First Rhino Keepers' Workshop

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DISNEY'S ANIMAL KINGDOM
MAY 7-9, 1999

PROCEEDINGS OF THE FIRST RHINO KEEPERS' WORKSHOP

Sponsored by Disney's Animal Kingdom

May 7-9, 1999
Double Tree Resort
Orlando, Florida

Introduction

In many cases, the captive propagation of rhino species is still problematic. Much work has been done to address the genetics, demography, health, nutrition, behavior and captive husbandry of these animals.

Disney's Animal Kingdom hosted a two-day rhino keepers' workshop on May 7-8, 1999 in Lake Buena Vista, Florida. This workshop focused on the keeper's role in the captive management of rhinos and included both speaker sessions and participation in working groups. The participants were keeper representatives from AZA institutions.

The First Rhino Keepers' Workshop was sponsored by **Disney's Animal Kingdom** and endorsed by the **International Rhino Foundation**, the **Rhinoceros Taxon Advisory Group**, and the **South African National Parks**.

First Rhino Keepers' Workshop May '99

Disney's Animal Kingdom

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Acknowledgements

The Rhino Keepers' Workshop Committee would like to extend its gratitude to Disney's Animal Kingdom and Walt Disney World Animal Programs for hosting this event. We would also like to thank the following people and institutions for their assistance and participation in this workshop.

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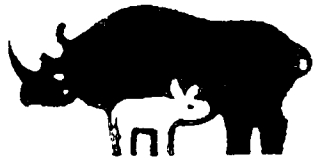
Jon Charles Coe	CLR Design, Inc.
Dr. Kathy Carlstead	Research Associate, National Zoological Park
Tarren Wagener	Conservation Science Manager, Fort Worth Zoo

The Workshop Committee would also like to express its thanks to our colleague and committee member Angela Yang for design of our workshop logo.

Workshop Endorsements:

IRF

INTERNATIONAL RHINO FOUNDATION



Regional Captive Propagation Programs

SOUTH AFRICAN NATIONAL PARKS

Workshop Participants

Lance Aubery	San Diego Wild Animal Park
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Jeb Barsh	Peace River Refuge
Terry Cannon	Knoxville Zoo
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Greg Peccie
Austin Preston
Kelly Reid
Mary Richards
Vicki Sawyer
Tracy Sorensen
Jay Therien
Lorie Thuesen
Bruce Upchurch
Angela Yang

PAPER PRESENTATIONS

1. ***Populations and Conservation of Rhinos***
   Thomas J. Foose, Ph.D, Program Director, International Rhino Foundation

2. ***Boma Management and Translocation of White Rhino in Kruger National Park***
   M. Kruger, D.G. Grobler and J.H. Malan, Kruger National Park

3. ***Black Rhino Conservation and Translocations in Namibia***
   Peter Erb, Chief Warden, Etosha Ecological Institute

4. ***Rhinoceros Nutrition Overview***
   Ellen Dierenfeld, Ph.D, Senior Nutritionist, Wildlife Conservation Society

5. ***Rhinoceros Health and Veterinary Medicine in North American Rhinoceros Programs***
   R. Eric Miller, DVM, Dipl. ACZM, Director of Animal Health and Conservation, St. Louis Zoo, Veterinary Advisor Black Rhino SSP and Rhino TAG

6. ***Rhino Reproductive Physiology—What We Know Today and What We Need to Know Tomorrow for Ensuring the Long-term Stability of our Captive Breeding Programs***
   Dr. Terri L. Roth, Ph.D, Director, Center for Research of Endangered Wildlife, Cincinnati Zoo and Botanical Garden

7. ***Reproductive Management of the Captive Rhinoceros***
   Robin W. Radcliffe, DVM, Adam I. Eyres, Charity A. Miller, Fossil Rim Wildlife Center

8. ***An Integrated Approach to Design: How Zoo Staff Can Get the Best Results from New Facilities***
   John Charles Coe, Principal, CLR Design, Inc.

9. ***Keeper Assessment of Black Rhinoceros Behavior and its Role in Exhibit Design***
   Kathy Karlstead, Ph.D, Research Associate, National Zoological Park

10. ***A Keeper's Guide to the Introduction and Management of the Indian, Black and White Rhinoceros***
    Randy G. Rieches, Curator of Mammals, San Diego Wild Animal Park

11. ***White Rhino Introductions—A Data Driven Approach***
    Angela Cecil and Deanna Debo-Ramirez, Keepers, Disney's Animal Kingdom

12. ***Rhino Training and Enrichment at Disney's Animal Kingdom***
    Sharon Joseph, Curator of Mammals, Disney's Animal Kingdom

POPULATIONS AND CONSERVATION OF RHINOS

Thomas J. Foose, Ph.D.
Program Director, International Rhino Foundation (IRF)
Program Officer, AZA Rhino Taxon Advisory Group (Rhino TAG)
Facilitator/Coordinator IUCN/SSC Global Captive Action Plan for Rhinos
Program Officer, IUCN/SSC Asian Rhino Specialist Group (AsRSG)

Rhinos are a radiation of mammals with a glorious past, recently a rather gruesome present, and an uncertain future. The family Rhinocerotidae is one of the, perhaps the, most critically endangered family of mammals. While some of the decline of this magnificent group of creatures has been due to habitat destruction, the predominant cause has been overexploitation by poachers who are after the horn and to a lesser extent other parts of the rhino. The primary markets for rhino horn have been in China and other countries with large Chinese populations. Traditional Chinese folk medicine considers rhino horn the most effective anti-fever drug. A lesser market that has impacted mostly the African rhino species has been Yemen where the horns are used as ceremonial dagger handles, the most important symbol of status for Yemeni men..

Over the last several years, there have been both progress and problems with the status of the five extant rhinoceros species and their various subspecies. Table 1 provides a summary of the latest reported numbers by species and subspecies for both wild and captive populations.

Worldwide, there are now about 14.000 rhino in the wild in 1999. This total number has improved considerably since the early 1990s when total rhinos in the wild were down under 11,000. However, the status of the various rhino taxa varies considerably, some are recovering, others are still declining or at least remaining as precarious as ever.

Over 60% of the surviving rhino are of 1 subspecies, the southern white rhino (*Ceratotherium simum simum*). (Figure 1) This subspecies represents one of the two great success stories in recent rhino conservation. This subspecies has recovered from a low point of about 30 rhino at the start of the 20th century.

Ironically, the northern subspecies (*Ceratotherium simum cottoni*) of white rhino is one of the 3 most critically endangered taxa of rhino with no more than 25 surviving. This subspecies has fluctuated in numbers and had been as high as 32 in the early 1990s but has declined again due to 2 civil wars in the Democratic republic of Congo, its last range state.

The black rhino (*Diceros bicornis*) had declined so precipitously from 1970 when there may have been 70,000 to the early 1990s when numbers were down to 2,300. This precipitous decline has received more publicity than the plight of any other rhino species. However, over the last 3-4 years, the species, and 3 of its 4 subspecies, have been recovering with at least 2,600 at the end of 1997/start of 1998 and probably 100-200 more today. The species is distributed securely in 5 major range states However, the 4th subspecies, the western, is also one of 3 most critically endangered taxa mentioned before.

Asian rhinos are more endangered than the African. The numbers of all 3 species of Asian rhino combined are probably fewer than the rarer of the African species, i.e. the black rhino. (Table 1 & Figure 3). Table 2 provides a summary by species and country of Asian rhino numbers.

Clearly, *Rhinoceros unicornis*, the Indian/Nepali rhino, is the other great success story in rhinoceros conservation. (Figure 4) In India, numbers have recovered from about 20 rhino at the start of this century to 1,800 today. In Nepal, numbers had declined to below 50 and now recovered to over 600. This success has been achieved by the most intense conservation supported almost entirely by the

governments of India and Nepal. This recover and the total numbers of this species are most encouraging.

However, long-term viability involves distribution as well as abundance and the fact that most of the Indian rhino are in just two populations. Limited distribution is a concern because of stochastic risks, e.g. the catastrophic floods that occur in Kaziranga or the social unrest that has decimated the once sizable population of Manas. For long-term viability, it is recommended that a rhino taxon achieve a total population of at least 2,500, preferably 5,000, individuals distributed across 10 or more populations, each of which is at least 100 in size and several of which are 500 or more in size.

The rarest of the species of rhino is the Javan (*Rhinoceros sondaicus*) with fewer than 70 estimated to remain in just 2 populations: one in Java (~ 50 individuals) and the other in Vietnam (with only 5-8 survivors, the last of the 3 most critically endangered rhino taxa.) (Figure 5).

However, the most critically endangered of all rhino species is probably the Sumatran (*Dicerorhinus sumatrensis*). (Figure 6). Although its numbers (~300) are greater than are the Javan, the populations are more fragmented and less secure, because the species is still under intense pressure from poachers.

While precarious, the status of both the Southeast Asian rhino species (Sumatran and Javan) has improved over the last 3 years with the establishment of anti-poaching teams know as rhino protection units or RPUs. The AsRSG and IRF has helped range states organize the RPUs, with support from the Global Environment Facility (GEF), US Fish & Wildlife Service Rhino & Tiger Conservation Fund, WWF, the American Association of Zoo Keepers, the Anna Merz Foundation, and other partners.

In conclusion, the situation for some rhinos is better but others are still on the brink of extinction. All rhino taxa remain conservation dependent and there is no cause for relaxation or complacency in efforts to conserve these spectacular creatures.

Clearly rhinos are examples of species with low numbers and fragmented distribution. Both conditions imperil long-term viability. Indeed, small populations are vulnerable to what are known as an extinction vortex:

EXTINCTION VORTEX

Small Size

□ □

Reduced Population Growth Increased Inbreeding

✔ ✔

Decreased Reproduction & Survival

Therefore, conservation strategies for species such as rhino need to be based on maintenance or recovery of viable populations, i.e. populations sufficiently large and well distributed to avoid demographic, genetic, and stochastic (i.e. catastrophes) risks. Development of viable population strategies usually entails a role for captive populations.

In general, there are four main roles and goals for captive programs as part of conservation strategies for threatened species like the rhino:

(1) **Propagation** to provide a genetic and demographic reservoir that could be used to reinvigorate or re-establish wild populations if and when the need and opportunity occur.

In other words, a captive population provides an insurance policy against catastrophes in the wild. It is usually easier to ensure protection of rhino when they are in captive situations. Ideally captive populations can be part of the metapopulation that will include integrated and interactive management of numerous disjunct wild populations (Figure 1).

(2) **Education** to provide the public with information and an appreciation of these magnificent species, their plight in the wild, and the need for active conservation programs.

(3) **Research** to provide information that can be useful to management of the species both in captivity and the wild.

(4) ***In Situ* Support** to provide funds for conservation in the wild from contributions recruited through captive institutions and programs.

Currently captive institutions are the source of over $1,000,000/year for *in situ* conservation although virtually all of these funds to date have been directed to the African and Southeast Asian rhino species. However, at this meeting I am happy to announce that through a contribution from Mrs. Anna Merz, the International Rhino Foundation (IRF) will provide at least $ 5,000 to Assam for intelligence work and another $ 5,000, for census work.

In terms of the propagation roles, captive populations can and should be part of metapopulation strategies, i.e. integrated and interactive management of geographically disjunct wild and captive populations by movement of rhino among them.

In order to preserve the genetic diversity and maintain the demographic security necessary for captive populations and programs to perform these conservation roles, it is critical to manage rhino in captivity scientifically. Such scientific management is the goal of the Species Survival Plans (SSPs) that originated in North American Zoos that are members of the AZA and have extended worldwide. The rhino serves as the symbol for all SSP programs worldwide.

There are three main components to the scientific management: genetics, demography, and husbandry. Together, these three form the captive management triangle. The AZA Husbandry Manual and the AZA SSP Masterplans for Rhinoceros elaborate on the details of this management.

Globally, there are about 1,100 rhino in captivity. (Table 1) However, analogous to the situation with rhinos in the wild, over half of these rhinos are southern white rhinoceros. Table 2 presents a more detailed summary of the status of captive rhino populations.

The captive population(s) of **southern black rhino** is increasing at a healthy rate, analogous to many wild populations. For the southern black, a major reason for its success is that it has been relatively recently established, in the 1980's, and has been managed very scientifically through the organized regional breeding programs like the Species Survival Plan (SSP) in North America and the European SSP in Europe.

The captive population(s) of **eastern black rhino** is not increasing because it is an older population, both in terms of when it was established, i.e. before modern management practices evolved, and of the ages of rhinos themselves. Captive managers are currently in the process of reconstructing a healthy age and sex distribution for the population and it is expected that this population may be able to emulate the southern black rhino in the future.

The captive population(s) of **southern white rhino** was not managed to optimize reproduction from the 1960's through the 1980's. Many animals were kept as pairs which is not conducive to reproduction in this more gregarious species. Indeed, many of the pairs were together from an early age and developed sibling relationships which further inhibited reproduction. As a consequence, much of the captive population has senesced. A subset of the captive institutions with this taxon have propagated very well. Captive managers are currently in the process of reorganizing and rejuvenating this captive population and hopes are high for viability in the future.

The captive population(s) **Indian/Nepali rhino** is also increasing at a healthy rate, again analogous to many wild populations Population growth rates would be even higher for Indian Nepali rhino except that 25% of the captive population is in Indian zoos where a skew of sex ratio toward males and some other management problems. has limited reproduction.

The captive population of **northern white rhino** is also one that was mot managed intensively until much of it had senesced. There is still hope that reproduction will resume at Dvur Kralove.

The captive population(s) of **Sumatran rhino** has prospered, but captive managers are adaptively modifying this program by moving animals from traditional zoos to breeding centers in native habitat. Research has also revealed that the species is a complex induced ovulator which has complicated attempts to reproduce the species. With this knowledge, captive managers think they know better how to manage the rhinos to induce breeding. There is evidence that these adjustments are succeeding with matings occurring at several facilities involving at least 6 females and 3 males.

While captive populations and programs are critical for rhino conservation, it is obvious that many problems remain to be solved. Much research is in progress to improve the management and the viability of rhino in captivity.

TABLE 1
WILD AND CAPTIVE POPULATIONS OF RHINOCEROS
1999

SPECIES OR SUBSPECIES	WILD POPULATION	CAPTIVE POPULATION
Southwestern Black Rhino	740	0
Northwestern Black Rhino	~10	0
Eastern Black Rhino	485	180
Southern Black Rhino	1,365	60
TOTAL BLACK RHINO	**2,600**	**240**
Northern White Rhino	25	9
Southern White Rhino	8,440	~700
TOTAL WHITE RHINO	**8,465**	**~710**
AFRICAN RHINO SPECIES	***11,065***	***~950***
TOTAL INDIAN/NEPALESE RHINO	**2,470**	**136**
Indonesian Javan Rhino	50-60	0
Vietnamese Javan Rhino	5-8	0
TOTAL JAVAN RHINO	**~60**	**0**
Eastern (Borneo) Sumatran Rhino	~50	3
Western (Sumatra/Malaya) Sumatran Rhino	~250	14
TOTAL SUMATRAN RHINO	**~300**	**17**
ASIAN RHINO SPECIES	***~2,830***	***~150***
ALL RHINO SPECIES	**~14,000**	**1,100**

Source: IUCN/SSC African & Asian Rhino Specialist Groups & The International Studbooks for Rhinos - May 1999

TABLE 2
OVERVIEW OF CAPTIVE RHINO POPULATION - 1999

TAXON	TOTAL POPULATION		SURVIVING BIRTHS SINCE 1/1/97		APPROXIMATE ANNUAL POPULATION CHANGE	
	WORLD	N. AMERICAN SSP	WORLD	N. AMERICAN SSP	WORLD	N. AMERICAN SSP
Eastern Black Rhino *Diceros bicornis michaeli*	*80\101 = 181*	*39\30 = 69*	*4\15 = 19*	*3\3 = 6*	*~ +1%*	*~ 0% to +1%*
Southern Black Rhino *Diceros bicornis minor*	*29\29 = 58*	*18\18 = 36*	*6\3 = 9*	*6\2 = 8*	*~ +10%*	*~ +10%*
Southern White Rhino *Ceratotherium simum simum*	*334\368 = 702*	*58\79 = 137*	*15\16 = 31*	*6\4 = 10*	*~ 0% to -1%*	*~ 0% to -1%*
Northern White Rhino *Ceratotherium simum cottoni*	*4\5 = 9*	*1\2 = 3*	*0\0 = 0*	*0\0 = 0*	*0%*	*0%*
Indian/Nepali Rhino *Rhinoceros unicornis*	*73\63 = 136*	*23\23 = 46*	*5\2 = 7*	*2\1 = 3*	*~ +3%*	*~ +4%*
Sumatran Rhino *Dicerorhinus sumatrensis*	*5\12 = 17*	*1\2 = 3*	*0\0 = 0*	*0\0 = 0*	*0%*	*0%*

Source of Data: ***International Studbook for African Rhinoceros;***
International Studbook for Greater One-Horned

Rhinoceros

International Studbook for Sumatran Rhinoceros
North American Regional Studbooks for Rhinoceros

Table prepared by Dr. Tom Foose, International Rhino Foundation (IRF)

BOMA MANAGEMENT AND TRANSLOCATION OF WHITE RHINO IN THE KRUGER NATIONAL PARK

M. Kruger[1], D. G. Grobler[1] and J.H. Malan[1]

INTRODUCTION

The Kruger National Park (KNP) is situated in the north-eastern corner of South Africa bordering Mozambique in the east and Zimbabwe in the north and covers an area of 1948528 ha (Figure 1). In 1961 the first white rhino were re-introduced from the Umfolozi Game Reserve to the KNP, over a twelve year period a total of 345 white rhino were relocated to the KNP. By 1998 their numbers had increased to 2954. In the KNP animals are translocated to provide other national parks, conservation organizations, breeders and game farmers with a source of founder populations of a species or to increase the numbers of, and introduce genetic diversity into an existing population.

CAPTURE OF THE WHITE RHINO

White rhino are routinely anaesthetised for marking, collection of samples, translocation and treatment, the emphasis will however be placed on the translocation of white rhino for overseas destinations in this article. The anaesthesia is complicated by the white rhino's sensitivity to opioids, severe respiratory depression under anaesthesia, hypertension due to opioids and peculiar anatomical features.

SELECTION OF ANIMALS

Preference is given to the younger range of adult animals (6-14 years), sub-adults (4-5 years) and calves (older than 9 months). The ideal unit is a 9-11 year old cow with her year old calf, as a "normal" cow would again be in early pregnancy at this stage. In this way three animals are actually translocated. Older animals have a shorter breeding time left and generally adapt with greater difficulty to the boma and are therefore not selected. Bulls in the age class of 7-10 years are normally selected as they are still wandering in small groups and are not yet as aggressive as the territorial bulls. Only healthy animals are selected.

[1]Game Capture, Kruger National Park, Private Bag X402, Skukuza, 1350, Rep. of South Africa.

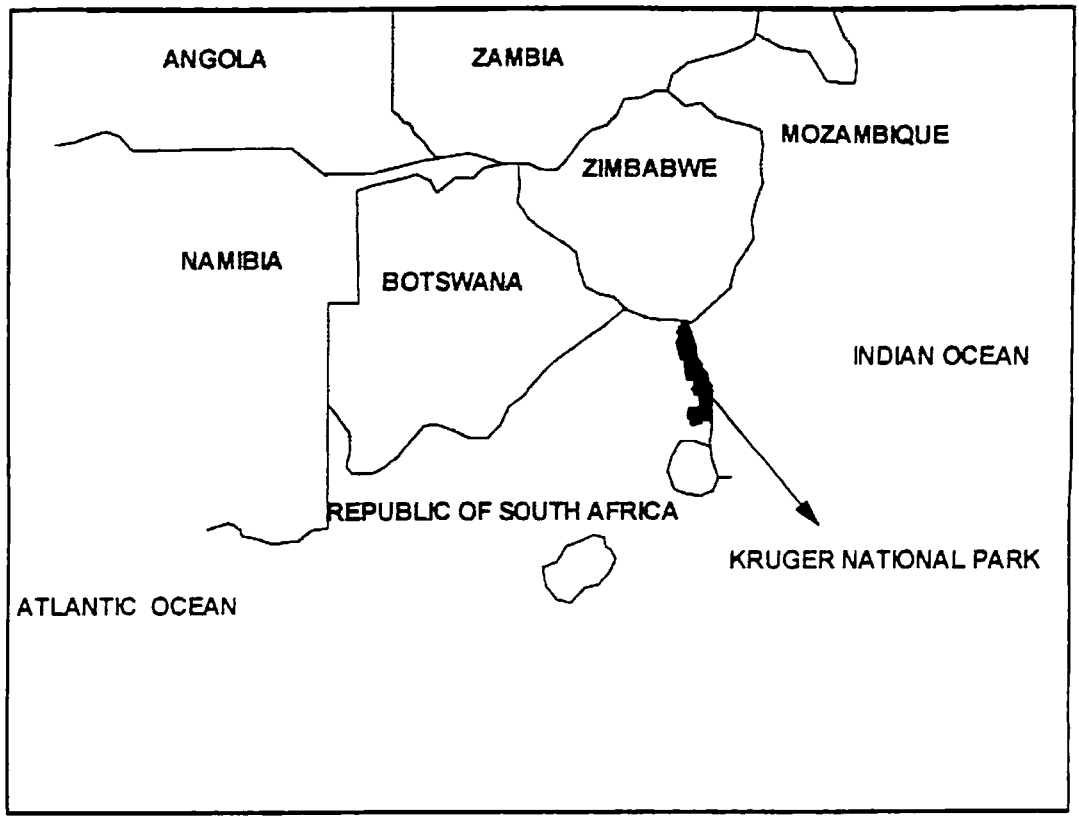


Figure 1. Locality map of the Kruger National Park, Republic of South Africa.

CHEMICAL IMMOBILIZATION

Dart system

An aluminium dart system with an acetic acid/bicarbonate charge is used during field captures from the helicopter. The drug is discharged only once the collar of the dart hits the skin to ensure deep intra-muscular deposition of the drugs. Needle lengths are 50 mm and are collared to ensure the dart stays in place.

The Dan-Inject system with smooth 60mm needles is used for darting rhino in the boma.

Drugs

Using the correct amount of drugs for different sizes of animals is of the utmost importance and darts are normally only made up once the animals are sited. The preferred combinations for field anaesthesia are shown in Table 1.

Table 1. Drug combinations in the anaesthesia of white rhino.

ANIMAL	M99	AZAPERONE	HYALAZE
Adult bull	4 – 5 mg	25 mg	5000 IU
Adult cow	4 mg	20 mg	5000 IU
Sub-adult	1.8 – 2.5 mg	15 – 20 mg	5000 IU
Calf	0.5 – 1 mg	10 mg	5000 IU

Once down, each and every rhino receives an intravenous catheter (18-20 G; 2 inch Jelco) inserted into an ear vein and 5-15mg Nalorphine is administered immediately to stimulate respiration. Dopram and Oxygen (O_2) supplementation is kept on standby as alternatives if more stimulation is needed. The Azaperone dosages are low in comparison and we have experienced difficulties in walking rhino if they received dosages above 30 mg.

For boma anaesthesia, 0.25-0.8mg M99 with 20-30 mg Azaperone is used if a standing immobilisation is required or 75 % of the field dosages of M99 with 10-50 mg Azaperone if recumbency in adults is required.

Animal manipulation

Rhino are heavy animals and difficult to manipulate once recumbent. One should always plan for the worst case scenario and have all equipment handy. The list should include:

Ropes: One strong soft cotton rope ± 20m with a 1 inch diameter for the head and a shorter rope of ±10m for a brake on the hind foot.

Blindfolds and earplugs: Blindfolds can be made of towels with Velcro on the ends. Earplugs should have long strings attached to them to avoid them being forgotten in the rhino's ears.

Axes: It may be necessary to remove some trees and branches around the rhino before administration of the antidote to avoid injury once the rhino stands and walks.

Shovels: They are used to dig/fill holes in the path of the walking rhino, or to remove sharp stumps in close proximity to the recumbent rhino.

Electric cattle prodders: They are used with much success on rhino if used with discretion, stimulating them to stand up after administration of the partial antagonist.

Animal monitoring

Although a pulse oxymeter can be used, procedures to load animals are generally fast. A rhino is loaded within 15 minutes after darting and respiratory rate, pulse, temperature and blood colour (seen in blood samples and use Jelco) are used to indicate the state of the recumbent rhino.

Physiological manipulation

Water is used to cool down rhino in extreme temperatures, but copious amounts are necessary to obtain any effect, it is therefore better to complete the capture early in the mornings when it is still cool.

Oxygen supplementation: It is not difficult to insert an endotracheal tube into rhino via the nose through which O_2 can be supplemented. The diameter of this tube should be far less than that of the trachea. A commercial horse stomach tube is adequate.

Intravenous line: As discussed before, a 18-20 G; 2 inch Jelco is inserted into an ear vein and left in place until the rhino is released into the boma. This is useful in emergencies, especially when the blood pressures drops.

Combined anaesthesia of cows and calves

Good success has been achieved in Kruger by darting the cow and calf in quick succession using a double barrel dart gun, then pulling away completely allowing the two animals to remain together and become recumbent in very close proximity. The cow should be darted first as the calf will remain with its mother, and can often be darted while standing by the recumbent cow. However, the opposite is not true.

Dart site and angle

A large muscle area should be selected for dart placement. The darts must be placed at right angles to the skin to avoid sub-cutaneous deposition of the drug. Preference is given to the gluteal and rump region from the helicopter while the neck area seems to work best in a boma situation.

Other interesting points

White rhino show a characteristic reduction in speed, a shortened gait often dragging their feet, followed by a high stepping gait, standing and sideways movement as soon as the drugs take effect. Prior to recumbency the head is held up high. A blindfold is placed over the animal's eyes to reduce stimulation.

The rhino can be assisted into recumbency by pulling on a rope on the hind foot or by pushing its body over. Although they tolerate lateral recumbency, sternal recumbency is preferred with the exception of heavily pregnant females. The pressure from the foetus on the diaphragm may be elevated by sternal recumbency. Animals should not lie downhill and any objects such as dangerous stumps or rocks should be removed.

