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A SCORING SYSTEM TO IMPROVE DECISION MAKING AND OUTCOMES IN THE ADAPTATION OF RECENTLY CAPTURED WHITE RHINOCEROSES (*CERATOTHERIUM SIMUM*) TO CAPTIVITY

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ABSTRACT: Ninety-four subadult and adult white rhinoceroses (*Ceratotherium simum*) were captured between February and October, 2009–11, in Kruger National Park and placed in holding bomas prior to translocation to other locations within South Africa. A simple three-category system was developed based on appetite, fecal consistency/volume, and behavior to assess adaptation to bomas. Individual animal and group daily median scores were used to determine trends and when rhinoceroses had successfully adapted to the boma. Seventeen rhinoceroses did not adapt to boma confinement, and 16 were released (1 mortality). No differences in boma scores were observed between rhinoceroses that adapted and those that did not, until day 8, when the first significant differences were observed (adapted score=13 versus nonadapted score=10). The time to reach a boma score determined as successful adaptation (median 19 d) matched subjective observations, which was approximately 3 wk for most rhinoceroses. Unsuccessful adaptation was indicated by an individual boma score of less than 15, typically during the first 2 wk, or a declining trend in scores within the first 7–14 d. This scoring system can be used for most locations and could also be easily adapted to other areas in which rhinoceroses are held in captivity. This tool also provides important information for assessing welfare in newly captured rhinoceroses.

Key words: Animal welfare, appetite, boma, maladaptation, white rhinoceros.

INTRODUCTION

Hundreds of white rhinoceroses (*Ceratotherium simum*) are captured and translocated each year. The risks of complications associated with immobilization are compounded by transport and boma confinement. Mortality for rhinoceros translocation in South Africa and Namibia is estimated to be 5% (International Union for Conservation of Nature African Rhino Specialist Group, pers. comm.). However, the prevalence of morbidity (i.e., anorexia, abnormal fecal consistency, onset of illness) is probably underestimated. The severe physiologic changes that occur in white rhinoceroses during immobilization have been well documented in the literature (Hattingh and Knox 1994; Bush et al. 2004).

Postcapture stress may also lead to complications such as anorexia, diarrhea, and secondary infections (Rogers 1993). In addition, white rhinoceroses are often administered long-acting tranquilizers that suppress appetite and impact behavior during the first week of boma confinement (Kruger et al. 1999). Development of a simple but standardized scoring system incorporating these observations to determine whether an individual is adapting to boma conditions would minimize morbidity and possible mortality associated with complications due to confinement.

MATERIALS AND METHODS

In total, 94 free-ranging white rhinoceroses were captured and transported to bomas during the morning hours (0700 and 1200 hours) between February and October 2009–11 (48 individuals in 2009; 28 in 2010; 18 in 2011) in Kruger National Park (23°49′60″S, 31°30′0″E),

South Africa. Rhinoceroses were immobilized according to the Standard Operating Procedure for the Capture, Transportation and Maintenance in Holding Facilities of Wildlife (protocol approved by South African National Parks Animal Use and Care Committee). Drugs were delivered remotely using 3.0 mL plastic darts with a 60 mm uncollared needle propelled by compressed air (DAN-INJECT, International S.A., Skukuza 1350, South Africa). Animals were immobilized by administering etorphine (Novartis, Kempton Park 1619, South Africa), azaperone (Stressnil, Janssen Pharmaceutical Ltd., Halfway House 1685, South Africa), and hyaluronidase (Hyalase, Kyron Laboratories, Benrose 2011, South Africa) in the dart. Butorphanol (Kyron Laboratories) was administered intravenously (IV) within 15 min of darting at a dose of 20 mg/1 mg etorphine. Doses were based on standardized age categories: subadult doses=2.5–3.5 mg etorphine, 20–40 mg azaperone, 5000 IU hyaluronidase; adult doses=3.5–4.2 mg etorphine, 40 mg azaperone, 5000 IU hyaluronidase. After rhinoceroses were loaded into transport crates, they received 12 mg diprenorphine IV (M5050, Novartis) and 50 mg zuclopenthixol acetate IM (Clopixol-Acuphase, H. Lundbeck Pty. Ltd., North Riding 0040, South Africa).

