EVALUATING THE COST AND EFFECTIVENESS OF RHINO CONSERVATION INTERVENTIONS IN THE GREATER KRUGER

An empirical analysis of intervention and poaching data from eleven reserves over five years (2017-2021)

Rhino Recovery Fund

GKEPF
GREATER KRUGER
ENVIRONMENTAL PROTECTION FOUNDATION

University of Cape Town • iYunivesithi yaseKapa • Universiteit van Kaapstad

Project FIRE: Framework of Interventions for effective Rhino protection Evaluation

Greater Kruger
South Africa

AUGUST 2023

THE PEOPLE BEHIND THE INTERVENTIONS

The interventions evaluated in this report do not stand alone. **Behind every intervention stands a dedicated team of managers, rangers, and others devoted to protecting rhinos, often at great risk to their own lives.** Rangers play an indispensable role in safeguarding the rhinos in the Greater Kruger. The area is fortunate to have many highly experienced and committed rangers and managers serving at the front line of defence against poaching.

Ultimately, all interventions are underscored by the managers and rangers who work relentlessly to preserve the Greater Kruger's rhinos. They are the rhino guardians who innovatively apply, adapt, and develop techniques and interventions to strengthen their efforts. Rangers' intimate knowledge of the landscape and understanding of the threat enables them to adapt and adjust the approaches necessary to combat rhino poaching. Their dedication extends beyond mere enforcement, encompassing an understanding and a will to improve both rhino protection and the future of nature for generations to come.

Here we recognise Cathy Dreyer (pictured), one of the many "people behind the interventions". She is Head Ranger at Kruger National Park. Cathy started her conservation career in Addo Elephant National Park with SANParks in 1999 before joining the SANParks Veterinary Wildlife Services Unit, conducting wildlife captures and translocations throughout South Africa and Africa for twelve years. Since then, she has worked in several roles dedicated to rhino conservation in South Africa, including management of a key black rhino population in the Great Fish River Reserve in the Eastern Cape, black rhino surveillance in Kruger NP, and a Conservation Manager position back at Addo. She returned to Kruger in May 2021 as Head Ranger, helping lead efforts against perhaps the most challenging poaching crises anywhere in the world.

Cathy was awarded the Tusk Award for Conservation in Africa in 2016, presented to her by Sir David Attenborough, in recognition of her leadership and outstanding contribution to conservation. She was the first South African, and first female, recipient of the award. While interventions may vary in their cost and effectiveness, the resolve and dedication of the leaders and teams behind them do not. **We will succeed. The cause of protecting these magnificent creatures is too great, and the people dedicated to the cause are too dogged, for any other outcome.**

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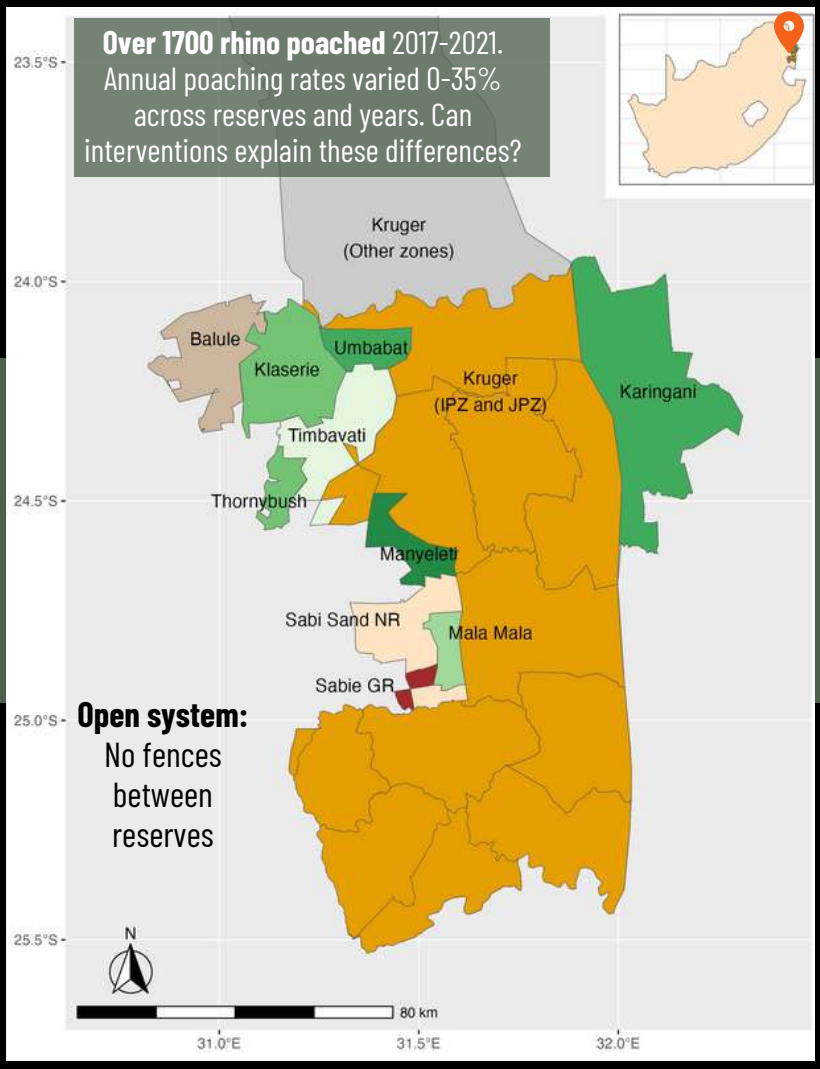
- **Project leads:** Sharon Haussmann (Greater Kruger Environmental Protection Foundation) and Steven Whitfield (South African National Parks).
- **Data analysts:** Dr Timothy Kuiper and Prof. Res Altwegg (Centre for Statistics in Ecology, the Environment and Conservation).
- **Steering committee:** Sharon Haussmann, Steven Whitfield, Dr Sam Ferreira (South African National Parks), Dr Jo Shaw (WWF South Africa), and Professor Daniel Polakow (University of Stellenbosch).
- **Data collectors**: Zianca Greef and Zala Hartman conducted extensive data collection and manager interviews.
- **Key support contributors**: Kim Lester, Sandra Snelling, and Marion Bourn provided excellent support in collating data for key reserves.
- **Reserve managers** provided feedback and input at all stages of the project.

BACKGROUND

We encourage readers to peruse the full report to appreciate the complexity, context, and nuance of the results. We have therefore excluded an executive summary (**see page 7-10 for main results**).



Project goal: to maximise insight into the cost and effectiveness of rhino conservation interventions in the Greater Kruger by combining robust statistical analysis with manager insights and operational experience. We hope this will inform the decision-making of reserve managers, government wildlife authorities, various non-governmental organisations, and local to global funding agencies.

South Africa conserves the majority of Africa's rhinos. Most of the national population resides in the Greater Kruger system (an open, unfenced landscape). Many years of high poaching losses in the Kruger National Park reduced populations to less than 3 000 white rhinos and approximately 300 black by the end of 2021. This represents a **population reduction of 65% for white rhinos since 2011, and 35% for black rhinos**.

Evidence-based conservation: We conducted an empirical statistical analysis to relate monthly data on rhino poaching losses and rhino protection interventions from 11 reserves (9 private and 2 state reserves, incl. Kruger NP) over 5 years (2017-2021).

Interventions: Access control, camera technologies, K9 units, integrity (polygraph) testing, dehorning, detection zones, air support, ranger training and equipment, rhino monitoring, fences, and fence alarms.

