COMPARISON OF FOUR DIFFERENT RADIO TRANSMITTER ATTACHMENTS ON BLACK RHINO IN MADIKWE GAME RESERVE

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ABSTRACT

A total of 17 black rhinos *(Diceros bicornis minor)* were collared or eartagged with four different radio tagging techniques before release into Madikwe Game Reserve in June 1996, October 1996 and August 1997. Results are compared and recommendations made after 29 months of continuous monitoring of the different radio tagging techniques.

RESUME

Au total, 17 rhinos noir *(Diceros bicornis minor)* ont été soumis au port de collier à travers quatre différentes techniques de radio tagging avant d'être lâchés dans la réserve de Madikwe en Juin 1996, Octobre 1996, et Août 1997. Les résultats ont été comparés et des recommandations ont été formulées après 29 mois de suivi continu des différentes techniques de radio tagging.

INTRODUCTION

In June 1996 nine black rhinos were translocated from Pilanesberg National Park to Madikwe Game Reserve -both protected areas are situated in the North West Province of South Africa. In October 1996 ten black rhinos were translocated from Umfolozi Game Reserve in Kwazulu-Natal to Madikwe Game Reserve. In August 1997 another five female black rhinos were introduced from the Umfolozi/Hluhluwe Park in Kwazulu Natal.

The North West Parks Board is committed to conserving black rhinos in its parks. Madikwe was recently established and considered to be ideal for black rhino introductions because of its large size and suitable rhino habitat. The management of Madikwe Game Reserve accepted that intense post release monitoring is essential for the long-term management of the black rhino population, and failures and successes must be documented for future reference to improve continuously our knowledge and efficiency with black rhino translocations.

Similar attempts to attach radio tracking devices to black rhinos for intensive post release monitoring has been implemented in other countries such as Zimbabwe (du Toit, pers comm; Kock, pers comm), Namibia (Erb, pers comm) and other parks within South Africa (Morkel, pers comm). All such attempts have had failures and successes, but overall, radio telemetry attachments in the form of collars and eartags have not had significant successes due to the problems described in the text below (Morkel, pers comm.; du Toit, pers comm.).

Each black rhino has detailed records in a master file, called an "identikit", and has its ears individually notched for identification. Madikwe has extensive areas of dense bush, so to aid in the rapid and effective monitoring of each rhino it was decided to attach radio transmitters to as many rhinos as possible before release.

Radio transmitters are notoriously difficult to attach to the neck of a black rhino because of their unusual neck shape (triangular and continuous with the top of the scull). Eartags have not remained attached for any significant time and have so far proven to be of little value in long-term radio telemetry monitoring of black rhino (Morkel, pers comm).

To determine what types of radio telemetry systems may best work for black rhino monitoring, four different radio transmitter types were used on 17 black rhinos. The goal of this study was to improve designs and techniques of attaching radio telemetry equipment to black rhinos for post release monitoring.

Horn implants were not used because the horns of most of the rhinos introduced into the Reserve were too small to fit implants, and there were no implants available at the time of the translocations. Therefore, no comment can be made on the success of horn implants compared to the radio transmitters used during this project.

DESCRIPTION OF TRANSMITTER TYPES

Two Logicpulse (TM) eartag transmitters manufactured by Merlin Systems, Inc - USA were attached **to** a male and a female black rhino in June 1996. These animals were released directly into Madikwe without a borma period. The transmitters had a pulse period of 1.5 seconds and were activated between 6am and 6pm on Monday, Tuesday, Thursday and Friday. The eartag consisted of a battery/ transmitter disk with a 10cm long antenna The transmitter was bolted on to another disk through a hole in the ear. The tag was 2.5cm deep and 15cm in diameter. No photo or drawing is available for this design.

Two collars made by Wildlife Decision Support Systems- Pretoria, South Africa, hereafter referred to as the McKenzie collars, were fitted on a male and female rhino in June 1996 and free-released into Madikwe (Figure 1).

