar et al., 2014; Soto et al., 2016). Logit models were estimated using the ‘logit’ command in the STATA statistical software package.

Because we included up to 18 covariates in our initial models to explain variation in the dichotomous choice responses, we used the corrected Akaike Information Criterion (AICc) to find the most parsimonious models (Pienaar et al., 2014). Two covariates (“trade attitudes” and “government attitudes”) were derived using weighted factor analysis (Tab. 5-2), which is used to reduce large sets of variables into smaller sets of latent underlying factors (Meigs, 2000). “Trade attitudes” is derived from four variables; (1) attitudes about the acceptability of global horn trade leading to intensive rhino farming, and beliefs that global horn trade will (2) benefit rhino owners, (3) benefit rhino conservation, and (4) reduce poaching. “Government attitudes” is derived from two variables; respondents’ beliefs that interacting with (1) the DEA and (2) their provincial environmental department increases the risk of poaching events for ranchers. We used an eigenvalue threshold of 1.0 to retain factors (per Meigs, 2000).

## **Results**

### **Response Rates**

We utilized 171 completed survey responses in our analysis. Response rates varied depending on distribution channel, where we achieved a 100% response rate from pre-testers and referrals, 18.4% from SCI convention attendees, 16.4% from the PHASA membership list, and 12.2% from our cultivated list. We are unable to calculate the response rates from the two newsletters because we cannot determine how many ranchers received the link to the survey.

### **Sociodemographic Characteristics of Respondents**

Most respondents were male (95.27%) and the median age range fell between 46 and 55 years old (Tab. 5-3). Respondents’ annual, pre-tax income created a U-shaped distribution where 24.9% of respondents grossed ZAR 1 million or less (~\$70,200 2017 USD), and 20.1% grossed greater than ZAR 7 million per year (~\$491,600). Approximately a third (31.95%) of all respondents owned, leased, and/or managed more than 5,000 hectares of land. Notably, 19.53%

of our sample (33 respondents) stated they were current rhino owners. This accounts for approximately 10% of rhino owners in South Africa (CITES Management Authority, 2016). Over 65% of respondents indicated they do not currently own rhinos and 19.3% preferred not to disclose information on their rhino ownership status. Respondents' attitudes towards horn trade legalization were, on average, very positive, whereas attitudes towards environmental governmental departments were modest (Tab. 5-3). On average, there was high concern about land reform among respondents.

### **Best-Worst Scaling Task**

Negative signs on coefficients in the random parameters logit (RPL) models indicate that the variables fall on the negative side of the reference case, not a negative relationship with the dependent choice variable. In both the CSO RPL model and the Unregulated Market RPL model, the minimum land requirement attribute was omitted and used as a reference case; i.e. its attribute impact (or mean utility across all levels) is equal to 0 (Tab. 5-4; Fig. 5-2).

In the CSO RPL model, the organization that managed the CSO was the least important attribute and payment was the most important attribute (Tab. 5-4; Fig. 5-2). For both of these attribute impacts, the mean coefficients are statistically significant. Because both standard deviations are also statistically significant, there is evidence of preference heterogeneity with respect to both attribute impacts. Among level scale values (i.e., deviations from mean utility), there is a statistically significant positive preference for WRSA management of the CSO, although there is also evidence of heterogeneity in the level of preference that respondents placed on WRSA managing the CSO. There is also evidence of preference heterogeneity with respect to De Beers managing the CSO. Payment level scale values followed the theoretically expected pattern of preference for higher payments. The median payment of R150,000 marks an approximate threshold from negative to positive utility (or not preferred to preferred, compared

to the reference case). There is no evidence of preference heterogeneity related to payment levels. Level scale values for each of the land requirements are not statistically significant at the 5% level. However, there is evidence of preference heterogeneity with regards to a minimum land requirement of 100 ha/rhino.

In the Unregulated Market RPL model, the market type and payment attribute impacts are both more important than the minimum land requirement (Tab. 5-4; Fig. 5-2). Both mean coefficients are statistically significant, and there is evidence of preference heterogeneity. Among level scale values, the mean coefficient on “open trading” is statistically significant and there is evidence of preference heterogeneity for open trading. Again, respondents preferred larger payments over smaller payments. Mean coefficients on payment level scale values were statistically significant, except for the median payment of R150,000. Among land requirements, only the mean coefficient on the 100 ha/rhino requirement was statistically significant, and there was no evidence of preference heterogeneity.