WE TOOK A TWO-PRONGED APPROACH

We sought to maximize our understanding of intervention cost and effectiveness by combining

ROBUST STATISTICAL ANALYSIS ⟷ **MANAGER INSIGHT AND OPERATIONAL EXPERIENCE**

Both have strengths and limitations and both are needed to generate clear evidence and insight

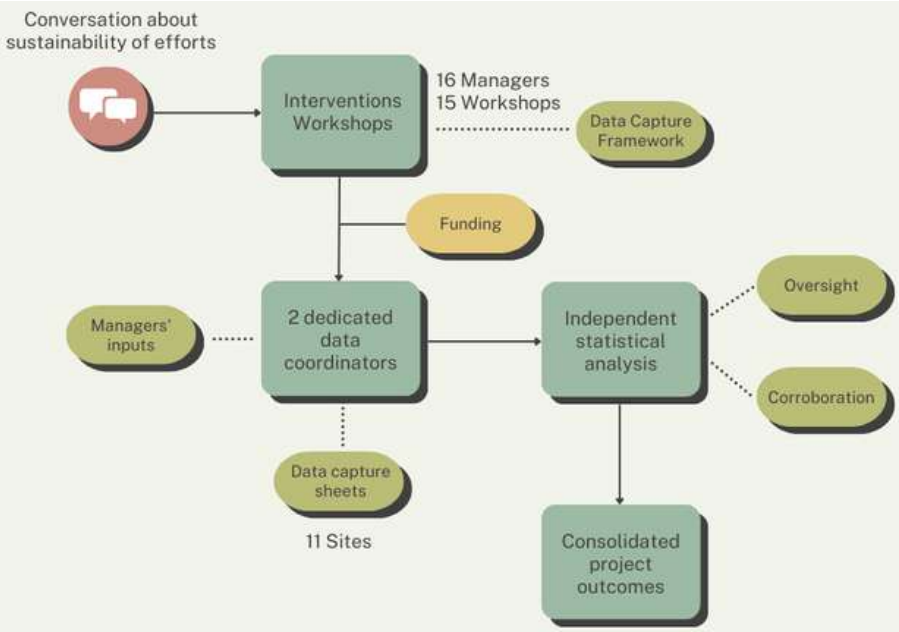
Statistical analyses help test managers' assumptions about how interventions work and challenge opinions with data. The same data may however be limited in several ways (e.g. there may not be enough reserves with and without an intervention to show its effect). The data may also not capture the full complexity of the system analysed and raw results require careful interpretation and contextualisation.

Through several workshops, managers provided expert input at all stages from project conception to final results. They helped define hypotheses about how intervention work (tested in the statistical model), shared their experience of intervention implementation and provided critical context and interpretation to the analyses. Where managers had differing opinions, the analysis helped guide debate and generate insight.

PROJECT FIRE

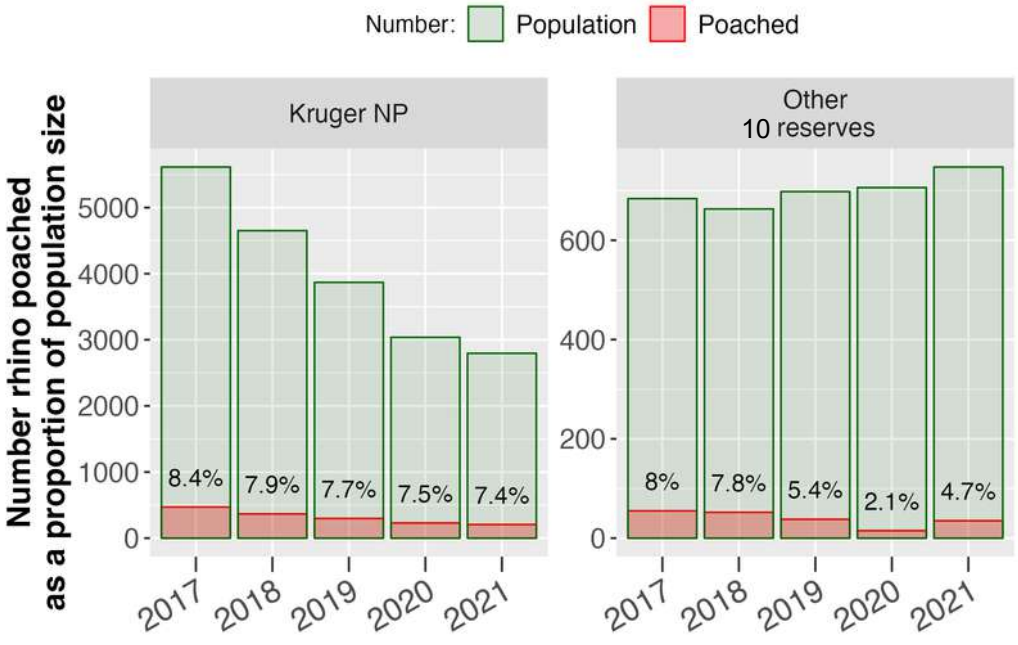
FRAMEWORK OF INTERVENTIONS FOR EFFECTIVE RHINO PROTECTION EVALUATION

As the Greater Kruger poaching crisis developed, managers recognised the need for strategic, holistic, collaborative, and evidence-based thinking. Project FIRE was born.



Project FIRE **brought together a wide range of stakeholders** (managers, field personnel and scientists) with diverse expertise and perspectives to develop an evidence-based understanding of intervention implementation, effectiveness, and cost. It was clear that a holistic approach to rhino conservation was needed in the Greater Kruger, a complex and interconnected system of state-managed and private protected areas.

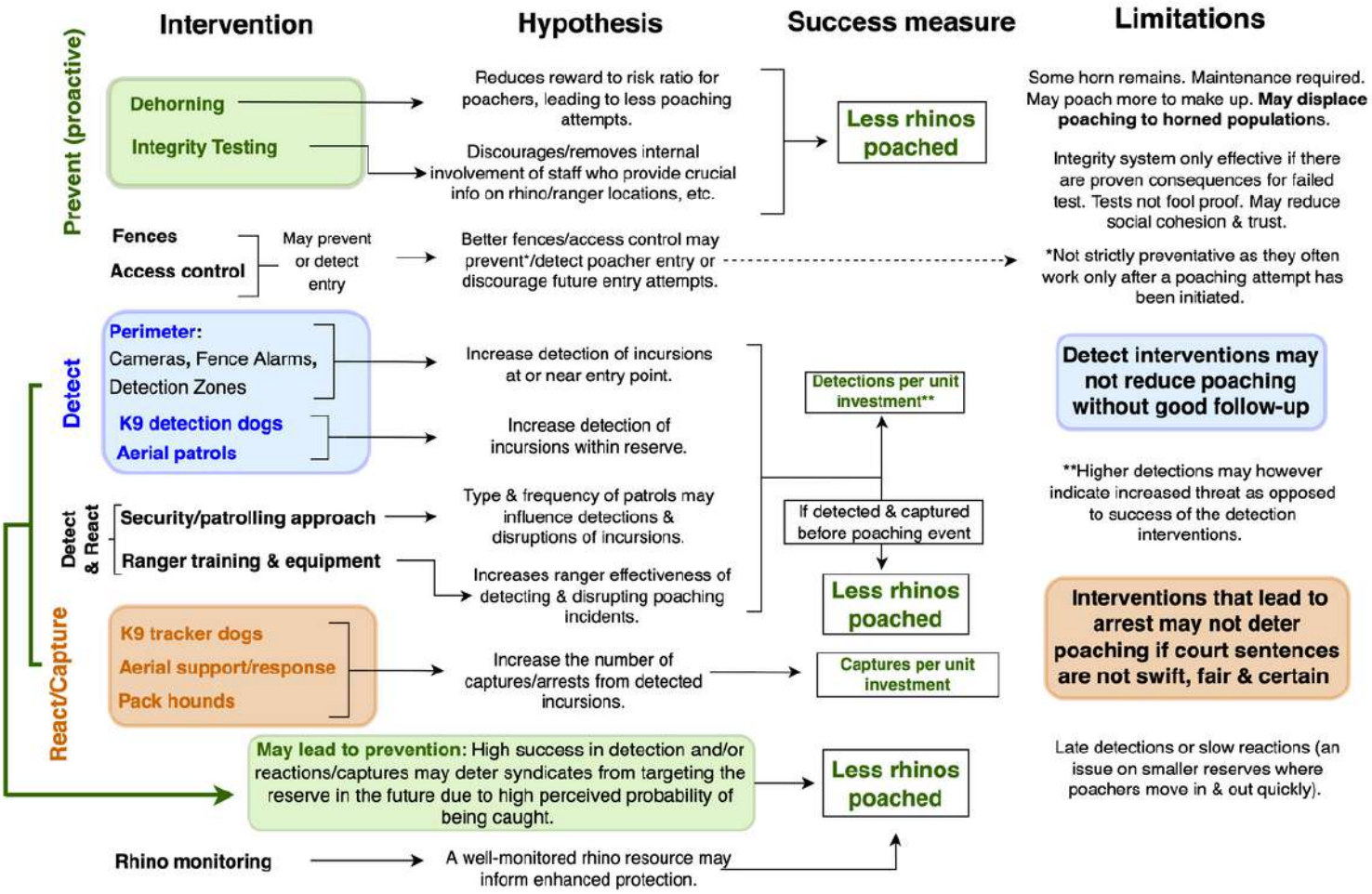
The project represents a hard-won and unique example of science-management collaboration, with all parties contributing meaningfully. Project FIRE endeavoured to ensure that all role-players' perspectives and experiences were integrated into the research process. Data sharing accelerated the pace of scientific discovery and knowledge dissemination.