Twelve collars were designed by Dr Markus Hofmeyr and Mr Gus van Dyk - both from the North West Parks Board and are referred to here as the Hofmeyr and van Dyk collars. A Telonics **MMK**4 or **MMK**6 transmitter with a D-size lithium battery was imbedded in dental acrylic (Vertex Self-Cure Dental Acrylic). The hot and cold antennae were embedded between two layers of 3cm wide canvas machine belting (supplied by SA Belting supplies [Pty]). A 15 to 35cm special elastic horse girth strip (also 3cm wide) joined the ends of the belting. After the neck of the rhino was measured, the collar was completed and slipped over the head of the rhino **to fit** snugly behind the head. Two males had collars attached in June 1996 and were fee-released into Madikwe. Two males and three females had these collars attached in October 1996 while still in the bomas, before their release into Madikwe. Five females had their collars fitted in July1997 in the bomas in Umfolozi Game Reserve before being released directly into the

Photo Credit: Markus Hofmeyr

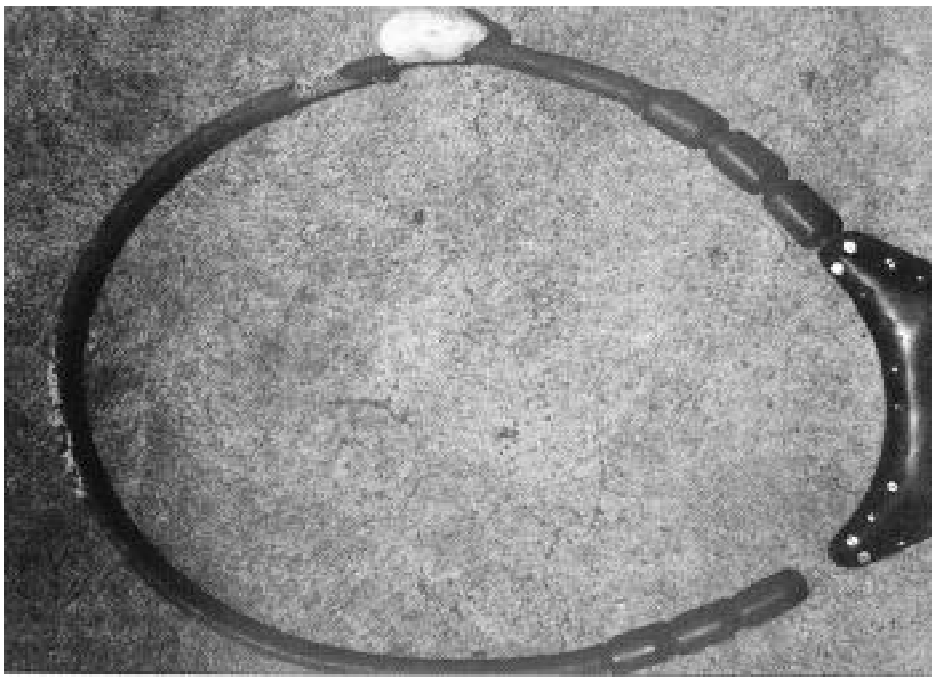

Figure 1. McKenzie collar.

A Telonics MMK 6 transmitter with a D-size lithium battery was placed in a pre-set acrylic casing. The casing was glued together after the transmitter/battery unit was placed in one side of the casing. The collar consisted of a steel cable fitted in acrylic beads. The cable ends were bolted around the rhino neck after a snug fit was obtained just behind the head.

veld in Madikwe in August 1997. The last five collars were fitted after attempts had been made **to** rectify the faults found in the original seven collars (Figures 2,3 and 4).