Rhinoceroses were housed in purpose-built "rhino bomas." Initially, animals were kept in enclosures approximately 25 m by 50 m to facilitate adaptation to their new circumstances. Once an animal was eating and defecating normally, it was moved to a smaller pen approximately 10 m by 20 m. All enclosures were constructed of vertically spaced wooden poles supported by a metal framework. Compatible animals, typically subadult rhinoceroses, were housed together; otherwise, a single rhinoceros was placed into each boma. There was ample shade and freshwater provided within the bomas. Ad libitum feed consisted of a mixture of 50% tef (*Eragrostis tef*) and 50% of high-quality lucerne (*Medicargo sativa*) hay. Any injuries, illnesses, or abnormal behaviors observed were immediately communicated by boma managers to the staff veterinarian.

A scoring system was developed to standardize and quantitate observations on appetite, fecal consistency/volume, and behavior to assess adaptation (Table 1). Scores were recorded on a daily basis once each rhinoceros arrived at the boma until the day of departure. A positive score was assigned for each category for healthy rhinoceroses. If the rhinoceros appeared ill, negative values were used, based on severity of the abnormality in each category. In order to balance the physiologic (appetite, fecal consistency/volume) with behavioral scores, points were divided between the three categories (maximum 5 points for appetite, 5 points for fecal quality, and 10 points for behavior, with a possible total of 20 points). Scores were assigned by one of two experienced boma managers to minimize variability. If an animal was deemed to be maladapted, it was released at its capture site as decided by the boma managers and veterinarian.

Daily boma scores for individual rhinoceros were analyzed using descriptive statistics for each year (2009–11). Scores were plotted to visually examine and determine trends. STATA 11 (Stata Statistical Software, Release 11, College Station, Texas, USA) was used to analyze the data. The nonparametric Wilcoxon rank sum test was used to compare the median scores on each day in the bomas between rhinoceroses that adapted well and rhinoceroses that did not adapt well (maladapted). Statistical significance was declared at $P<0.05$.

RESULTS

During the study period, 11/48 (22.9%) rhinoceroses in 2009, 2/28 (7.1%) in 2010, and 5/18 (22.2%) in 2011 were released/lost due to maladaption (1 mortality in 2009). In order to assess the utility of the scoring system for differentiating characteristics of boma-adapted and maladapted rhinoceros, a median daily boma score was calculated for each group of rhinoceroses and compared over time (Table 2).

During the first week in the bomas, there was no statistical difference between boma scores of rhinoceroses that adapted and those that did not, although there was a borderline difference in median scores at day 7 ($P=0.068$; Table 2). Day 8 was the first time significant differences were observed in the median boma scores for adapted and maladapted rhinoceroses (score=13 versus 10, respectively). Median boma scores after day 8 for maladapted rhinoceroses remained constant at 10, and this value was significantly different from scores for adapted rhinoceroses, which increased from 13 at day 8 to 15 at day 16 (Table 2).

In order to assess the approximate time needed for adaptation, median daily boma scores of all rhinoceroses, grouped by capture year, were plotted over time (Fig. 1).

TABLE 1. Scoring system for monitoring individual white rhinoceros captured between February and October, 2009–11, in Kruger National Park and placed in holding bomas prior to translocation to other locations within South Africa.

	Score	Appetite	Fecal consistency/volume	Behavior score	Behavior
Healthy animal	5	Eating 90% to 100% of normal intake[a]	Brownish/green large stool (multiple defecations per day)	10	Calm and alert, but doesn't avoid people; standing stationary and turns head and/or ears towards stimulus[b]
	4	Eating 50% to 75% of normal intake[a]	Dark brownish/green medium stool (3 to 5 balls more than once a day)	8	Calm but avoids people; walks away slowly in response to stimulus[b]
	3	Eating 25% to 50% of normal intake[a]	Dark small stool (1 or 2 balls more than once a day)	6	Mildly nervous and/or aggressive; trots and/or walks away rapidly for a short distance in response to stimulus[b]
	2	Eating 0% to 25% of normal intake[a]	Putty-like dark, small stool or loose feces	4	Moderately nervous and/or aggressive; runs or trots away and/or charges once or twice in response to stimulus[b]
	1	Not eating at all	Not defecating	2	Extremely nervous and/or aggressive; runs around and/or frequently charges and/or hits poles/doors in response to stimulus[b]
Sick / ill animal	−1	—	Stool is loosely formed (similar to domestic cow)	−2	Mildly depressed; minimal movement of ears, partially closed eyes, walks slowly only short distance in response to stimulus[b]
	−3	—	Diarrhea (light brown or green in color)	−6	Moderately depressed; no response of ears, eyes, or movement while standing in presence of stimulus[b]
	−5	—	Profuse watery diarrhea (dark brown/black in color)	−10	Very depressed; recumbent with no response to stimulus or physical touch[b]

[a] Normal intake for an adult white rhinoceros is approximately 25–40 kg of mixed hay/d. Animal size and type of feed will affect the amount that is considered normal intake and should be adjusted for each facility based on consumption by adapted animals.

