FIELD NOTES

Anti-poaching strategies employed by private rhino owners in South Africa

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Introduction

Rhinos throughout Africa suffered from heavy poaching through the 1970s to the mid-1990s, but in South Africa this had mostly stabilised with an average of fourteen rhinos poached per year between 1990 and 2005 (Milliken and Shaw 2012). Since then, the number of rhinos poached has increased substantially. Over 1,000 animals were poached each year from 2013 to 2017 (DEA 2019), although overall poaching declined slightly in both 2018 (DEA 2019) and 2019 (DEFF 2020). Despite this poaching pressure, by the end of 2017, the South African population of around 15,625 white rhinos (*Ceratotherium simum*) represented over 86% of the total wild population (Emslie et al. 2019). South Africa was also estimated to hold around 2,046 black rhinos (*Diceros bicornis*), amounting to 37% of the total population (Emslie et al. 2019). The relative numbers of rhinos poached on state-protected public land versus private land are unclear, but more than 42% of South Africa's black and white rhino populations are held by private owners (Emslie et al. 2019). The potential contribution of private owners to the conservation and protection of rhino numbers is therefore considerable.

Since the 1980s, anti-poaching strategies have made increasing use of military technology and techniques (Duffy 2014) in response to more heavily armed poachers (Lunstrum 2014). Historically, militarized anti-poaching strategies were more common on state-owned than on private land (Shaw and Rademeyer 2016), but they have been increasingly applied on private land over the last decade (Lunstrum 2014). While large state-owned properties may be able to shoulder the high cost of such actions, private rhino owners receive no government funding or support (Lee and Du Preez 2016) and so must fund these expensive anti-poaching strategies themselves (Balfour et al. 2015). These escalating costs of protecting rhinos have been linked to increasing disinvestment in rhinos by private owners in South Africa (Jones 2013).

Much research on anti-poaching strategies has focused on emerging technologies such as unmanned aerial vehicles (UAV) or remotely piloted aircraft systems (RPAS), more commonly known as drones (Mulero-Pázmány et al. 2014; Schiffman 2014). The ease of operation of RPAS and their relative robustness enhances their usefulness in the field (Gross 2014). Furthermore, decreasing prices of RPAS (Paneque-Gálvez et al. 2014) are likely to further increase the accessibility of RPAS technology to the private sector.

However the factors which make RPAS attractive in anti-poaching activities also make them useful for poachers (Arts et al. 2015) by allowing them to locate and track poaching targets and anti-poaching personnel. A 12-month RPAS study in KNP, initially piloted in the Olifants West area (Schiffman 2014), found that detection of poachers was not reliable enough for the programme to continue, although the company that developed the technology claimed that this was due to lack of integration of the technology with the anti-

poaching teams rather than problems with the technology itself (Martin 2017).

Other emerging technologies that have been suggested as a means to deal with the rhino poaching crisis include the use of real-time sensors attached to rhinos (O'Donoghue and Rutz 2016). However, Arts et al. (2015) advise against too much focus on digital technology at the expense of low technology options, since the latter are likely to be more available to those stakeholders who have to generate their own funds to undertake anti-poaching activities.

The aim of this study was to identify the range of anti-poaching strategies employed by private rhino owners within South Africa. To understand more about the patterns of use of different anti-poaching strategies and expenditure on security measures we investigated whether the number of rhinos on a property, the number of poaching events on a property, and/or the expenditure on security was associated with the number of anti-poaching measures deployed. Although it is very difficult to assess the effectiveness of anti-poaching strategies, we also looked for any evidence of a decrease in poaching after the implementation of particular anti-poaching measures.

Methods

An online survey of private rhino owners was conducted throughout 2016. Owners were asked to provide information on the anti-poaching measures that were used on their property, the dates when each of the measures were implemented, and the cost (manpower and monetary) of each measure. They were also asked to provide information on their security expenditures, including rhino-specific security costs (in other words costs that would not be incurred if rhino were not present on their property), non-rhino specific security costs and the increase in total security expenditure over the previous decade. Details of poaching events that had occurred prior to, or subsequent to the implementation of anti-poaching measures were also recorded, as well as the number of rhinos on their property.