One collar designed by Ms Keryn Adcock, freelance ecologist specialising in black rhino ecology was

Photo Credit: Markus Hofmeyr

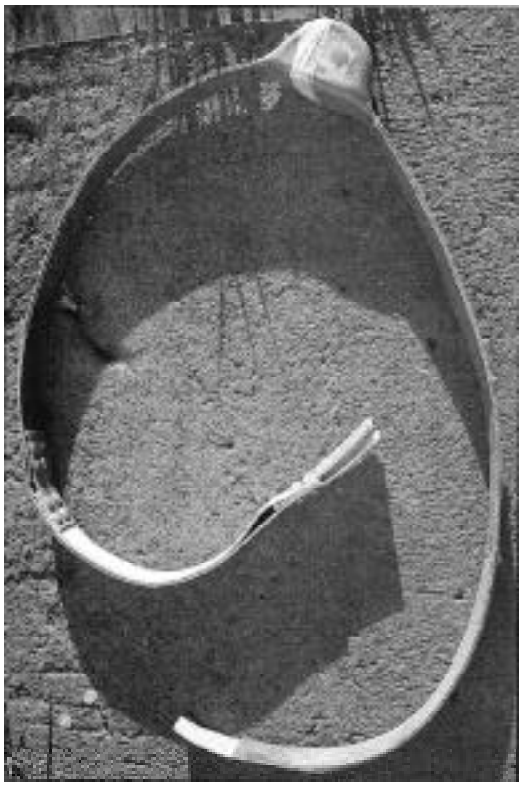

Figure 2. Photo of the Hofmeyr and van Dyk collar.

Photo Credit: Markus Hofmeyr

Figure 3. Fit of the Hofmeyr and van Dyk collar.

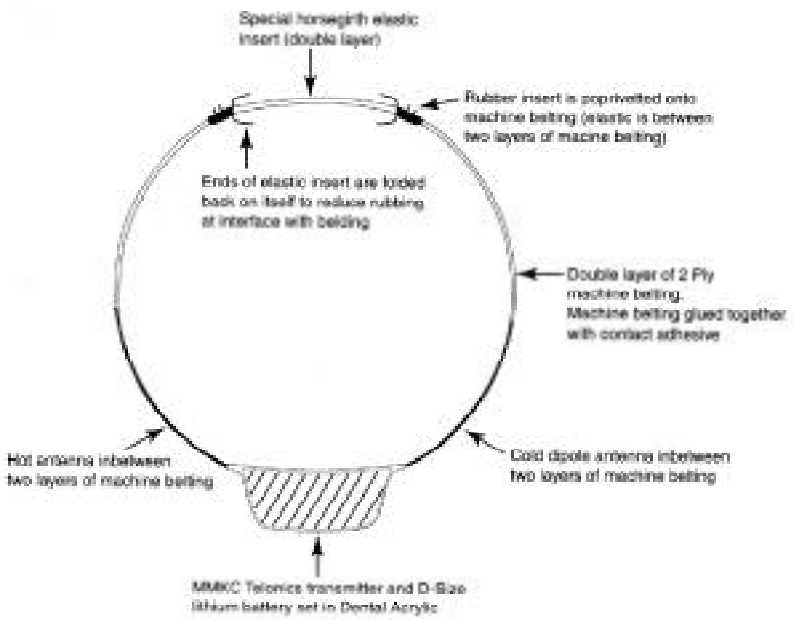

Figure 4. Diagram of the Hofmeyr and van Dyk collar.

placed on a female rhino in October 1996 and is referred to as the Adcock collar (Figure *5.)*. The rhino died within a week after release and will only be referred to in the text for reference only. This collar was not tested under the circumstances.

All collars had a 50cm 'hot' (this comes from the antenna port on the transmitter) and 'cold' (this comes from the negative, ie. from the battery) antenna. Receiving equipment consisted of a TR4 Telonics receiver with a Telonics 'rubber duck' antenna The transmitter frequency range was between 148 to 149.5 MHz. All telemetry monitoring took place on foot or from a vehicle. Hills were frequently climbed to obtain optimum range.