[b] Stimulus = presence of a person at ground level in view of the animal close to the poles of the boma.

A consistent pattern was observed between years, with approximately 3 wk (median 19 d) required to reach or exceed a threshold score of 16 (value at which boma scores plateaued). When individual boma scores were calculated over the entire boma confinement period, scores from maladapted rhinoceroses clustered at values below 15 (Fig. 2) or were identified by a declining score within the first 7–14 d (data not shown). Although two adapted rhinoceroses had median scores less than 15, both showed steadily increasing values during boma confinement. The median individual score over the entire boma period for adapted rhinoceroses was significantly higher at 18 compared to 10 for maladapted individuals ($P<0.01$).

DISCUSSION

The scoring system used in this study reports the first semiquantitative criteria for assessing adaptation of white rhinoceroses to bomas after capture. Of the 94 white rhinoceroses placed in bomas during the 3 yr study period, 17 were deemed maladapted (18%). This is almost double the estimated 10% rate that is estimated for maladaptation of wild white rhinoceroses to bomas (Kruger et al. 1999). One mortality occurred during this study due to suspected acute salmonellosis. Early problem identification was important in preventing serious complications and permitting early release. Historically, rhinoceroses captured and placed in bomas were monitored using subjective assessment by animal care staff, relying on variable knowledge and experience of personnel. More recently, guidelines for boma management of rhinoceros have become available (Morkel and Kennedy-Benson 2007).Use of the boma scoring system in this report provided a more objective method for early detection of maladaptation. Rhinoceroses that did not reach a threshold value of 15 (Fig. 2) or showed a downward trend in score during the first 2 wk (Table 2) were more likely to be maladapted. This system was also useful in documenting setbacks that could reflect a stress response to changes in boma management, such as addition of a new animal, change in feed, or shift to a smaller enclosure within the boma complex.

The scoring system used physiologic and behavioral categories with defined criteria for healthy animals using positive scores, and negative scores for ill/sick rhinoceroses (Table 1). This was important so that animals that were showing signs of illness were immediately scored lower, which alerted managers and veterinarians to a problem. When all rhinoceros were used to evaluate temporal trends, a consistent pattern was observed for time required to adapt to boma confinement, as determined by plateau in daily boma scores (Fig. 1). Although some individual animals adapted more quickly, the time to reach the plateau value of 16 for the 3 yr period was approximately 3 wk (median 19 d). This was consistent with the boma managers' observations of 3–4 wk as an adaptation period. It is also similar to what has been recommended for boma adaptation for black rhinoceroses that were being translocated in both South Africa and Namibia (Henwood 1989; Geldenhuys 1993).

When overall individual boma scores were compared between adapted and maladapted rhinoceroses, there appeared to be a significant difference between groups starting at the end of the first week (Table 2), with scores showing increased differences over the entire boma confinement period. An individual score of 15 out of 20 points was chosen as a minimum value for successful adaptation (Fig. 2). Although there were several adapted individuals for which median scores fell at or just below this threshold, their daily scores were increasing over time, and so those lower scores may have represented animals that were slower to adjust or had minor setbacks. Therefore, both score and trends in scores over time are crucial for evaluation of adaptation and assessment of individual welfare.

Adaptation to captivity in other species appears to follow similar patterns to those observed in this report. Eighty percent of wild brushtail possums (*Trichosurus vulpecula)* became habituated to their caregivers within 1 wk of being placed in captivity and were approaching people by 1 mo (Day and O'Connor 2000). Wild vicunas, captured for wool-shearing, were monitored by physiologic, hematologic, biochemical, and cortisol values, which declined to baseline and were comparable to those of captive animals by day 12 after capture (Bonacic and Macdonald 2003).

White rhinoceroses frequently exhibit postcapture anorexia for 7–10 d or more when placed into bomas (Rogers 1993). Other investigators have indicated that the first 7 d are critical for getting a rhinoceros to eat

TABLE 2. Distribution (25th percentile, median, and 75th percentile) for total score each day among rhinoceroses that adapted and those that did not adapt to boma conditions at Kruger National Park, between 2009 and 2011.