### **Dichotomous Choice Task**

The results reported here were analyzed for protest responses (Freeman et al., 2014), of which none were found, and adjusted using the certainty-7 correction (Morrison & Brown, 2009). The two reported logit models for each experiment (Tab. 5-5) were the most parsimonious models according to their AICc. For each experiment (the CSO and the Unregulated Market), we generated an all effects-coded model, providing estimates for each choice experiment attribute, and a model where “payment” was quantitatively coded (referred to as the continuous payment model), which was used to derive the reservation payment estimates (Tab. 5-5; Tab. 5-6). For these logit models, positive coefficients represent an increased probability of participation and negative coefficients represent a decreased probability of participation in the market.

For the CSO logit models, the results are similar for both the all effects-coded model and the continuous payment model (Tab. 5-5). In both models, the probability of participation increased if the CSO was managed by WRSA. A CSO managed by De Beers is not a significant determinant of participation. The all effects-coded model provides us with estimates for the discrete payment attributes, where we see the theoretically expected pattern of increasing probabilities of participation as the payment increases. The two lowest payment values are associated with a decreased probability of participation in the market and the highest two are associated with an increased probability of participation in the market. In the continuous payment model, the “payment” coefficient is positive and significant at the 1% level. None of the minimum land requirement attributes are significant in either model.

In both CSO logit models, respondents with positive attitudes towards horn trade legalization were more likely to enter the market (Tab. 5-5). Concerns about land reform decreased the probability of market participation. Respondents who owned more land and those who owned rhinos were more likely to participate in the market. The negative, significant coefficient on “gender” indicates women were less likely to enter the market. Income and negative attitudes towards governmental environmental departments were not significant determinants of the likelihood that respondents would participate in the market.

Reservation payments represent the minimum payment required for respondents to enter the rhino horn trade (under given market structures) (Pienaar et al., 2014). The reservation payments calculated in Tab. 5-6 are only for males (given that they represent over 95% of our sample) and are reported separately for rhino owners and respondents who either did not own rhinos or refused to disclose this information. On average, rhino owners in our sample would require a minimum of R604,150/kg of horn to enter the horn trade market under a policy where

the CSO is managed by the DEA and there is no minimum land requirement (Tab. 5-6). This mean reservation payment increased to R894,150 for respondents who do not own rhinos (and presumably would incur substantial costs to acquire rhinos). Average reservation prices are highest when the CSO is managed by the DEA and the minimum land requirement is 50 ha/rhino, and average reservation prices are the lowest when the CSO is managed by WRSA and there is no minimum land requirement.

The results for the two Unregulated Market logit models are similar. Among policy attributes, neither the market structure (auction or open trading) nor any of the minimum land requirements are significant determinants of participation in the market (Tab. 5-5). For the effects-coded model, we again see a pattern of increasing probability of participation with increasing payment. For the continuous payment model, the “payment” coefficient is positive and significant at the 1% level.

Positive attitudes towards horn trade and negative attitudes towards governmental environmental departments are associated with an increased probability of participation in the unregulated market and concerns about land reform are associated with a decreased probability of market entry (Tab. 5-5). Rhino owners and respondents who own more land are more likely to participate and women are less likely to participate in the market. Respondents’ incomes do not significantly impact their likelihood of participation in the market.

Auction market structures were associated with higher mean reservation payments within our sample than open trading market structures (Tab. 5-6). Again, 50 ha/rhino land requirements were associated with the highest reservation payments and no minimum land requirements were associated with the lowest payments. Rhino owners consistently required lower average



reservation payments than other respondents (e.g., R342,560/kg versus R552,560/kg required to enter an auction market with a minimum land requirement of 50 ha/rhino).