Manager workshops and interviews: Over 20 workshops and 10 interviews were conducted with managers and other stakeholders with intervention-specific expertise. The operational experience of managers provided critical insight into intervention implementation, helping highlight the hypotheses behind how each rhino protection intervention works in practice, and possible limitations to the effectiveness of each: **the ideal foundation for statistical analyses.**

TESTING INTERVENTION HYPOTHESES

We started by clearly defining hypotheses for how each intervention is meant to reduce poaching. We then tested the evidence for each hypothesis using empirical data in the statistical model.



FOR EACH RESERVE AND QUARTER, WE QUANTIFIED 11 INTERVENTION INDICES (OFTEN COMBINING SEVERAL VARIABLES FOR EACH):

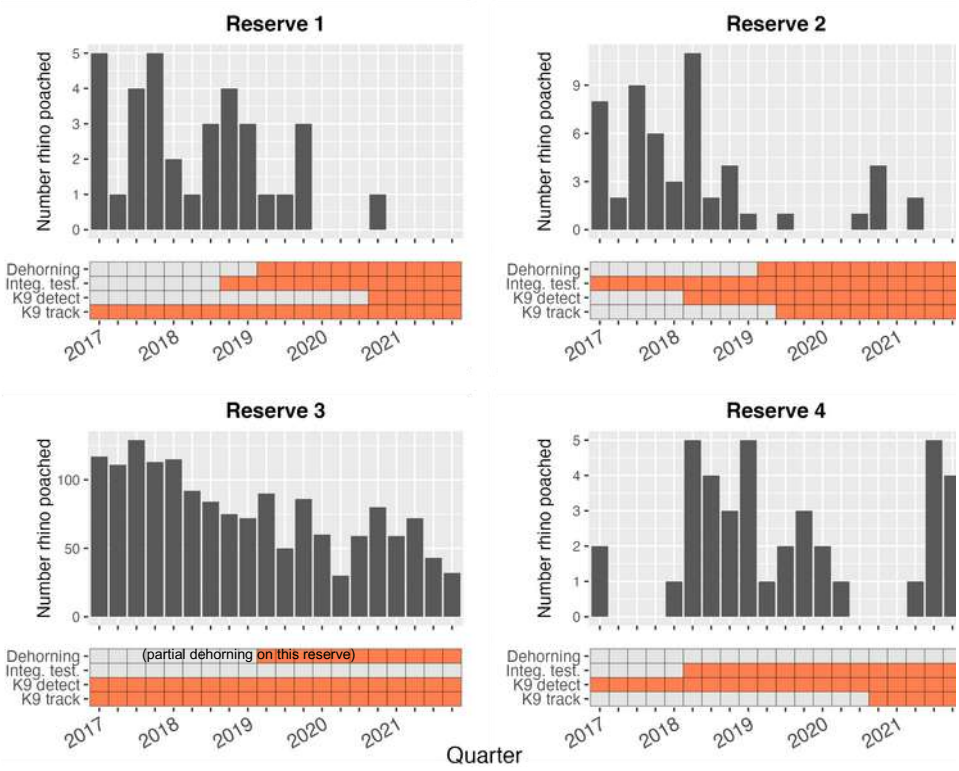
1. **Security index** - presence/absence of control room and rapid response team (plus characteristics of each)
2. **Anti-poaching rangers** per 100km^2
3. **Rhino monitoring** - staff, databases, tracking devices
4. **Dehorning** - proportion of population dehorned
5. **K9 - tracking dogs** per 100km^2
6. **K9 - detection dogs** per commercial gate
7. **Integrity testing** - (a) proportion of security staff tested over the previous year and (b) staff removals/failures over the previous year
8. **Detection zone index** - coverage and maintenance frequency
9. **Access control** (CCTV, staff, boom gates, and other tech)
10. **Fence investment index** - fence type and add-ons
11. **Fence alarm index** - number of zones and distance between

Temporal unit of analysis: Quarter (three-month period)
Spatial unit of analysis: Reserve

STATISTICAL ANALYSIS

Independent expert analysis from the University of Cape Town Centre for Statistics in Ecology, Environment and Conservation

SEEC - Statistics in Ecology, Environment and Conservation



We tested for empirical associations between poaching rates and the intensity of implementation of interventions (the 11 intervention indices above)

- We related the intensity of implementation of each intervention to poaching rates across 11 reserves over 5 years.
- We used a tailored statistical approach that accounts for differences in baseline poaching across reserves, regional poaching trends, and the effects of multiple overlapping interventions.
- We used a **Bayesian hierarchical model** with random effects for reserve and quarter (three-month period).
- We used raw rhino losses and poaching rate as the dependent variable in two separate models.
- Full details on the methodology are available on special request.

Managers and other stakeholders with intervention-specific expertise (a) helped generate hypotheses about how interventions work (to be tested in the analysis), (b) provided input into how interventions were measured (the indices above), (c) helped define success measures (raw losses and poaching rates), and (d) provided critical interpretation of statistical results.

Overlapping and interacting interventions: we included all the intervention indices in a single model to ensure that the effect of each intervention was measured having accounted for the effects of other interventions. We also tested interactions between key interventions that were hypothesised to work together (such as camera detection and tracking dog follow-up capability).

Limitation 1: not experimental - The underlying data are observational, not experimental. This is because interventions were not randomly assigned to reserves, and we do not have clear control (no intervention) and intervention sites. This makes it **difficult to estimate the counterfactual** - what would have happened if an intervention was not implemented.

Limitation 2: low statistical power - Overlapping interventions, a lack of variability in sites with and without each intervention, and a relatively small sample size may have limited the statistical power to pick up intervention effects. This means that it is possible that an intervention that is effective may nevertheless not show a strong statistical association with poaching.

The importance of random effects and confounding variables

Random effects are a powerful statistical tool for controlling for variation in the poaching data that are not to do with the main factor of interest (the interventions). The reserve (spatial) random effect helps to account for differences among reserves in baseline poaching rates (factors like the baseline vulnerability or accessibility of a reserve that are not to do with the interventions). The temporal random effect (year quarter) accounts for region-level (common to all reserves) changes in poaching over time that are independent of the interventions. Such changes may be due to events like the COVID-19 pandemic or the arrest of a member of a high-level criminal syndicate.

This allowed us to compare rhino losses on a particular reserve and year when an intervention was in place, with losses that would be expected in that year based on poaching levels on that reserve in other years (the spatial random effect) and based on poaching levels on other reserves that year (temporal random effect).

CONVERGENCE OF INTERVENTIONS

MANAGER INSIGHT AND OPERATIONAL EXPERIENCE

The statistical results in this report are best understood within the context of the complex environment in which interventions are implemented. To complement the statistical results, **the manager narrative below provides insight into the implementation and effectiveness of several interventions evaluated through this project**

A convergence of effectively deployed interventions leads to a high-level arrest

This case study is just one example showing that:

- Interventions do not stand alone; they converge to achieve results.
- The complex environment in which interventions are implemented.
- Management expertise and wide collaboration are required to effectively deploy interventions.

Balule Nature Reserve implemented several interventions to stem spiraling rhino losses. In addition to pre-existing interventions (specially trained rangers, K9 dogs, and air support), the following interventions were implemented: integrity testing in the latter part of 2018, full dehorning starting in April 2019, a rhino monitor being appointed in 2019, and detection Camera AI capability initiated in early 2020.

During initial "blanket" **polygraph tests** performed in 2018, an employee "Abel" (not his real name) failed his tests with regard to involvement in rhino poaching. He was removed from the reserve. At the time he was employed in the region suffering high rates of rhino losses. On 5 October 2020, we received information that "Abel" and 3 others had illegally entered the protected area with firearms with the intent to kill a rhino.

Intensive rhino monitoring had determined that there was a rhino bull with substantial regrowth (dehorned 18 months prior) in the area. At approximately 3:50 am on 10 October 2020, we received an alert from our **AI camera network** that 3 individuals had been detected in the region in question. The camera was deployed on an exit route used by poachers in the past. A reaction unit was dispatched to perform the follow-up. The unit had a **tracking dog (K9)** and advanced **thermal capabilities.** The dog took the track immediately. The K9 indicated that the poachers had proceeded northwards towards the Olifants River, and they were moving fast. A stopper group was placed north of the Olifants River (a known exit point). Two hours of follow-up had passed and daylight was fast approaching.

Control organised a **helicopter** to aid follow-up and it was dispatched at first light to the ground reaction unit. The ground team and K9 had closed in on the group and the stopper group had been repositioned to intercept the poaching group. Contact was made and the poaching group split into two. The decision was made to follow the group that had the bag that would contain the horn as it was required for evidence. The helicopter hampered the movements of the primary target group while the ground team and K9 were in hot pursuit.