Adaptation	Statistics	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7
Adapted	25th percentile	8	8	9	9	10	11	11
	Median	8	10	11	11	11	12	13
	75th percentile	10	11	11	12	13	13	13
	Count	61	73	73	75	74	74	75
Maladapted	25th percentile	8	10	10	10	10	9	9
	Median	9	10	11	11	11	12	10
	75th percentile	10	11	12	12	13	13	13
	Count	15	17	17	17	17	17	17
Total	25th percentile	8	9	9	10	10	11	10
	Median	9	10	11	11	11	12	12
	75th percentile	10	11	11	12	13	13	13
	Count	76	90	90	92	91	91	92
Wilcoxon rank sum test[a]	*P*-value	0.706	0.3835	0.2205	0.8946	0.9055	0.2774	0.0688

(Kruger et al. 1999). If animals are not eating properly by 12–14 d, it has been recommended that they be released, similar to the findings in this study. In some cases, housing white rhinoceroses together may facilitate this transition (Osofsky et al. 1996; Galphine 2006). Studies of activity patterns show that white rhinoceroses spend 49% of their time feeding during a 24 h period, so access to ad libitum food and water is essential. In this study, appetite was one of the criteria used to predict boma adaptation

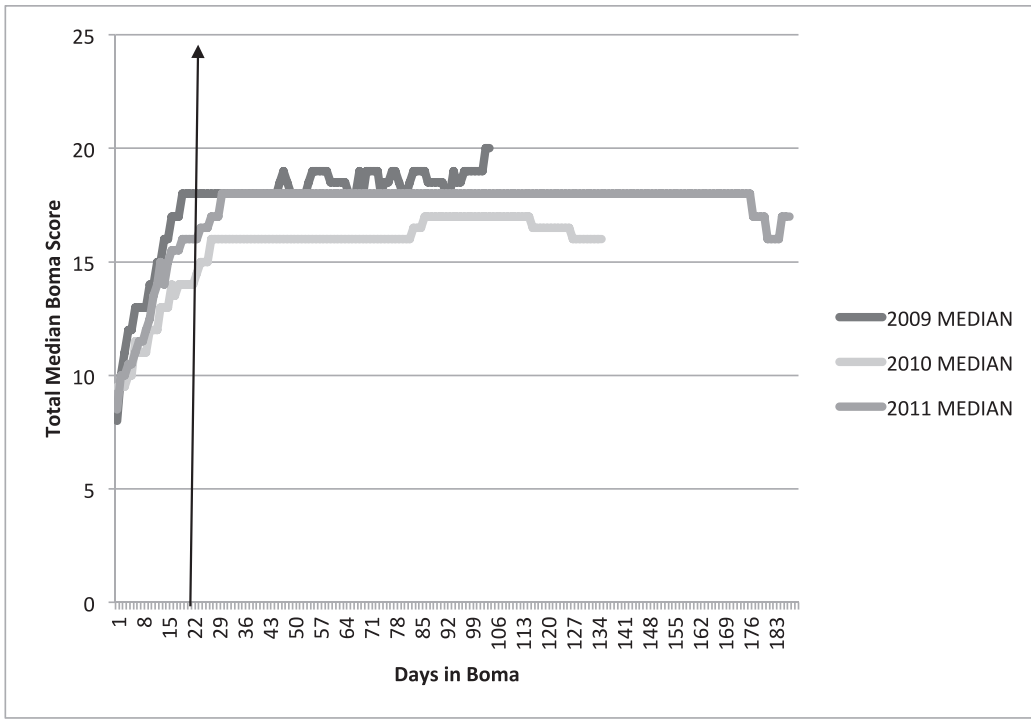

FIGURE 1. Median daily boma scores for white rhinoceroses captured between February and October, 2009–11, in Kruger National Park and placed in holding bomas prior to translocation to other locations within South Africa.

TABLE 2. Extended.

Day 8	Day 9	Day 10	Day 11	Day 12	Day 13	Day 14	Day 15	Day 16
11	11	12	12	12	13	13	13	14
13	13	13	14	14	15	14	15	15
15	15	15	16	16	16	17	17	18
75	75	75	75	75	75	75	75	75
9	9	9	8.5	9	8	9.5	9	9
10	10	10	10	10	10	10	10	10
12	13	11	11.5	11	11	11	11	10
17	17	17	16	13	11	8	8	5
10.5	11	11	11	11	12	12	13	13
12	13	13	13	13.5	14	14	14	15
14	14	15	16	16	16	16	17	17
92	92	92	91	88	86	83	83	80
0.0012	0.0003	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	0.0003

[a] The Wilcoxon rank sum test compares the median score value between adapted and maladapted rhinoceroses.