### **Discussion**

Our BWC approach generated consistent and complementary results between the BWS and DCE analyses. Across all models, a CSO managed by WRSA was preferred to one managed by the DEA. This is consistent with Davies-Mostert's (2014) observations that ranchers distrust the government. It is interesting to note that ranchers displayed mixed opinions about De Beers managing the CSO. We assumed that since De Beers is a neutral, private organization that operates in the international diamond trade, ranchers would derive positive utility from De Beers managing the CSO. However, the mean coefficient on CSO management by De Beers was not significantly different from zero in any model, although there was evidence of preference heterogeneity. A subset of respondents derived disutility from De Beers managing the CSO, relative to the reference case. This is interesting because it suggests that, among non-governmental entities, respondents prefer management by an industry organization with which they are familiar (WRSA), over an external, neutral organization (De Beers). If a CSO market structure is required, we suggest it should be managed by WRSA to increase market participation.

Within the Unregulated Market models, support for auctions and open trading markets were mixed. In the RPL model, there was significant evidence that an auction was preferred over open trading, however the auction and open trading systems were not significant determinants of market participation in the logit models. Thus, we recommend an auction structure if policy-makers aim to avoid a CSO approach, although further research on this topic would be helpful.

Across all models, respondents preferred higher per unit payments for horn. Payments of R15,000 and R50,000 were consistently considered too low (i.e., negative preference relative to

the reference point and associated with a decreasing likelihood of market entry) by respondents. There was no evidence of preference heterogeneity related to the payment per unit horn. Higher payments were always preferred, which is consistent with economic theory. Our results suggest that payments of greater than R150,000/kg are necessary to increase the probability of market entry, which is a particularly important finding in a CSO market structure where prices are set.

The reservation payments required for various policy scenarios are also important to consider. Notably, rhino owners consistently require lower average reservation payments than other respondents to participate in the market. This is likely because rhino owners have already substantially invested in procuring rhinos and in rhino-related security and management. As such, they require a lower payment to enter the horn market. Other respondents, however, may not have made those investments, and thus they require a considerably higher payment to enter the market. This is important when considering the effects of legalizing horn trade on rhino conservation—different magnitudes of payment are needed to convince current rhino owners to enter the horn trade market versus attracting new investment in rhino conservation. As an interesting extreme case, in a market where the DEA manages a CSO, non-rhino owners require reservation payments that approach and exceed estimated black market prices (~R912,000/kg; Hubschle, 2016). In this example, a legal horn trade may not be competitive with the black market. Across both rhino owners and non-rhino owners, the most competitive markets, or those that require the lowest reservation payments, are an open trading market and a CSO managed by WRSA. These markets likely provide the necessary incentives for large-scale investment in rhinos and habitat.

Land size requirements were rarely significant in any model, which was surprising because one might expect that more stringent land requirements would reduce ranchers' utility

from entering the horn trade and/or would increase reservation prices for horn. Interestingly, there was evidence of preference heterogeneity with regards to the 100 ha/rhino requirement in the CSO RPL, indicating mixed opinions about intensive versus extensive rhino management. Informal conversations with respondents indicate that some respondents may be more accepting of the idea that horn trade legalization may lead to intensive rhino farming (i.e., they may accept or even prefer a policy with no minimum land size), whereas others want legalization to result in substantial habitat conservation (by requiring large minimum land areas). Because of concerns about horn trade legalization leading to intensive rhino farming (see Wright et al., 2016), we suggest further exploration of preferences towards minimum land requirements or other policy tools that can be used to link the supply of rhino horn with habitat conservation.

Although we specifically focused our survey on global horn trade legalization, these results are also likely applicable to South Africa's newly legalized domestic horn trade. While the first horn sale in South Africa in 2017 occurred through a private auction (Du Toit, 2017), the Private Rhino Owners Association of South Africa is also exploring the establishment of a CSO to handle future trades (Jones, 2017b). Our results can provide guidance for increasing trade participation as South African ranchers prepare for horn trade on a larger scale.

A limitation of this study is the small sample size used for analysis, although van der Waal and Dekker (2000) found comparable response rates in their mail-based and industry newsletter surveys to wildlife ranchers. There are documented challenges associated with surveying wildlife ranchers in South Africa, particularly about rhino-related topics, including their distrust of scientists and unwillingness to participate in research due to fears of increased industry regulation (Davies-Mostert, 2014). While we caution against the sole use of this

research to design policy, we do believe it provides interesting initial insights that should be explored further.