The 'bag' group cleared the **reserve fence.** The suspect with the bag split in a different direction before he was apprehended and identified as the notorious Abel. He was held in custody until the police arrived. The helicopter team and stopper group continued to pursue the breakaway group, but they reached their pick-up vehicle and sped away. Upon arrival, the police opened the bag and found the horn, which later DNA tests performed positively linked the horn to the carcass found in the reserve.

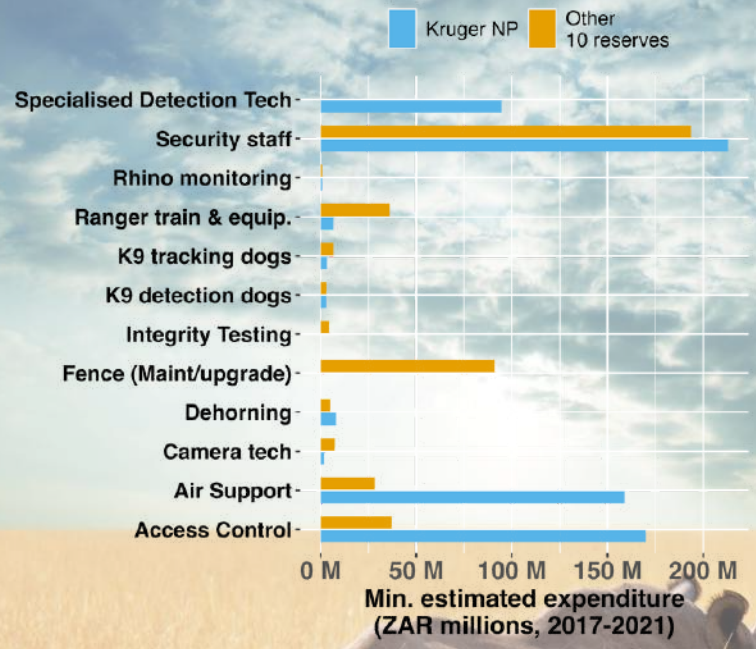
The arrest of Abel was due to the careful adaptive management and cumulative effects of various critical interventions. It demonstrated the need and value of integrity testing, which indicated some 2 years prior to the incident that Abel was involved in poaching for many years. The arrest allowed for the uncovering of the last remaining internal network that was assisting this prolific poaching group within the reserve.

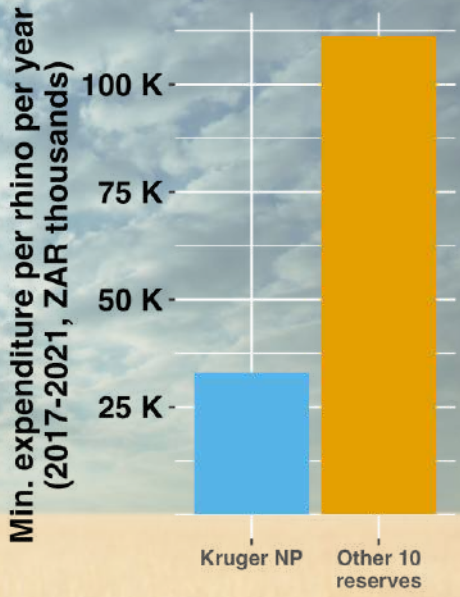
However, **the story does reveal the limitations of interventions. Abel**'s removal through integrity testing did not prevent him from entering the reserve again and poaching the rhino in the above story. Also, the rhino poached had been dehorned, but there was significant regrowth. Finally, many similar arrests have involved suspects being released on bail only to be caught poaching again on the same or neighbouring reserve. Nonetheless...

...After Abel's arrest, the reserve experienced a period of 1089 days without another rhino loss

INTERVENTION COSTS

OVERALL COSTS

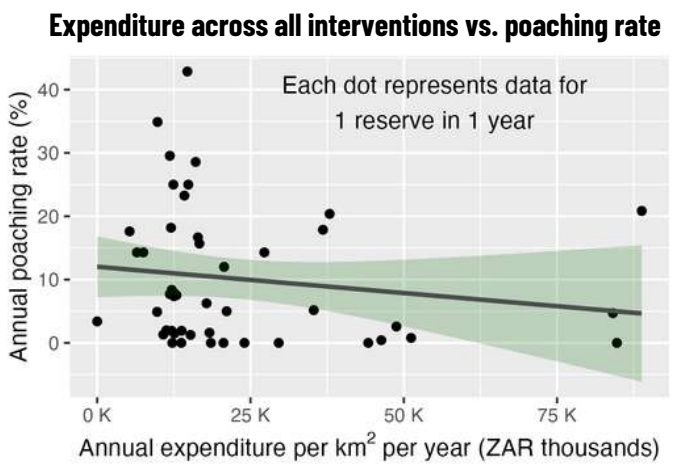


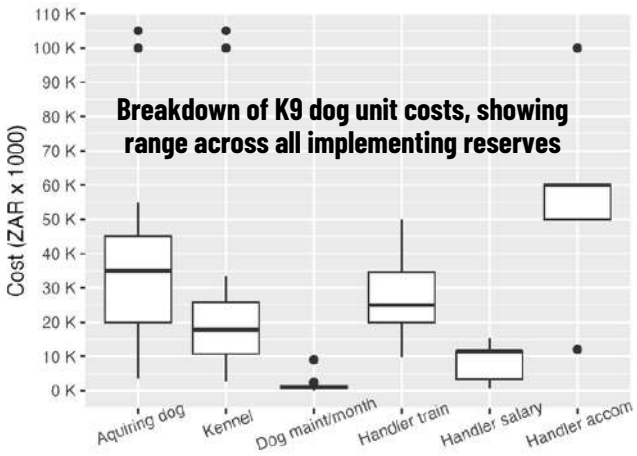


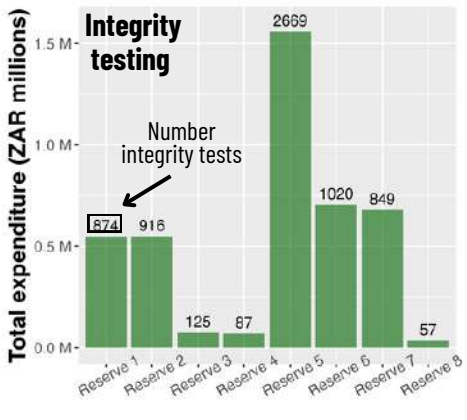
1 USD ~ ZAR 18
*Aug 2023

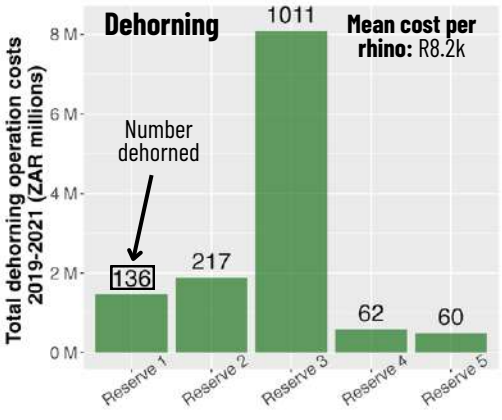
THE MINIMUM ESTIMATE OF THE TOTAL EXPENDITURE ACROSS ALL INTERVENTIONS AND RESERVES (2017-2021) WAS **ZAR 1.1 BILLION (USD 61 MILLION)** OF WHICH ZAR 660 MILLION WAS SPENT ON KRUGER NP.