The rhino should always be blindfolded and earplugs inserted. Special care should be given to their position, to avoid them lying on their back legs too long as this results in occlusion of the blood supply and later a reluctancy to stand. It is good management to shift their weight from time to time during recumbency, or to throw them over into lateral recumbency before they are walked or pulled into a crate.

The dart wound is treated immediately with an intra-mammary broad-spectrum antibiotic preparation.

Temperature should not exceed 39 degrees Celsius and can be reduced by pouring copious amounts of cool water onto the animals or by covering them with branches.

White rhino are notoriously poor ventilators and it is good practice to administer 5-15mg of Nalorphine I.V. immediately when the jelco is inserted, as this increase the rate and depth of respiration and has a positive effect on blood gas values. A primitive but good method to monitor this is to allow the blood to drip from the Jelco. As blood colour is directly correlated to oxygenation, we have learned to interpret this and act accordingly. Initial respiration rates can be as low as 3-4 per minute but should increase to 6-12 per minute after the Nalorphine administration.

White rhino typically show muscle shivering, or rising of the front quarters, or typical running movements of the legs if in lateral recumbency. Generally it is not regarded to be a problem as the animals are loaded as quickly as possible.

It is difficult to monitor depth of anaesthesia in rhino. Ear movement, increase and deepening of respiration rate and attempts to stand up are some of the better indicators.

Loading a white rhino into a crate

If the crate can be placed in front of the rhino, the middle of a rope is tied with a blood knot around the rhinos blindfolded head, with the knot in position behind the smaller horn and over the blindfold. The two loose ends are laid out in front of the rhino, through the crate and tied to a strong vehicle, or 10-12 men are placed in front to pull the rhino into the crate once revived.

The selection of the antagonist is very critical at this stage. Normally, for adults, a bolus of 40 mg Nalorphine in combination with 1-2,5 mg Diprenorphine results in a smooth recovery without excessive struggling against the pulling team. If the animal is to awake, it will fight against the pulling action. Care must also be taken to guide the animal into the crate so that the pulling action is not against the crate itself. Once inside the back of the crate is blocked off and the ropes and blindfolds removed. At the same time the remaining Diprenorphine is administered through the Jelco (3 times the M99 dosage) as well as additional Azaperone (roughly 100-200 mg for adults and 50-80 mg for sub-adults; calves are only given Azaparone in cases of severe anxiety (20-40 mg).

Regular stops on the way to the boma are made to inspect the animals. Animals lying sternally and breathing well with good ear movement are generally left alone while pressing animals and front leg collapsing ones are rectified by gentle electrical stimulation.

Walking a white rhino

It is often not possible to place the transport crate close to the recumbent animal due to evironmental restrictions. Fortunately it is possible to walk a white rhino; up to a mile or more if needed; from the site of recumbency to more suitable terrain, or to the crate.

This is conducted by tying the middle of a rope (blood knot) around the rhinos blindfolded head. The two loose ends of ±10m each are laid out in front of the rhino and 4-5 men are placed on each rope to act as pullers. A second rope of 10 m is tied with a slipknot around one hind leg. This rope acts as a brake and 2 strong men should handle it. The route that will be followed to the crate should be discussed and cleared, and 2 persons should walk ahead to remove loose branches and rocks that may jeopardise the walking rhino.

Small dosages of Nalorphine (20 mg increments in adults and sub-adults; 10 mg in calves) are given through the Jelco into the ear vein and the animal is stimulated with the electric prodder to test its response. A good response is normally when the animal lifts its head and starts walking with the front legs. More stimulation at the back in co-ordination with the handlers in the front pulling the ropes results in a smooth walk.

EMERGENCIES

Here we are only referring to the animal! Most problems are experienced with animals going into respiratory difficulty and but rarely into complete arrest, which have to be dealt with fast and immediately. If no improvement is experienced with the administration of Nalorphine, the operation is abandoned and Naltrexone

is administered IV without delay. This normally results in an extremely lively rhino within a short period of time.

Excessive fighting in the crates is normally handled with large dosages of Azaperone, varying from between 200-400 mg IM. Again this is seldom seen as diprenorphine is used as antagonist (which is not a complete antagonist) once the animal is inside the crate.

OFF-LOADING AT THE BOMA

The receiving pen in the boma should be prepared, and water and food supplied before off-loading captured animals so that there are no disturbance after the off-loading. The animals are evaluated before they are let out of the crates and generally the following are done: a pour-on acaricide (0,5 % Deadline, Bayer) is poured onto them to kill all ticks. Additional Azaperone is normally administered depending on the animal, mostly about 100-200 mg for adults and 50-80 mg for sub-adults. Adults also receive 100-200 mg of Acuphase (Clopixol), which is a long-acting tranquiliser. Naltrexone (complete antagonist) is administered routinely to all animals to ensure that no re-narcotisation will take place, 1 cc (50 mg) is given intra-muscularly in adults and 0,5 cc in calves and sub-adults. A last check is done to ensure all rags have been removed from the ears and Jelco catheters are out.

Calves are released before their mothers into the same boma.

CAPTIVE HOUSING OF WHITE RHINO

Most white rhino that are translocated are kept in a "boma" to tame them down, adapt them to the lucerne and teff mixture and to acclimatize them to their new environment. When constructing a rhino boma only strong, solid material should be used, because a rhino will search for a weak point and work on that point until it escapes.

Some requirements that need to be taken into consideration when planning a boma are the following:

- The area selected should be on high-lying soil with good drainage to prevent muddy, unhygienic conditions.
- There must be enough shade and where possible natural trees must be kept else additional shade must be provided.
- A rubbing post as well as a wallow must be provided and must be situated in such a way that the wallow can easily be refilled.
- A water trough that can be cleaned daily should be constructed and should be large enough to contain between 150 – 200 liters of water, with the sides not higher than 300 mm.

- A concrete slab, which serves as a feeding area, must be provided under a solid roof and must be cleaned daily.

CONSTRUCTION OF THE BOMA

- Figure 2 shows the design and the dimensions of the boma used in the KNP.
- Use tanalith treated saligna poles that are 3,0 m long with a top diameter of 150 – 175 mm, these are concreted into the ground 2,5 m apart in $1m^3$ holes.
- Two 6,0 m treated poles with the same diameter as the above are then hung horizontally (equally spaced 500 mm from the top and the bottom) onto the planted poles, onto which 2,0 m treated poles also with the same diameter are hung 100 mm apart with 12 mm round steel bar that is bent around on both ends.
- Steel sliding gates with a width of approximately 2.0 m should be used between pens, this enables easy movement of animals.
- In the KNP the animals are loaded and offloaded with a truck mounted mobile crane (16-20 ton/m^2 capacity) and no ramps are used.
- Two catwalks are also included in the design and are essential for observation especially in the first 14 days after capture.

ADAPTATION OF THE ANIMALS TO THE BOMA

In the adaptation or boma training phase of white rhino a system of large and small pens are used (Figure 2). White rhino are prone to not feed for at least some period after wild capture. The large back pen is 20 X 50 m (or bigger where possible), the front small pens are each 10 X 20 m but are subdivided into two compartments for cleaning purposes. Transportation crates are attached to the front pens for crate training.

Newly captured animals are off-loaded in the large back pens to accustom them to confinement, they are kept in this pen for seven days unless they start feeding before this in which case they may be moved to the smaller front pens (nights 3 – 5 are critical because this is when the animals may try to escape). The next seven days are crucial because it is in this period that one has to make sure that the animal(s) are eating and defecating properly. A good indication of the status of the animal is its dung; the amount, consistency and the colour thereof. Rhino normally defecate for the first two days after capture, then stops for approximately two days when they normally start eating. Initially the colour of the dung is dark from the grass eaten in the field. When eating properly each animal should have two or three dung heaps that are firm (not putty like) in which grass fiber's are visible with an olive green colour.

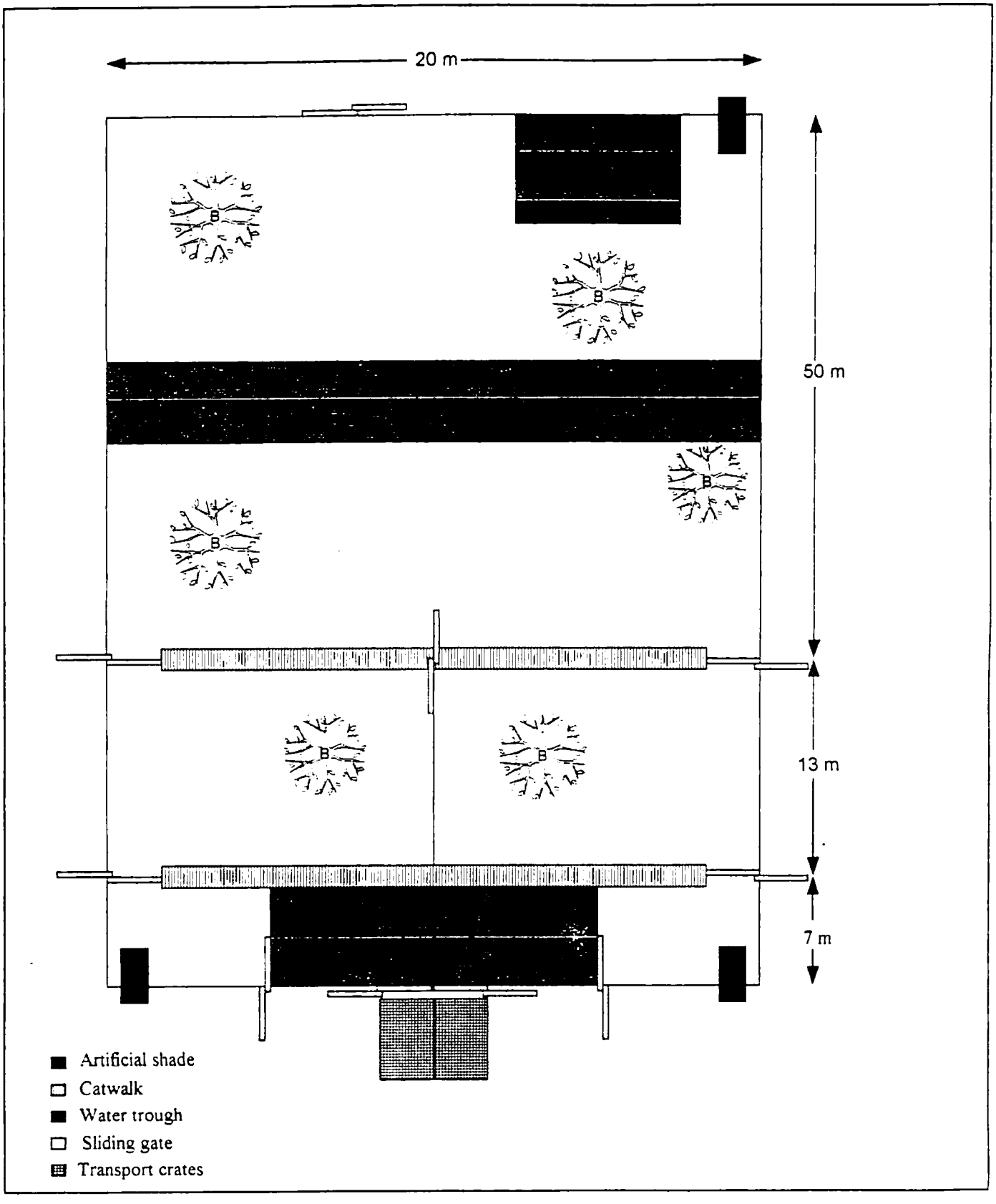


Figure 2. Design and dimensions of the boma used in the KNP.

Animals are normally released if they haven't eaten properly for 12-14 days. They are released at the capture site, 10% of wild captive white rhino are normally "non-eaters". Most problems are experienced with single, adult animals that find it difficult to adapt.

Feeding of animals

As it is difficult to get wild captive white rhino to eat in the boma, highly palatable grass such as freshly cut *Panicum spp.* should initially be fed. Once the animals have taken to the fresh grass it can be mixed with commercial *Eragrostis tef.* This should always be made available separately and mixed with about 30% lucerne from day one. Only the best quality teff and lucerne must be used in order to stimulate the animals to eat. Rhinos are fed twice a day throughout captivity. Animals are fed according to their size, adult animals will eat approximately 25–40kg of mixed feed per day.

Water must always be available *ad. lib.* and troughs must be cleaned thoroughly on a daily basis and disinfected twice weekly. Vitamin B complex syrup is added to the water as an appetite stimulant at a dilution rate of 5 ml per liter of water, until the animals are eating properly. This is always done in the evenings since vitamin B complex is inactivated by sunlight.

HABITUATION

Once the animals are moved into the small pens and are eating properly, the taming and crate training is started. The taming involves spending time with animals, getting them use to the presence of humans.

Crate training

As mentioned before, transportation crates are attached to the exit gates of the small pens adjacent to the concrete feeding slab. When the crate is opened the feed is placed in the opening of the crate and gradually moved deeper into the crate until the rhinos whole body is inside the crate when feeding. This procedure is carried out to get the animal used to being in a confined space.

Depending on the distance and the method of transportation the process of crate training is extended and intensified. When transporting animals for approximately one day by road, normally within the same country, animals should have been crate trained for at least two weeks and eating all their food inside the crates.

When transporting white rhinos by air it is preferred to boma train and crate train the animals for at least 5 months. In the last 4 - 6 weeks before transportation the final intensified crate training is done. This

involves getting the animals to drink from a plastic water trough inside the crate and confining the animals to the crate. Initially the plastic trough is put in the empty concrete trough and then gradually moved towards the crate and finally into the crate, where it is attached to the front of the crate. The animals then needs to be conditioned to only drink when water is provided to them, to accustom them to a routine which will be followed during transportation. In this phase water is only provided twice a day. Finally the animals may be confined in the crates for a day, in a shady place, just to get them use to being confined for a prolonged period. This is done in the same way as when the animals will be loaded eventually and involves darting the animals with M99. If this procedure is followed it should be done more than seven days before the final transportation date to prevent any effects from the drug being present when the animal is darted again.

POTENTIAL PROBLEMS DURING ADAPTATION AND HABITUATION

Injuries

Some animals show superficial wounds to the face especially from day 3 – 5 from trying to escape. Because rhinos are so bulky and heavy they are prone to pressure sores, especially just above the front feet on the fetlock joints and on the hock joints. For this reason the front pen is covered with a layer of fine river sand which also serves to absorb urine. When the front horn is broken off, usually in the transport crate after capture or when a animal charges the walls of the boma, a big bleeding wound results which normally looks worse than it really is. The wound will dry up and heal on it own, but it is better to treat it. All of the above injuries can be treated with a 1:500 acriflavine solution mixed with lotagen concentrate and administered with a pressurised garden spray. This antiseptic solution promotes scab formation. If considered necessary the animals may be darted, wounds cleaned and antibiotics administered. Wounds should always be checked for blowfly maggots, which can be treated by spraying the wounds with Cylence (a Bayer product with Cyfluthrin 1% as active ingredient).

Diarrhoea

Diarrhoea is usually caused by a dietary problem or an infection. Lucerne should be withdrawn and the animals should be treated with a diarrhoea powder such as biolyte (Milborrow) which contains electrolytes, glucose and furazolidone, this is best administered through the drinking water.

Constipation

This condition is seldom seen in rhinos, and is associated with an animal that is not eating. Symptoms are hard or no dung, loss of appetite, listlessness and rapid breathing due to stomach discomfort. To treat this condition magnesium sulfate (Epsom salts) is used, which is dissolved in 50 l of drinking water at a rate of between 50 g for a juvenile to 500 g for a big adult bull. This may be repeated after 36-48 hours if necessary. Care should be taken not to give rise to diarrhoea when giving Epsom salts.

DISEASES OF CONCERN

There is very little known or published with regards to endemic diseases of white rhino.

Bacterial diseases

Anthrax has been diagnosed in white rhino and has caused sporadic mortalities during natural epizootics amongst free-ranging ungulates. It appears to be incidental casualties and are not important role players during these epizootics.

Salmonellosis caused by *Salmonella typhimurium, S. kottbus* and *S. enteritidis* have all been diagnosed in captive animals, and are fulminating infections that cause acute fatalities. In most cases the fodder is the source of *Salmonella* and it is therefore important to check on the quality of the lucerne and teff.

Bovine tuberculosis is one bacterial disease that probably causes the most concern. This disease has however never been reported in free-ranging white rhino. The veterinarians in the KNP and Hluhluwe/Umfolozi Park do on average 15 white rhino necropsies per year between them, and have never diagnosed a case of bovine tuberculosis in this species.

Viral diseases

These are probably of the greatest concern to the regulatory authorities.

Foot and mouth disease (FMD) has never been reported in white Rhino, being perissodactyls it is unlikely that they will be susceptible to this disease. In excess of 50 white rhino sera tested negative for the presence of antibodies to FMD, all of these sera originated from the KNP which is an endemic FMD area with frequent cyclic endemics in several cloven hoof species.

Orbiviruses – no seralogical evidence of infection of either Blue Tongue or African Horse Sickness has ever been reported in white rhino.

Other Arboviruses – no seralogical evidence of white rhino being susceptible to Equine Encephalosis, Lumpy Skin Disease, Rift Valley Fever or Bovine Ephemeral Fever has ever been found.

Rickettsial diseases

The rickettsial disease of the highest zoosanitary importance is probably Heartwater (Cowdriosis), since white rhino are a primary predilection host for *amblyomma* ticks, the natural vectors of this disease. Unfortunately nothing is known about the role of white rhinos in the epidemiological cycle of this disease. Clinical Heartwater has never been reported in white rhino, and this is not surprising as this is primarily a disease of ruminants, and perissodactyls are refractory to infection. It is unknown whether white rhino become infected with this organism or have any maintenance potential which could result in them serving as reservoir of Cowdria organisms in the presence of a patent vector. Studies are presently being undertaken to determine the status of Heartwater.

Protozoal diseases

Unidentified Babesia and Theileria like piroplasms have been described in blood smears of white rhino. It is not known whether these are host specific, or whether there is any potential for interspecies transmission. Trypanosomiasis has been described in both black and white rhino in east Africa and Zimbabwe. No tsetse flies have however been found in the KNP during intensive surveillance since 1983. With the exception of *Trypanosoma theilera*, non tsetse transmitted trypanosomes such as *T. vivax* or *T. evansi* have been identified in thousands of blood smears examined in the laboratory in Skukuza over the past few decades. This laboratory receives between twenty and two hundred blood smears a month from a variety of species, as part of anthrax surveillance actions.

Ectoparasites

White rhinos in their natural states are frequently infected with a large range of ixodid ticks, including those of the genera *Amblyomma, Rhipicephalus, Dermocentor* and *Hyalomma*. Many of these are potential vectors or reservoirs of both protozoal or rickettsial diseases of veterinary importance, therefore all rhinos are treated with a suitable acaricide prior to transportation to ensure that they are tick free, and kept tick free for the entire boma period.

Endoparasites

Many endoparasites including arthropod larvae, nematodes, trimatodes and cestodes are found in white rhino. Most appear to be fairly host specific. For deworming of white rhino an intramuscular injection of

1% Doramectin at a rate of 1mg per 50kg is recommended and is effective against a broad range of helminths and arthropods.

TRANSPORTATION OF WHITE RHINO

PERMITS FOR TRANSPORTATION

Each country normally has their own regulation concerning permits. Some permits are however standard and will be required for the export of all white rhino. Although permit are regarded to be a formality, it is important to have all the necessary permits to avoid delays and unwanted stops.

- Cites import permit. Obtained from the conservation body in the country of final destination.

- Cites export permit. Obtained from the local conservation body, one has to be in possession of the cites import permit before this permit will be issued.

- Veterinary health certificate. Obtained from the local State Veterinarian, and is completed to comply with the importing country's requirements.

- Bank form (f178/nep in South Africa). Obtained from the Foreign Exchange Department of any bank. This is completed by the exporter and attested to by the bank.

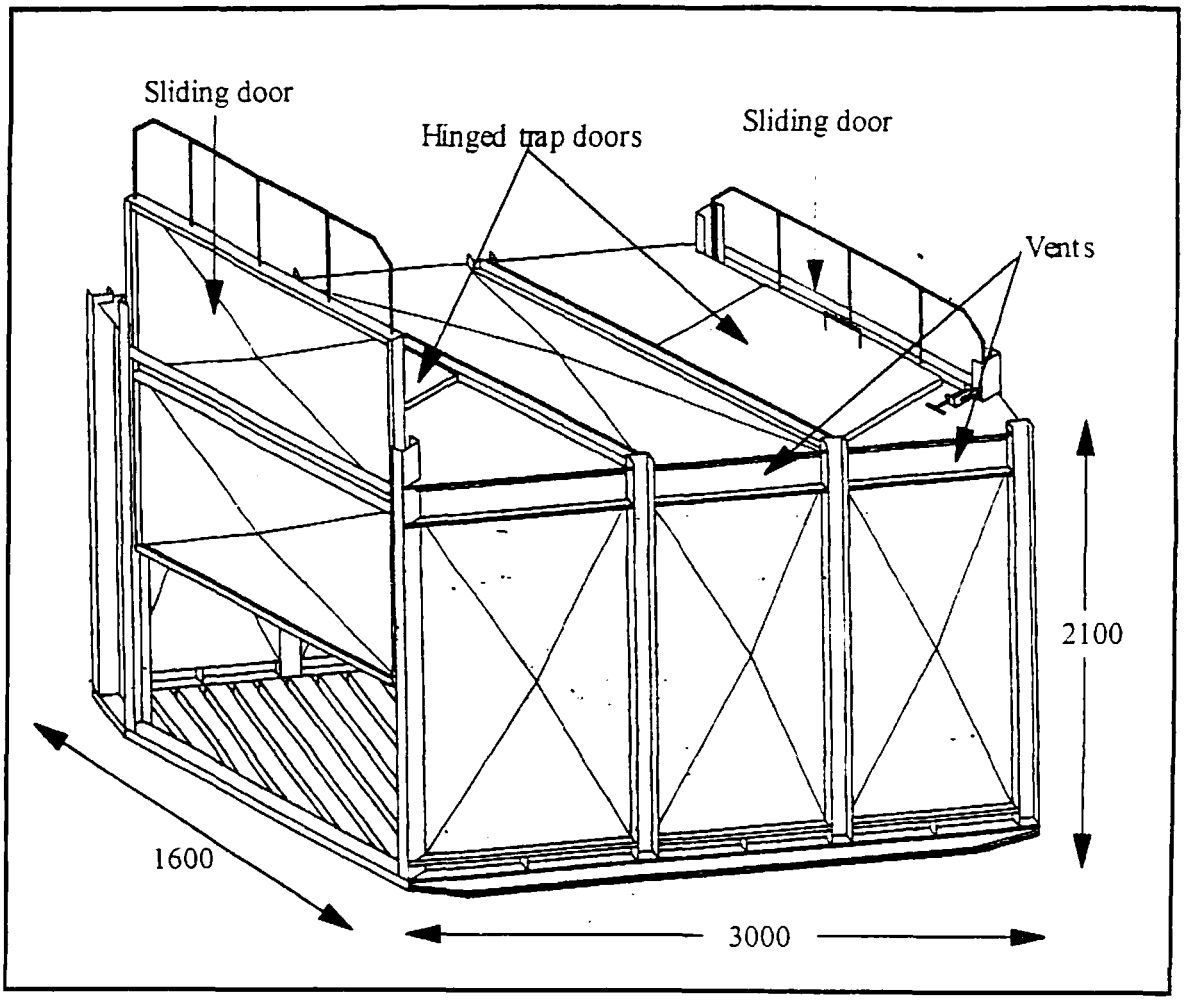
- Airway bill. Obtained from the carrying airline and completed by the exporter or the airline.

- Bill of entry/export (DA550). Obtained from the freight agent or Department of Customs and completed by the exporter.

- Customs Export. Obtained from the freight agent or Department of Customs and completed by the exporter.

CRATE DESIGN

Two types of crates are used in the transportation of white rhino, the one is a diamond shaped steel crate that is also used for the field capture, and the other is the export crate that consists of mainly steel and wood.



.Figure 3. Diamond shaped crate used in field capture as well as road Transport of rhino.

Table 2. Inside dimensions of export crates used by the KNP for the air transportation of rhino.

CRATE	ANIMAL	LENGTH (mm)	WIDTH (mm)	HEIGHT (mm)
1	Large bull	3580	1500	1820
2	Adult	3300	1310	1820
3	Sub-adult	3000	1100	1820
4	Juvenile	2570	900	1360

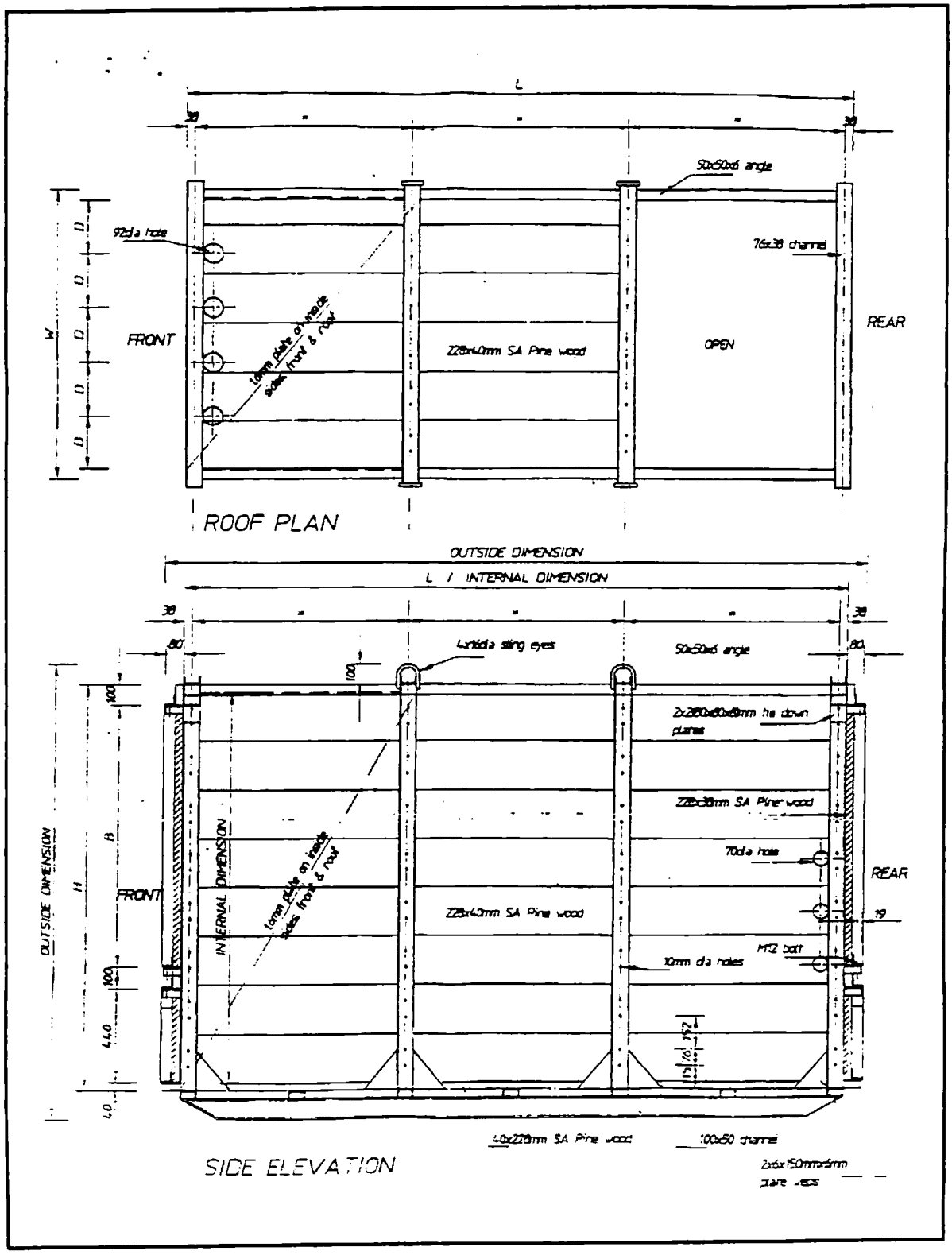


Figure 4. Design and dimensions of the export crate used in air transportation of rhino.