### **Conclusions**

Our results show that market attributes, such as market structure, the market management organization, and the payment per unit of horn, affect ranchers' willingness to participate in the trade in rhino horn. Therefore, we argue that studies that do not explicitly account for market structure in their analyses (e.g., Crookes & Blignaut, 2015; Haas & Ferreira, 2016) may not be as helpful for guiding policy as they initially appear.

To the best of our knowledge, this is the first study to explore the market preferences of potential global rhino horn trade supply-side stakeholders. This research is particularly timely given the recent reversal of the national moratorium on domestic rhino horn trade in South Africa. By understanding which market attributes increase the likelihood of trade participation by wildlife ranchers, policy-makers can introduce policies that are likely to increase market participation and rhino conservation on private lands.

Table 5-1. Description of experiment attributes and levels and the effects coding used for analysis.

Attribute/Level	Effects coding	Effects coding	Effects coding	Effects coding
CSO Experiment				
CSO managing org.	WRSA	De Beers		
DEA	-1	1		
WRSA	1	0		
De Beers	0	1		
Payment/kg	R50,000	R150,000	R300,000	R500,000
R15,000 (~1,000 2017 USD)	-1	-1	-1	-1
R50,000 (~\$4,000)	1	0	0	0
R150,000 (~\$11,500)	0	1	0	0
R300,000 (~\$23,000)	0	0	1	0
R500,000 (~\$38,000)	0	0	0	1
Minimum land requirement	50 ha/rhino	100 ha/rhino		
No minimum land req.	-1	-1		
50 ha/rhino	1	0		
100 ha/rhino	0	1		
Unregulated Market Experiment				
Market type				
Open trading	1			
Auction	-1			
Payment/kg	R50,000	R150,000	R300,000	R500,000
R15,000 (~1,000 2017 USD)	-1	-1	-1	-1
R50,000 (~\$4,000)	1	0	0	0
R150,000 (~\$11,500)	0	1	0	0
R300,000 (~\$23,000)	0	0	1	0
R500,000 (~\$38,000)	0	0	0	1
Minimum land requirement	50 ha/rhino	100 ha/rhino		
No minimum land req.	-1	-1		
50 ha/rhino	1	0		
100 ha/rhino	0	1		

Table 5-2. Explanation of covariates included in most parsimonious models.

Covariate	Explanation	Coding for logit models
Trade attitudes	Respondents' attitudes toward rhino horn trade legalization	Weighted factor analysis: increasing positive attitude towards horn trade legalization
Government attitudes	Respondents' beliefs about how interaction with governmental environmental departments increases poaching risks	Weighted factor analysis: increasing negative attitude (i.e., increasing belief of risk) towards governmental environmental departments
Land reform	Respondents' concern regarding land reform/restitution in South Africa	Scale: 1 (not at all concerned) – 4 (very concerned)
Income	Pre-tax income of respondent (in millions of ZAR)	Used midpoint of range categories, maximum of smallest category, and minimum of largest category (1, 1.5, 2.5, 3.5, 4.5, 6.5, 7)
Land total	Total amount of land respondent owns, leases, or manages (in hectares)	Used midpoint of range categories, maximum of smallest category, and minimum of largest category (0, 100, 300, 750, 1500, 2500, 3500, 4500, 5000)
Gender	Gender of respondent	0 = male; 1 = female
Rhino ownership	Rhino ownership status of respondents	0 = do not currently own rhinos or prefer not to disclose; 1 = currently own rhinos

Table 5-3. Sociodemographic and attitudinal characteristics of respondents.