Security expenditure (general and rhino-specific), number of rhinos on a property and the number of poaching events on a property were each grouped by the number of anti-poaching measures employed on a property and also by the total increase in security expenditure over the previous decade. Differences between these groups, due to the number of anti-poaching measures utilised or the percentage increase in security expenditure, were tested using ANOVA or Independent-Samples Kruskal-Wallis tests. Correlation analysis (Pearson's or Spearman's dependent on the normality of the data) was used to identify any associations between security expenditure and the number of rhinos or the number of poaching events on a property. Expenditure was calculated and analysed in South African Rand, but results are presented in US dollars to facilitate comparison with other work. As the questionnaire was live throughout 2016, the IRS yearly average exchange rate of USD 1 to ZAR 15.319 is used throughout.

Results

Data were received from 22 private rhino owners who completed the survey, which was distributed by email and on social media (Table 1). The properties ranged widely from single species breeding facilities, to extensive properties engaged in ecotourism holding a range of species in a natural or semi-natural environment.

The mean number of anti-poaching measures employed by the properties was 4.82 (Table 1; range: 1–8), and increase in security expenditure over the previous decade ranged from 25–49% (1 property) to >200% (11 properties; Table 1). There was no correlation between rhino-specific security costs and non-rhino security costs (r = 0.20, p = 0.49) and so each was assessed separately. There were no significant differences in rhino-specific security costs based on the number of anti-poaching strategies utilised (ANOVA, F = 2.59, p = 0.11, df = 5,8) or the increase in total security expenditure over the previous decade (ANOVA, F = 0.11, p = 0.90, df = 2,11). There was no correlation between rhino-specific security expenditure and the number of rhinos held on a property (r_s = 0.24, p = 0.57, n = 8). There were no significant differences between the non-rhino security costs due to the number of anti-poaching strategies utilised (ANOVA, F = 0.95, p = 0.51, df = 6,9) or the increase in security expenditure over the previous decade (ANOVA, F = 1.95, p = 0.19, df = 2,12). There was no correlation between non-rhino security expenditure and the number of rhinos held on a property (r_s = 0.38, p = 0.32, n = 9), and there were no significant differences in the increase in total security expenditure (Kruskal-Wallis, H = 2.63, p = 0.27, n =

Table 1. Anti-poaching strategies and security expenditure.

Property ID	Number of rhinos held	Rhino-specific security expenditure (US$)	Non-rhino security expenditure (US$)	Expenditure increase in previous decade	Staff patrols	Volunteer patrols	Trained APU	Security dogs	Security cameras	Security alarms	Unstaffed watch towers	Staffed watch towers	Drones	Dehorning	Other
1		1,000–2,500	1,000–2,500	>200%	X	X		X	X					X	
2				25–49%	X		X	X					X		
3	20–50	2,500–5,000	<1,000	>200%	X		X	X	X						
4		5,000–10,000	2,500–5,000	100–199%			X	X	X						Air patrols
5	<10	<1,000	2,500–5,000	50–99%	X		X		X			X		X	
6	<10	1,000–2,500	<1,000	>200%	X	X			X					X	
7				>200%	X		X	X	X	X	X				
8	>100	1,000–2,500	5,000–10,000	>200%	X			X		X	X			X	
9			<1,000		X										
10		5,000–10,000	2,500–5,000	>200%	X	X	X	X	X			X			External monitoring team
11	20–50	1,000–2,500	<1,000	>200%			X		X	X		X	X		
12	10–20	2,500–5,000	2,500–5,000	50–99%	X		X		X	X	X	X			
13	50–100	5,000–10,000	1,000–2,500	>200%	X		X								
14	>100	>40,000 combined cost		>200%	X		X		X			X			Ground to air communication
15		10,000–20,000	10,000–20,000	50–99%	X	X	X	X	X		X				Thermal imaging cameras
16	20–50			50–99%	X	X		X						X	
17				100–199%	X				X					X	Local informant network
18	50–100	<1,000	2,500–5,000	50–99%	X		X			X				X	
19		10,000–20,000	1,000–2,500	>200%	X		X	X	X	X		X			Rhino monitoring
20	<10		<1,000	100–199%	X	X	X		X		X			X	
21		5,000–10,000	1,000–2,500	>200%			X	X		X					Fence breach notification system
22	10–20			>200%	X	X	X	X	X		X			X	Rhino monitoring

Note: Where no data is shown on rhino numbers and expenditure, this indicates that no information was provided in the response to the questionnaire.