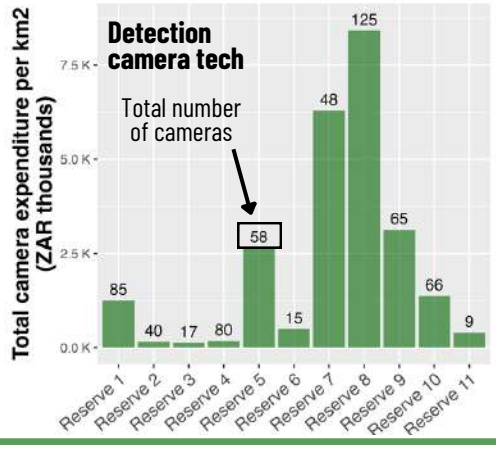
COST DEEP DIVES





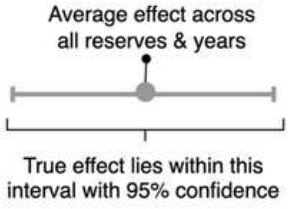






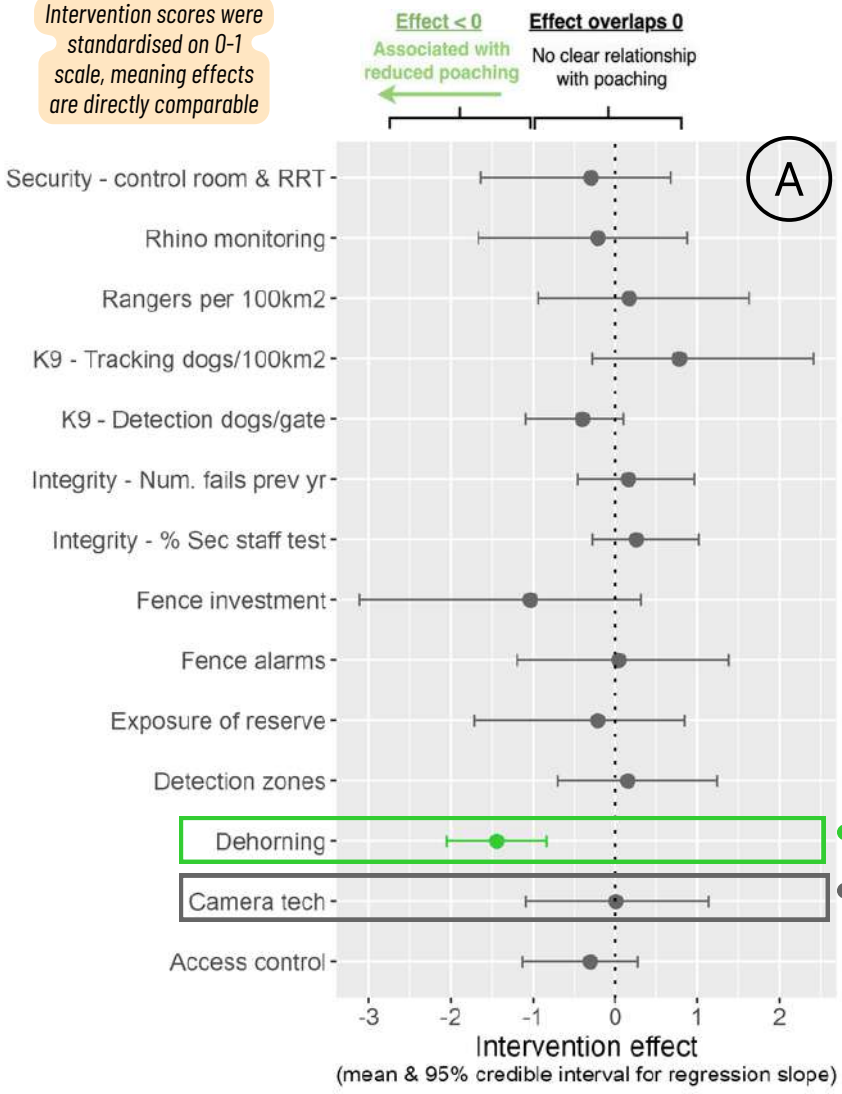
INTERVENTION EFFECTIVENESS

OVERALL STATISTICAL RESULTS

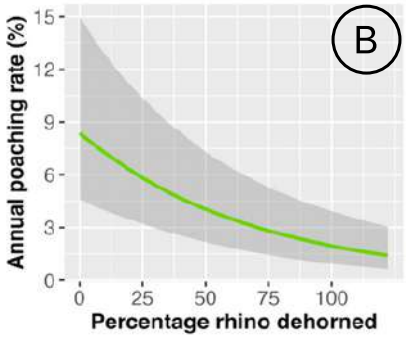


How to interpret: Effectiveness was measured as the slope of the relationship between each intervention and the **poaching rate (dependent variable).** A negative value in **Figure A** means a negative slope (the intervention is associated with reduced poaching). Only if the full credible interval for the slope is to the left of zero do we conclude that there is strong statistical evidence for effectiveness. **Figures B and C** show the same results in a different way. They are conditional effects plots, showing the effect/slope of dehorning and camera tech, respectively, having accounted for all other interventions.

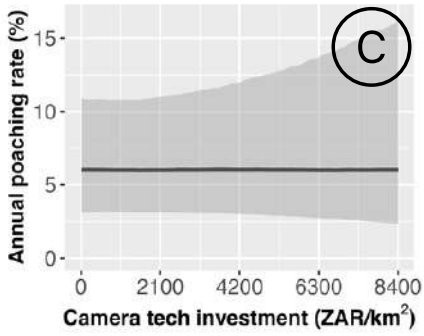
Intervention scores were standardised on 0-1 scale, meaning effects are directly comparable



***For dehorning**, the full credible interval is to the left of zero, indicating **strong evidence for effectiveness.** The slope is steep and the confidence bands are narrow.*



***For all other interventions**, as shown here with camera tech, the credible interval overlaps zero, indicating **no clear relationship with poaching** (flat slope and wide confidence bands).*



*Results were very similar in the two supplementary models (with raw **rhino losses and incursions as the dependent variable**, respectively). We also tested for interactions between several combinations of interventions but found no significant effects (likely due to low statistical power). Finally, we ran a version of the analysis with Kruger NP excluded, but this did not change the overall result above.*

***Ranger training and equipment, and tracking technologies** were correlated with other interventions and were tested in a separate model. Both showed no relationship with poaching.*

SUMMARY AND CRITICAL INTERPRETATION OF HEADLINE STATISTICAL RESULTS

- **Dehorning was the only intervention that showed strong statistical evidence for reducing poaching.**
- This does not necessarily imply other interventions were ineffective, only that evidence was inconclusive given the available data.
- Many interventions were successful by intervention-specific measures as shown on page 10 (e.g. tracking dogs achieved many arrests, while camera tech led to many poacher detections). However, this did not necessarily translate into less poaching.

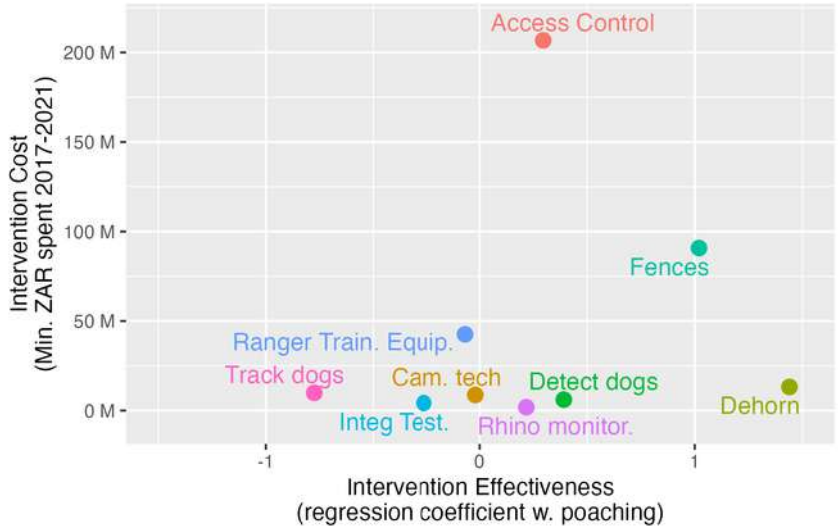
MOST INTERVENTIONS DO NOT DIRECTLY ADDRESS, AND ARE AT THE MERCY OF, SIGNIFICANT EXTERNAL FACTORS SUCH AS SOCIOECONOMIC INEQUALITY, ENTRENCHED CRIMINAL SYNDICATES, CORRUPTION, AND HORN DEMAND.

Reasons why an intervention that is effective in principle may nevertheless show no statistical association with poaching:

- A lack of variation in the data (not enough reserves with and without an intervention) reduces statistical power. For example, on most reserves and for most years there was at least one tracking dog present, so it was hard to fairly compare their effect with a no-dog baseline.
- **Internal involvement** (corruption) allows otherwise effective interventions to be circumvented using inside information.
- Some interventions were limited by **poor implementation** at some sites (low management capacity). This dampens estimates of effectiveness. Properly deploying K9 units, or strategically placing and monitoring cameras, requires specialist expertise.
- **Detect interventions** (like camera technologies or detection zones) may perform their function well (lead to detections) but will not reduce poaching without rapid and effective follow-up capability.
- **Interventions designed to lead to poacher arrests** (e.g. tracking dogs) may perform their function well, but will not deter future poaching if criminal courts are not effective, and sentences are not swift, fair, and certain. Poachers may thus remain willing to take the risk, as the evidence of multiple repeat offenders confirms.