Characteristic	% of Sample	Characteristic	Mean	S.D.	Minimum	Maximum
Gender		Trade attitudes	14.64	1.63	3.15	15.74
Male	95.27					
Female	4.73	Government attitudes	7.75	1.80	1.86	11.15
Age		Land reform	3.39	0.90	1	4
18 – 25	0.59					
26 - 35	10.06					
36 - 45	27.81					
46 - 55	34.91					
56 - 65	18.34					
66 - 75	7.69					
≥ 76	0.59					
Income						
≤ R1,000,000	24.85					
R1,000,001 - R2,000,000	23.08					
R2,000,001 - R3,000,000	10.06					
R3,000,001 - R4,000,000	8.28					
R4,000,001 - R5,000,000	4.14					
R5,000,001 - R6,000,000	5.92					
R6,000,001 - R7,000,000	3.55					
> R7,000,000	20.12					
Amount of Land						
No land	9.47					
< 100 ha	2.37					
100 - 500 ha	4.73					
501 – 1,000 ha	7.10					
1,001 – 2,000 ha	18.34					
2,001 – 3,000 ha	11.24					
3,001 – 4,000 ha	11.24					
4,001 – 5,000 ha	3.55					
> 5,000 ha	31.95					
Currently Own Rhinos	19.53					

Table 5-4. Best-worst scaling task: random parameters logit model results

CSO RPL Model	Mean Coeff. (st. error)	S.D. Coeff. (st. error)	Unregulated Market RPL Model	Mean Coeff. (st. error)	S.D. Coeff. (st. error)
Attribute			Attribute		
Impacts			Impacts		
CSO			Market type		
managing org. (CSO)	-0.24** (0.11)	0.98*** (0.13)		0.89*** (0.07)	0.27** (0.11)
Payment	0.63*** (0.10)	0.75*** (0.13)	Payment	0.44*** (0.06)	0.27** (0.12)
Minimum land req. (Land)	0.00		Minimum land req. (Land)	0.00	
Level Scale Values			Level Scale Values		
CSO by DEA (DEA) <sup>a</sup>	-1.88		Auction <sup>a</sup>	0.27	
CSO by WRSA (WRSA)	1.84*** (0.17)	1.20*** (0.22)	Open trading	-0.27*** (0.06)	0.40*** (0.09)
CSO by De Beers (De Beers)	0.04 (0.14)	1.27*** (0.17)	Payment of R15,000 (R15) <sup>a</sup>	-1.18	
Payment of R15,000 (R15) <sup>a</sup>	-1.46		Payment of R50,000 (R50)	-0.35*** (0.10)	0.06 (0.22)
Payment of R50,000 (R50)	-0.52*** (0.13)	0.08 (0.16)	Payment of R150,000 (R150)	0.01 (0.10)	0.04 (0.18)
Payment of R150,000 (R150)	0.19 (0.12)	0.18 (0.18)	Payment of R300,000 (R300)	0.66*** (0.11)	0.20 (0.28)
Payment of R300,000 (R300)	0.54*** (0.13)	0.16 (0.32)	Payment of R500,000 (R500)	0.86*** (0.12)	0.26 (0.26)
Payment of R500,000 (R500)	1.24*** (0.18)	0.35 (0.49)	No minimum land req. (Land0) <sup>a</sup>	-0.11	
No minimum land req. (Land0) <sup>a</sup>	-0.15		50 ha/rhino land req. (Land50)	-0.10 (0.07)	0.18 (0.22)
50 ha/rhino land req. (Land50)	-0.07 (0.09)	0.22 (0.17)	100 ha/rhino land req. (Land100)	0.21** (0.08)	0.03 (.18)
100 ha/rhino land req. (Land100)	0.22* (0.12)	0.91*** (0.14)			

Asterisks denote significance: (\*\*\*) at the 1% level, (\*\*) 5% level, and (\*) 10% level

<sup>a</sup> Effects coded: coefficient calculated using the negative sum of the level scale values corresponding to this attribute.



Table 5-5. Dichotomous choice task: logit model results.