Diamond shaped crate (Figure 3)

This is a rugged steel crate that is used in the field capture as well as the road transport of rhino within South Africa. The crate is built in the diamond shape to be able to fit two crates onto the 6m bed of a truck and is built out of channel iron and steel plate. The crate is well ventilated with vents on the sides at the top and the bottom, the doors should not contain vents. The reason is to prevent the rhino from getting its horn stuck in the vent and breaking it off.

Export crate (Figure 4)

This crate is used when transporting rhino by air, and is made out of channel iron and pine planking. The front third of the crate is clad with steel plates on the sides and the top. This size of the crate is individually determined by the size of the animal and must be large enough for the animal to be able to lie down comfortably but not so large that the animal is able to turn around, or is thrown around inside the crate during transit. The dimensions of four standard crates that are used by the KNP are given in Table 2. The doors that are fitted are also clad with steel plates and consist of a big top door (size depend on height of crate) and a small bottom door (480 mm).These doors are mounted with lock nuts so that they can be removed. The bottom door always stays on to keep the dung and feed inside the crate. Four vertical bars (60 mm pipe) are fitted through holes on top and the bottom in front just inside the doors of the crate. The two middle bars are bent and shaped so that the plastic water troughs can be slid through at the bottom. Three similar straight bars are fitted horizontally to the back of the crate through holes in the sides to close the animal in when loading it.

LOADING OF THE ANIMAL INSIDE THE CRATE

The animal is closed in the front pen and is darted with a minute amount of etorphine (Adult – 0.7 to 0.8mg; Sub-adult - 0.3 to 0.5mg; Juvenile – 0.2 to 0.3mg) without any Azaperone. After 10 – 15 minutes the animal will show a high stepping gait and the tendency to follow moving objects. A white rag tied to a long stick is waved in front of the rhino and slowly moved towards the crate, the rhino will then follow. Once in the crate the tranquilisers (see transport by air) and antidote are administered. During this process, it should be very quiet and no movement or sound made to distract the animal. The animal is then loaded onto a truck with its head facing backwards and transported to the closed airport or transported by road to its final destination.

TRANSPORT BY AIR TO FINAL DESTINATION

In the past almost all rhino were exported by sea, but in the KNP we prefer to do it by air, for obvious reasons. Although more expensive, the time of confinement is considerably shorter and potential problems are much less than by sea.

Crate training and proper habituation of the various animals normally ensures the minimal use of tranquilizers. We are of the opinion, through experience, that it is better to use drugs from the beginning of the translocation process (from when the animal is finally crated) until it reaches its new destination. The most docile and tame rhino can turn into a frantic and scared animal, throwing its full weight around in the crate, whilst the spirited animal in the boma can be the most docile animal when crated. Each rhino should be treated as an individual case and care should be taken on the entire route to ensure the maximum calmness in the new surroundings, be it in the plane or on the truck.

Azaperone (100 mg/ml) is the drug of choice for white rhino during transport and regular evaluation of all the rhino during the process should be done to ensure the full effect of tranquilization. After loading the animals in the crate for road transport to the nearest airport, it is not fully reversed as only diprenorphine is used to antagonize the M99's effects. Known difficult animals should then receive their first full dosage of Azaperone IM (Bull: 200-400 mg; Cow: 150-300 mg; Sub-adult: 100-200; Calf: 40-100 mg). Tamer animals can be started with half the Azaperone dosage, with the first full Azaperone dosage to be administered within 4-6 hours after being loaded. The animals should constantly be monitored, as we have moved animals to the USA without a single injection of Azaperone, but others had to be kept tranquilized the entire way. With "highly strung or spirited" animals as we call them, good effects have been obtained by using Acuphase (Clopixol) at a dosage rate of 200 mg per adult, in addition to the regular dosage of Azaperone. It is necessary to repeat Azaperone injections every 4-6 hours to keep a white rhino fully tranquilized. Notes should be kept of when the various animals received Azaperone as well as the dosage, and a good place to write this is on the crate itself with a permanent marker pen.

It is further important to note that the animals are most likely to react during loading into the plane and off-loading onto the trucks. During the take-off and landing process animals tend to react more as well, so one must ensure that the difficult animals are well tranquilized during these periods. Another important aspect is to ensure that animals are well fed during the entire trip. Well habituated animals eat well during the flight and the eating will decrease the boredom or anxiety. We have also noted that a period of rest (sleep) for the animals coinciding with their own "night time" in KNP also work wonders to calm them down. This is achieved by turning off all the lights in the plane's cargo hold for a few hours. Temperature regulation is also of the utmost importance during the flight. Care should be taken not to cool the cargo hold down too much.

Emergency situations have been described and experienced with road transport of wild white rhino going totally mad in their crates. If Azaperone and even double Azaperone dosages don't work for these animals, small amounts of M99 (0,5-0,75 mg) should be used in addition to the Azaperone to calm these animals down.

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Black Rhino Conservation and Translocations in Namibia

By Peter Erb, Chief Warden, Etosha National Park

Namibia is the driest country in Africa, south of the Sahara, with an area of 824,268 km^2. Tourism is as important for us in Namibia as it is here in Florida. The 1995 estimated population was 1,688,000, giving the country an overall population density of 2 persons per km^2. Florida in 1990 had an average population density of 83 persons per km^2. The only city of significant size is Windhoek (population for greater city 125,000). 70% of Namibians are living in rural areas.

Namibia has 700 black rhinos in formal conservation areas, communal land and on private farming land. This makes Namibia one of the four important range states for black rhino together with South Africa, Kenya and Zimbabwe. Etosha National Park is roughly 1/7 the size of Florida or a little bigger than New Jersey. It's our important conservation area in terms of size, wildlife and economic importance. Roughly 150,000 tourists visit Etosha per year. Population sizes for some of the wildlife are: Elephant, 1200: Black rhino, 450; Lion, 180 (FIV free); Burchell's zebra, 9000; Wildebeest, 3000; and Springbok, 30,000. Other species include roan and sable antelope, giraffe, Red hartebeest, Black-faced impala, Brown and Spotted hyaena, leopard and cheetah.

The rhino conservation goals in Namibia are:

A. To establish a long-term, viable population of at least 2000 black rhino in suitable habitat and similarly, 500 white rhino.

B. To institute an utilisation scheme for black and white rhino to achieve and justify the above-mentioned goal in accordance with CITES regulations.

C. To investigate and institute a National Rhino Conservation Plan, an annual Action Plan and research projects to cover actions such as de-horning, vaccination, translocation and sale of live animals; in cooperation with regional and international organisations as far as possible.

The black rhino population in Etosha national Park currently represents the largest black rhino population in a single conservation area and 70% of all *Diceros bicornis bicornis*, the subspecies that occurred

formerly in the Cape Province of South Africa, Namibia and southwestern Angola. In 1966, a start was made to consolidate the population in Etosha with rhinos caught on commercial farmland and communal land. Rhino captures in 1966-1968 were largely experimental captures, these being the first rhino captures in Namibia and some of the first involving drug immobilisation, using various chemicals in Africa. In total, 6 rhino were caught, of which 3 died during the capture and a further one after translocation and recapture. In the years 1970-1977, sixty-two black rhino were caught and resettled in Etosha. These translocations were far more successful in that 53 of 62 rhino were resettled successfully. Since 1993, forty-two rhino have been translocated onto commercial farmland, with only one mortality being recorded during capture and the post-release period.

Translocation within Etosha 57 rhinos have to date been translocated within Etosha, from concentrations in the west to sparsely populated areas in the east. 18 rhino were, for example, translocated to the Chudop waterhole between 1978-1981. Rhino translocated within Etosha normally settled down in the general release area (30 km radius) and did not wander back to their original home ranges. The translocations were over a distance of 200 km or more. One rhino released 50 km away from his capture site returned to his home range.

Translocations out of Etosha In recent years, Etosha has been the prime donor reserve for rhino. 99 rhino have been located out of Etosha since 1973 for the establishment of new populations both in Namibia and South Africa. Peripheral rhino especially have been removed from danger zones to safer areas.

Censusing and monitoring Early estimates of Etosha's rhino population were based on appraisals of ground sightings, 24 and 48-hour waterhole counts or from data accumulated from aerial surveys, designed primarily for elephant and plains ungulates. Waterhole counts undertaken initially could have been very misleading as individuals are known to visit a waterhole more than once per night and different waterholes within a 72-hour period, especially in the east where springs are generally spaced 1 km apart. Based on drawings alone, many of these duplications could not be recognized.

A monitoring and censusing program designed to overcome these shortcomings was instituted in 1986 in western Etosha and extended during the next two years to the remainder of the Park. The methodology of these improved waterhole counts essentially entails that individual rhino are photographed at close distance at night when coming to drink. Individual waterholes are monitored by one or two observers, during the full moon period for two to three nights. A frontal and lateral picture is taken, the photos together with the relevant notes re then compared to the photo rile of the different rhino in order to try and identify the individual rhino. In the last couple of years, we have started to put all the rhino data and the photos into a computer database. This works well and simplified the process of finding the photos for particular rhino or comparing different rhino with similar characteristics. Data relating to different aspects of rhino biology and behaviour can be summarised efficiently.

Present distribution Today, rhino inhabit the majority of the available habitat in Etosha N.P., this is made possible through the provision of artificial water points. In some areas, rhino are still limited by the restricted availability of surface water. Additional bore-holes in southeastern Etosha will, for example, render a further 3800 km^2 suitable for black and white rhino. With the exception of the saline pans, which cover approximately 25% of the Park's area and possible areas further than 15 km from a permanent water source, the remaining 12, 360 km^2 of Etosha seem to be good rhino habitat with a very conservative estimated carrying capacity of 0.05 rhinos/km^2 (618 on 12,360 km^2). Sub-population density reaches 0.2 rhinos/km^2. Up until 1985, this subspecies of black rhino occurred in only two populations in Namibia. Since then, rhino have been re-introduced into their former range in South Africa and into conservation areas and private land in Namibia. In Namibia, 10 new populations have been established since 1989.

Several farms exist in Namibia which are suitable for rhino with regard to habitat, security and size. The Ministry of Environment and Tourism started with this initiative to let private land owners share in the responsibility of looking after the country's black rhino. A group of six rhino is given on loan to selected farmers to look after. We consider six animals a reasonable compromise between having a big founder population and not stocking these relatively small properties with too many animals initially. These farms vary in size between 60 and 400 km^2. The animals and their offspring remain government property. The

farmer benefits from the rhino as these are a big tourist attraction and the status associated with being selected as a rhino custodian. Criteria to rank potential farms according to their suitability as recipients of founder populations of rhino were decided on by the national Rhino Advisory Committee. Potential farms are inspected, evaluated and ranked by a team of Ministry officials. In 1993, the first two groups of custodianship rhinos were resettled on private farmland. Today there are seven groups and these have increased from initially 42 to 52 rhino.

Translocation in general Establishing black rhino in their former range is an important aspect of our national rhino conservation strategy. While rhino captures were initially hazardous to both animal and capture crew, rhino translocations, if planned and executed properly have become very safe for both parties involved over the years. During the capture operation, it is very important to have the right equipment and a well-trained team. Rhino are tracked down or spotted from a fixed-wing aircraft, before being immobilized from a helicopter. The rhino are then loaded into a crate and transported to a holding pen or directly to the release pen (boma). In the boma, rhino are kept for 3-4 weeks to let them settle down and get used to their new surroundings and the local browse. Initially, we had some mortalities from translocating different age groups together and sub-adult males being killed in fights subsequently. Weaned calves are also difficult to translocate, as they are very inexperienced as rhino and seem to be much more affected by the changes associated with a translocation facing the animals. In general, the best age group to translocate seems to be the young adults. We try and avoid translocating cows with un-weaned calves.

Rhinoceros Nutrition Overview
Ellen S. Dierenfeld, PhD, CNS

Keeper Workshop – Disney's Animal Kingdom, May 1999

Background History

At a meeting held at White Oak Conservation Center in the early 1990s, the chemical composition of native forages consumed by black rhinos was summarized as the basis for evaluating captive diets fed to these species. On the basis of approximately 7 field studies for which chemical data were reported, captive diets, in general, were found to be high in crude as well as available protein, and likely to be deficient in fatty acids, linolenic acid in particular. Although no data were reported on the soluble carbohydrate content of native browses, fibrous carbohydrate components offered in captive feeding programs were felt to be, in general, less lignified and highly digestible. Mineral imbalances were suggested both in native forages (low Zn, Se, Na, P) as well as in captivity (particularly high Ca). Further, vitamin E was found to be much higher in native forages than dry zoo diets, and carotenoids were suggested as a possible important source of vitamin A. All major nutrient categories were found to be in need of improvement or better understanding in feeding captive rhinos. Recommendations from this summary included: 1) feed mixed grass and legume hay rather than either as the sole forage source (to balance out some of the nutrients), 2) supply proper carbohydrates (less digestible) and fats (essential fatty acids), 3) investigate the mineral status of rhinos and native browses in more detail and 4) re-evaluate fat-soluble vitamin supplementation. It appeared, at the time, that vitamin E was being supplemented adequately but that circulating vitamin A levels in captive animals were higher than in free-ranging animals.

A number of diseases with possible nutritional links were highlighted with respect to these various nutrient entities including: 1) hemolytic anemia – vitamin E deficiency was originally felt to underlie this syndrome, but was since shown to be not associated; however, overall poor antioxidant status may have a link with other diseases. 2) Ulcerative dermatitis – was suggested as possibly due to glucose imbalance, amino acid deficiency, specific fatty acid deficiency, and/or mineral imbalances. 3) Hemosiderosis – reported in black rhinos was felt to be due to mineral imbalances, particularly Fe and Cu. 4) Overall impaired immune function – could be due to any or all combinations of nutrient imbalances suggested above. 5) More recently (1998) a new disease entity was identified -- peripheral vasculitis – with a possible regional proclivity, suggested as linked to vitamin C deficiency, antioxidant imbalance in general, and/or singly or in combination with mineral and fatty acid imbalances.

How can the keeper contribute to achieving the goal of maintaining healthy captive rhino populations? One important means is to stay abreast of current research questions, controversies, and questions in the feeding of zoo rhino populations. Another is to be aware of, and follow, current feeding recommendations for the species. If you don't understand the rationale underlying specific recommendations, ask – take the initiative to query your Supervisor, your Curator, the Nutrition Advisor. Do some background reading yourself, and familiarize yourself with the current literature, become informed and take responsibility for meeting the needs of the species under your care. Your attendance at this meeting shows a great commitment towards meeting that goal, and we appreciate your participation and interest.

More Recent Investigations

A number of ongoing nutritional studies have been conducted over the past 5 years to fill in some of the gaps in our knowledge of rhinoceros nutrition, and will be summarized briefly.

Fat Soluble Nutrients

A survey of fat-soluble vitamin constituents, funded by the International Rhino Foundation, looked at retinol, carotenoids, vitamin D, and E in tissues and blood samples from 4 species of rhinos. Elephants and domestic horse samples were compared as possible physiologic models. Samples from the US tissue bank in St. Louis, and 28 blood samples from free-ranging Zimbabwean rhinos supplied by Dr. David Jessup (also funded by IRF) were used in this evaluation. Retinol (a measure of vitamin A activity) was found to average 0.03 ± 0.01 µg/ml in free-ranging black rhinos, compared with 0.10 ± 0.10 in captive black rhinos. No carotenoids were

detected in any blood samples, free-ranging or captive. The mean found in the free-ranging animals is about 10 times lower than most domestic animals, and probably represents a physiologic normal for this species. We are possibly feeding diets containing excessive vitamin A to captive black rhinos.

Free-ranging black rhinos have vitamin E (tocopherol) concentrations ranging from 0.2 to 0.8 µg/ml, depending upon habitat, and captive animals currently are being supplemented and have achieved a mean concentration of 0.7 µg/ml, which is not different from that seen in captive white (0.06 µg/ml) or Asian (0.7 µg/ml) rhinos. Overall, rhinoceros do not have high circulating concentrations of this nutrient, and attempting to duplicate levels in domestic herbivores (1 to 3 µg/ml) does not appear warranted. We still do not understand vitamin E metabolism in rhinoceros. They have no high density lipoprotein fraction in their plasma, which is responsible for vitamin E transport in other species, and the absence or presence of tocopherol transport protein in the liver is currently under investigation (detection and sequencing) by Dr. Maret Traber at Oregon State University (funded by IRF).

Protein

As far as protein investigations, tyrosine deposits have been identified as cellular inclusions in rhinoceros by Harley et al at the University of Capetown (1997). The significance of this finding, is at this time, unclear. Salivary binding proteins, a possible ecological adaptation for dealing with diets high in condensed tannins, have been detected in captive black rhinos in Australia (Neiper, 1998), and is being followed up with other captive and free-ranging rhinoceros samples by Fickel in Berlin. Dave Jessup has submitted free-ranging black and white rhino plasma samples for amino acid determination, to provide baseline normal data for comparison with samples collected on zoo rhinos.

Condensed tannins have been measured in Zimbabwean and North American browses by Wright (1998) and found (by relative score) to be about 10 times higher in browses than typical diets fed to rhinos in North American zoos. Further work on tannins in Texas browses is being conducted by Ward (Ft. Worth Zoo) and Pond (Texas A&M). Woodfine and others (University of Kent & Zimbabwe) are looking at tannins in native browses, as well as investigating total and bound protein fractions.

Fiber, Energy & Digestive Physiology

Several intake and digestion trials with browsing rhinos have been conducted over the past 5 years, or are in process. Atkinson (University of Harare, 1996) fed rhinos in bomas in Zimbabwe with native browses, and found diets to be 30 to 50% digestible. Sumatran rhino (n=3) trials were conducted at Cincinnati zoo (1997) and diets were found to be up to 80% digestible. A further digestion trial with native browses was conducted in Malaysia with Sumatran rhinos in 1998 (Kilbourne et al), and results of that study are pending. With funding support from IRF, intake and digestion trials for captive black rhinos are being conducted in the UK, Germany, Australia & Japan in 1999, as well as in a Zimbabwean semi-reserve. Diet quality is also being assessed for a number of rhinos on reserves in South Africa, with funding from the St. Louis Zoo and IRF (Adcock). Although intake and digestion trials are time consuming and require extra work (weighing and collecting all feed, refusals, and feces), the information gleaned from these studies is essential. Often times, success or failure of these types of studies hinges directly upon support and assistance from the keeper staff.

Fatty Acids

Several fatty acid investigations have been conducted, including an evaluation of native and North American browse composition by Wright (1998). Briefly, she found that fresh browses contained 15 times higher concentrations of linolenic acid compared with linoleic acid, but that oxidation of linolenic acid initiated as soon as browse was cut (undetectable within 20 minutes). Further, she looked at fatty acids in zoo diets compared with browses, and found linoleic acid concentrations 5-fold higher, and linolenic acid concentrations to be one-third those found in fresh browses. These findings may have health implications for browsing rhinos. In a survey of 20 adipose tissue samples evaluated from dead zoo rhinos, using fatty acid concentrations as a measure of long-term diet effects, Dierenfeld and Frank (1998) found that 25% of the animals were deficient in linoleic acid, and more than 50% had undetectable levels of linolenic acid.

Linoleic acid (omega-6 eicosanoids) have been linked with proinflammatory responses, allergies, arthritis, psoriasis, and colitis in other species, while linolenic acid (omega-3 eicosanoids) have the opposite effects. Imbalances in the omega 6:omega 3 ratio in the diet is associated with immune system disorders, neurologic disorders, problems with carbohydrate metabolism, joint abnormalities, cardiovascular irregularities, and cancers in humans and study species. Clinical trials with dietary supplementation of linolenic acid (flax-based product) in zoo rhinos has shown a positive response in altering plasma omega 6:omega 3 ratios (Suedmeyer and Dierenfeld, 1998). Longer term studies, with more animals in several institutions, is underway. Additionally, fatty acid ratios are being documented from free-ranging rhino plasma samples (IRF funded), and fatty acid composition of adipose tissue in a biopsy specimen of a living rhino has recently been obtained.

Minerals

Mineral investigations include plasma and tissue concentrations from 4 species of rhinos, with elephants and horses as the physiological models (funded by IRF). Samples from the US tissue bank in St. Louis, and 28 blood samples from free-ranging Zimbabwean rhinos supplied by Dr. David Jessup (also funded by IRF) were used in this evaluation. Blood work is currently underway, but the liver samples have been processed. Preliminary data showed that many animals (particularly black rhino) had excess Ca, Fe, and Se in the liver, and Zn, Cu and Mo interactions were apparent. Additionally, heavy metals (As, Pb, and Cd) were detected in some samples, which were detailed to staff at the respective facilities for followup. The horse was used as the physiologic model for the minerals evaluated. Na, K, Mo, Zn, and P all appear to be within horse normal ranges for all rhino species. No normal range for sulfur was found for horses, but all rhino species displayed liver S concentrations between 2000 and 3000 mg/kg. Se and Ca were higher than horse normal ranges for black rhinos only, and Cu appeared excessive compared to horses in the grazing rhinos (whites and Asian), but not the browsers. Fe concentration was high for all for rhino species compared with domestic horses; half of the black rhinos displayed liver Fe concentrations 20 times higher than the overall rhino mean.

Ferretin saturation is being evaluated in a number of black rhinos, particularly those displaying tissue iron deposition (Paglia et al, this conference and elsewhere). High Fe diets are suggested to lead to hemosiderosis, and/or trigger an oxidative damage cascade metabolically. Suggestions that natural browse-based diets high in tannins, phytates, and fiber constituents that may bind Fe to make it less available, and associated health benefits to captive browsing rhinos, are being pursued through an integration of many of the studies outlined here. Mineral investigations, particularly with respect to the idiopathic hemorraghic syndrome reported in black rhinos, are being conducted by Frederick (University of Arizona) and Ward (Fort Worth Zoo) and Pond (Texas A&M). Marginal trace mineral status (especially of Zn and Cu) is known in the southwest, and may contribute to this problem. Detailed diet evaluations are underway. Copper is particularly targeted as a key component of several enzyme systems including ceruloplasmin (involved in Fe metabolism), lysyl oxidase, superoxide dismutase, cytochrome C oxidase, tyrosinae, ascorbate oxidase, catalase, desaturase (fatty acid metabolism), and neuropeptide release.

Dietary and fecal mineral concentrations in free-ranging rhinos are being investigated by Adcock in South Africa, and Woodfine and others in Zimbabwe, funded by the St. Louis Zoo and IRF. Understanding the basis and interactions of these minerals will likely be crucial in alleviating some of the problems that may be induced by diet.

Captive Diets Alterations

Finally, optimal captive diet development is being investigated through development of several commercial products attempting to combine the information gathered through these investigations to supply proper balances of major nutrients, minerals, vitamins, and fatty acids. Many of these products are incorporating native or substitute browses to supply protein, carbohydrate, and other chemical constituents that possibly can't be duplicated by refined ingredients. We hope these integrated efforts will rapidly move us forward in improving the captive feeding management of browsing rhinos. Several years ago, a project was discussed that involved ranking browses fed to rhinoceros in zoos through a series of palatability and nutrient composition trials. This idea should be revived, and championed, by the keeper staff caring for the browsing rhinos. Input, suggestions, and feedback directly from the animal care staff involved are critical in success of all these studies. As you're well aware, switching animals to new diets often involves extra time and effort, but the rewards can be more than short-lived. In the case of the browsing rhinos, we feel that proper diet is key to very survival of the species.

RHINOCEROS HEALTH AND VETERINARY MEDICINE IN NORTH AMERICAN RHINOCEROS PROGRAMS

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Black Rhinoceros Species Survival Plan and,
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Veterinary medicine is an integral part of the management of captive rhinoceros populations. In North America, Veterinary Advisors have been appointed to each rhinoceros Species Survival Plan (see addendum). For white rhinoceroses (*Ceratotherium simum*), and with a few exceptions, greater Asian One-horned rhinoceroses (*Rhinoceros unicornis*), diseases have not been remarkable or unusual when compared to those in other domesticated hoofstock. However, for black (*Diceros bicornis*) and Sumatran (*Didermocerus sumatrensis*) rhinoceroses, several rather unique medical problems have been a limiting factor in the maintenance of captive populations.

Attempts to determine the cause of these diseases have led to over a dozen research projects at 10+ institutions. In order to organize the sample collection necessary for these studies, a "Rhinoceros Blood and Tissue Collection Protocol" has been written and distributed to each North American rhinoceros holding institution. It outlines samples that are requested from both living and dead rhinoceroses. In order to obtain comparative data, it is vital that whenever possible, samples are obtained from all rhinoceros species.