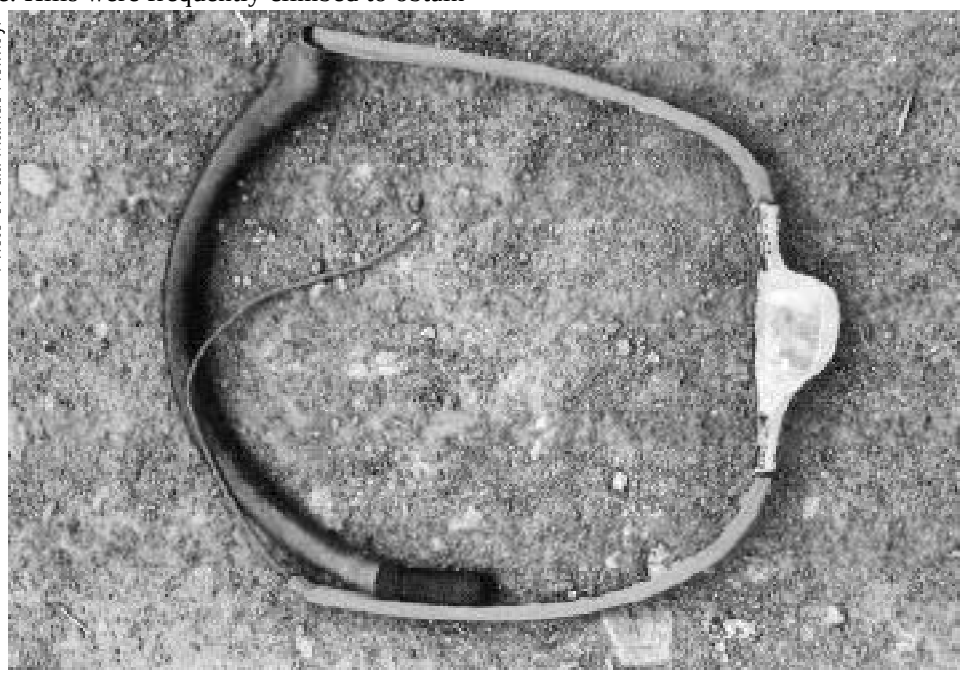

Photo Credit: Markus Hofmeyr

Figure 5. Photo of the Adcock collar.

RESULTS OF DIFFERENT TRANSMITTER *Disadvantages* TYPES

A brief summary of the advantages and disadvantages are given which became apparent during the monitoring period from fitting of the collar (indicated in brackets) **to** the date of this article. Telemetry monitoring took place randomly for 22 **to** 28 days every month. Range distances for the signal apply for ground telemetry only - aerial telemetry was not used.

Eartag

This method was applied to one male and one female rhino in June 1996.

Advantages

- small and lightweight.
- aesthetically acceptable.
- no visible irritation to the rhino.
- quick to apply.
- eartags still attached **to** the ear after ten months with no visible lesions or irritation to the ear.

Disadvantages

- slow pulse frequency resulted in poor localisation of the signal.
- duty cycle impractical, which resulted in difficulty locating the actual
- transmitter. transmission range is a third of the range of a collar-fitted transmitter. Under optimal conditions a 3km range was obtained. Range was always less than 1kmon flat ground in wooded terrain.
- short life of functional transmitter even with data cycle and slow pulse frequency (date last signal recorded- 19/9/96 and 10/11/96 respectively for the two eartags transmitters). The functional transmitter life for the eartags was four months and six months respectively. The eartag transmitter came out of the

ear of the female after ten months and after 11 months in the male.
- signal transmission was irregular and not constant to a set frequency ie., a receiver had to be fine-tuned at each recording to obtain the best signal.
- signal transmission was severely affected by body movements of the rhino and frequently could not be picked up from a constant receiving position.

Comments

Eartags are ideal for small reserves especially if aerial telemetry is used, but are not suitable for ground telemetry in larger reserves due to the disadvantages mentioned above. Considerably more time was spent locating eartag transmitters than collar transmitters (recordings were taken once a week as compared to daily recordings for the collars). Poor range and weak signal also make the eartags unsuitable for ground telemetry. One eartag obtained a nick in the antenna soon after the rhino's release, which resulted in halving the already poor range.

The eartags proved motto fulfill the requirements of intense post release monitoring because of the few records and intense searches for the rhinos with eartags. They did supply limited data but rhinos without radio transmitters were seen more frequently than these two rhino. The effort used **to** fond these two rhinos could have been better for tracking rhinos without radio transmitters.

Adcock collar

This collar was fitted to one female in October 1996.