CSO Logit Model	Coeff. (st. error) All effects coded	Coeff. (st. error) Continuous payment	Unregulated Market RPL Model	Coeff. (st. error) All effects coded	Coeff. (st. error) Continuous payment
CSO by DEA <sup>a</sup>	-0.27	-0.40	Auction <sup>a</sup>	-0.09	-0.06
CSO by WRSA	0.30** (0.12)	0.37** (0.11)	Open trading	0.09 (0.17)	0.06 (0.16)
CSO by De Beers	-0.03 (0.15)	0.03 (.12)	Payment of R15,000 <sup>a</sup>	-0.80	
Payment of R15,000 <sup>a</sup>	-0.77		Payment of R50,000	-0.33* (0.17)	
Payment of R50,000	-0.35* (0.19)		Payment of R150,000	0.24 (0.17)	
Payment of R150,000	0.09 (0.19)		Payment of R300,000	0.33* (0.17)	
Payment of R300,000	0.43** (0.19)		Payment of R500,000	0.56*** (0.17)	
Payment of R500,000	0.60*** (0.20)		Payment (quant. coded) <sup>b</sup>		2.29e-3*** (0.00)
Payment (quant. coded) <sup>b</sup>		2.49e-3*** (0.00)	No minimum land req. <sup>a</sup>	-0.03	0.05
No minimum land req. <sup>a</sup>	0.07	0.06	50 ha/rhino land req.	-0.05 (0.12)	-0.05 (0.11)
50 ha/rhino land req.	-0.11 (0.12)	-0.05 (0.11)	100 ha/rhino land req.	0.08 (0.15)	1.82e-3 (0.12)
100 ha/rhino land req.	0.04 (0.15)	-0.01 (0.12)	Trade attitudes	0.36*** (0.07)	0.36*** (0.07)
Trade attitudes	0.52*** (0.08)	0.52*** (0.08)	Government attitudes	0.14*** (0.05)	0.14*** (0.05)
Government attitudes	0.07 (0.05)	0.07 (0.05)	Land reform	-0.18** (0.09)	-0.18** (0.09)
Land reform	-0.16* (0.09)	-0.16* (0.09)	Income	0.01 (0.04)	0.01 (0.04)
Income	-0.04 (0.04)	-0.04 (0.04)	Land total	1.01e-4** (0.00)	9.96e-5** (0.00)
Land total	1.56e-4*** (0.00)	1.56e-4*** (0.00)	Gender	-0.81** (0.38)	-0.80** (0.38)
Gender	-1.38*** (0.45)	-1.38*** (0.45)	Rhino ownership	0.42* (0.22)	0.42* (0.22)
Rhino ownership	0.58** (0.23)	0.58** (0.23)	Constant	-6.58*** (1.05)	-7.02*** (1.06)
Constant	-8.74*** (1.23)	-9.22*** (1.24)			
Log likelihood	-431.83	-433.77	Log likelihood	-467.00	-471.29

Asterisks denote significance: (\*\*\*) at the 1% level, (\*\*) 5% level, and (\*) 10% level

<sup>a</sup> Effects coded: negative sum of the below level scale values corresponding to this attribute.

<sup>b</sup> Unit is thousands of ZAR

Table 5-6. Mean reservation payments/kg by market structure and rhino ownership (in thousands of ZAR).

CSO Market Structure	Own Rhinos	Do Not Own Rhinos/ Prefer Not to Disclose	Unregulated Market Structure	Own Rhinos	Do Not Own Rhinos/ Prefer Not to Disclose
DEA, no min req.	604.15	894.15	Auction, no min req.	292.56	502.56
DEA, 50 ha/rhino req.	659.15	949.14	Auction, 50 ha/rhino req.	342.56	552.56
DEA, 100 ha/rhino req.	639.15	929.15	Auction, 100 ha/rhino req.	317.06	527.06
WRSA, no min req.	219.15	509.15	Open trading, no min req.	232.56	442.56
WRSA, 50 ha/rhino req.	274.15	564.15	Open trading, 50 ha/rhino req.	282.56	492.56
WRSA, 100 ha/rhino req.	254.15	544.15	Open trading, 100 ha/rhino req.	257.06	467.06
De Beers, no min req.	389.15	679.15			
De Beers, 50 ha/rhino req.	444.15	734.15			
De Beers, 100 ha/rhino req.	424.15	714.15			

**Step 1** Tick one option you prefer most and one you prefer least

Prefer MOST      Prefer LEAST

CSO managed by Wildlife Ranching South Africa

Receive R150 000/kg

Must have at least 100 ha/rhino

**Step 2** Would you want to participate in the legal market exactly as it is described above?

Choose one

- YES. I would participate
- NO. I would NOT participate
- I would like to participate. but I do not currently have at least 100 ha
- I support legalized trade. but I do not like the market structure so I would NOT participate
- I support legalized trade. but the price is not high enough so I would NOT participate
- I support legalized trade. but I would NOT participate for the following reason:

Figure 5-1. Example of a BWC policy scenario.