General

As with other species, rhinoceros health care is best focussed on preventive measures. Biannual fecals are recommended. Tapeworms are commonly found, but overall, gastrointestinal parasites are rarely a serious problem in captive rhinoceroses. In the black rhinoceros, vaccination with a leptospiral bacterin has been recommended,[2] however, allergic-like post-vaccinal reactions have occurred in several animals. Whenever, possible neonatal examinations should be performed in the first 48 hours of life. They should include weight, a dipstick blood glucose, full blood evaluations if possible, and sera/plasma for vitamin E levels. Examinations may also include vitamin and antibiotic injections and the placement of a identification transponder.

Blood collection in black rhinoceros can take place from several sites. In awake animals, the ear vein is most commonly used (although in standing or laying rhinoceroses, some have also used the medial carpal vein on the inside of the lower front leg). In anesthetized rhinoceroses, the medial carpal vein can be used to collect relatively large amounts of blood (1-8 liters) in a short period of time.

Although it should never be undertaken lightly, in general, anesthesia of rhinoceroses is safe and usually predictable. Several methods exist. Full anesthesia is nearly always performed with narcotics or their derivatives (eg, etorphine [M99], carfentanil). "Standing" sedations can also be done using low doses of narcotics or a variety of tranquilizers and sedatives. It is important that in any standing procedure that personnel are careful and protected in such a way as to not have a rhinoceros fall on them. While anesthetized, it is important to monitor a rhinoceros' vital signs including temperature. Additionally, it is important that they are properly padded (particularly the elbow) to prevent nerve damage that can result from laying on the legs and that can lead to temporary (although up to several days) paralysis.

Finally, training rhinoceroses to the use of restraint devices (e.g. as has been done at The Wilds and the Fossil Rim Conservation Center) should be done wherever possible as it can reduce the need for anesthesia for many basic diagnostic and research procedures.

Descriptions of the general diseases of rhinoceroses are available from several sources.[1,3,5,9,12,13,14] Recently, two bibliographies for rhinoceroses have been published.[6,15] Several diseases of large animals, such as tuberculosis, can presumably affect all rhinoceros species. Currently, the numbers of infected cases have been low, and because of that, the data are not sufficient to make specific testing recommendations. However, it is interesting to note that several infected animals have had positive reactions when tested with the most commonly used USDA product.

Other "general" diseases that have affected one or more of the rhinoceros species include "colic" due to sand impaction and to gut torsion, osteoarthritis, lymphosarcoma, and salmonellosis. The latter disease appears to be more commonly reported, and recently has caused the deaths of several black rhinoceroses. Signs include profuse, watery diarrhea. Excessive build-up of oral plaque has been frequently noted in captive black rhinoceros, and an oral examination of all anesthetized rhinoceroses should be done.

Leptospirosis, a bacterial infection, has been noted in some of the black rhinoceroses undergoing hemolytic anemia (see below),[2] and has also been identified in an aborted fetus from a greater Asian one-horned rhinoceros (*Rhinoceros unicornis*).

Exposure to creosote has been associated with a syndrome of liver failure in black rhinoceroses, and so should be carefully avoided in all species of rhinoceroses.

Finally, when a rhinoceros dies, it is vital that it receive a complete necropsy and that both formalinized and frozen tissues are saved as requested in the "Rhinoceros Blood and Tissue Protocol."

White Rhinoceros

In contrast to the diseases of the other rhinoceros species, those of the white rhinoceroses (*Ceratotherium simum*) appear to be more similar to those of large domestic animals and of an apparently lower incidence.

Greater Asian One-Horned Rhinoceros

Diseases of greater Asian one-horned rhinoceroses have been notable for an apparently increased incidence of abortion (note above that one case was associated with leptospiral infection) and stillbirths, chronic foot problems and infections, and uterine leiomyomas (benign tumors of smooth muscle).

Sumatran Rhinoceroses

Although the number of Sumatran rhinoceroses held in western captivity has been limited, their medical histories have been notable. Causes of death have included intestinal "colics" and uterine mass (in Great Britain). There are indications that another captive female may also have uterine abnormalities.

Black Rhinoceroses

Diseases of black rhinoceroses are characterized by several syndromes of unusual nature and uncertain cause. These include hemolytic anemia, mucocutaneous ulcerative disease, encephalomalacia, idiopathic hemorrhagic vasculopathy, hemosiderosis and fungal pneumonia.

Hemolytic anemia, a type of anemia in which the red blood cells (RBCs) rupture within the body, has been identified as the leading cause of death in captive black rhinoceros.[7] Leptospiral infection accounts some, but not all, of the hemolytic cases,[2] so a series of investigations were initiated to study the function of the black rhinoceros red blood cell (RBC). To date, the most significant findings have resulted from studies of RBC metabolism.[11] In light of the metabolic findings, exposure to oxidative agents and many drug compounds should be avoided (e.g., naphthalene, drugs like isoniazid). In several cases, low serum levels of phosphorus have developed with the hemolysis and may contribute to red cell destruction, so oral or intravenous supplements have been given. Additionally, plants and compounds, such as red maple or members of the Brassica (cabbage) family, that cause hemolytic anemia in domestic animals should also be avoided in rhinoceroses.

A syndrome of oral and/or skin ulcers has also had a major impact on captive black rhinoceroses (45+ cases identified).[10] The first signs are often small blisters (vesicles) or ulcers over points of wear, that may progress to cover large areas of the body. Most often, the ulcers resolve on their own, however, in some cases, they may become severe and contribute to the death of the rhinoceros. At the present time, the cause of the skin ulcers remains unknown. Wild black rhinoceroses can be infected with a parasite that can cause a similar appearance, however, that parasite has not been seen in captive rhinoceroses. To date, tests

for viruses have been negative.

Seven black rhinoceroses have been affected by a newly named syndrome, "Idiopathic Hemorrhagic Vasculopathy" (IHV). Nearly all of the affected animals have been from Texas, although the significance of that is unknown. Signs include acute swelling of the forelegs and neck (from bleeding into the tissue), lameness, possible sloughing of the hooves, anemia, and/or difficulty in breathing. At the present time the cause remains unknown, although research is ongoing.

Pneumonia caused by fungi is rare in nearly all mammalian species, however, it has been relatively common in the black rhinoceros. Unfortunately, it is extremely difficult to diagnose prior to death. Treatment of fungal pneumonia in black rhinoceroses is very expensive and due to lack of a good method for pre-mortem diagnosis, often not attempted. Further studies are underway to determine the immune status of black rhinoceroses.

Encephalomalacia, a disease in which a portion of the brain degenerates, has been reported in young black rhinoceroses (4 calves of 6 months or less and one 2 year old).[8] To date, all the animals have been female. The neurological signs can range from excitement to near coma, and mimic the signs of other diseases. So examination of brain tissues is warranted in all rhinoceros deaths.

Additionally, accumulation of iron in the tissues of black rhinoceros has been shown to be correlated with length of time in captivity.[4] More recently it appears that it may be related to several of the syndromes of black rhinoceroses, and further studies are ongoing to determine if this is from diet or other factors.

The Role of Keepers in Rhinoceros Health

Keepers are the most important link in the chain of personnel that maintains rhinoceros health. In a species with what sometimes appears to be a limited behavioral repertoire, it is the keepers who can best detect the early changes that may indicate abnormal health or disease. Additionally, many of the keeper's daily activities are vital to rhinoceros health, e.g., feeding methods that prevent sand impaction, etc.

In zoological institutions, it is also most often the keepers who are responsible for basic rhinoceros training regimens that can have major impact on the veterinarian's role in monitoring rhinoceros health and diagnosing disease. Keepers are vital to train rhinoceroses to accept blood collection (as noted above) while awake. Training can also include some aspects of the physical examination, and for at least two zoos, includes the acceptance of rectal ultrasound while minimally restrained.

ADDENDUM

North American Veterinary Advisors to Rhinoceros SSP Committees

Identification of disease in individual rhinoceroses is the first step in the process that allows SSP Veterinary Advisors to identify patterns of disease and syndromes. Below is a list of the North American SSP Advisors:

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RHINO REPRODUCTIVE PHYSIOLOGY - WHAT WE KNOW TODAY AND WHAT WE NEED TO KNOW TOMORROW FOR ENSURING THE LONG-TERM STABILITY OF OUR CAPTIVE BREEDING PROGRAMS

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Considerable progress has been achieved through reproductive studies in all four captive rhinoceros species. Research results have revealed interesting variation among species within this taxon and also have provided information that will facilitate the management of captive populations. Much of the current reproductive database has resulted from studies that relied upon sample collections and/or behavioral observations conducted by keepers working directly with the animals. For example, keepers have collected fecal, urine, saliva and blood samples for hormone analyses which have been used by researchers for characterizing the reproductive cycles and determining pregnancy status in rhinos of each captive species. Observations and data from behavioral check-sheets recorded by keepers have been instrumental in determining estrous behaviors, breeding activity and inter-animal relationships. For more intensive studies, such as those requiring ultrasound evaluations and blood collection, animals have been conditioned to enter a chute or move near the side of the enclosure and stand still for the procedure. This type of conditioning also was either conducted by the keepers or, at least, involved their significant participation. The diligent efforts of numerous keepers are reflected in our current knowledge of rhino reproduction.

Blood collection once was thought necessary for evaluating hormone levels in animals, however, we now know that animals excrete hormones in slightly modified forms (metabolites) into the urine and feces. The discovery of this noninvasive method of determining hormone levels opened the door to tremendous opportunities in studying nondomestic species. Noninvasive fecal hormone metabolite monitoring has been the primary method used for characterizing rhino reproductive cycles, and resulting data have provided a foundation of basic knowledge upon which we now can build by employing additional research tools like ultrasonography. Already, ultrasonography has proven useful for identifying reproductive characteristics that might otherwise have remained undetected.

The African black rhinoceros (*Diceros bicornis*) has been the most prolific and best studied of the captive rhinos. Most female black rhinos are exhibiting reproductive activity. Their reproductive cycles average about 25 days, however, variable cycle lengths are common, with approximately 50% of cycles <20 or >30 days. Although reproductive success has been relatively high, there are several animals that appear to be healthy and reproductively active but continue to breed without becoming pregnant. Identifying the cause of this apparent infertility is the primary challenge ahead for black rhino reproductive research. However, the greatest threat to the captive black rhino population is their unusual susceptibility to several uncommon diseases.

Fecal sample collection in the African white rhinoceros (*Ceratotherium simum*) has been difficult due to the common social group management style adopted by many institutions and, thus, the inability to identify fecal samples from particular individuals. Several potential fecal markers (cake decorating dye, sunflower seeds, biodegradable barrier tape, art glitter) were tested by rhino keepers at the San Antonio Zoo, but none proved both safe and effective for long-term use. Regardless of the challenge, keepers at numerous institutions have diligently collected samples, providing enough material for researchers to obtain a significant data-set on reproductive activity in the captive population.

Fecal progesterone data for the southern white rhinoceros, has been more difficult to interpret than that of its close relative, the black rhino. Approximately 50% of captive female white rhinos appear acyclic, showing no reproductive behavior and no change in progesterone levels. The remaining female white rhinos can be categorized as exhibiting one of three different types of reproductive patterns: 1) 60-70 day cycles; 2) 30-35 day cycles; or 3) a mixture of long (60-70 day) and short (30-35 day) cycles. Several females with 70 day cycles are breeding without producing calves. These long cycles are characterized by an extended luteal (nonreceptive) phase identified by prolonged elevated progesterone, and fertility is questionable since no pregnancies have been documented in animals exhibiting long cycles exclusively. Determining the causes of both acyclicity and extended cycles are research priorities for the southern white rhinoceros. Additionally, early pregnancy loss and uterine pathology have been documented by ultrasound in a few animals and

further examinations of additional animals are necessary to determine their prevalence and potential association with infertility.

The reproductive cycle of the Indian rhinoceros *(Rhinoceros unicornis)* has been characterized by both behavioral observations and urinary hormone metabolite monitoring. The reproductive cycle appears to vary among individuals ranging from 39 to 64 days in length and also can vary between cycles within an individual. In this rhino species, significant increases in urinary estrogen metabolite concentrations are associated with estrous behavior and breeding. Recent research using serial ultrasound examinations in a young, regularly cycling female has revealed the development of extremely large follicles (>10 cm diameter) on the ovaries several days before ovulation which might explain the high levels of estrogen produced by this species. Captive breeding of the Indian rhino has been relatively successful, however, aggressive interactions between some male-female pairings, even during the female's estrus, have interfered with breeding success on several occasions. These behavioral incompatibilities between individuals of specific pairs limit our ability to genetically manage the captive population. The development of artificial insemination may provide a useful method for overcoming this hurdle in the Indian rhino captive breeding program.

The other Asian rhinoceros in captivity, the Sumatran rhino (*Dicerorhinus sumatrensis*), has been studied intensively during the last few years. In the last century, captive breeding efforts with this species have been unsuccessful due to our inability to detect estrous behavior combined with aggressive interactions between pairs when animals are introduced during the female's nonreceptive period. Long-term serial ultrasound examinations, serum hormone analyses and behavioral observations have revealed that the Sumatran rhinoceros experiences a 21 day reproductive cycle and is an induced ovulator, meaning she ovulates only if she breeds. This characteristic has not been reported for any other species within the perissodactyla family. Early pregnancy loss has been detected in one animal on three occasions, and uterine pathology has been reported in several other animals. The reason for this uterine pathology is unknown and warrants investigation. Similarly, the cause of early pregnancy loss is a mystery and determining why it is occurring and how to overcome it will be research priorities as efforts to produce offspring in the captive Sumatran rhino continue.

Future reproductive research in rhinos often will require more invasive methods. For example, ultrasound examinations are recommended for animals that breed repeatedly without producing calves to determine if they are undergoing early embryo loss, or simply never becoming pregnant. Ultrasound also will be important for identifying reproductive tract pathology that might explain reduced fertility (or infertility) in some animals. Several institutions already have conditioned several rhinos of each species to walk into a chute and to allow rectal ultrasound examinations and/or blood sample collections. Rhino keepers typically play an integral role in the process. The benefits of conditioning rhinos for simple procedures are far-reaching. Not only will it facilitate research efforts, but it also will help veterinarians care for the animals. For example, if an animal becomes ill or injures itself, veterinarians will be able to examine the individual closely, and diagnose and treat problems without forced contact or anesthesia which could further stress an already compromised animal.

There are many ways in which our knowledge of rhino reproduction can be exploited to benefit animal managers. Perhaps one of the most obvious benefits is the ability to detect pregnancy early in gestation. Pregnancy can be diagnosed by ultrasound as early as 16 days after breeding. A single examination could be used prior to introducing a male-female pair for another breeding, and this might alleviate the efforts and concerns involved with pairing a pregnant animal with a male. It also will provide managers with a relatively accurate conception date so that preparation for parturition is timely. Concerns about the potential loss of pregnancy later in gestation could be alleviated by an ultrasound examination confirming a fetal heartbeat. Alternatively, to detect and monitor pregnancy, serial blood, fecal or urine samples collected over several weeks can be analyzed for progesterone or progestin metabolites. Sustained elevated progesterone levels serve as a relatively accurate indication of pregnancy.

In addition to diagnosing pregnancy, ultrasound examinations can be used to detect reproductive tract abnormalities causing infertility. This information is important for both the institution managing the animal and for the Species Survival Plan which might make a recommendation to transfer the rhino to a different facility in hopes of a successful breeding with a genetically valuable male. Furthermore, if a reversible or treatable condition is identified, steps can be taken to improve the condition so that reproductive success might be achieved by the female.

Serial fecal, urine or serum collection also could prove beneficial when a pair of rhinos exhibits no reproductive activity over a long period of time. These samples can be analyzed for hormone metabolites to determine if the female is exhibiting reproductive activity. Once acyclicity is ruled out as the cause of reproductive apathy, other factors could be considered and the introduction of a new male or transfer of the female to a new male might be warranted.

In summary, great strides have been made in characterizing reproductive activity in all captive rhinoceros species, and this progress would not have been possible without the help of rhino keepers who have played an integral role in sample collections, behavioral observations and animal conditioning. We now know that the reproductive cycle of each rhino species differs, ranging from 21 days in the Sumatran rhino to 70 days in some white rhinos. Similarly, ovarian activity differs among species. For example, preovulatory follicles in the Sumatran rhino are ~20-25 mm in diameter and breeding induces ovulation. In contrast, preovulatory follicles in the Indian rhino grow to >10 cm in diameter and spontaneously ovulate. With a clearer understanding of each species' reproductive physiology, and future challenges defined, it is time to move forward with research that will help us overcome those obstacles currently limiting the long-term stability of captive breeding programs. Challenges for the future include understanding the reasons for: 1) repeated copulations without pregnancy; 2) early pregnancy loss; 3) uterine pathology; 4) extended luteal phase cycles and acyclicity in the white rhino; and 5) aggressive interactions between Indian and Sumatran rhino pairs introduced for breeding. Similar to previous reproductive research, the success of these studies will depend upon continued cooperation and assistance from rhino keepers at institutions throughout the US. As a result, the rhinos, researchers and animal care staff all should benefit from what is learned.

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Reproductive Management of the Captive Rhinoceros

A Collaborative Approach to Maximize Rhino Health and Reproduction

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INTRODUCTION

The focus of our rhinoceros research has been the characterization of basic reproductive biology by ultrasound and its application to captive management of these endangered species, work intricately dependent upon a dedicated and collaborative animal care and health team. Our rhino care and research objectives are facilitated by a rhino internship position created to help with ongoing reproductive studies of the black rhinoceros *(Diceros bicornis minor)* and white rhinoceros *(Ceratotherium simum simum)*. The rhino internship has evolved into a position which provides a significant benefit to our research, daily care, and medical management of our rhinoceros. This position provides hands-on training and experience in the care of captive rhinoceros through exposure to research, medicine and husbandry of these endangered perissodactyls.

Our reproductive research of rhinos provides two important benefits to rhinoceros conservation. The first and most obvious benefit is the elucidation of new information about rhinoceros biology through data collection and analysis. The information accumulated will serve to improve our knowledge of the basic reproductive function of the rhinoceros - information essential to their successful management in captivity and possibly in the wild. The second benefit is an application of the first: development of an intensive program to monitor rhinos with ultrasound in order to characterize their reproductive state.

RHINOCEROS REPRODUCTIVE RESEARCH

Procedure and conditioning

The reproductive management of captive African rhinos can be enhanced through the application of transrectal ultrasonography, without the need for sedation. Routine daily examinations have been facilitated by the use of a "free-stall" chute that eliminates the stress of confinement and allows the rhino to choose its own response to the process (Figure 1). Our rhino keeper and interns have dedicated long hours to conditioning rhinos through feeding and touching the subjects while in the chute, allowing for the eventual application of transrectal ultrasound in even our most "wild" rhinos.

Characterization of basic biology

Reproductive studies in the southern white rhinoceros *(Ceratotherium simum simum)* have focused on the characterization of ovarian dynamics and early pregnancy in one female over a 15 month period. A 5.0 MHz convex array transducer facilitated reproductive examinations, with a modified 10 foot transducer cable and extensor needed for ovarian examinations. The interovulatory interval in the subject white rhinoceros averaged 33 days (n=2). Two nonconceptive periods lasting approximately 10 weeks were observed in association with early embryonic death. A possible sign of infertility in this female was the identification of intrauterine fluid collections in late diestrous, as has been reported in the horse.

Reproductive work in the southern black rhinoceros *(Diceros bicornis minor)* has involved the documentation of normal gestational parameters and the characterization of the estrous cycle in two females. Ultrasonography in the black rhino was performed with a 5.0 MHz linear array transducer, without the need for an extensor. Weekly examination during a black rhino gestational period from Day 56 through parturition on Day 475 allowed for the documentation of: fetal heart rate, fetal mobility/orientation within the uterus, and measurements of various fetal parts (Figure 2). A second gestational monitoring period facilitated characterization of the early black rhino embryo from Day 27 through late fetal stages. Preliminary results in these rhinos suggest that the measurement of fetal foot and eye diameter may be useful for assessment of gestational age in the black rhinoceros. If sufficient data were collected to document and chart fetal dimensions such as eye diameter or skull length as has been done in the horse, gestational age charts could be developed for the rhino. Initial ultrasonographic investigations of ovarian function in the black rhino confirm previous hormonally and behaviorally-based reports of a cycle length of 25 days. For both species of African rhinoceros, concurrent fecal hormone assays confirmed ultrasonographically identified reproductive cycle dynamics.

REPRODUCTIVE MANAGEMENT

Ultrasonography as a tool for applied reproductive management

Ultrasonography is a tool being applied in captive management to resolve some of the basic mysteries surrounding rhinoceros reproduction. Managed breeding decisions can be enhanced with this technique through objective reproductive assessments of individual animals. The ability to characterize the reproductive state of the rhinoceros is the first, essential step to management of a healthy and reproductively efficient captive breeding program. As in the management of mares on a broodmare farm, the basic information provided by routine reproductive examination is fundamental to managed reproduction. The following summary highlights some of the more important changes this information can facilitate, and includes specific case studies that illustrate use of ultrasound as a management tool for enhancement of reproductive efficiency in the rhino:

1) Prediction of estrus and impending ovulation in females that lack overt signs of behavioral estrus.
2) Timed breeding in individual animals (or species such as Sumatran rhino) that are incompatible outside of estrus.
3) The documentation of reproductive state. For example, this information allows separation of male and female following confirmed conception.
4) Shortening of the inter-calf interval in rhinos through early confirmation of return to cycling post-calving and documentation of pregnancy.
5) Identification and therapeutic management of infertility.
6) Nutritional modifications needed to meet the increasing demands of late gestation.
7) Facility modifications and preparations necessary for an impending birth.

CASE STUDY I

Conditioning and reproductive assessment of an untractable black rhinoceros

An approximately 12 year-old female southern black rhinoceros (*Diceros bicornis minor*) was captured in Zimbabwe, held in a boma for several months, and then transferred to the Fossil Rim Wildlife Center in Texas, U.S.A. in April of 1992. Starting in January of 1993, a full-time intern began intensive conditioning of the rhino to allow hands-on examinations with the hopes of eventually performing transrectal ultrasound evaluations without sedation. The conditioning process involved exposing the female to long hours of human contact along with visual, tactile, and auditory stimuli, including the intermittent playing of a radio to add background noise to her normal environment.

The positive conditioning process began with food such as apples and sweet potatoes as a reward for tolerating the proximity of people. This soon expanded to the application of human touch on different areas of the rhino's body at the time of feeding. Over a period of several months, the rhino began to trust her human caretakers enough to facilitate twice daily examination and treatment of a potentially serious hoof crack. The rhino was never restrained physically or chemically for the purposes of conditioning, examination, or treatment. Starting in July of 1995, the female was exposed to daily rectal examination in the chute without chemical restraint. Within 2 weeks the application of transrectal ultrasound was successful, and documented that this female was late-term pregnant. This was important management information as it allowed for both nutritional and facility modifications needed in preparation for an impending birth.

The management implications of this work are obvious regarding captive rhinoceros propagation. In this case, a decision to postpone immobilization of the black rhino female for more aggressive treatment of the hoof crack was based partly on ultrasonographic confirmation of late-term pregnancy. Furthermore, the conditioning process not only allowed for the transrectal ultrasound examinations, but enabled successful treatment and monitoring of the hoof problem in a previously untractable rhino.

CASE STUDY II

Medical and reproductive management of a pregnant black rhinoceros

On June 15, 1996, a 5.5 year-old female southern black rhinoceros *(Diceros bicornis minor)* was bitten on the upper lip by a suspected rattlesnake *(Crotalus sp.)*. The rhino was approximately 8 months pregnant at the time of envenomation, and the subject of an ultrasonographic study to document normal fetal changes throughout gestation in this species. The pregnant cow developed signs of respiratory distress, marked swelling at the site of the bite, and a skin reaction. Following several days of supportive care, the rhino appeared to have recovered. The rhino managers were concerned; however, that the envenomation may have adversely affected the fetus - a routine ultrasound exam confirmed that the fetus appeared healthy with a visible heartbeat. Another medical problem occurred several months previously in which the same female was treated with the antibiotic Trimethoprim-sulfa and subsequently developed a severe skin reaction to this medication. Ultrasound was used as a "tool" to assess fetal viability during a suspected allergic drug reaction in this rhino.

CASE STUDY III

Facilitated breeding to shorten the inter-birth interval in a black rhino cow with young calf

An adult female southern black rhinoceros *(Diceros bicornis minor)* was part of a study to ultrasonographically characterize the reproductive cycle of this species. Although this female did show obvious signs of estrus, we were able to document the ovarian changes that accompanied these behavioral events. In this way, the rhino keeper and researcher were able to work together to predict when this female would return to estrus and thus help plan an introduction of the male to facilitate a "timed breeding". A complicating factor in this effort was the simultaneous concerns over compromising the health of this cow's ~9 mo-old calf if included in the breeding process, a common factor that has been primarily responsible for an unacceptably long interbirth interval in most captive breeding situations for the black rhinoceros. In this case, ultrasonography together with behavioral observation were utilized to plan a separation of cow and calf for a short period (~5 hrs) and introduction of the male and female for breeding. The female eventually bred successfully producing an estimated interbirth interval of approximately 26 months with pregnancy confirmed via ultrasonographic identification of a 27 day-old embryonic vesicle. This technique of timed breeding would be especially useful in individual rhinos that lack overt signs of behavioral estrus.

CASE STUDY IV

Infertility diagnosis, therapy, and anesthetic considerations in a white rhinoceros

A 35 yr-old southern white rhinoceros *(Ceratotherium simum simum)* was diagnosed with a chronic uterine enlargement via routine ultrasound exam. This female was reproductively evaluated without sedation in the free-stall chute as previously described. Although chute conditioning of the rhinoceros has limited the need for anesthesia, occasions still arise when anesthesia becomes necessary. Immobilization

of this rhino was performed on multiple occasions for diagnostic and therapeutic reasons. At these times, we have found that a well-conditioned animal can be safely anesthetized with a less-potent anesthetic drug combination utilizing butorphanol and azaperone. The benefits of this combination include reduced risks of adverse side-effects compared to the more commonly used potent narcotics (ie. etorphine or carfentanil); this technique would not be possible without a rhino well-conditioned to people and medical procedures. For example, use of butorphanol/azaperone for "standing" anesthesia in a white rhino facilitated the first successful laparoscopic surgery in this species, and was only possible in a conditioned rhinoceros within a controlled environment. Ultrasound has proven to be an essential tool to diagnose, assess, treat and monitor this case.