Comments

Unfortunately this collar was placed on a rhino which died one week after its release. No reliable data could be collected within such a short monitoring period. Further testing is necessary but this collar type could work. Good signal strength and range were obtained from the few days of monitoring.

McKenzie collar

This collar was fitted to one male and one female in June 1996.

Advantages

- fairly easy to fit.
- sits snugly just behind the neck without any signs of visible irritation to the neck.
- aesthetically very pleasing, can hardly be seen on the neck.
- good signal strength and range (optimum conditions -10km range), signal is also very constant.
- durable.

Disadvantages

- no elasticity in collar, can only remove it manually, could damage the rhino if it grows into the collar or if the collar gets hooked onto a solid object.
- both collars stopped transmitting well before the expected battery life should have expired due to water leaking into transmitter housing via the antenna cable and rusting the battery and antenna connections, causing the transmitter to stop transmitting. Collars stopped transmitting two weeks and six months after attachment to the rhino.
- need to re-immobilise the animal to remove the collar.

Comments

This collar technique could work well if the battery problems can be rectified. It is aesthetically acceptable, and after ten months of attachment no visible lesions or irritation could be seen. The first collar on the female came off after four months. The second collar on the male came off after eight months. The fact that there is no elasticity does predispose the collar to problems, because the rhino may grow or get caught on a branch and damage itself. The rhino needs to be frequently monitored and the collar removed if necessary.

This collar design did allow for the intense post release monitoring of rhinos with minimal effort and was ideal when considering the range and signal strength.

Hofmeyr and van Dyk collar

This collar was fitted to two males in June 1996 and **to** four females and two males in October 1996 and again **to** five adult females in July 1997.

Advantages

- easy to attach once the collar is fully made up
- elastic insert allows collar to expand or shrink which allows a snug fit with no visible irritation to the rhino
- aesthetically acceptable
- durable
- very good signal strength, range and consistency (optimum conditions - 15km range)
- if the collar should catch on a rigid object the elasticity allows it to give or even come off if necessary
- elastic insert will most likely perish with time so that immobilisation will not be necessary to remove the collar. The elastic is expected to last for up to two years, which is slightly shorter than the expected battery life.

Disadvantages

- essential that snug fit is obtained when the neck is at its maximum diameter, as a loose collar will easily come off.
- if too tight (eg. if the animal grows), the collar could cause lesions on the neck.
- if the elastic insert is too long it tends **to** break easily and also allows the collar to come off easily if the rhino frequently robs itself on its neck.
- the attachment of the rubber insert to the belting is the weak link in the collar. All except one collar that came off was a result of the rubber tearing at the attachment either from excessive force or continuous rubbing. Two collars slipped over the head of the rhino because they were attached too loosely.

Comments

Two collars attached in July 1997 are still attached at the date of this article being written (15 months later). Both collars still fit snugly and no visible lesions or irritations are present. Two of the collars remained attached for 18 and 19 months respectively. The rubber attachment broke at those times, which resulted in the collars coming off. This was considered an advantage because the transmitters were recovered without having to re-immobilize the animal.

The above-mentioned collar, which remained attached for 19 months, did cause some discomfort to the rhino. It was a male animal which appeared to have had a fight with another rhino in September1997. The rhino obtained a head wound and the collar was pulled diagonally over the right ear and into the head wound. The collar remained in this position and prevented the wound from healing. The rhino was darted on foot, and the collar proved **to** be essential as the rhino ran five kilometres before becoming immobilised. Without the collar, this animal would not have been found because of the difficult terrain. The collar was removed and the wound cleaned. The wound has appeared to heal properly (Figure 6).

This incident highlights the importance of regularly checking on radio collared animals **to** monitor any negative impacts the collars may have on the rhino. Fortunately, darting on foot is possible without too much risk of losing the animal. This in turn reduces the cost of darting, because the expense of an aircraft can be saved.