12), nor the number of anti-poaching strategies utilised (Kruskal-Wallis, $H = 6.27$, $p = 0.51$, n = 12) due to the number of rhinos on a property.

Only seven properties provided information on the dates anti-poaching measures were adopted (and complete information was provided by only four properties). Most anti-poaching measures were instigated after poaching events had occurred. While some anti-poaching measures (alarms and staff patrols) had failed to prevent subsequent poaching events on any property, others (anti-poaching units [APU], dogs, cameras, watchtowers and dehorning) had proven to be partially effective; deterring subsequent poaching events on some properties, but not others. A total of 59 rhino were poached during several different poaching events on different properties in the study area between 2003 and 2016. At least five of the poached rhinos had been recently dehorned and additional information supplied noted that at least 13 had been poached shortly before they were due to be dehorned (and so dehorning permits had already been applied for). There was no correlation between the number of rhinos poached and the percentage increase in total security expenditure over the previous decade (ANOVA, $F = 0.07$, $p = 0.94$, df = 2,10), but there was a correlation with the number of anti-poaching strategies utilised (ANOVA, $F = 5.80$, $p = 0.02$, df = 5,7), with more poaching events occurring on reserves employing a wider range of anti-poaching strategies. There was no association between the number of poaching events on a property and the rhino-specific security expenditure ($r = 0.17$, $p = 0.67$, n = 9), but there was an association with non-rhino security expenditure ($r = 0.75$, $p = 0.01$, n = 10).

Mean person-days and security costs per month were calculated for the anti-poaching activities for which they were available (Table 2). One property provided both person-days and monetary costs for their APU (62 person-days and USD 2,284.74); therefore each person-day on this property cost USD 36.85.

Discussion

While private rhino owners utilise a wide range of anti-poaching measures, none appear to be completely effective, and poaching events occurred on properties regardless of the number or range of anti-poaching strategies in place. The implementation of anti-poaching measures is often reactive and triggered by a poaching event on the property. The measures adopted vary widely between properties, and there were no associations between the number of measures implemented and security expenditure. We also found no associations between anti-poaching effort and the number of rhinos held or the number of different measures implemented.

While most of the reserves utilised (presumably experienced) staff patrols and trained APUs (often with military training; Milliken and Shaw 2012), some reserves deployed volunteers to conduct patrols. This may be cheaper, however the quality of patrol provided by volunteers is questionable (Aung 2007). The substantial expenditure associated with extra, trained patrols may be a limiting factor in private land anti-poaching efforts as well as on state land.

Taylor et al. (2015) calculated the mean wage for all permanently employed workers on private wildlife ranches to be USD 244.34 per month. The analysis completed here found a mean person-day security cost of USD 36.85. This suggests a monthly security expenditure of USD 1,032–1,142 per person. It is therefore clear that a substantial proportion of expenditure is over and above that required for staff wages and is likely to be spent on items such as equipment, fuel and ammunition. The economics of protecting wildlife, and rhinos in particular (e.g. Taylor et al. 2015; Milliken and Shaw 2012), have been studied elsewhere. There was no indication from this study that simply increasing expenditure on anti-poaching efforts results in a reduction in poaching. The sample size for this study was relatively small, however, and a larger-scale project might yield sufficient data to investigate the cost-effectiveness of anti-poaching measures and therefore inform decisions on the most efficient

Table 2. Mean person-days/month and expenditure (USD) on anti-poaching activities.

	Staff anti-poaching patrols	Trained APU	Security dogs	Security cameras	Unstaffed watch towers	Staffed watch towers	Dehorning	Other
Person days/ month	210	220		320		59		96
Cost (USD)	3,590	2,285	49	196	326		914	1,632

allocation of the funds available for anti-poaching strategies.

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