MEDICAL ISSUES AND NUTRITION

The medical care of the black rhinoceros species, in particular, is facilitated by a well-conditioned rhino in collaboration with an attentive rhino keeper and intern. For example, the ability to examine the rhinoceros without anesthesia and its associated risks is a key component of our daily management. The conditioned rhinoceros allows touching over all parts of its body and evaluation of feet, hooves, eyes, ears, and oral cavity. In addition, routine blood collection is facilitated by a rhino care staff that works closely with the animals through feeding in the chute and touching of legs and ears where blood collection is performed. Early detection of important diseases of the black rhinoceros is essential to successful management and treatment. Frequent evaluation of the oral cavity for ulceration or dental disease is done routinely when rhinos are fed their daily vitamin E. Observation of mucous membrane color (especially the conjunctival area) is critical in a species that has a propensity for hemic disorders including hemolytic anemia and a nonhemolytic vasculopathy. Another very important part of medical care of the rhino involves the keepers ability to pick up on subtle variances in an animal's behavior, movement or appearance that can only come from a close relationship with his/her animals.

One of the most significant factors in health of the black rhinoceros, nutrition is another area where the rhino keeper is essential to management and research of an improved captive diet. Browse studies including palatability of different local species as well as the possible use of frozen browse are two examples of keeper-based projects designed to facilitate improved dietary management of our black rhinos.

CONCLUSIONS

The rhino keeper and intern are an integral part of Fossil Rim's animal care and health team. This collaborative approach is important to successful management of the captive rhinoceros by providing the following key benefits:

1) Close monitoring of behavioral aspects for reproductive research
2) Early identification and monitoring of medical conditions and disease
3) Nutritional management of the rhino
4) Training of interns

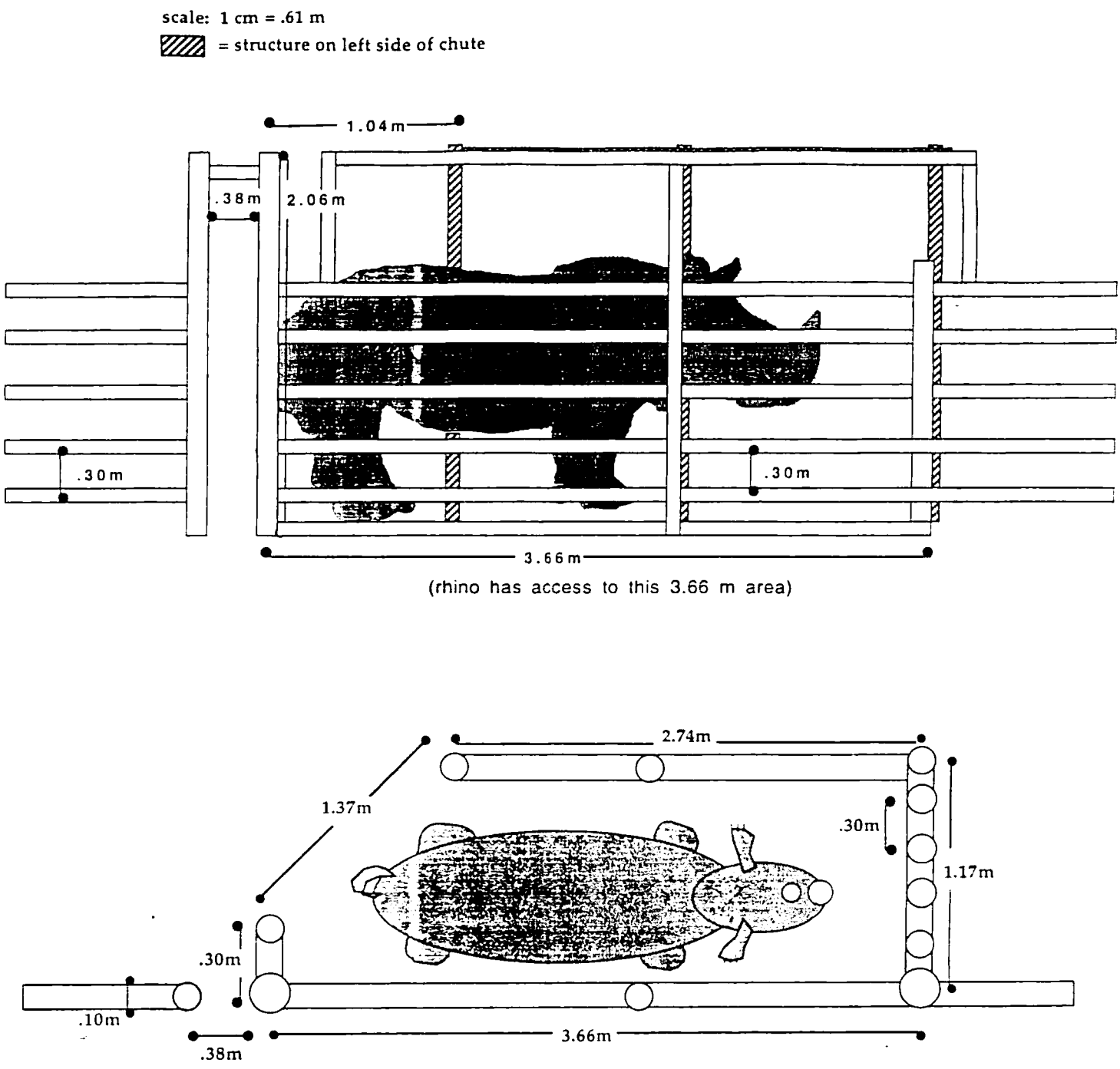
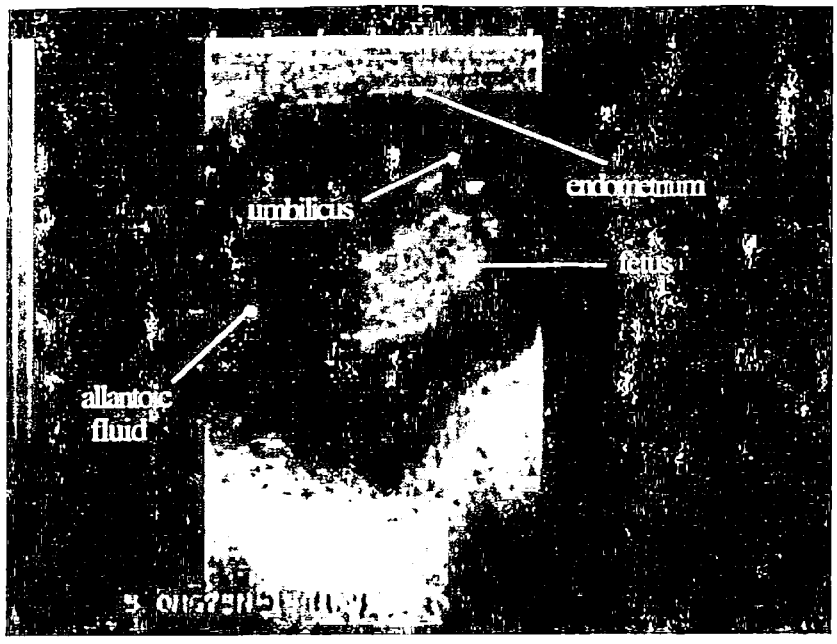


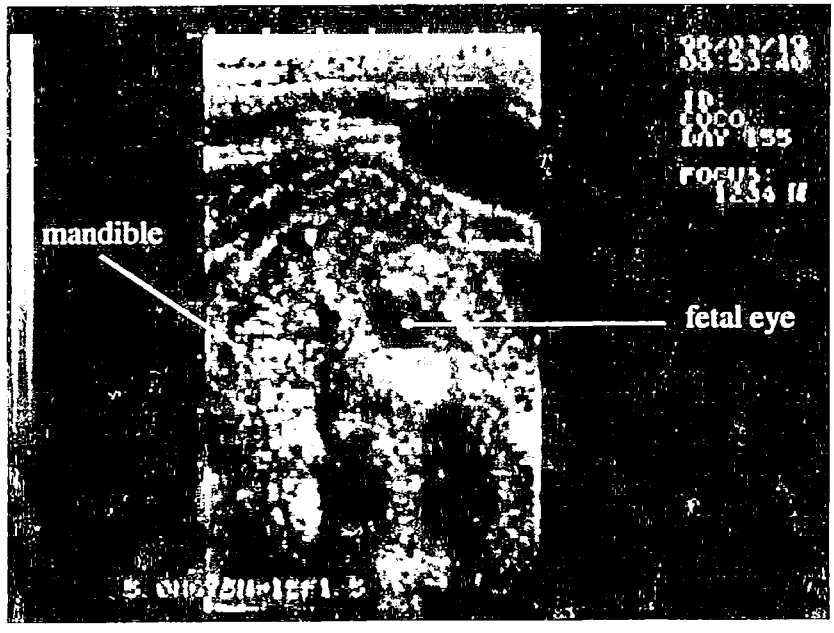
Figure 1

Diagramatic representation of the "free-stall" chute that has facilitated transrectal ultrasonographic reproductive evaluation in the black rhinoceros (Adapted from Radcliffe, Bommarito, and Osofsky, 1996. Pachyderm No. 21).

Figure 2



Ultrasound image of a 56 day-old black rhinoceros fetus.



Ultrasound image of the fetal head and eye in a 155 day-old black rhinoceros fetus.

First Annual Rhino Keeper Workshop
Disney's Animal Kingdom
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AN INTEGRATED APPROACH TO DESIGN: HOW ZOO STAFF CAN GET THE BEST RESULTS FROM NEW FACILITIES

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ABSTRACT

Good exhibit and facility design depends upon close collaboration between all "stakeholders" on the zoo staff with the professional design team. Animal care staff play a critical role in this interdisciplinary process. It is also essential that the animal and exhibit management plan be developed concurrently with the exhibit design plan and that designers continue to have input with staff during the critical "commissioning" process after the exhibit opens.

This paper will briefly discuss the "design process" and suggest ways that animal care staff and other zoo professionals can become better informed consumers of design services and thus contribute more successfully in the design of the facilities they will be called upon to operate.

Question: "Should keepers and other frontline animal care staff play a significant role in planning the design and operation of exhibits?

Answer: "Yes, if they are prepared to make a significant contribution."

INTRODUCTION

It may not be in your job description, but you too are a designer. If you have ever identified a need, envisioned a solution and achieved the desired outcome, you have been a designer. Architects, landscape architects, engineers and museum designers are just different types of designers. So are dieticians, management planners and animal husbandry specialists. Professionals in the former list know all about design; you know all about your animals, staff and resources. How can these two spheres be blended to create the best results? One answer lies in developing an informed interdisciplinary process that is both interactive and collaborative.

Traditional top-down zoo design may involve only the director, general curator, donor and architect. If the director encourages the architect to interview zoo staff independently, the process becomes interdisciplinary but not necessarily collaborative. This process can be seen in zoos of all sizes with strong minded and visionary directors. Small zoos typically use local generalist architects and very large zoos often use in-house designers. In either case, the results can be very good or very bad, depending upon the knowledge, vision and leadership of the principals, but either way front line keepers are often left out of the loop.

Many mid-sized zoos use specialist zoo design consultants like CLR or one of our excellent professional colleagues. We recommend using a collaborative workshop process, but the client determines who to invite to the workshops. If the purpose of the workshop is to discuss large scale planning issues such as where the exhibit should go, or when among competing zoo priorities a given exhibit should be developed, we suggest only involving upper level zoo staff from a wide variety of disciplines, hoping to have what are called "big picture people". When we are designing a specific exhibit, we usually request that at last senior keepers be included in all of the design workshops. Sometimes management agrees with this strategy, sometimes they chose to involve only higher level staff instead, with occasional input from keepers.

Why involve multi-disciplinary zoo team members in exhibit design? (Bierlein and Sammons 1997, Coe 1998, McGill 1998, Torres and Spiegel 1996)

1. Because the Zoo Mission Statement implies multiple values and goals.
2. To cover all the bases, assure nothing is overlooked.
3. To learn from other points of view.
4. Because there is strength in diversity.
5. To improve support and buy in from a broad range of zoo departments.
6. Because innovation usually occurs at the inter-sections of different professions and viewpoints.
7. Because exhibits are so expensive to build they must serve many masters well to justify the investment.

Why involve animal care staff in exhibit design? (Keeper point of view)

1. They know the animal "clients".
2. They know what has worked before.
3. They and the rhinos are the primary users of the project, so individual preferences are important.
4. To improve buy in and continued support for the project.
5. To ensure coordination between project design and husbandry design.

Why should keeper staff be excluded from the design process? (Common senior staff response)

1. May not be up-to-date in husbandry practices such as operant conditioning, behavioral enrichment, etc.
2. May only have limited experience.
3. Facility may outlive generations of individual caregivers and animals and shouldn't be designed for individual preferences.

ZOO TRENDS WHICH ENCOURAGE KEEPER PARTICIPATION

Activity-Based Design and Management

Until very recently, animal husbandry, behavioral enrichment, operant conditioning training and exhibit and facility design were carried out by separate specialists, at least that is often the case in larger zoos. This unnatural separation can lead to conflict and competition. The concept of Activity-Based Design and Management is to fully integrate these and other important elements into a single interactive plan. This plan combines the physical design for the facility with the husbandry plans for the animals and plants and the interpretive/entertainment plans for the zoo guests.

> *Definition: Activity-based design begins with the premise that the animals' long term well-being is paramount and that environments, programs and procedures which advance this goal are frequently of great interest to the visiting public. Healthy animals with stimulating behavioral choices tend to be active animals. Therefore, opportunity-rich animal environment, enlightened animal care and caretaker devotion should all be made visible to the public within a setting*

which demonstrates the animals' innate competence. Whether simulations of naturally or culturally derived habitats, or pure functional facilities, these environments are abundantly provided with appropriate behavioral opportunities for the animals, keepers and zoo visitors. (Coe, 1997)

Integration of Facility Design and Operation

Many new highly integrated exhibits are still being operated with old-fashioned linear management systems and not performing up to capacity. New thinking in design requires new thinking in operation and management (Coe 1998). Several zoos are moving toward team-based exhibit management, following a significant trend in industry. The full integration of facility design and operation is an important aspect of Activity-based Design and Management.

ARE YOU PREPARED TO CONTRIBUTE?

To you as animal care staff, design will be a new field, with new jargon and new cultural values. To prepare yourself, you should know more about the design process.

The design process, as taught in schools of design involves five steps and is generally analogous to the "scientific method."

Step 1 – Site Inventory. This is the data collection period. Subjects may include, microclimate, soils, topography, existing vegetation, facilities, views and vistas, etc.

Step 2 – Site Analysis. The data is analyzed to identify trends, processes, opportunities and constraints that the existing site offers.

Step 3 – Program. Definition of client goals and needs, everything from "why are we doing this?" to "how many pounds of manure does a rhino produce per day?" The designer can help organize the program elements, but the staff have to provide the data and direction. Program elements are usually prioritized into "project imperatives" (what you must have), "project preferences" (what you want) and "project wish-list" (what you can do without if necessary).

Some clients feel they can save money by preparing their own program before bringing in the design team, but our experience is that all this data must be later confirmed by the designers anyway, and programming can best be done with the help of the professional designers.

Step 4 – Synthesis. This is the creative part, the alchemy of forming golden concepts and visions from base data. It is largely an intuitive process and defies description in linear terms. It is often an uncertain process when no clear outcome is visible, until suddenly a potential solution presents itself from the apparent fog of variables. Clients who like certainly are often uncomfortable with this step.

Step 5 – Evaluation. This is the testing stage when ideas from earlier stages are evaluated against program goals and criteria. Usually several concept alternatives are compared and the final concept, often a hybrid of previous concepts, is selected.

Linear vs. Cyclic Processes

The design process outlined above is usually thought of as a linear process, with a discrete beginning and end. In our experience, however, it is best thought of as a cyclic or spiral process. After the first pass through, the concept is refined by repeating the process in greater detail or refinement. This process continues to repeat with the design of each component of the project.

The Project Development Process

The design process outlined above can be applied to many problem-solving needs. In terms of the designer's professional service, the project can be broken into five distinct phases.

1. **The design phase** develops the users program and design concept and elaborates it into a well-developed set of drawings, models and construction budgets approved by the zoo. This is the period in which zoo staff can have the greatest input.

2. **The construction document phase** converts the design into the technical language of the construction industry, commonly called "blueprints and specifications". Staff review of these documents is important for quality control, but changes and additions are very expensive and may not be possible. Since zoo staff are not trained to understand these documents, they must insist that the designers thoroughly explain everything to them.

3. **The bidding process** is used to select the building contractor and subcontractors. When bids exceed construction budgets, cuts have to be made and changes can result which have unforeseen consequences. A strong, effective staff design team may be able to help evaluate "value engineering" cutbacks.

4. **The construction phase.** In order to avoid confusion (and potential lawsuits) zoo staff, other than the zoos "client representative" are not allowed to interact directly with any of the contractors during project construction. Changes can occur during this time which frequently disappoint keeper staff. Therefore the zoo's staff design team should continue as advisors to the client representative.

5. **Commissioning** . Just as ships are not considered complete until they return from their commissioning voyage, zoo exhibits should not be considered complete until after the animals and staff have used them for a while. While this worthwhile concept is new to zoos, Brookfield Zoo has made it an essential part of their team approach to planning and design (Vernon 1997).

FACTORS FAVORING SUCCESS IN THE DESIGN TEAM

If keepers are to become important contributors to the design of new animal facilities, they, like all the other players, must be prepared and committed to make a positive contribution.

1. **Knowledge and experience.** How much have you learned about rhino behavior beyond your immediate experience through reading, research, trips to other zoos or study of wild rhinos? Are you familiar with recent advances in operant conditioning and behavioral enrichment with rhinos and other species? Have you kept abreast of medical or dietary issues?

2. **Spirit of collaboration and teamwork.** We sometimes hear keepers bemoan the "good old days" when "the animals were the most important thing" and the animal department made all the important decisions at the zoo. We've also heard zoo staff say "... we could have a great zoo if it weren't for all the people!" Needless to say, keepers who strongly share these two sentiments would not add much to a collaborative design team.

3. **Buy-in and responsibility.** The price of real participation is the requirement to take responsibility, not only for your own work, but for the success of the entire project. If you are simply willing to "leave it to the experts", then don't complain about the final results. Make communication within the team and with the designers a personal responsibility. Don't expect the designer to read your mind. Insist on having your ideas discussed and tested, but first make sure these ideas are well reasoned.

4. **Follow through.** How often are ideas developed during creative brainstorming sessions actually used by staff after the exhibit opens? Very rarely, because there is often little continuity between zoo staff who help with the design and the staff which operate the facility. Designers may have a lot to do with the design, but rarely have any input during exhibit operation. Continuity of vision and function are in the hands of zoo staff, especially the day-to-day users. If these keepers help to create the design they want and need, and follow through during operation, they will have made a real contribution to the welfare of the rhinos in their care.

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Keeper Assessment Of Black Rhinoceros Behavior And Its Role In Exhibit Design.

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Zookeepers play a valuable role in the design of rhinoceros exhibits when they participate in cross-institutional husbandry research, such as the "Methods of Behavioral Assessment" (MBA) Project. The role of keepers in this research is to provide behavioral assessments of the animals in their care that can be compared to assessments of rhinos in other zoos. Ultimately these assessments are used to identify husbandry problems associated with the design of rhino exhibits.

In this summary I will refer only to research on black rhinoceros. The results I present should not to be generalized to other rhinoceros species, because there are probably pronounced differences between species in how they respond to captive environments. Certainly black rhinos are considered the most nervous and stress-susceptible of the 5 rhinoceros species. However, the methods I will present may be used for other species.

For black rhinos in captivity, the birth rate is lower than the death rate and the captive population is not self-sustaining without infusion of wild-caught individuals. Some zoos are very successful breeding them and some are not, and there seems to be no rule of thumb that can be passed from one zoo to another so that all rhinos in the captive population reproduce at an optimal rate. The most common causes of poor breeding results are held to be pair incompatibility, stress-related disease, high mortality or inappropriate management.

One very good reason for differences between zoos in breeding success or mortality, etc. could be related to the facilities in which black rhinos are kept. For black rhinos, as for most zoo animals, there is no proven industry-standard facility, and exhibit design ends up being based on anecdote, tradition, and presumed needs of animals based on its natural history in the wild.

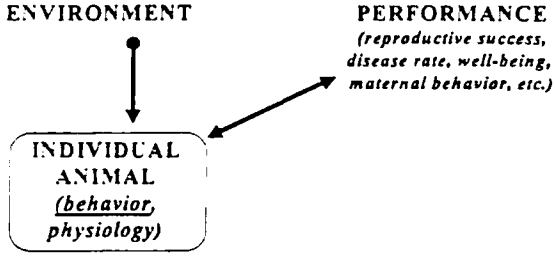
Black rhino facilities vary considerably between zoos. However, the exact impact of facility design on black rhinoceros reproduction is very difficult to ascertain. If one zoo in Texas, for example, does very well breeding black rhinos and another with about the same climate does not, is it because of the space they have, the number of public visitors, the age of the rhinos they have, the density of rhinos, or the character of the individual rhinos? Furthermore, more often than not the failure to breed black rhinos will be attributed to how frequently animals are introduced to each other. While this is doubtlessly a concern for black rhinoceros because of their very aggressive courtship behavior, it is still likely that the facilities in which they are housed influences how humans manage introductions. Facility design may exacerbate, or minimize, the chances of injury during introduction.

Sometimes researchers attempt to compare zoos that successfully breed a species with those that are less or non-successful, and to ferret out statistically the possible advantages of the successful institutions. However, this may not tell us much because most environmental variables are too complexly correlated to single out the most important factor for the difference in breeding success. For example, enclosure size may be related to the maximum distance the animal can be from the public, the type of substrate, the number of trees, how and how often the enclosure is cleaned, and sometimes even with they type of construction of barriers and containment. We would need a VERY large sample size of zoos to statistically separate out the effects on black rhino performance of each and all of the possible things that vary between zoos. This may be impossible to do. For black rhinoceros there are only around 30 zoos in the US with paired animals.

Incorporating behavior into multi-institutional analyses of zoo facilities and performance can help this problem. An institution's performance with a species is affected by facilities and husbandry **via the effects the environment has on the individual animal**. If we want to determine which aspects of the environment are most important for breeding animals or for health or mortality, we *first* need

to do look at the features of zoo rhino facilities that influence the *behavior* of animals living in them.

For the past 6 years a team of behavioral researchers from 12 zoos has been conducting the Methods of Behavioral Assessment Project with the goal of developing simple methods of comparing



the behavior of animals across zoos. The general methods we used to analyze black rhinoceros facilities were as follows: We sent behavior questionnaires to keepers at 19 US zoos for 29.31 black rhino in total. An MBA researcher then visited each zoo to conduct facilities assessments, interview staff about animal management, collect medical and breeding records, and conduct behavior tests with each rhino in the study. The Black Rhinoceros Studbook was used to calculate individual and institutional reproductive success, number of females and reproductive rate, and institutional mortality. Data analysis consisted of two steps: 1) developing behavior profiles for each rhino based on keeper assessments of their behavior and 2) statistical comparison of behavior profiles to environmental variables and to reproductive success.

BEHAVIOR PROFILE DEVELOPMENT

To develop behavior profiles of individual black rhinos we relied on keeper assessments of animal behavior and temperament. Keeper assessments of behavior are valuable and underutilized, for keepers are the people who, on a daily basis, observe how an animal behaves and reacts under a variety of conditions and situations. First of all we asked keepers at each zoo to fill in behavior questionnaires for the animals in the study at their zoo. The questions had quantitative answers; keepers were mostly asked to rate on a 1-5 scale how frequently or intensively an animal performs certain behaviors or demonstrates certain attributes.

Keepers rated animals on the frequency or strength of up to 52 behavior elements. Generally we asked at least 2 keepers at each zoo to independently rate the same animals so we could assess the degree of agreement/disagreement between keepers for each of these 52 elements. By comparing the disagreement between keepers we were able to eliminate most of these variables and retain only the most reliably-rated 15 behavior elements for our behavior profile.

Next, correlations between these 15 elements are examined in order to cluster them into a smaller number of traits. We gave a name to each group of correlated behaviors and a score for each individual on each trait that was the sum of their ratings for each element in the group. So for black

rhinoceros, the final **Behavior Profile** for each individual consisted of scores on 6 traits: *dominant to conspecifics*, *fearful* (timid/shy, anxious, sleeps a lot), *olfactory behavior* (anogenital investigation, urinespraying, urine/feces investigation), *agitated behaviors* (stereotypy, charging/chasing and mouthing), *patrolling* and *friendly to keeper* (allows touching, approaches when called).

Next we validated these behavior profiles based on keeper ratings by comparing them to how the animal actually behaves during a standardized test of behavioral reactivity to a novel object – and a novel conspecific scent. We found significant correspondence between each trait in the Behavior Profile derived from keeper ratings and some aspect of the rhinos' behavior during these behavior tests.

RESULTS

Once we developed and validated these behavior profiles, we could compare them on a cross-institutional level with aspects of black rhinoceros environment and their performance in captivity. Following are the results we have found for black rhinos using behavior to identify aspects of captive environments that influence rhino reproduction and mortality. We analyzed males and females separately.

Enclosure Size

For **males** we found that individuals in larger enclosures were rated as more submissive to other rhinos than males in smaller enclosures, who were rated as more dominant, aggressive and assertive to other rhinos. This was **not the case for females** in the same enclosures.

We also found a strong positive correlation between a zoo's overall reproductive success with black rhino and the total area of its outdoor rhino enclosures. Zoos with large outdoor enclosures over the years have breed more black rhinoceros. From the graph of this relationship (see Carlstead et al, 1999b), a cut-off point for a minimum size of a breeding enclosure for black rhinoceros should be around 4000 sq, meters (43,000 sq. ft, or about one acre).