One of the collars attached to a male in October 1996came off after six weeks. This collar was visibly loose when attached and the rhino lost condition after

Photo Credit: Markus Hofmeyr

Figure 6. Wound caused by fighting and irritated by the collar.

his release, which resulted in the collar becoming even looser. The collar first moved diagonally across the head (fitting behind the eye and between the ears across the bottom of the jaw) where it remained for four days without any visible signs of irritation to the rhino. It came off on the fifth day.

Two female rhinos with collars died within one week of their release, but both rhino had their collars still attached at the time of death.

Two collars attached to rhinos in October 1996 lost their collars at four months and five months respectively after attachment. Both these collars broke off. Both breaks were situated at the attachment of the rubber insert into the machine belting. This is the weakest point of the collar. If the insert were shorter, breakage may have been prevented. In future the robber insert will only be 15cm long and will be situated on the top of the neck because robbing is unlikely to affect this part of the collar. The fact that the collars broke indicates that both collars were under a fair amount of stress when this happened. For the requirements of this study the design fulfilled its purpose by breaking, because if it did not break the rhino may have been injured. The collars did, however, remain on the two rhinos long enough to determine their home ranges.

The collar fitting technique recommended after the initial trial of seven collars was used on five rhinos released in **to** the Reserve in August 1997. The technique was refined from the original seven Hofmeyr and van Dyk collars and attempts were made to avoid the mistakes which occurred during the fitting of the collars in the trial period.

The new collars were made out of machine belting (supplied by SA Belting Supplies [Pty]) 3.5cm wide. The transmitter and battery were set in dental acrylic (Vertex Self-Cure Dental Acrylic) and attached **to** the belting. The transmitter had a 50cm hot and cold antenna. The two antennas were placed and glued between two layers of 2-ply belting with contact adhesive. An elastic insert (special horse girth with a width of 3.5cm) with a maximum length of 15cm was attached to one end of the belting and the other end was secured to the belting once the collar had been measured around the neck of the rhino. The elastic was doubled up and fastened to the belting with pop rivets. Care was taken to affix the elastic insert in such a manner that it lay on top of the neck of the rhino once attached and not on the side of the neck.

The collar was put around the neck of the rhino after a smug fit was obtained with the rhino lying in a relaxed position - ie., the neck must be stretched out and the head must be lying freely on the ground. if the animal becomes immobilised while head pressing or with its head pressed up against an object, then the neck measurement becomes unreliable due to the huge difference in the diameter of the neck. The key **to** attaching these collars successfully is to fit them snugly while the neck is in its most relaxed state (ie. when the neck diameter is at its minimum).

A properly fitted collar sits just behind the jaw and in the neck fold immediately behind the ear base. The collar must sit tightly, but with at least a thumb width between the collar and the neck. The elastic band must be in a position where it is just about stretching.

Of the five collars fitted in July 1997, one was removed after two weeks while the female was still in the boma, as the rhino developed a skin reaction. The collars were all made one night before the being attached to the rhinos. Each collar was painted black with 'AEROLAK LACR-SPRAY', a quick drying spray paint. The glue used to stick the collars was 'PATTEX' contact adhesive. The type of skin reaction was typical of an allergic reaction —redness, swelling, and itchiness, and the rhino rubbed itself raw on the lesion. The collar was removed a day before the rhino was released. Subsequent sightings of the rhino showed complete healing with no complications. This female was also pregnant **at** the time, and gave birth prematurely in the bomas before release. The calf died two days after birth. The fact that the female was far advanced in her pregnancy may have been a factor in her hypersensitivity to the collar or its components.

Two of the collars came off after seven and ten months respectively. One was possibly broken off during a fight (deduction made from tracks in the area where the collar was found), and broke off **at** the joint of the rubber and belting. The second collar was found with the rubber again tom **at** the joint of the belting and the rubber insert. Excessive rubbing may have caused this collar to break.

Final results indicate that this collar design may work well with black rhinos. The collar fit and length of the elastic insert are important for this collar to stay in place, ie. the collar needs to fit smugly just behind the head with a short elastic insert (maximum 15cm in length) situated at the top of the neck. The North West Parks Board will continue to use this design on black rhino to test its reliability fully.