(Table 1). Observed alterations in appetite, along with fecal volume/consistency and behavior, contributed to statistically significant differences in boma score between maladapted and adapted rhinoceroses beginning at day 8 (Table 2). This is also the time when the individual scores began to show a downward trend in the maladapted rhinoceroses, suggesting that animals should be closely monitored especially during the

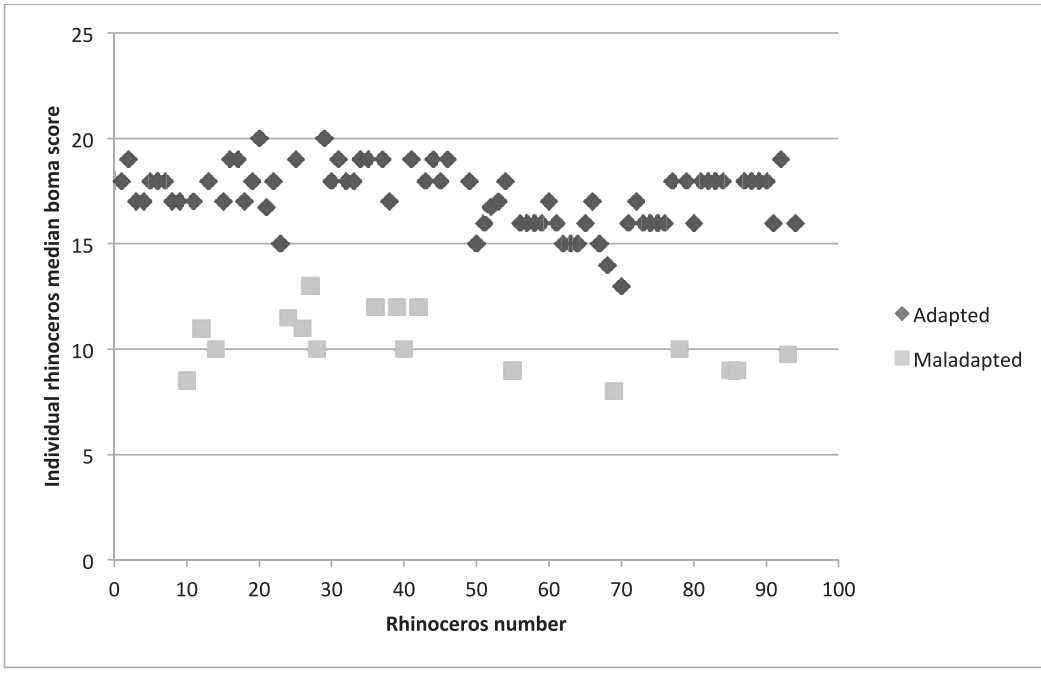

FIGURE 2. Individual animal median boma scores for white rhinoceroses captured between February and October, 2009–11, in Kruger National Park and placed in holding bomas prior to translocation to other locations within South Africa.

second week of boma confinement for signs of problems.

Life-threatening problems may develop in maladapted rhinoceroses unless these animals are released. Infectious enterocolitis due to *Clostridium* and *Salmonella* species has been documented in white rhinoceroses, especially under stressful conditions (Kruger et al. 1999; M Miller, pers. comm.). Translocated black rhinoceroses have shown elevated fecal cortisol levels consistent with a stress response (Turner et al. 2002). Other changes such as anemia, leukocytosis, and lymphopenia imply a stress response, especially in young and female translocated black rhinoceroses confined to bomas for 3–4 wk (Kock et al. 1999). Similarly, black and white rhinoceroses placed in bomas had elevated fecal corticoid levels for up to 17 d before declining (Linklater et al. 2009).

In summary, assessment of white rhinoceros adaptation to boma conditions may be facilitated using a scoring system based on appetite, fecal volume/consistency, and behavior. Simple defined categories permit a practical daily scoring for each category. Consistent scores over a 3 yr period have shown that individuals that do not show a steady increase over the first 7–14 d usually do not adapt to bomas and should be released prior to the development of more serious consequences. On average, white rhinoceroses take 3 wk to reach a boma score that signals adaptation to boma conditions. This system can be adapted for different situations and rhinoceros species to ensure improved welfare.

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