For males we also found that their dominance scores were negatively correlated with their individual breeding success - the more submissive the male the more offspring he had. So enclosure area does seem to be an important aspect of black rhino facilities – but it has most impact on males, not females.

So all together, the result that enclosure size affects a zoo's breeding record with black rhino is not surprising, but by looking at behavior we are able to propose a mechanism for this effect (that space restriction causes more aggressiveness/assertiveness in males and compromises breeding)

But we can also offer an explanation for exceptions to this rule; for example, that some successful males in small enclosures might by nature have a more submissive character. Husbandry considerations would be to place a more assertive, dominant male at a zoo with larger enclosures.

High, Concrete Enclosure Walls

For **female** black rhinos we found an entirely different environmental influence on breeding success. First of all we found an effect of walled enclosures on female black rhino behavior. The higher the percentage of high concrete walls around a rhino enclosure the higher the females' scores on the group of aroused/agitated behaviors – chasing/charging, stereotypy and mouthing.

We also found that the scores of females for these behaviors were negatively correlated with their individual breeding success. So females in walled enclosures perform more of a type of behavior that is directly negatively linked to their breeding success.

There are some indications in the data that the effect of walls on females is auditory or olfactory, and it points to an area of rhino biology of which we know little. Walls could be amplifying ambient noise, or it could be providing a visual barrier to the source of infrasonic vocalizations from other rhinos. Infrasound would pass through the walls. They could also provide increased substrate for urine-spraying and marking by the various individuals that inhabit an enclosure at different times. The agitated behavior in walled enclosures could also be an indicator of some type of stress. In any case, basic research on the role of auditory and olfactory cues in black rhino communication and reproduction need to be investigated.

Number Of Females At A Zoo

We didn't find a direct link between the percentage of walls and an institution's breeding success with rhinos. This just illustrates how other factors contribute to reproductive success, and how other things might offset the effects of walls. For example, one thing we did find for females is that the rate at which an institution breeds black rhinos is significantly affected by the number of females they have in one area of the zoo. Zoos with more than one female, either with or without a male for each female, had a lower rate of reproduction and a later age of first reproduction for the females. However, with our methodology we couldn't pinpoint behavioral differences between females at zoos with only one female verses those at multi-female zoos. Measuring comprehensive behavioral traits as we did does have limitations; the behavioral differences probably exist but may be very subtle.

Zoo Visitors

We also found some interesting and perhaps disturbing results for black rhino mortality. We measured the degree (%) that black rhino enclosures are surrounded by the public. For male black rhinos their score on fear – timid/shy/anxious/sleeps a lot – was positively correlated with the degree of public access around their enclosure. So for males again, it appears that people having access to a large portion of the perimeter of their enclosure behaviorally affect them in a negative way.

We also found a significant positive correlation between the mortality rate for black rhino at a zoo and the degree to which the public surrounds its enclosures. We feel this strongly suggests that too much exposure to the public around enclosure perimeters is a stressor for black rhinoceros – this should be investigated with cross-institutional assessments of stress hormone levels.

CONCLUSIONS

These results suggest that male and female black rhinos are sensitive to different aspects of their captive environments. Males are sensitive to the amount of space they have and to perceived limitations on that space by people. This makes sense when you think of black rhinos in the wild – the males have larger home ranges and defend larger territories than females.

Females on the other hand seem to be sensitive to the social environment – the number of other females around them, and to sensory restrictions caused by walls. This also makes sense because wild females have overlapping home ranges with males and other females, and are therefore thought to be more tolerant of other rhinos. They would presumably rely on auditory and olfactory communication to space themselves or identify themselves to each other, perhaps more than males would.

Altogether, our results for black rhinoceros are a good basis for concluding how future black rhino exhibits should be designed: large in area (one acre or more), minimum high concrete walls, and minimum exposure to the public along the perimeter. Whether a zoo should have one or two pairs of black rhino might depend on how ideal the enclosures are for each pair; certainly the possible reproduction-suppressing effects of females on each other should be investigated more closely.

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A KEEPER'S GUIDE TO THE INTRODUCTION AND MANAGEMENT OF THE INDIAN, BLACK, AND WHITE RHINOCEROS

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Before introducing any rhinoceros to their new enclosure, both the barn stalls and the enclosure should be evaluated for animal health and environmental hazards. A number of facilities holding rhinoceros have noted the following items as possible causes of injury:

A. Areas in the barn or enclosure where animals can get their heads or feet through and become trapped.
B. Sharp objects or protrusions on the walls or floor, that can damage foot pads and cause medical problems. This includes cement with an overly rough finish.
C. Tree protection in which animals can become entangled.
D. Moats that are too steep, or are designed with a sharp drop-off.
E. Ponds or pools that are too deep, or have sides that are too steep.

All animal introductions should be preceded by investigating the behavior of the animal(s) at their previous location. Also, note the social structure of the group in which the animal was previously housed.

When the new animal has cleared quarantine, and all results from medical testing have been analyzed, the animal should be given visual access to animals currently held at the facility. This, with the addition of tactile access through the bars or exhibit barrier, can take from one week to one month, depending on the aggressive nature of either of the animals to be introduced. Recording the behavior seen during this period will benefit your staff greatly as they proceed with the introduction of the animals. Additionally, allowing each animal access to the other's dung before introduction can often help with acclimating them to each other's scent.

Introduction of the Greater One-horned Indian Rhinoceros (*Rhinoceros unicornis*)

Communications from facilities holding Indian rhinoceros show that most young male Indians tend to be very aggressive during introductions. They become highly excited when first encountering the female, at which point she takes a defensive posture or starts to vocalize. As a result, the male immediately becomes aggressive towards her. As they mature, and introductions or copulations become more routine, the intensity of the behavior lessens.

Unlike the black or the white rhinoceros, the Indian rhinoceros rarely uses its horn during an intense altercation. The incisors are their weapons of choice for true aggressive confrontations. During less intense pushing or ritual skirmishes the horn is used. Managers and keepers should note that, as mentioned previously, rhinoceros introductions can be somewhat aggressive, and it is important not to separate the animals at the first sign of a confrontation. As a species, rhinos are extremely sturdy, and much more capable of enduring physical stress and trauma than one would think.

The Indian rhinoceros breeds well in both pair or group situations. They are easily kept in single or multi-species exhibits, and are kept in almost every climate conceivable. This species is a browser and should be fed copious amounts of different browse species.

Keepers should never underestimate the strength, speed, and agility of rhinoceros. Indian rhinoceros are more territorial than the African rhinoceros, which should not be forgotten when introducing them to new enclosures or enclosure mates.

Introducing the male to the new enclosure first allows different options. After the male is aware of all aspects of the new area, he can be moved back into the holding area, providing the opportunity to give the female access to her new enclosure. Once she has explored the area and is comfortable in her new surroundings, the introduction of the male can commence. It is better if the female is more familiar with the enclosure, so that she can use it to her advantage during the introduction process. Also, if she has been given more time out in the larger yard, she will have more stamina, allowing her to elude an excessively aggressive male. Some animal managers attempt introductions only when the female is in estrus. This is an excepted practice within the zoo industry. However, good animal management, coupled with knowledge of the animals' behavior and their enclosure, has allowed rhinos to be introduced at any time with positive results.

Estrus behavior:

Recognizing estrus behavior is critical to the success of a breeding program, particularly when the breeding male is housed separately from the females.

Following are behavioral characteristics to look for in the male when a female is in estrus:

1. Walking around with his nose to the ground, following a scent trail, occasionally lifting his head to catch a scent in the air.
1. Testing the female's urine (flehmen).
2. Restless or agitated behavior.
3. Dribbling urine.
4. Vocalizations in a whistle/snort pattern.
5. Being chased by the female/chasing the female.
6. Semi-erection.
7. Chin resting.
8. Mounting the female.

Behavioral characteristics to look for in the female:

1. Vocalizing in a whistle/snort pattern.
2. Wet rear legs, due to urine dribbling.
3. Squirting urine in short periodic blasts.
4. Agitation with increased activity level while male is present.
5. Decreased appetite.
6. Pink, slightly dilated vulva.
7. Observation of pre-mating bond.

8. Female allowing male to chin rest.
9. Female allowing male to mount.

Through years of observation, two types of behavioral estrus have become apparent: *full estrus* and *partial estrus*. Females have been impregnated while exhibiting each of these behaviors. A third category has also been included, *hidden* or *unobserved estrus*, in which no changes in behavior have been observed but the male Indian rhino has been able to impregnate the female. The female may appear to cycle during the first few months of her pregnancy, and may even allow the male to mount her.

Full Estrus: The female has reached full estrus when she becomes active and agitated, starts vocalizing with varied snorts and whistles, and spray-squirts urine. Typically, the female will exhibit one or all of these behaviors in a mild form, gradually escalating to the "height" of her estrus when she actively pursues the male, abandoning her calf if she has one, vocalizing several times a minute, and spraying or squirting urine every few minutes. Duration of the "height" generally lasts from two to six hours, although she may be receptive for up to 24 hours. Occasionally, the female will abruptly reach full estrus without the typical build-up of other behaviors.

The cow can exhibit estrus behaviors up to five days before the peak. The behaviors occurring in advance of peak estrus may only last several hours, then stop suddenly. On one occasion, a female had been bred five days before her peak and then again during her peak.

Partial Estrus: As in full estrus, the female may display one or more of the previously mentioned behaviors, but in a mild form, lacking the intensity and build-up of full estrus. She will not actively pursue the male, and may rebuke his advances, especially if she has a calf. Occasionally, successful copulations occur. It is often difficult to discern partial estrus without the presence of an adult male to exhibit breeding behaviors in the female's presence.

Hidden or Unobserved Estrus: In full or partial estrus, copulations have been observed. In hidden or unobserved estrus, only the evidence of copulation is seen. This evidence includes scuff marks or semen stains on the female's back, vaginal discharge, and very lethargic behavior characteristic after copulation. In these cases, it is possible that estrus behavior, a mounting, and/or copulation has occurred, though nothing has been observed.

General Information:

Estrus cycle	27 to 42 days
Peak estrus	12 to 24 hours
Gestation	470 to 531 days
Calf interval in the wild	3 to 5 years
Calf interval in captivity	2 to 3 years
Age at first birth	5 years, 10 months
Number of captive births from 1824 to 1994	79.55.3 = 137
Number of recorded stillbirths	12.13.3 = 28
Longevity record	40 years, 4 months

Breeding Introductions:

Due to limitations of available space and facilities, breeding males are often separated from the females or from the rest of the rhino herd. This usually requires the transfer of rhinos from the exhibit to holding areas, and vice versa, to ensure successful breeding with minimal risk to individual rhinos.

As previously stated, the keeper should watch young females for signs of estrus at approximately two-and-a-half to three years of age. Typically, if a cow in estrus has a very young calf, the calf should be held in an off-exhibit area away from the introduction, although calves as young as four months have been left with cows during introductions. Any rhinos that have been observed to be incompatible with the breeding male should be taken off-exhibit.

Before an introduction, the staff should discuss their procedures for separating the rhinos, should the animals become too aggressive.

When introducing animals for breeding purposes, remember that females are in estrus for 12 to 24 hours. Wait until the female is in a heightened state of arousal before introducing the male to her. This will decrease the aggression and running seen during courtship. During the first encounter, the male will act uninterested and the female will pursue him, nuzzling his abdomen and genital area, and presenting to him. During this time, she will also exhibit the typical estrus behaviors of urine spraying and frequent whistle/snort vocalizations. As the male becomes more interested, he may start to follow her and perform flehmen. He may also spray and/or dribble urine. They may then take turns pursuing each other throughout the exhibit, and may even seem to lose interest in each other for several hours before meeting up again. If the introduction becomes too aggressive, the staff may opt to separate them for fifteen to twenty minutes before reintroducing them. This often helps break the male's aggressive advances towards the female.

Just before copulation, the male will lay his head on the female's back in preparation for mounting her. She may walk away several times before allowing him to mount. If he doesn't already have an erection, he will develop one quickly after mounting. The male is usually able to penetrate the female after only a few attempts. Copulation usually lasts for about 30 minutes to one hour, although pregnancies have resulted from copulations as short as fourteen minutes and as long as 95 minutes. Upon withdrawal, the pair usually go their separate ways. Both the male and the female will generally show signs of fatigue for the next 24 to 48 hours. At this point, the female's estrus behavior customarily stops, though there have been occasions when several copulations have been observed. Recreational breeding has been seen in this species, even after pregnancy has been confirmed.

Labor and Birth:

Udder development generally occurs several weeks prior to parturition. Development of the udder is usually not as dramatic in females giving birth for the first time. As the cow gets closer to calving, the udder will fill and the teats will elongate and swell slightly. Up to 48 hours before birth, the udder will become tight, pushing the teats apart toward the sides of the udder. Milk will start staining the insides of her rear legs; walking may cause the teats to rub

against her legs, causing more discharge. Milk may start flowing freely within 24 hours of giving birth. A mucous plug can be found 12 to 24 hours before the female gives birth.

Just before parturition, the cow commonly loses her appetite, acts restless and agitated, and may vocalize frequently. She may press her head against a wall, stretch, lie down and get back up frequently. Labor may last from 12 minutes to several hours. Posterior as well as anterior presentations have been observed; posterior presentations have not posed difficulties for animals during the birth process. Keepers should not become overly anxious when posterior presentations are witnessed unless the birth has not progressed for a period of time.

When the calf is born, the cow will nuzzle and push the calf to encourage it to rise. The calf can stand after 30 to 45 minutes, and will attempt to nurse right away. The first successful nursing should occur within the first two to three hours. The calf will rapidly gain proficiency in finding the teat and suckling. As the calf grows stronger, nursing will increase in duration but lessen in frequency.

It is common practice in some institutions to separate the calf from its dam within 24 hours of birth for a quick physical check and weight measurement. The time of separation should be kept to a minimum to reduce stress on the mother. Birth weights have ranged from 89 to 200 pounds. A constant watch should be kept for the first 24 hours to monitor the calf's progress, and to ensure sufficient nursing bouts are occurring (see monitoring sheet).

A room can be set up next to the birthing room that allows the calf access, but not the dam. The calf's natural curiosity will lead it into this room, giving the keeper the opportunity to make the calf more tractable by rubbing the calf's belly and the inside of its rear legs. Calves seem to vary greatly in tractability; some seem to relish attention, while others accept the keeper's attention more slowly, while still others never become tractable. Future weight measurements and health checks are dependent upon the tractability and health of the calf. If the calf is very tractable, weights can be taken frequently. If the calf is not tractable and appears healthy, weight measurements need not be taken, which will help avoid undue stress on both the calf and the dam.

Release of Dam and Calf Into the Exhibit:

It can be difficult to decide when to release the rhino calf into the exhibit with the rest of the rhino herd. The calf is vulnerable at this time to a variety of factors, including aggression from other rhinos, or perhaps the calf's curiosity leading it to areas in the exhibit it is not able to negotiate. The main factors to be considered are the age and vitality of the calf, weather, and exhibit conditions. Just before releasing the calf into the enclosure, the decision should be made as to which rhinos will be left on exhibit with the calf and its dam, depending on the dam's relationships with the other rhinos.

As competence with rhino management has increased, calves are being introduced to exhibit elements or other rhinos at a much younger age. At the San Diego Wild Animal Park, calves were initially held off-exhibit for long periods of time; as an example, one of the first calves produced was held off-exhibit for one year and eight months. Currently, calves are introduced at two months of age.

Medical Problems:

Following are common medical problems encountered with Indian rhinoceros:

1. Cracked toenails: For a variety of reasons, Indian rhinos have a tendency to get cracked toenails. Usually a daily application of Koppertox for a period ranging from two to six weeks is sufficient to improve this condition. Occasionally, the cracks may deepen and widen, and an abscess may form. When this occurs, it may be necessary to soak the foot daily in a Betadine solution until improved.

2. Cuts, scrapes, and soreness: During introductions or confrontations, Indian rhinos can inflict fatal injuries. Fortunately, the injuries inflicted are usually not severe. They typically consist of minor cuts and scrapes in the hindquarters, on the flanks, and on the head. Left alone these cuts have a tendency to fester and can become insect ridden; the rhinos can be treated daily by spraying a Nitrofurazone solution mixed with fly spray on the affected areas. After an aggressive encounter, often including extensive running, the rhinos may be sore when walking. Depending on the severity of the encounter, they may be given Banamine to lessen the severity of the soreness.

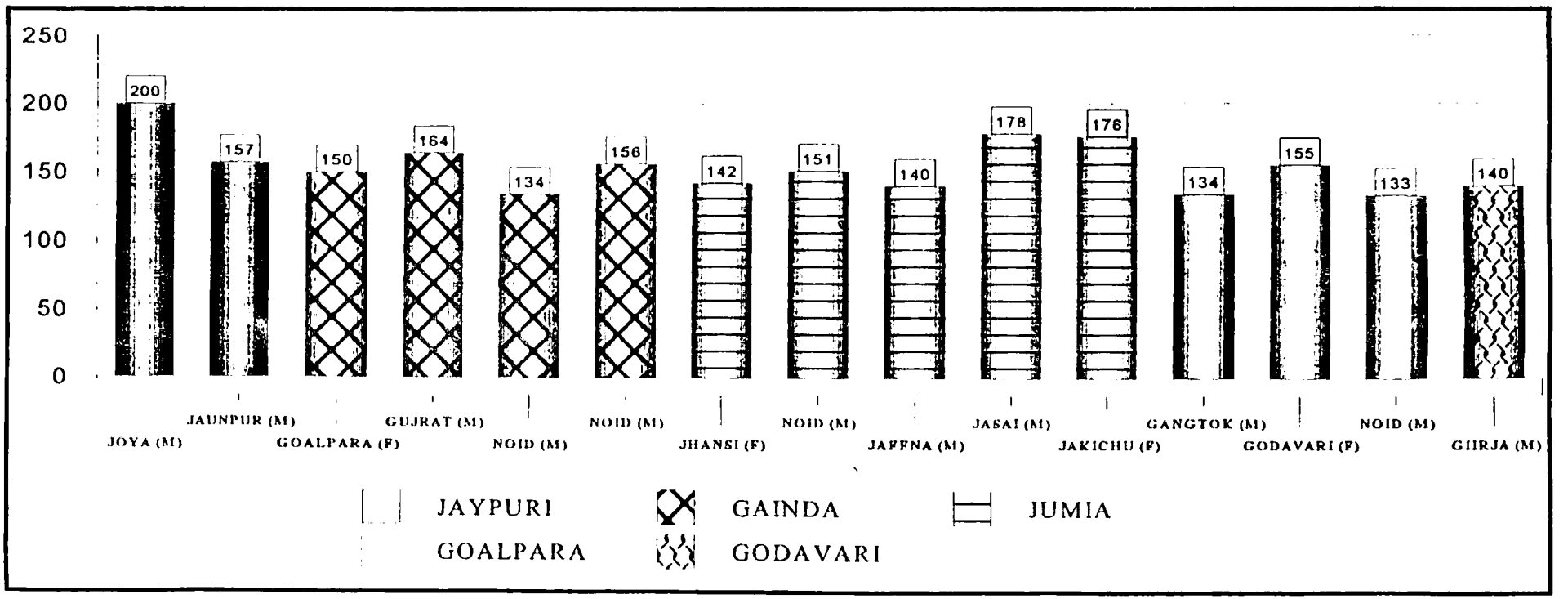
INDIAN RHINO BIRTH WEIGHTS

INDIVIDUAL DAM AVERAGES

(All weights listed in pounds; only weights from full term pregnancies have been included)

JAYPURI	178.5	n=2	JUMIA	157.4	n=5
GODAVARI	140.0	n=1	GAINDA	151.0	n=4
GOALPARA	140.7	n=3			

Group Average = 154 n=15
Range = 133-200



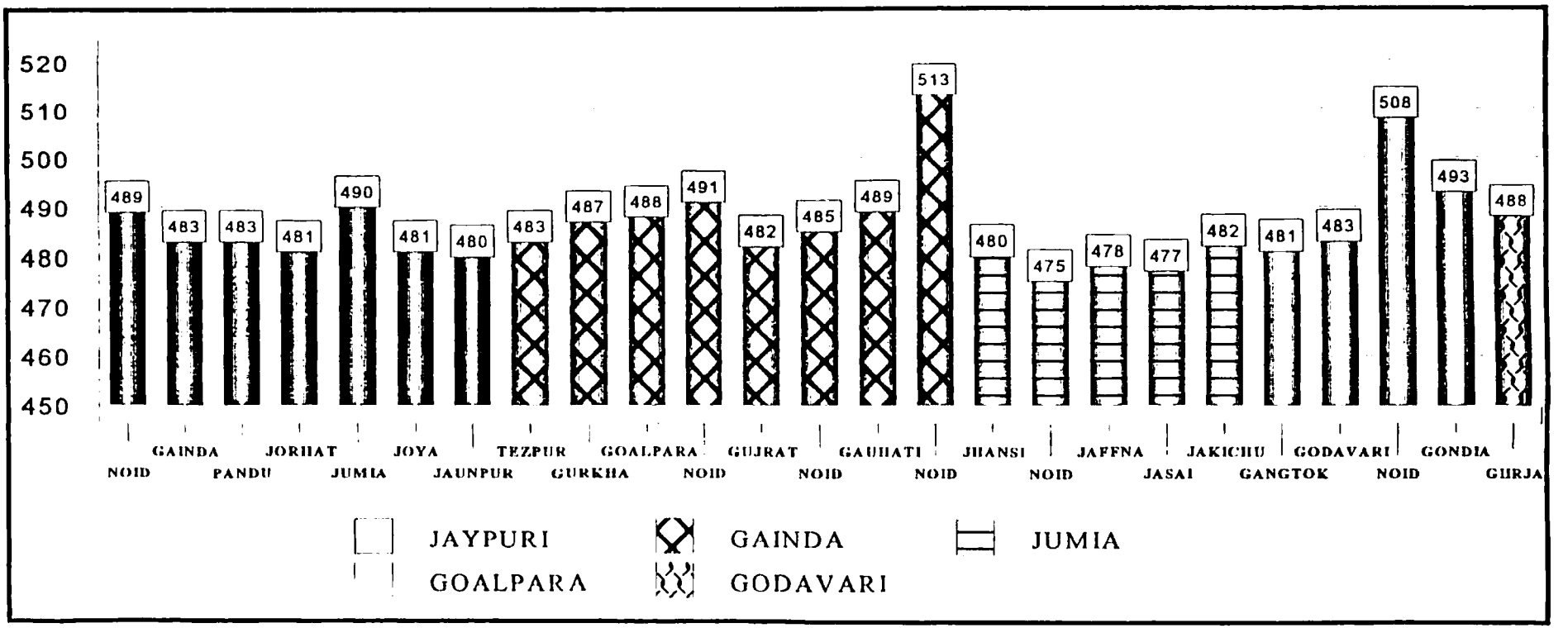
INDIAN RHINO GESTATION PERIODS

INDIVIDUAL DAM AVERAGES

(Gestation periods listed are full term pregnancies. Premature births not included)

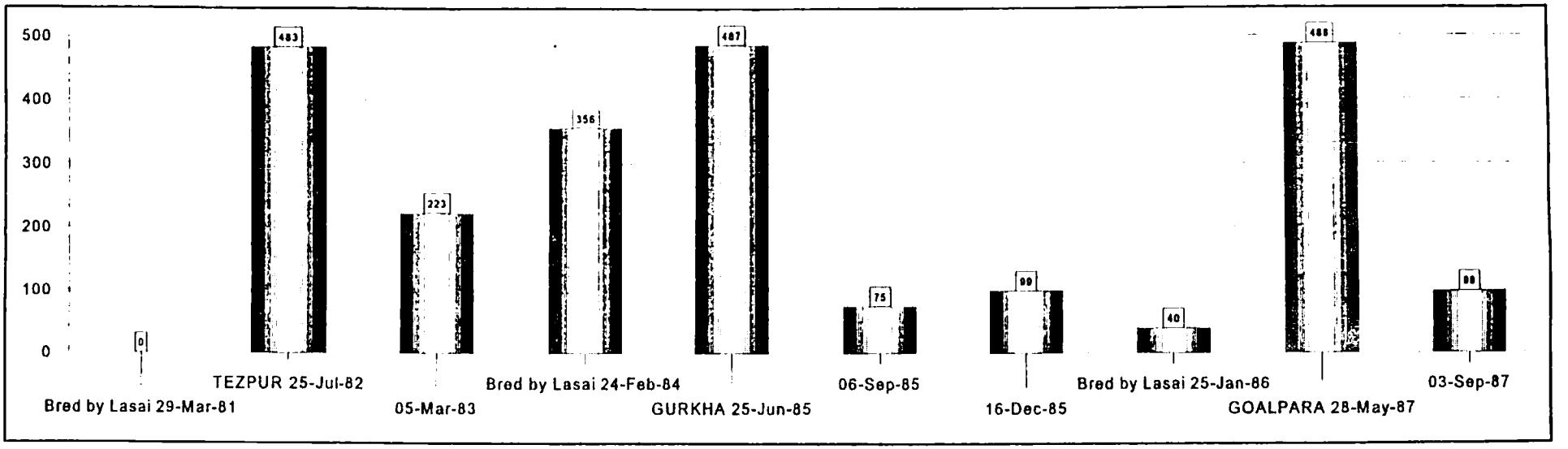
JAYPURI483.9n=7JUMIA478.4n=5
GODAVARI488.0n=1GAINDA489.8n=8
GOALPARA491.3n=4