An additional three collars of this type were attached to three black rhinos in Kruger National Park using the same attachment technique as described above. No complications have been reported to date and a similar result as was achieved in Madikwe has been attained in Kruger National Park. One collar broke off after sevenmonths and one is still attached. The third collar stopped transmitting after a few months and has not been found.

Another useful function of this collaring technique was fitting it to a sick rhino. A sick black rhino was darted on foot in Madikwe and the collar fitted during the immobilisation. The animal was then monitored closely on a daily basis after receiving treatment. Unfortunately the rhino died two weeks later, but the collar proved to be useful and was still attached snugly when the rhino died.

This collar design was also tried on an injured white rhino in Pilanesberg National Park (van Dyk, pers corn) and it came off after four months. No lesions were visible on the rhino's neck. The collar fit was slightly loose, and this may have been the reason it came off. The rhino could, however, be monitored closely on a daily basis. This particular rhino was darted three times for follow-up treatment, and darting would not have been possible if the rhino was released without the collar due to the difficult terrain. In addition, this collar design did allow for an intense post release monitoring of rhino with minimal effort, and was ideal while they were working when considering signal range and strength.

DISCUSSION

An interesting problem became apparent while collaring the rhinos. The neck size of a black rhino can change by up to 15cm depending on its posture at any one time. This needs to be taken into consideration when fitting any collar. Ideally the collar needs to be fitted snugly when the neck is at its minimum diameter. Some of the rhinos headpressed against the boma wall during the immobilisation phase when the collars where attached. When the animals headpressed the neck diameter was at its maximum, and this became apparent when the rhinos awoke and relaxed their necks, causing a tight fitting collar to become loose. The overall condition of the rhino also influences the diameter of the neck. In all cases the collars were loose with condition loss and fitted snugly after the condition improved. Based on these findings, it is questionable if fixed collars are at all ideal for rhino because of their varying neck diameter as discussed above.

Collar summary

- Collar transmitters gave greater signal strength, consistency and range than the eartag transmitters.
- Eartag transmitters were found not to be ideal for ground telemetry in Madikwe.
- McKenzie collars could be promising if transmitting life could be extended.
- Hofmeyr and van Dyk collars show promising preliminary results and these are recommended for trials in other parks and reserves on black rhinos.
- Neck diameter variability is an important consideration when attaching collars.

The results of the different collaring techniques are summarised in Table 1.

CONCLUSION

The Hofmeyr and van Dyk collar technique was tested most extensively in Madikwe Game Reserve because the initial trials showed that it was a potentially useful technique.

The recommended collaring technique from the trials is the Hofmeyr and van Dyk collar. If attached correctly the collar can stay on the rhino for up to 19 months. There are inherent weak points, which reduces the attachment time. All except one collar of this design broke off at the attachment of the rubber insert and the belting. If more rhinos are collared in Madikwe Game Reserve, then this technique will be used with the as yet untested strengthened joint of the rubber insert and the belting.

The above mentioned collar technique has shown similar and improved results compared with other collaring techniques elsewhere in Africa (Morkel, du Toit, Kock and Adcock, pers comm).

Only two rhinos reacted to the collar negatively and no life threatening side effects were seen on any of the collars. The telemetry information obtained from the radio tagging devices has provided the Reserve management with invaluable information regarding the post release movements and population dynamics of the released rhinos. Without the aid of radio telemetry, little post release data would have been collected because of the difficult terrain to monitor the rhinos in Madikwe.

The Hofmeyr and van Dyk collaring technique is recommended for other parks in Africa and could be could be used on other rhino species in Africa and in Asia Further improvement of the technique must be researched and compared to the horn implant as a radio tracking attachment in black rhino.