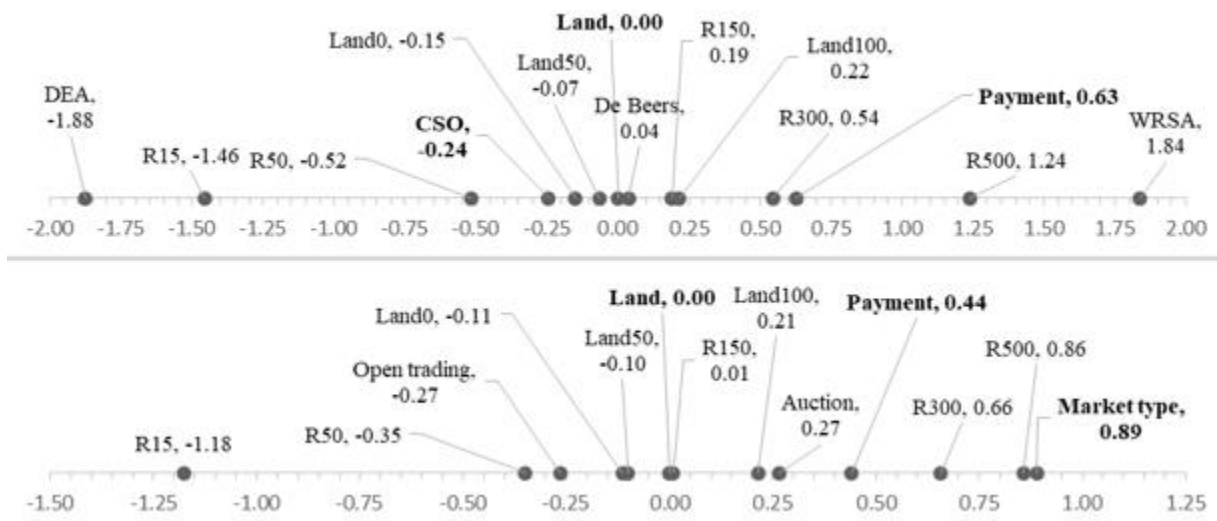


Figure 5-2. Ratio scale depiction of the CSO and Unregulated Market random parameters logit model attribute mean coefficients, respectively (attribute abbreviations from Tab. 5-4; attribute impacts are in bold).

## CHAPTER 6 CONCLUDING REMARKS

South Africa's private sector contributes significantly to rhinoceros conservation and will likely play a larger role in rhinoceros conservation in the near future (Rademeyer, 2016). As such, understanding the motivations and challenges of these stakeholders is critical to generating policy recommendations to incentivize further conservation.

This research illustrated that, in addition to complementary solutions, global horn trade legalization has the potential to provide private rhinoceros owners with an additional income stream that may help offset expensive security costs. Rhinoceros owners voiced support for a legal horn trade, noting that, while they are primarily non-financially motivated, such a trade would help defray some of their costs and make private rhinoceros ownership more sustainable. There was similar support for global horn trade legalization among private wildlife industry members more broadly. This indicates a recognition that financial aid is necessary for viable rhinoceros ownership. Finally, this research identified the horn trade market attributes that will incentivize participation in a legal global horn market, thus increasing rhinoceros conservation.

There has been much academic debate about the rhinoceros horn trade ban (see Biggs et al., 2013; Ferreira et al., 2014b). But despite being significant rhinoceros conservation stakeholders, no research to date has explored the preferences of rhinoceros owners and private wildlife industry members on such a large scale. By including these stakeholders in conservation research, their on-the-ground expertise can be represented in policy decision-making.

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Elena Rubino attended Gettysburg College for her undergraduate degrees in economics and environmental studies, the University of Delaware for her master's degree in energy and environmental policy, and the University of Florida for her Ph.D. in interdisciplinary ecology. She is interested in applying quantitative and qualitative methods to understanding natural resource policy problems.