COST EFFECTIVENESS

Dehorning, the most effective intervention according to the statistical results, was also one of the most cost-efficient. Notably, dehorning was also able to generate revenues beyond its cost on some reserves, through offers of dehorning experiences to paying guests. For the other interventions, the lack of a clear and significant association with reduced poaching precluded direct calculations of effectiveness per unit investment. Instead, **we present a schematic relating cost and effectiveness below**.



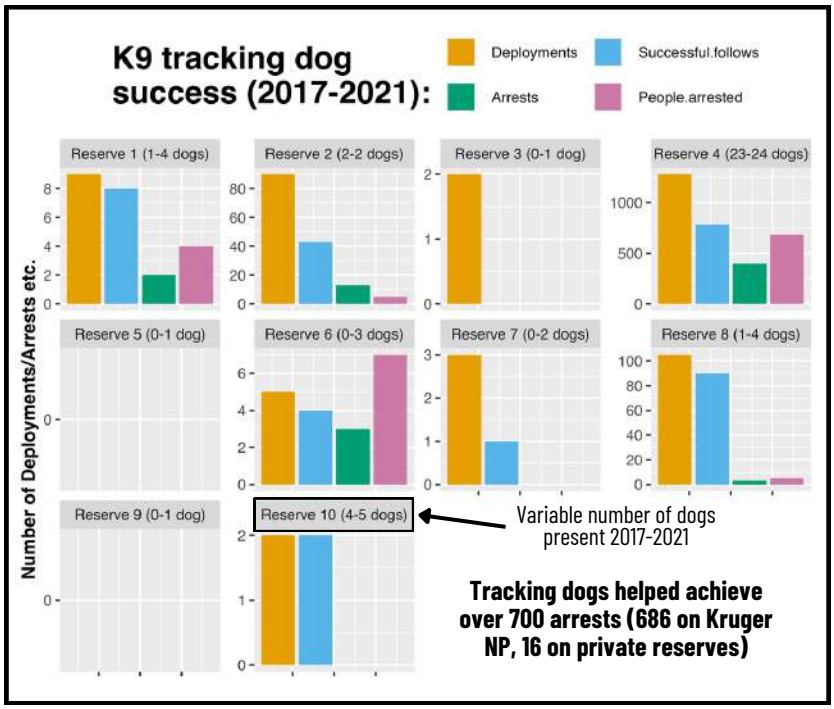
Access control
No clear effectiveness
High cost

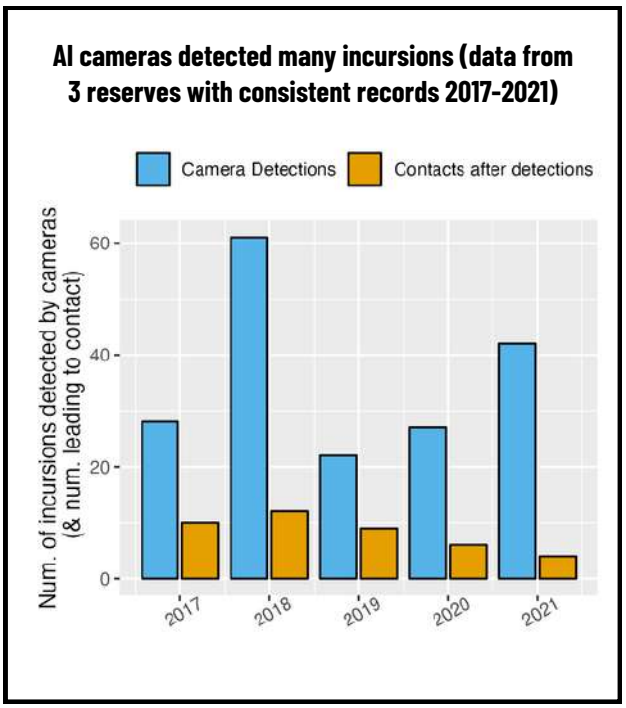
Dehorning
High effectiveness
Low cost

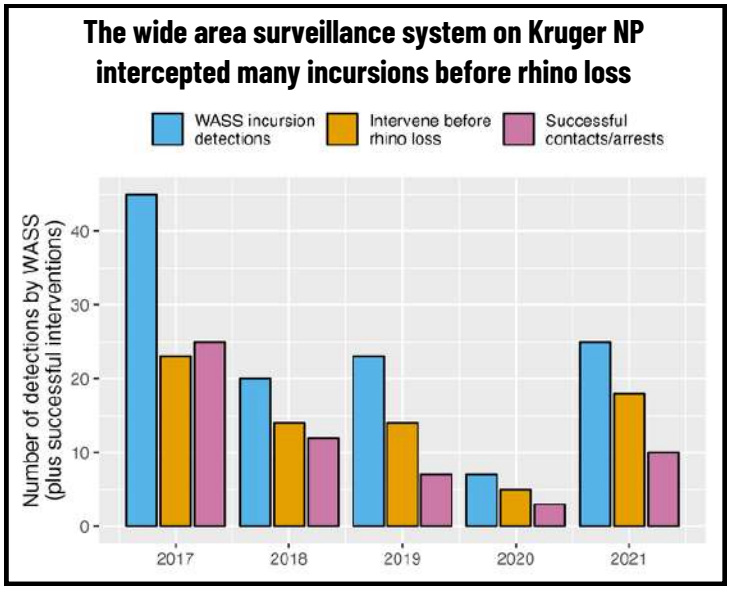
INTERVENTION-SPECIFIC RESULTS

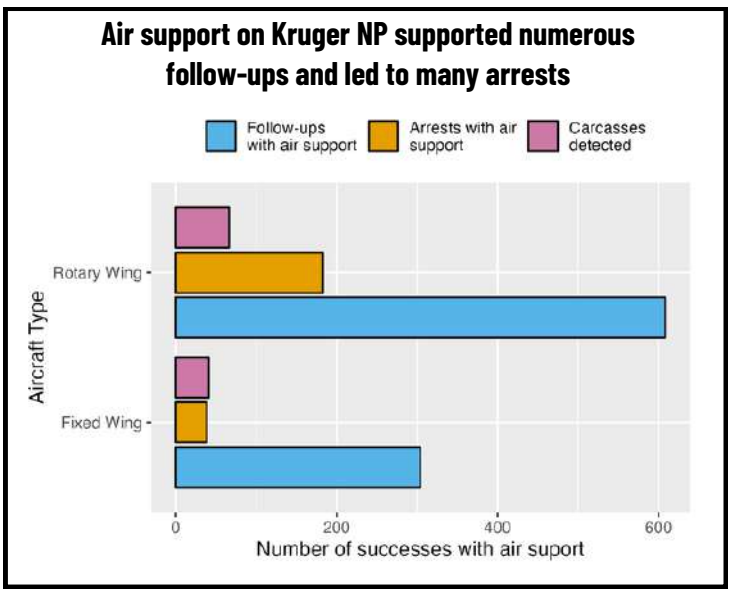
SUCCESS MEASURES SPECIFIC TO THE FUNCTION OF KEY INTERVENTIONS

A significant statistical association with reduced poaching (overall statistical results on page 8) is a high bar for success. **We may instead measure interventions using function-specific success measures**. For example, AI cameras resulted in many successful poacher detections, K9 tracking dogs achieved many significant arrests over the project period, and integrity testing successfully led to the removal of numerous reserve staff linked to criminal syndicates.







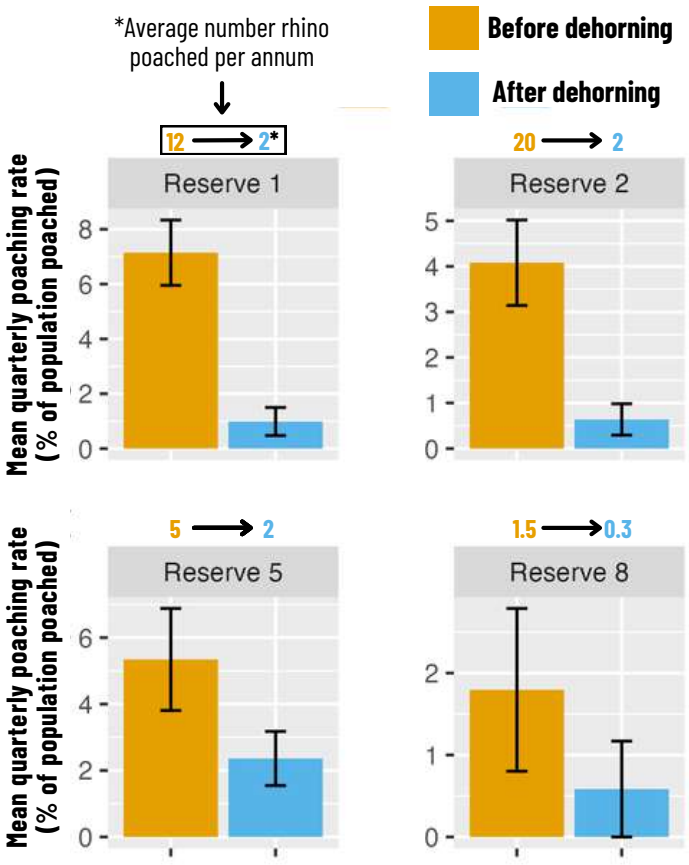


Detecting and arresting poachers is critical, but not enough...