Table 1: Summary of success or faiture of the initial collars attached to rhino

Rhino name	Collar Type	Duration of	Duration of transmission	Optimum transmitting	Comments attachment distance
Totolina	EARTAG	4 months	10 months	3km	Did not give good results in Madikwe; attachment time good
Hansa	EARTAG	6 months	±11 months	3km	Did not give good results in Madikwe; attachment time for eartag transmitter.
Hughey	MCK collar	6 months	±1 year	10km	Water leaked to the battery and connection to transmitter rusted, cable rusted and broke off resulting in collar coming off the rhino
Buglehorn	MCK collar	2 weeks	±6months	7km	Same problem as above; collar assembly not good because of water leakage and rusting.
Female 1	ADK collar	N/A	N/A	10km	Rhino died within one week of release with collar still attached
Female 2	H & vD collar	N/A	N/A	15km	Rhino died within one week of release with collar still attached
Female 3	H & vD collar	N/A	N/A	15km	Rhino died within one week of release with collar still attached
Maoka	H & vD collar	Still transmitting after collar came off	6 weeks	15km	Collar was visibly loose when attached and had a 25cm elastic insert, collar came off intact.
Champion	H & vD collar	As above	4 months	15km	Collar visibly loose and had a 20cm elastic insert, collar broke off at elastic attachment to belting; elastic on side of neck.
Tholo	H & vD collar	As above	5 months	15km	Collar was visibly loose when attached and had a 20cm elastic insert; the collar broke off at elastic attachment to belting, elastic on side of neck.
(*)George	H & vD collar	As above	18 months	10km	Collar broke off at elastic attachment to belting, elastic visibly perished; rhino immobilised after collar attached for 15 months to treat superficial wounds caused by collar irritating wounds caused by fighting; no complications and wounds healed quickly, ground darting with the aid of telemetry.
Mpofu	H & vD collar	As above	19 months	15km	No complications noticed to date; first collar attached with snug fit and 15cm elastic insert, correct fit. Rubber insert perished.
Mmapinda	H & vD collar	As above	19 months	15km	No complications experienced to date, released August 1997 in Madikwe (free-release).

Table 1. Continued

Rhino name	Collar Type	Duration of	Duration of transmission	Optimum transmitting	Comments attachment distance
Kwezi	H & vD collar	As above	7 months	15km	No complications experienced, collar fitted while rhino was headpressing and collar fitted very tightly in that position, once the rhino relaxed the collar fitted snugly. From evidence from tracks she may have been in a fight which resulted in the collar breaking off.
Zondo	H & vD collar	As above	10 months	15km	No complications, free release into Madikwe, 2 Aug 1997. Collar broke off at join of belting and rubber insert. Extensive rubbing may have been the cause.
Punana	H & vD collar	As above	Still attached	15km	No complications; free-released into Madikwe 20 August 1997.
Ester**	H & vD collar	As above	2 weeks	15km	Removed while still in bomas at capture slte (Umfolozi G.R.) because of skin reaction to paint or glue from collar; lesions superficial and disappeared once collar was removed.

Note:

- MCK collar = McKENZIE COLLAR; ADK collar = ADCOCK COLLAR; H & vD collar = HOFMEYR AND VAN DYK COLLAR.
- Optimum transmitting distance refers to the maximum distance over which radio transmitter signals were received with a Telonics TR4 receiver. Only ground based telemetry was used, and optimum transmitting distance indicates distances obtained under field conditions. Greater distances are expected if radio telemetry is done from an aircraft.
- Duration of transmission indicates actual transmitting periods of transmitters while attached to the rhino. Some of the collars came off before the expected battery life expired.
- Duration of attachment refers to the time the collar stayed on the rhino.
- (*)The collar on 'George' slipped into a wound, which was caused by fighting with another rhino. The collar may have been pulled into the wound, which was in front of the right ear, by the actual fight. The wound was very superficial but the collar irritated it so that it would not heal. The rhino was darted on foot and the collar was placed back around the neck. The collar looked in good condition. The wound healed within a week without complications.
- (**) One collar was removed from a female rhino due to be released in Madikwe. She showed a skin reaction two weeks after the collar was attached to the animal.

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REFERENCES

Adcock, K. (pers corn) Ecologist, Pietermaritzburg, South Africa

Kock, M. (pers corn) Department of National Parks and Wild Life Management, Zimbabwe.

du Toit, R. (pers comm) WWF and Department of National Parks and Wild Life Management, Zimbabwe.

Morkel, P. (pers corn) South African National Parks Board.