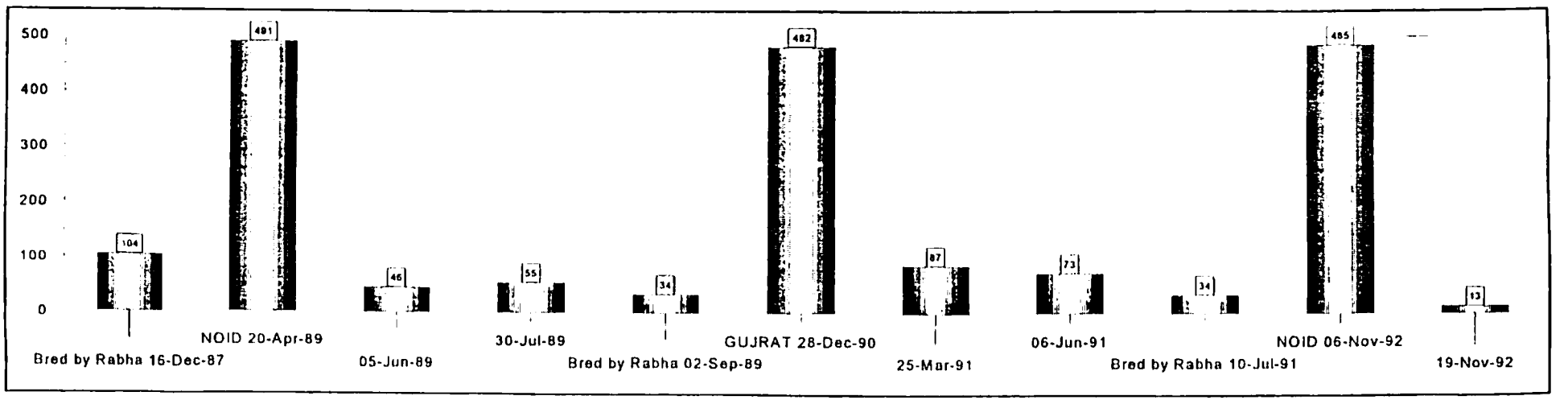
Group Average = 486.2



INDIAN RHINO - GAINDA

Number of days between behavioral cycles29 March 1981 - 19 November 1992

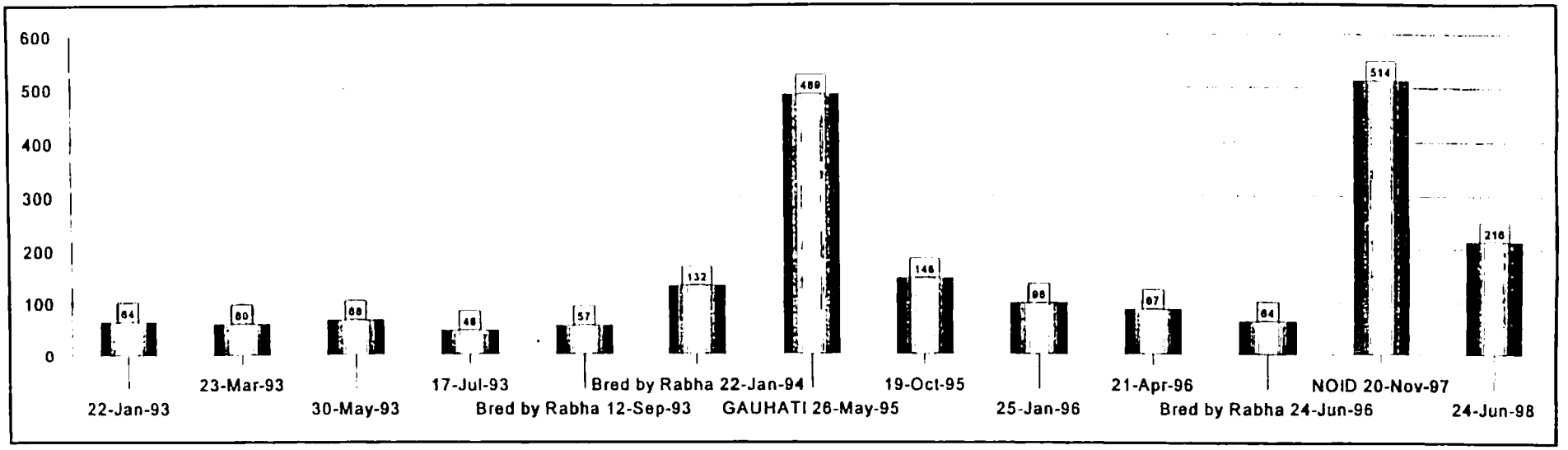




INDIAN RHINO - GAINDA

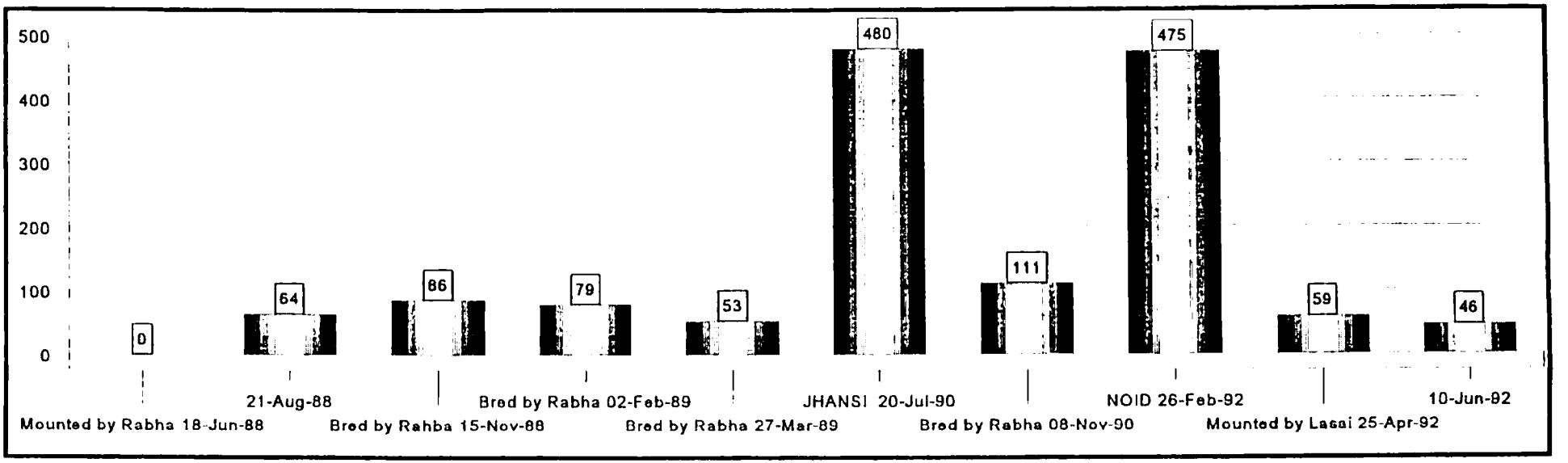
Number of days between behavioral cycles

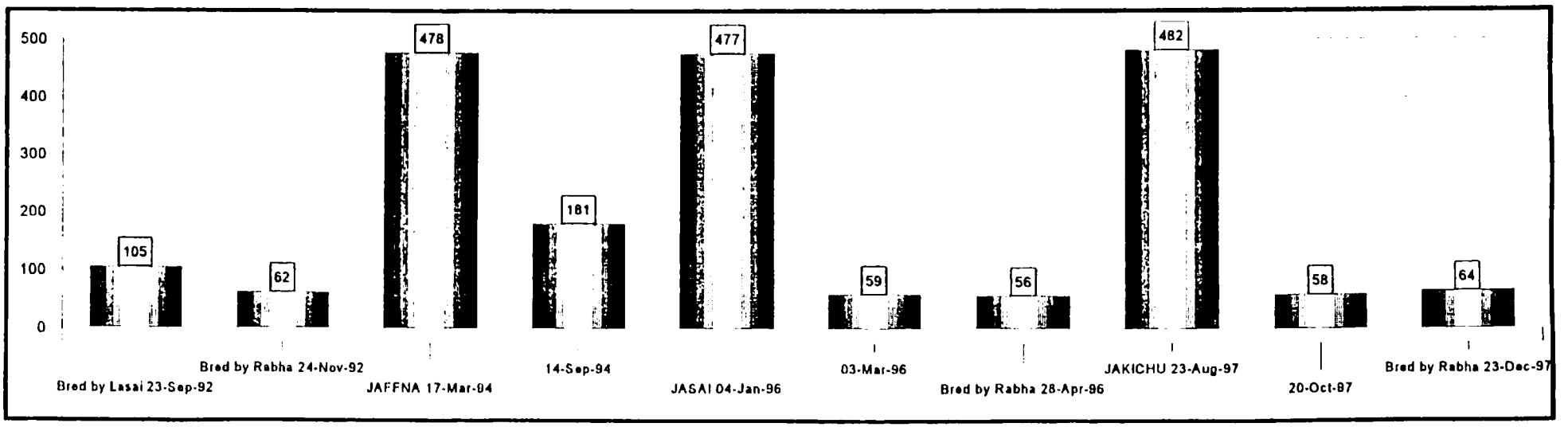
22 January 1993 - 24 June 1998



INDIAN RHINO - JUMIA

Number of days between behavioral cycles





Introduction of the Black Rhinoceros (*Diceros bicornis*)

Unlike the white rhinoceros, the black rhinoceros is not gregarious. Even so, black rhinoceros introductions are not usually as aggressive or problematic as Indian rhinoceros introductions; most of the aggression occurs between breeding males and females.

Almost all of the institutions holding black rhinoceros house them in pair situations, although they have also been exhibited in trios (1.2). If this is being considered, animal managers should watch the behavior of the dominant female closely, as female suppression has been recorded in select cases. Unlike other taxa of rhinoceros, black rhinoceros have been semi-problematic in mixed species exhibits. Both sexes have attacked and killed neonate and adult ungulates.

Of all of the rhino taxa reproduced in captivity, the black rhinoceros is one of the most problematic. Poor reproduction rates, survivability and continual health problems have plagued this species, regardless of different management techniques used by animal managers. It is my theory that with this particular species, visual barriers in the enclosure and copious quantities of browse play a large part in eliminating some of the problems seen. This species is a browser, and should be fed large amounts of browse on a daily basis.

Ritual Behavior:

Following is a list of ritual behaviors seen in this species:

1. Dung pile investigation
2. Ritual defecation
3. Ritual urination
4. Foot dragging
5. Horn scraping
6. Scent marking
7. Threat posturing
8. Face-to-face staring
9. Open-mouth threat
10. Fencing or sparring
11. Horn strikes
12. Mock charge

Estrus Behavior:

Following are behavioral characteristics to look for in the male when a female is in estrus:

1. Walking around with his nose to the ground, following a scent trail.
2. Testing the female's urine (flehmen).
3. Observation of a pre-mating bond (can be seen up to five days prior to mating).
4. Restless or agitated behavior.
5. Horn swiping.
6. Proximity to female.
7. Semi or full erection.

8. Chin resting.
9. Mounting the female.

Behavioral characteristics to look for in the female:

1. Urine squirting.
2. Agitation with increased activity level while male is present, or searching for the male.
3. Vocalizations have been observed, however not witnessed in all females.
4. Wet rear legs due to dribbling urine.
5. Decreased appetite.
6. Pink, slightly dilated vulva.
7. Observation of pre-mating bond.
8. Female allowing male to chin rest or mount.

General Information:

Estrus cycle	21 to 31 days
Peak estrus	24 to 48 hours
Gestation	438 to 552 days
Calf interval in the wild	2.5 to 3.5 years
Calf interval in captivity	31 months to 3 years
Age at first birth	5 years, 8 months
Number of captive births from 1941 to 1994	145.134.13 = 292
Number of recorded stillbirths	16.6.11 = 33
Longevity record	44 years, 9 months

Breeding Introductions:

It bears repeating that the staff should inspect the holding areas and the enclosure for any hazards. Investigating the behavior of the animal in its previous situation will help the staff make better informed decisions during the introduction process. They should also discuss procedures for separating the animals to be introduced in case the introduction becomes too violent. All introductions should be preceded by the animals having visual and tactile access to one another. After the new animal has been given the opportunity to explore and become comfortable in the new facility, introducing the animals can commence. Many options are available, and all should be discussed by the managers and keepers to make sure that all of the current information about the enclosure and the animals is utilized. In this species, animals have been introduced at all different times, with excellent results.

When introducing animals during estrus, careful evaluation of the female's behavior is key. The female has reached full or peak estrus when most of the previously mentioned behaviors have been observed. The male will start pursuing the female relentlessly, attempting to nuzzle her vaginal area. When the female no longer rebuffs the male, he will attempt to chin rest. When she routinely allows him to do so, he will mount. Copulation will follow with intromission lasting from ten minutes to one hour. Mountings can be observed two to ten times during a single estrus, which can last for 24 to 48 hours.

As stated in the section discussing Indian rhino introductions, the amount of aggression during breeding introductions can be decreased by allowing the female to reach peak estrus before releasing the male into the yard or enclosure.

Labor and Birth:

The udder will begin to develop one to two weeks prior to parturition. As the udder fills out, the teats will become engorged, no longer appearing flaccid, and will start to separate, pointing outwards. The cow's vulva will become distended, dilated, and pink in color. A mucous plug can sometimes be found up to 24 hours prior to birth.

The birthing area should be bedded to keep the calf warm and dry when born. If the barn stall has a concrete floor, sand or decomposed granite should be spread to give the newborn a surface that is not too slippery when attempting to stand. The surrounding area should be kept quiet, without distractions for the female if possible. Just prior to birth, the female will lose her appetite and become quite agitated. The birth process can last from 25 minutes to one hour.

If a calf does not attempt to rise shortly after being born, the female will attempt to help it to its feet. Calves will usually attempt to stand within 20 to 30 minutes, sometimes taking up to an hour. Nursing has been observed within 30 minutes, and in other instances has not been seen for up to 24 hours. Nursing bouts will last from two to six minutes in length. Frequency is sporadically recorded at 13 bouts in six hours to 26 bouts in the first 19 hours. Calves will nurse for a period of one to one-and-a-half years, or until the female gives birth to her next calf. She will normally drive her older offspring away one to two weeks prior to parturition.

Weights for black rhinoceros calves vary from 65 to 137 pounds at birth, averaging a weight gain of 50 to 80 pounds per month. Calves will start to pick up solids as early as two to three weeks of age. Unlike the white rhinoceros, the black rhinoceros calf follows the mother when moving about.

Release of Dam and Calf Into the Exhibit:

When introducing the cow and calf into the enclosure for the first time, several items should be considered: The vitality of the calf; pools, ponds or moats; exhibit hazards where calves can become trapped; aggression from exhibit mates; adequate shade for the newborn calf (very young calves can become sunburned); and the mother-calf bond.

Medical Problems:

Following are some of the common medical problems encountered with black rhinoceros:

1. Ulcerative dermatitis: This is probably due to the lack of mud wallows, or dry conditions.
2. Parasitic skin ulcers.
3. Gastrointestinal torsion or impaction.
4. Creosote toxicity: Creosote poles must never be used in or around rhinoceros enclosures.

5. Hemolytic Anemia.
6. Toenail Cracks: Soak in a foot bath and apply Koppertox to cracked areas.
7. Constipation: Administer oral laxatives or mineral oil.
8. Diarrhea: Administer Tribrissen paste
9. Tuberculosis.

Introduction of the White Rhinoceros (*Ceratotherium simum*)

As stated with the other taxa of rhinoceros, all introductions should be preceded by evaluating the enclosures and holding areas for environmental hazards. Separation options should also be discussed in case animal aggression becomes too intense or animal damage is observed. A fire hose or fire extinguisher staged in several areas outside the enclosure will help to break up an altercation that has escalated to the point where separation is being considered. In most enclosure designs, a round-robin situation works well for animal introductions, as the animals always have the opportunity to get away from one another without becoming trapped. Sufficient time should be allocated for the new animal to become familiar with its new surroundings. Also, visual and tactile access should be given to its new enclosure mates to facilitate an easier introduction.

The white rhinoceros is the most gregarious of all taxa of rhinoceros. Crashes of up to twelve or more animals have been described in the wild. In captivity, large numbers have been kept together with little or no problems observed. In larger areas, young males can be kept in the herd up to 18 to 20 months before intense aggression by the adult male occurs. Young females are seldom aggressed against, unless a female is driving her young calf away before giving birth to her next offspring. This is usually seen two weeks prior to parturition.

As females mature, they often form pair bonds or alliances with other females that do not have calves at their side. Allowing a new female to bond with females currently at your facility may give her allies during the introduction of the male. Successful introductions usually occur when the female is able to defend her position in the enclosure, or to utilize alliances she has formed with the other females to help defend against the male. Females that remain solitary will often need more room to escape aggressive advances by the male, or the male's advances during courtship. As stated previously, rhinos are quite aggressive during introductions of enclosure mates or in breeding situations, and they should not be separated at the first sign of a confrontation resulting in blood being observed by staff. This species is extremely tolerant to physical contact, stress, and trauma. Some institutions housing multiple males observe aggressive encounters on a daily basis. Horn clashing, vocalizing and intense pushing or mock charging may be tolerated without adverse problems noted. Trimming or removal of the horn can in most instances reduce or eliminate aggression in both males and females. Introducing a female in estrus may alleviate some of the male's aggressive tendencies, as he may become more interested in mating than chasing her.

Ritual Behavior:

Following is a list of ritual behaviors seen in this species:

1. Dung pile investigation

2. Urine investigation
3. Ritual defecation
4. Ritual urination or spraying
5. Foot dragging
6. Horn scraping
7. Scent trail investigation
8. Scent marking
9. Threat posturing
10. Mock charging

Estrus Behavior:

Following are behavioral characteristics to look for in the male when a female is in estrus:

1. Walking around with his nose to the ground, following a scent trail
2. One to six days prior to estrus the male will attempt to be in closer proximity to the female than normal
3. The male will be seen pressing the female or the female coalition to cull out the estrus female
4. Urine spraying increases
5. Stiff-legged dragging of rear feet is observed after the male has tested urine or fecal matter
6. Vocalizing in a wheezing or hiccup manner
7. Increased flehmen behavior
8. Horn swiping
9. Observed with semi- or full erection
10. Nudging the female's hind quarters
11. Chin resting
12. Attempts to mount
13. Mounting and copulation

Behavioral characteristics to look for in the female:

1. In the 24 hours of her estrus, the female is much more tolerant of the male's presence, and allows him in close proximity, exhibiting less aggression towards him
2. Periodically squirts urine in short bursts
3. Urine staining down rear legs
4. Allows chin resting
5. Decreased appetite
6. Can be more irritable
7. Allows mounting and copulation

General Information:

Estrus cycle	27 to 44 days
Peak estrus	24 to 48 hours
Gestation	485 to 555 days
Calf interval in the wild	3 to 5 years

Calf interval in captivity	19 to 24 months (the norm is 3 years)
Age at first birth	4 years, 4 months
Number of captive births from 1967 to 1994	C.s.s. 253.217 = 479
	C.s.c. 1.3 = 4
Number of recorded stillbirths	19.13.3 = 35
Shortest birth intervals	409 days
Reproduction record	14 live calves in a captive situation
Longevity record	44 years, 9 months

Breeding Introductions:

When breeding males are housed separately, recognizing estrus behavior is paramount. Even the most observant keeper can miss a subtle estrus. Housing the male with the female at all times can ensure that every breeding opportunity is maximized.

Two different types of cycles can occur: "normal", occurring in approximately 30-day intervals, or "Extended Luteal Phase" or ELP cycles, ranging from 40 to 90-day intervals. Acyclic females exhibit none of the normal cycling signs, and are not bred by the male. Behavior of cycling females can range from the very obvious to the most subtle of signs. Females will be much more tolerant of the male's presence during a normal cycle. Females will often have wet staining between their thighs indicating possible previous mountings by the male. Scuff marks on her back and hips may be indications of chin resting and dismounts.

If the female has a young calf, it will remain with her during the courtship. If the female is part of a social pair or alliance, the other female may follow the couple or may not stay near at all.

The male will test urine and feces within the enclosure to help identify which females are approaching estrus. As he identifies a female in estrus, he begins to follow her, approaching her with a hiccuping vocalization. He may also spray urine as he approaches her. He then patiently follows, vocalizing, urine spraying and chin resting until the female allows him to mount. Copulation will follow shortly. However, several mountings may be required before the male can successfully copulate with the female. Copulation may last as long as a half-an-hour to an hour, taking place many times over a period of 24 hours, or more rarely, two days. After copulation, the female's thighs and legs may be stained with semen. Both the male and female may seem tired, resting or sleeping much of the following day. The female will usually search out her social partner or female alliance after breeding.

Females born in captivity appear to start cycling earlier than wild females. Wild-caught females usually cycle at about five to six years of age, where captive born females have cycled as early as 26 months. This early estrus has resulted in pregnancies and viable full-term offspring.

Labor and Birth:

After a 16- to 17-month gestation, the female gives birth to a single calf weighing approximately 125 to 165 pounds. A day or two before the birth, she isolates herself from her social partner or group. Females that have previously given birth may leak milk as the udder

becomes engorged. On occasion, females that were close to term have been observed to steal another cow's young calf, rejecting her own offspring when born.

Breathing may become labored as the birth approaches. Vocalizations are not unusual. She will usually lie on one side, resting between contractions. After 30 minutes to two hours, the calf is delivered. The normal presentation is front feet and nose first, however, numerous posterior presentations have been observed. The mother will nuzzle the calf clean and occasionally help it to stand by nudging it with her horn. The calf will attempt to nurse within 30 to 60 minutes. Nursing bouts of three to five minutes will occur every two to four hours. Females have been known to eat the placenta, which is believed to have nutritional value.

She may remain separated from the rest of the females for several weeks until she feels comfortable with the other animals being around her calf. Unlike the black rhinoceros, the white rhinoceros calf leads it's dam, who will guide her newborn with her horn, which she places on one side or the other, depending on the direction she wishes to go. She will nurse this calf until her next calf is born, driving the older calf away two to three weeks prior to parturition. The normal birth interval in this species is two and a half to three years.

Medical Problems:

Following are some of the common medical problems seen in white rhinoceros:

1. Toe nail cracks
2. Foot pad cuts or abscesses
3. Post copulatory wounds around face or vaginal area on the female
4. Weeping eyes due to dust, heat or dry environment
5. Skin problems due to lack of a wallow
6. Cancerous tumor in aged females
7. Constipation
8. Diarrhea

SAN DIEGO WILD ANIMAL PARK
SOUTHERN WHITE RHINOCEROS

GESTATION PERIODS/BIRTH INTERVALS

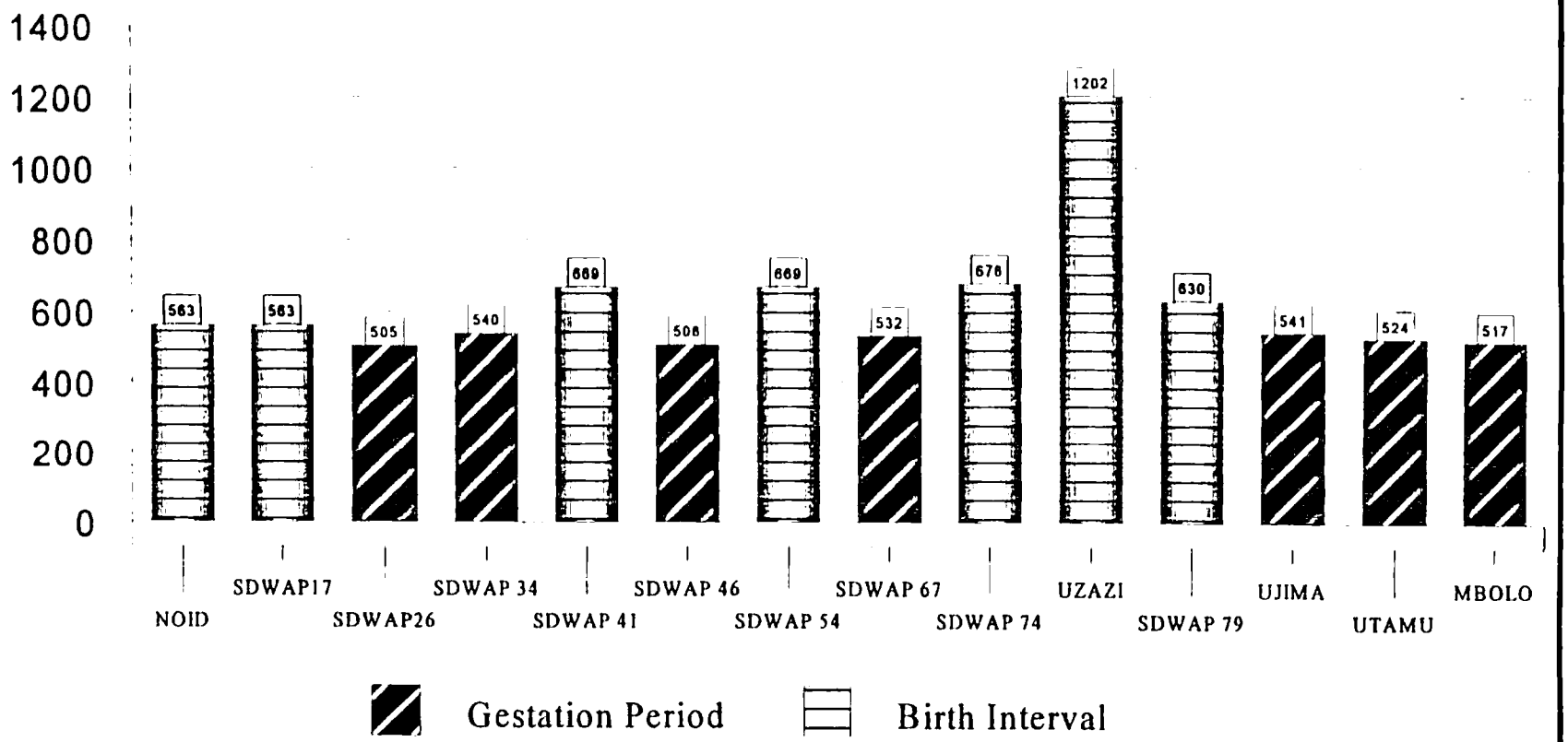
KOMAAS		MFOLOZI		NTHOMBI		UJIMA	
SDWAP 23	1186 days	NO ID	563 days	NO ID	522 days	*Uhuru*	***511 days***
SDWAP 29	***492 days***	SDWAP 17	563 days	***WAP 02***	***514 days***		
SDWAP 35	578 days	***SDWAP 26***	***505 days***	***SDWAP 31***	***497 days***		
SDWAP 39	517 days	***SDWAP 34***	***540 days***	SDWAP 38	730 days		
NO ID	608 days	SDWAP 41	669 days	***SDWAP 43***	***513 days***		
Karibu	***502 days***	***SDWAP 46***	***508 days***	***SDWAP 50***	***540 days***		
SDWAP 61	***496 days***	SDWAP 54	669 days	***SDWAP 57***	***532 days***		
SDWAP 68	***483 days***	***SDWAP 67***	***532 days***	SDWAP 65	578 days		
SDWAP 73	526 days	SDWAP 74	678 days	SDWAP 71	563 days		
Kusini	1408 days	Uzazi	1202 days				
Kisiwa	***539 days***	SDWAP 79	630 days				
Kutu	745 days	***Ujima***	***541 days***				
Kengele	***493 days***	***Utamu***	***524 days***				
		Mbolo	***517 days***				

Note: Gestation periods are indicated in ***bold***. If gestation period is unknown, birth interval is listed.