Many interventions clearly achieved critical successes in terms of detecting poachers and aiding follow-up and arrest. Poaching rates may well have been higher without these interventions. Yet we failed to find strong statistical associations between these interventions and poaching rates in the overall model on page 8. **This suggests that arrests do not necessarily translate into reduced poaching**. A possible reason is that court sentences are often not swift, fair and certain and hence do not deter future poaching. This is supported by evidence of many repeat offenders in this system (often out on bail). Similarly, high socio-economic inequality means there are likely many people willing to take the risk despite the chance of arrest. Internal corruption, furthermore, offers a potential way around many interventions and thus reduces the probability of being caught. For reserve-level interventions to work well, significant improvements are required in criminal justice, the transparency and integrity of reserve, police and government staff, as well as fair socio-economic development.

DEHORNING DEEP DIVE

UNDERSTANDING THE HEADLINE RESULT



To dehorn or not to dehorn? The logic behind the effectiveness of dehorning is clear: (A) Dehorning is a pro-active intervention that directly dissuades poachers from entering a reserve by reducing the reward, while most other interventions involve reacting once a poacher has already entered. (B) Dehorning cannot be easily circumvented with internal information, as can other interventions. (C) The implementation of dehorning is more straightforward than many other interventions (one either dehorns a rhino or not) and is, therefore, less dependent on management competence, additional resources, and operational experience. **The significant statistical evidence and strong logic for dehorning combine to make a strong case for dehorning as a strategy to reduce poaching.**

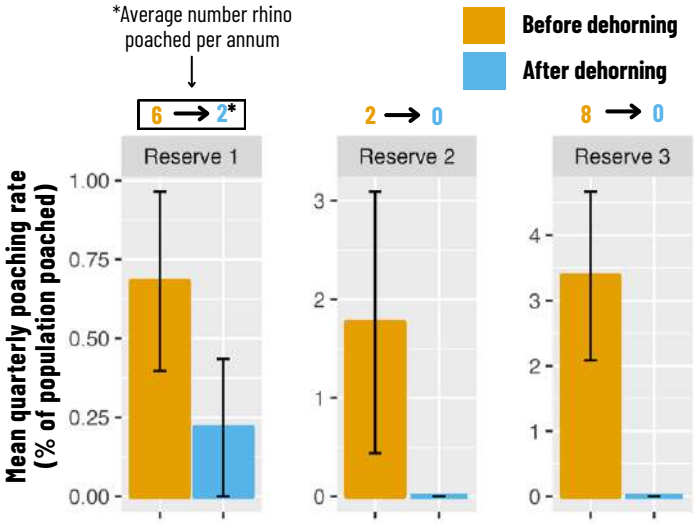
However, dehorned rhinos were occasionally poached (particularly those with significant regrowth). Also, one project FIRE reserve did not dehorn any rhino and yet suffered only minor rhino losses across the 5 years. Furthermore, dehorning in the Greater Kruger may have displaced poaching pressure to horned populations within the system and also elsewhere in South Africa. It remains to be seen whether dehorning would be as effective in the absence of horned populations accessible to syndicates. Finally, current research suggests dehorning may alter rhino space use, but has found no evidence for effects on survival and reproduction (though more work is needed).

The four reserves shown on the left each implemented total dehorning at different points between early 2019 and early 2020.

On all four of these reserves, poaching was substantially lower after total dehorning (2020-2021) than it was before total dehorning (2017-2019). Although, on average, the five reserves that did not implement dehorning also saw a decline in poaching over the same period (perhaps due to the COVID-19 pandemic), the decline was only slight. All four dehorning reserves also implemented maintenance dehorning within 18 months of initial dehorning to account for horn regrowth. Kruger NP also implemented dehorning during the project period but is excluded from the figure as it had only dehorned 25% of its rhinos by the end of 2021.

Overall statistical results: The figure on the left shows only raw data patterns, while the full statistical model (results on page 8) accounts for the effects of all other interventions, as well as unmeasured spatial and temporal effects (like the COVID-19 pandemic). In this statistical model, dehorning showed strong and consistent statistical evidence for effectiveness. Having accounted for other intervention effects, **total dehorning was estimated to reduce poaching by 75% from pre-dehorning levels**. This is shown in Panel B on page 8 (overall statistical results). While this relationship may not be directly causal, these results suggest that many rhino losses were prevented by this intervention.

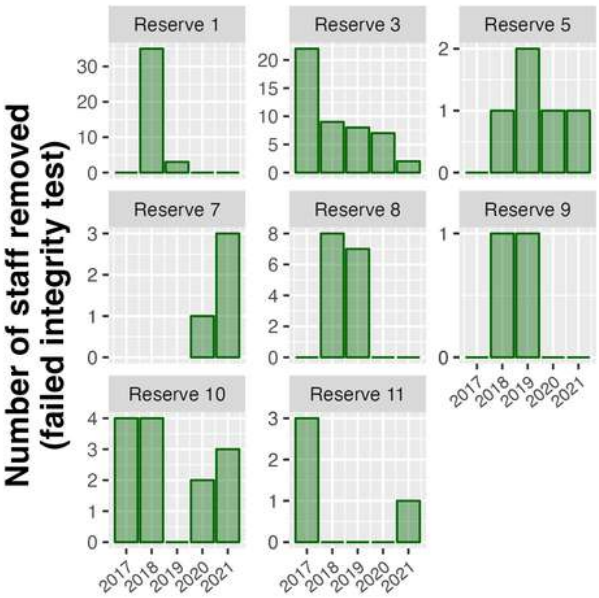
Three reserves that were non-dehorning during the project period (2017-2021) implemented dehorning in 2022 (after the project period and therefore not analysed in the overall statistical model). Basic records show, however, that all three reserves recorded a decline in poaching after dehorning (2022) compared to before (2020-2021).



MANAGER INSIGHT AND OPERATIONAL EXPERIENCE

FOR KEY INTERVENTIONS

The narratives below are designed to add nuance and critical interpretation to the overall statistical results, by highlighting the logic, value and challenges involved in implementing key interventions.



Integrity testing and the challenge of internal involvement

Integrity tests (polygraph tests) were **implemented to address what had become perhaps the most significant facilitator of rhino poaching in the Greater Kruger: the internal involvement of rangers and other reserve staff.** Poaching syndicates recruit people on the reserve to provide critical internal information such as rhino locations, ranger patrol locations, and intervention implementation. The graph on the left shows both the extent of internal involvement and the outcome of integrity testing (legally staff can be removed from private reserves after two failed tests if there is sufficient evidence that they are a threat to the reserve).

Integrity testing, when applied correctly, can amplify the success of other interventions by reducing the chance that they are circumvented with internal information. Many of these interventions deliver excellent results which justify their high expense. If, however, a reserve deploys these interventions without an integrity testing policy in place, the return on investment can be significantly compromised.

While it might be argued that testing compromises staff trust, **rangers and other staff often express support for testing as a means of demonstrating their honesty and commitment while ensuring consequences for those who engage in illicit behaviour**. Crucially, it gives rangers confidence that when entering a dangerous situation they can trust the people with them.

Despite these positives, neither the intensity of integrity testing nor the number of staff removals were statistically associated with reduced poaching. This partly reflects challenges in measuring the effects of this intervention. More tests and removals may deter poaching, but may also correlate positively with poaching because more tests are conducted around specific incidents, while higher staff removals may signal a greater integrity problem. Also, it is possible to get around a poorly-implemented integrity test and manager interviews indicate that the early implementation of integrity testing was fraught with challenges. Finally, as the story of "Abel" indicates (see page 6), those removed after a failed test may nevertheless remain involved with criminal syndicates and even return to the reserve to poach.

Technology: deep dive to follow

Globally, technology has been heralded as a critical tool in the effort to tackle the illegal wildlife trade. Project FIRE involved extensive data on the implementation of specific technologies across the state and private reserves, including cameras and drones to detect and follow up on incursions, specialised detection technologies like underground magnetic cables, devices affixed to target animals, fence detection technologies, and artificial intelligence-enabled detection cameras.

Our current project scope did not, however, allow full analysis and evaluation of these technologies. We were limited to using standardised data on camera and tracking technology across reserves and years (both of which showed no strong statistical association with poaching). **We have identified a critical need for more focused and extensive quantitative and qualitative analysis of the effectiveness, cost, and logic of tech interventions in this landscape**. We have planned a detailed "tech deep dive" which will be conducted in the near future.

MANAGER INSIGHT AND OPERATIONAL EXPERIENCE

FOR KEY INTERVENTIONS

K9 Units

K9 units (tracking and detection dogs) have been deployed widely in the Greater Kruger. **Tracking dogs were very successful at performing their function of following tracks and leading to significant arrests** (during 2017-2021, 686 people were arrested on Kruger NP and 16 people were arrested on private reserves; see page 10). Tracking or "line" dogs are generally used to systematically follow tracks, with follow-up operations often starting soon after sunrise and could last the entire day. A good tracking dog can follow tracks up to 12 hrs old. In Kruger NP and Karingani, both very large reserves, tracking dogs have drastically increased the rate at which detections of poachers translate into arrests. **Detection dogs were less successful** in terms of detections at gates and arrests (during 2017-2021 there were only 3 detections and 6 people arrested on Kruger NP, and only 2 detections and zero arrests across private reserves).

However, when looking across all reserves and years, **neither the number of detection dogs per gate nor the number of tracking dogs per 100 km2 were associated with reduced poaching in the full statistical model**. Thus more dogs did not necessarily translate into less poaching, which suggests that a dog successfully achieving an arrest does not necessarily deter future poaching (see the discussion on page 10). The caveat here is that most reserves used tracking dogs at some point, so there was not a lot of good data from times and places where there were no dogs, making it difficult to test their effectiveness. However, there were very few deployments of tracking dogs on private reserves compared to Kruger NP, which reduces the statistical power to detect effectiveness. Finally, successful implementation of K9 units requires specialist expertise and training - poor deployment at some sites may have dampened effectiveness.

Ranger well-being and support

Intervention implementation and success cannot be separated from the welfare of rangers and other staff. A strong, motivated, supported, well-trained, and resilient ranger team, as well as good leadership, must be at the centre of the fight against wildlife crime.

Law enforcement operations often place the modern-day ranger in life-threatening situations. Greater Kruger rangers work in an environment that continues to change and evolve. Previously the threats to rangers were from animals and the environment but in recent times criminal intentions, armed conflict, and the legal implications they may face present enormous challenges.

Never before has it been more important for organisations to support their staff. This includes better remuneration, counseling support to provide rangers with a safe space to talk about their work pressures, and offering financial literacy training to reduce their vulnerability to entrapment through debt. It is also essential to provide legal support to rangers to ensure that they are properly trained in the applicable legal frameworks and rules of engagement in the field. Training places an emphasis on social safeguards and human rights and helps to reduce the risk and liability to rangers, whilst also protecting the human rights of suspected poachers.

Research has shown that staff who chose to become involved in deviant behaviour in their organisations is often linked to them feeling unsupported, demoralised, and undervalued.

HIGH-LEVEL CONCLUSIONS

SUMMARY AND CRITICAL INTERPRETATION OF HEADLINE STATISTICAL RESULTS

- **Dehorning was the only intervention that showed strong statistical evidence for reducing poaching**.
- This does not necessarily imply other interventions were ineffective, only that evidence was inconclusive given the available data. Lack of variation in sites with and without certain interventions will have reduced the statistical power to pick up effects.
- Many interventions were successful by intervention-specific measures as shown on page 10 (e.g. tracking dogs achieved many arrests, while camera tech led to many poacher detections).
- However, our analysis suggests that detecting and arresting poachers is not enough. Arrests did not necessarily translate into reduced poaching (see below).

KEY INSIGHTS ARISE FROM ASKING THE CRITICAL QUESTION: WHY, FOR MOST INTERVENTIONS, WAS THERE NO CLEAR RELATIONSHIP WITH REDUCED POACHING?

Reason 1: Most interventions were re-active (detecting and arresting poachers). Dehorning is more proactive, which may explain high effectiveness. Reactive interventions have several weaknesses:

- They often happen after a rhino has been killed.
- They carry a high human cost (dangerous contacts between rangers and poachers).
- They are easily weakened by other factors: detect interventions won't work without good follow-up, and arrest interventions won't work without effective courts.

Reason 2: Interventions do not address, and are at the mercy of, significant external factors such as socioeconomic inequality, entrenched criminal syndicates, corruption, and horn demand.

Reason 3: Internal involvement - many interventions can be circumvented with inside information (less so dehorning).

Reason 4: Management implementation and competence varies widely. Null effects may be due to poor implementation, not a poor intervention. Effective operational management is essential for the efficient functioning of any of the interventions applied to rhino protection. It requires strong leadership, strategic planning, and the ability to make informed decisions in a dynamic, challenging, and ever-changing environment.

Reason 5: Challenges with National and provincial government's capacity to provide legal, judicial, and investigative support (as evidenced by multiple repeat offenders in this system).

LESSONS FOR THE FUTURE OF RHINO CONSERVATION

This collaborative research project has highlighted that addressing complex rhino protection challenges requires interdisciplinary cooperation across the science, management, and policy spheres. We believe that Project FIRE serves as a springboard for the refinement of rhino protection interventions across Africa and reassessing of strategic approaches going forwards.

Our headline results point to the importance of proactive approaches such as dehorning, and bring into sharp focus the challenges and limitations of combatting poaching at the reactive level when poachers have already entered reserves. This is not to downplay the value of front-line rangers, who daily risk their lives as rhino custodians. Their work has achieved numerous significant arrests and it is easy to imagine how there would be no rhinos left were it not for them. However, the significance of repeat offenders, poor law enforcement investigations, and slow courts have worked to jeopardise the effectiveness of ranger efforts on the frontline.

Manager insight and operational experience suggest that the null results for many interventions analysed here can be traced to the variation in implementation at some sites. We therefore advise that general efforts and specific projects to conserve rhinos should take into consideration and seek to support each reserve's management and operational capabilities.

In addition, a key area for growth in proactive approaches is a greater focus on the complex socio-economic climate from which poachers are recruited and mobilised. Criminal syndicates have become entrenched in many of the communities in the Greater Kruger, often exploiting their socio-economic vulnerability. With the right vision and support, local communities can be empowered to be the key agents for positive change in this landscape. Regional interventions are needed that seek to enhance the safety and well-being of all in the landscape: people, broader biodiversity, and rhinos. Any project or intervention targeted at reducing poaching should seek to, where possible, actively engage factors beyond reserve boundaries: socio-economic inequality, transparent governance of key institutions and organisations (state and private), and the broader criminal justice system.

THE POWER OF SHARED LEARNING

While the results obtained from this project were not as definitive as initially envisaged, the project has undoubtedly contributed immensely to the growing body of knowledge surrounding rhino protection. The insights gained, even if they raise further questions, lay the foundation for future studies and the refinement of strategies aimed at safeguarding these magnificent creatures.

One of the most positive project outcomes was the exchange of knowledge among the individuals involved. **Managers collaborated with scientists and academics and shared insights and experiences freely, fostering an atmosphere of intellectual exchange that stimulated learning and growth**. This amplified the project's impact, enabling participants to broaden their horizons, expand their understanding, and forge valuable connections. This project provided a platform for early-career managers to work alongside experienced managers, fostering the exchange of knowledge, skills, and ideas. All participating managers expanded on their expertise, networks, and motivation to drive forward innovative and impactful rhino protection initiatives.

Acknowledgments

Sharon Haussmann and Steven Whitfield, with the help of the reserve managers and other key stakeholders, developed the bold vision of project FIRE. The Rhino Recovery Fund and World Wildlife Fund South Africa provided critical financial support, along with expert guidance.

Senior SANParks staff helped facilitate and guide this project. The Greater Kruger reserve managers contributed hundreds of hours of combined time helping to design this project, consolidating the data required, and providing critical insight and experience to help interpret and contextualise the results. The steering committee provided expert oversight and much-needed direction to this project. The data collectors patiently and persistently tackled the mammoth task of gathering standardised data over countless reserve visits. Credit and appreciation to the UCT team, specifically Dr Tim Kuiper, for his exceptional commitment and intense application of acumen beyond the original brief of this project.

Finally, the team would like to acknowledge the strong and kind leadership of Sharon Haussmann during this project, specifically her role in creating an environment in which managers, scientists, and field personnel worked together towards a shared vision and goal.

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Rhino Recovery Fund

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