5-May-1999

SOUTHERN WHITE RHINO MFOLOZI - GESTATION PERIODS

(Gestation Period OR (if unknown) Birth Interval)



RHINO NEWBORN WATCH

Date: Animal: Observer: Pg

Nursing			Dam/Calf (D, C) Behavior						Maternal Behavior			Comments
Time	Strt	Stop	Eat	Drink	Urin	Def	Loco	Voc	Nudge	Lick	Smell	

RHINO LABOR/BIRTH WATCH

Date: Animal: Observer: Pg

	Female Labor					Birth				Comments
Time	Strch	Push	Contr	Mucous	Placen	Emer	Anterior/ Posterior Presentation	Drop	Stand	

Crate Training Rhinoceros

At some point in working with this species, animal managers will need to move an animal from one zoo to another. To make it as easy as possible on the animal, it should be acclimated to the shipping crate it will be transferred in. To accomplish this, you must first make sure that the crate is the correct size for the animal. One size does not fit all!

A general rule of thumb is to have a foot of space available in front of the animal, and a foot of space available behind the animal while the animal is in a standing position. There should be 10 inches of space to either side of the animal while lying down. With rhinoceros, having too much room can be extremely hazardous as it may allow the animal to turn around and become stuck. Always make sure the width of the front bars are such that the animal can not fit its muzzle between them. If this happens, the sinus cavities can be badly damaged, and if the animal's head goes through to the eyes, permanent eye damage can result.

Most crate doors are split, and open independently of one another. You should never open the bottom door first, as several rhinoceros have broken their horns off, catching them on the closed upper door. The same holds true for the rear door; if the lower door is opened with the top door closed, an agitated animal may slip its leg between the bars, striking its hocks on the bottom of the upper door.

The transfer crate should be set up two to three weeks prior to shipping. More time may be necessary if the animal is particularly high strung. Food should slowly be changed from its normal location into the crate. Eventually all of the animal's food should be given in the crate. As the animal becomes more relaxed, the keeper should start walking in front of and around the crate while the animal is inside. The most important, and, unfortunately, the most neglected aspect of crate training is closing the crate door while the animal is inside, several times prior to the day of shipment. (While I realize that this is traumatic, it is more so on the keeper than on the rhino, and must be done.) Animals can be shipped without fully acclimating them to the crate, and have been shipped without any crate training. However, the more time spent at the outset, the higher probability of good results during and after the transfer.

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White Rhino Introductions,
A Data Driven Approach

Written by:
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Animal Keepers at Disney's Animal Kingdom

I. Introduction:

Although many successful rhino introductions have taken place in captivity, these events can be stressful and dangerous (to the animals and their keepers). Safety and well-being is the primary concern in any animal procedure. Additionally, social organization and cohesiveness of an animal group can have long-term effects on the success of captive reproduction and management.

Historically, *ad lib.* observation and intuition have been used to guide the introduction process. Furthermore, documentation of rhino introductions is lacking (Fouraker and Wagener, 1996). This style of management can be considered "the art of animal management." As the profession develops, management techniques are being implemented that allow us to move toward a "science of animal management." However, moving from 'the art' to 'the science' requires a more disciplined approach (Read, 1995).

Animal introductions typically take place in several Phases: Phase 1: auditory, olfactory, and visual acclimation; Phase 2: limited tactile acclimation (also known as a 'howdy' set-up); and, Phase 3: the actual physical introduction. Even after a physical introduction, decisions are often required regarding night housing arrangements, daily herd management, and adding more animals to the group. Every animal is different, as is each facility. For these reasons, a data-driven management plan for guiding animal introductions is ideal to assist in safely making decisions.

At Disney's Animal Kingdom (DAK), we have been developing and testing a data-driven process to monitor and guide animal introductions (Burks, Maple, and Mellen, 1998). The introduction model was developed by Kyle Burks and, to date, has been used successfully to introduce a bachelor group of gorillas (*Gorilla gorilla gorilla*), a herd of female African elephants (*Loxodonta africanas*), and a troop of mandrill baboons (*Mandrillus spinx*). Most recently, Burks' model was successfully used to introduce a group of southern white rhinoceros (*Cerototherium simum simum)*. The purpose of this study was to utilize a data-driven process as a decision making tool during the phases of the white rhino introductions at Disney's Animal Kingdom (DAK).

II. Methods

As with previous data-driven animal introductions at DAK, prior to the actual introduction, animal keepers, researchers and managers met to identify and define species-specific behaviors associated with rhino introductions. These behaviors were categorized as: active aggression (i.e., physical contact), passive aggression (i.e., threats), stress-related, and affiliative behaviors exhibited by captive white rhinos. Using the *Rhino Husbandry Resource Manual*, (Fouraker and Wagener, 1996), 20 individual behaviors were defined and categorized into the four behavior groups (Appendix 1-ethogram).

Subjects

The subjects of the study were four female white rhinos ranging in age from three to 30, and a 30 year old, wild caught male.

Table 1. Subject descriptions

Studbook ID	Sex	Age	House Name
1045	M	4Y	Tex
1079	F	3Y	Maggie
1020	F	5Y	Julie
391	F	~30Y	Edith
533	F	19Y	Gloria
379	M	~30Y	Samson

Maggie and Tex were introduced at DAK one year prior to the arrival of the new herd. The new herd was housed together at another institution before their shipment to DAK in October 1998. As per Species Survival Program (SSP) recommendations, Samson was to be the herd male and Tex was to be managed as a solitary male until he is older and recommended for breeding. Therefore, Tex was separated from Maggie after the arrival of the new herd.

The introduction order (Table 2) and plan for this introduction was based on recommended methods from the *Rhino Husbandry Resource Manual*, (Fouraker and Wagener, 1996). A single female, Maggie, was to be introduced to an established male/female group. Therefore, introductions were initiated by introducing Maggie to one of the herd females. Additional females were introduced after each grouping was socially stable (i.e. aggression low; affiliative behaviors developing; shifting on and off exhibit routinely as a group). The male was introduced last to the group of females. This plan stems from the white rhinoceros' natural social organization of herding females and solitary males. The actual order that the females were introduced was based on disposition profiles observed during the baseline study and the quarantine adjustment period. The least dominant of the new herd was the first to be introduced Maggie and the dominant female was introduced last.

Table 2: The Introduction order

a) Maggie (M) → Julie (J)

b) Edith(E) → M, J

c) Gloria (G) → M, J, E

d) Samson (S) → M, J, G (Edith was separated for calving)

Data Collection

A four-step process developed by Burks and Maple (1995) was used as the basis for decision making (see also Burks, et al., 1998). Behavioral data were collected daily during each phase. The duration of each phase was guided by analysis of behavioral occurrences.

Introduction phases were as follows:

- Baseline- Each animal was studied in its current environment prior to any changes that occurred in preparation for the transport. Six days of data were compiled from this phase.
- Auditory/Olfactory/Visual contact (A/O/V)- Each animal had visual contact in the rhino barn across the keeper aisle from each other with no physical contact. Data collection began the first evening of off-load into the barn and continued until seven days after the arrival of the last animal (The animals were shipped individually over a 2 weeks period of time for transportation logistic reasons).
- Tactile or "Howdy"- Each animal had limited tactile contact through a barrier (gates and ballards). This phase allows each animal to acclimate to the other while limiting potential for physical injury.

- Physical contact- Animals were placed together in the same enclosure.

The last two phases could not begin until all rhinos had passed quarantine periods and exams. Data collection for these two phases lasted for seven weeks, but as the *Rhino Husbandry Resource Manual* reports, the method used can take as long as ten weeks. The speed at which the introduction takes place depends on behavioral data analysis results and the number of individuals in the herd.

A *one/zero* or check-sheet sampling technique was chosen to allow a reasonable margin of error and still provide high inter-observer reliability (Lehner, 1996). Twenty-minute observations recorded behaviors initiated by each focal-animal in 30-second intervals (Appendix 2). Focal-animals included those individuals directly involved in the introduction at a given time.

The animals involved in each introduction phase were observed in random order for 20 minutes each. Observation sessions began as soon as the animals had access to each other, and introductions started at roughly the same time each day. In addition to the 19 behaviors monitored with 'one/zero' methods, proximity was noted every five minutes using a scan sampling method, recording if the subjects were within one body length of the focal animal. Data were collected on all involved animals through each phase of the introduction daily and occurrences for the 30 second intervals were tallied and converted to a 'modified-rate per hour' ([# of occurrences / Total # of intervals] X 2). The modified rates per hour were then graphed and compared to base-line levels. The graphs were used to make decisions about the speed at which the introduction progressed. Subsequent phases of introduction were not pursued until aggression levels returned to baseline and stayed there for several days.

Facility

Phase I: Baseline data on the incoming herd were collected at White Oak Conservation Center, (Yulee, FL). They were held in an open pasture setting of 3.5 acres with adjoining paddocks.

Baseline information for the female already at DAK (Maggie) was collected in the savanna exhibit when she was still housed with Tex. The savanna is a 9-acre mixed species exhibit furnished with many trees, grasses, and a large mud wallow.

Phase II: Auditory/Olfactory/Visual data were collected with the animals in their night stall set up, off exhibit. The new herd was housed across from Maggie with a 15 foot service aisle between them (Figure 2).

Phase III: Data for the 'howdy' phase were collected in off-exhibit holding paddocks with gates set to allow limited tactile access between two paddocks (Figure 3).

Phase IV: The female-to-female physical introductions took place in the same paddocks with all gates locked open to connect two paddocks, forming a run-around loop with hide zones (Figure 4). Each female or group was given access to the open paddock area prior to the physical introduction to acclimate to the new arrangements. The introduction of the male to the female group took place on the savanna due to space limitations in the off-exhibit holding areas. The male was allowed time to acclimate to the savanna exhibit prior to the introduction.

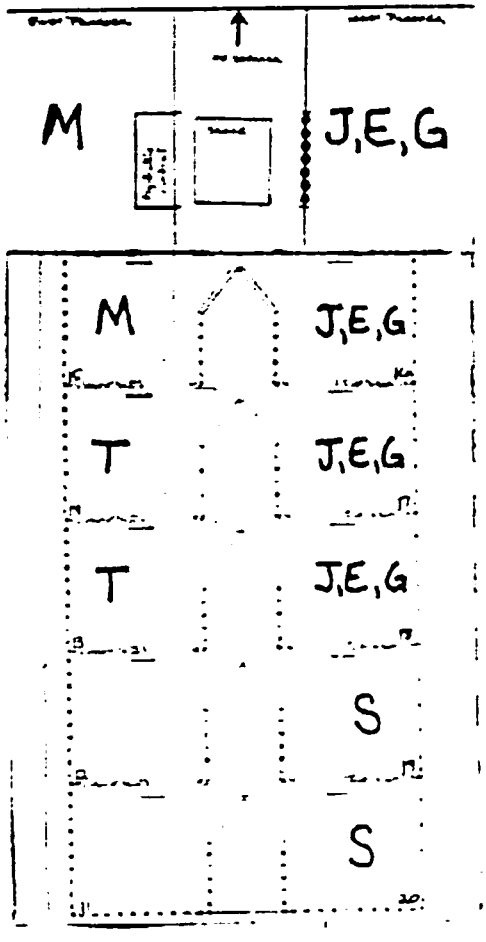
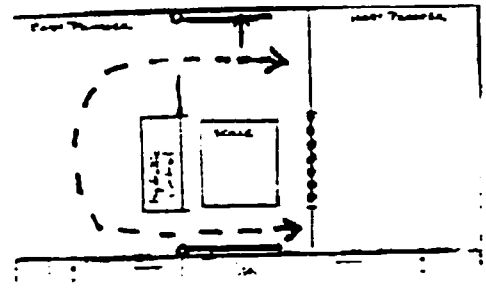


Figure 2: Night Stall Set-up



or

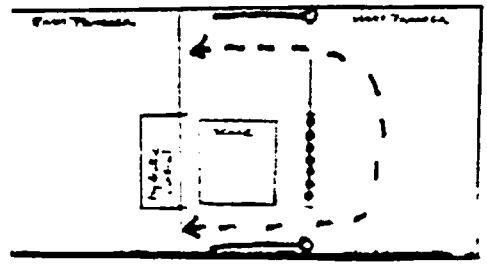


Figure 3: "Tactile/Howdy" Set-up for Paddocks

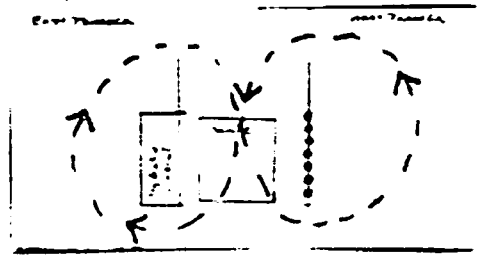


Figure 4: "Figure 8" Set-up for Physical Introduction

M=Maggie; J=Julie; E=Edith; G=Gloria; S=Samson; T=Tex

III. Results

The Burks model predicts that rates of aggression will increase from baseline levels

at the beginning of the visual phase, and that the rates of these behaviors should then attenuate to baseline over time (Figure 5). The same pattern is expected for the subsequent phases with the largest increase being in the physical introduction. The model also predicts that affiliative levels would not show a recognizable trend in reference to an introduction because social bonds typically develop over longer periods of time, (Lindburg, 1986; Burks, et al., 1998).

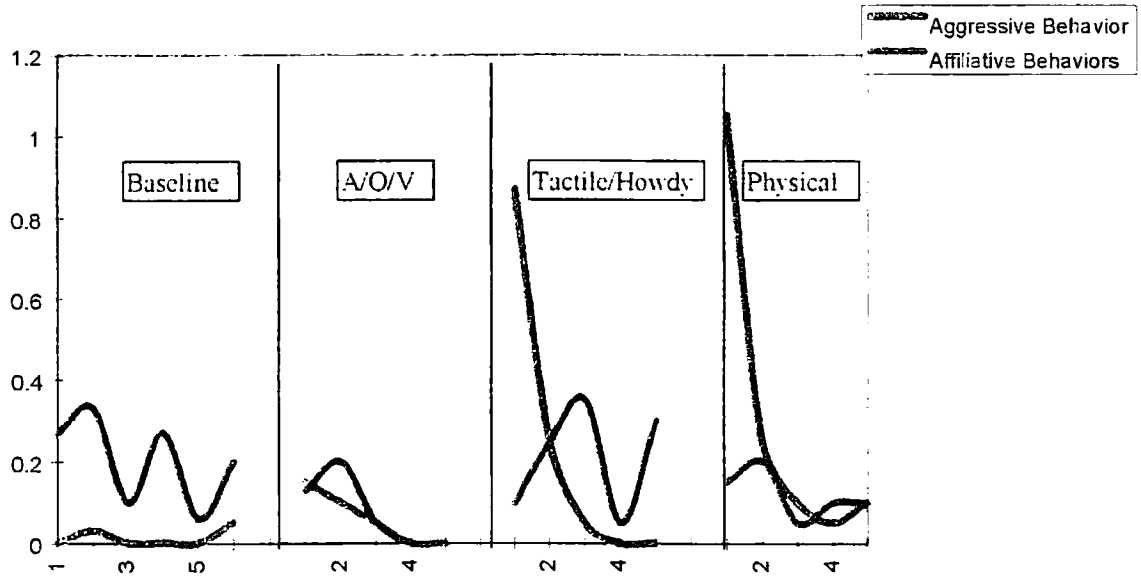


Figure 5: Hypothetical model for Introductions (Burks, 1998)

Data for the female herd introductions in each phase are shown to compare the data to the Burk's model (Figures 6-9). This example is taken from the much larger data set that includes daily observations throughout the entire process. The subset is the group of data from the introduction process that included all four cows. Each data point represents the modified rate per hour for the corresponding daily observation of each cow.

The trends for active aggression exhibited by the four females are similar to the Burks model, except that a significant increase was not apparent until the physical introduction (Figure 6). This is consistent with the fact that active aggression was defined

as contact aggression. The animals did not have full ability to aggress physically until they were actually together. Note that each phase was continued until the level of aggression returned to baseline and stayed at or near that level for a minimum of three days.

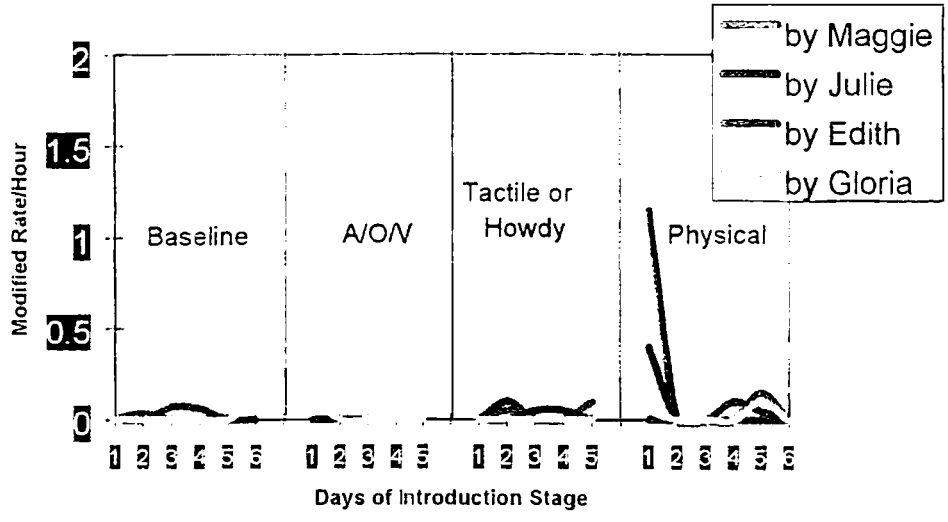


Figure 6: Active aggression results for 0.4 introduction

Passive aggression showed a similar pattern, except that only slightly higher levels existed overall than in active aggression (Figure 7). Threats presumably allow for conflict resolution without the dangerous hazards of contact aggression. If the animals can use the time in the beginning stages of an introduction to establish some dominance hierarchy by using threat behaviors perhaps it might aid in decreasing active aggression in the physical phase.

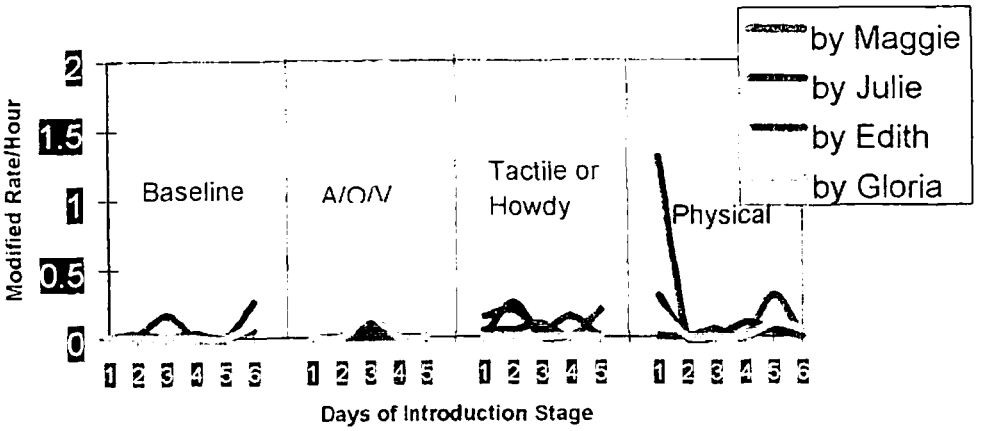


Figure 7: Passive aggression results form 0.4 introduction

The stress measurements, or the occurrence of behaviors we presumed were stress related, suggests that these introductions were not high stress incidents (Figure 8). Levels were only slightly above baseline and returned to baseline in a short amount of time. As Lindburg (1986) predicted, there were no apparent patterns of affiliative behavior (Figure 9). However, there was definitely an elevation by some individuals. This may have been due to the fact that three of the four cows were already established socially.

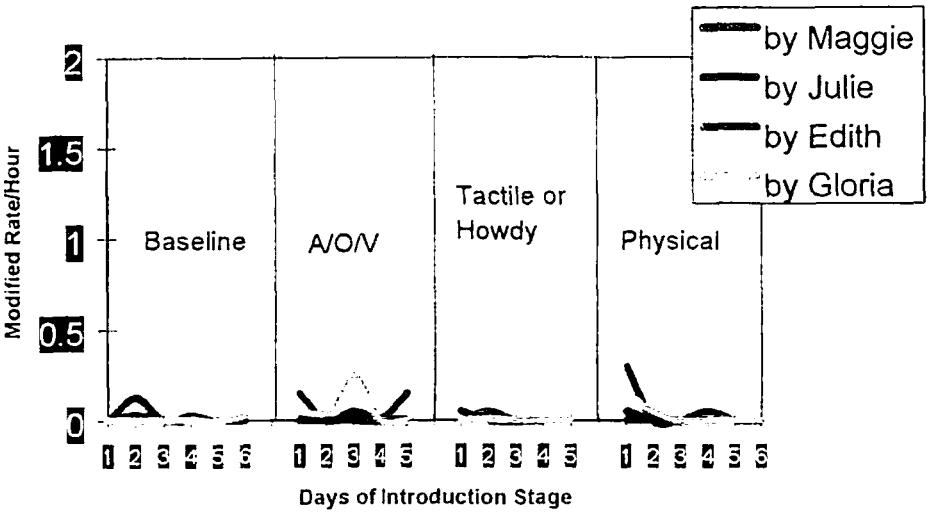


Figure 8: Stress measurements for 0.4 introduction

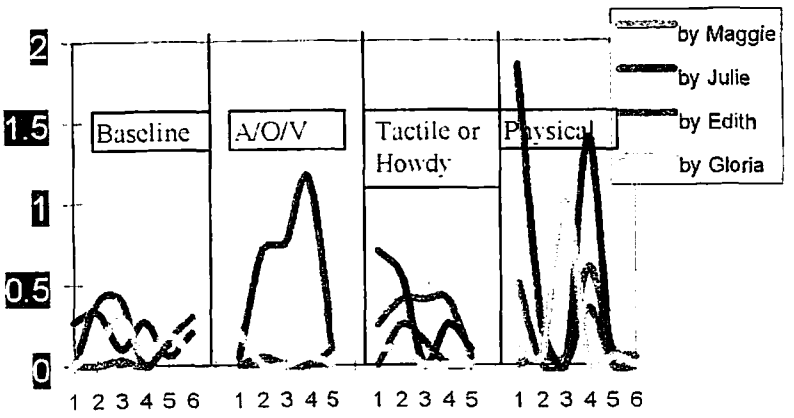


Figure 9: Summary of affiliative behaviors for 0.4 introduction

IV. Discussion and Conclusions

The goal of this project was to apply a data-driven model to rhino introductions at Disney's Animal Kingdom (DAK). However, future developments stemming from this learning opportunity aim to include multi-institutional application of this approach. Data from this study, and future studies, will be analyzed to develop a simplified method of monitoring introductions using data-driven management.

One benefit of using data driven management is that facts are used to impact decisions. With this method, an introduction progresses only as the animals' behavior dictates, rather than proceeding to beat a deadline. Using Burks' model also allows for 'team' decision making. As data collectors, keepers are able to present results to managers that indicate the appropriate time to move to the next step of an introduction and the decision can be made as a team.

Another very big benefit is that it gives keepers a chance to intensively observe their animals. This broadens knowledge of the species and of the individuals in the collection. This formal methodology provides a framework for keeper observations, providing structure and a common language.

It was through observation during a pilot study of 1.1 white rhinos (Studbook 1045 and 1079) that the methodology was improved. Once the first introduction was complete, the information was used to simplify the model. The ethogram was simplified, reducing the number of behaviors from 32 to 20, eliminating behaviors that were not pertinent to the decision making process. In addition, the remaining behaviors were defined in greater detail to increase the reliability of observation scores.

Summary sheets for each day were developed, making data entry less laborious. Data entry was one of the more challenging areas, but by the second introduction, a spreadsheet was designed on Microsoft Excel to allow each day's data to be entered with ease and graphs to be automatically updated. 'Cheat sheets' for calculating modified rate per hour were made so that results could easily be attained by referring to a chart of pre-calculated values. It was only through the experience of the first introduction that these adjustments could be made. With each introduction that is conducted adaptations can be made to continue to refine techniques.

Concerns that were encountered before and during this study allowed learning opportunities to aid in the transition from using 'art' to 'science'. Can managers, zookeepers and scientists all take part and have an equal say? The answer is yes. Each person depends on the other and each contributes equally. The keeper may know an individual animal's behavior and how the facility works best; while the manager probably has past experience; and the scientist knows about data collection and data analysis.

Another concern may be getting peers to 'buy-in' to the research. It definitely takes a team to make any research project happen. Involving everyone through action plan meetings or by having people help with different areas of the research (data

collection, data entry, and analysis) may help.

Time commitments are also a concern. How long will the introduction will take? The answer is that the animals behavior dictates the speed of the introduction. Why rush an introduction? The plan needs to be as efficient as possible and fit it in to the daily routine without compromising animal safety or 'good science' techniques. Data collection time was decreased from 2 hours to 1 hour during the pilot study and from 30 minute focal animal to 20 minute focal animal during the 1.4 introduction. Data could still be compared since we were using the modified rate per hour.

This is a low budget project. A stop watch and a computer are the only research supplies required. If these are not available, a wrist watch and a tablet of graph paper will work as well.

Travel to other institutions is not always an option prior to an animal translocation. Ideally, baseline measurements should be collected on individuals in pre-shipment herd situation to collect 'normal' values to use in comparison after shipment, during the introduction phases. If a pre-shipment baseline measurement is not attainable, a decreased and stable plateau of aggression levels will suffice. After an initiation of a new introduction phase, if aggression levels decrease and stay at the same level for a minimum of three days, a stable pattern is assumed. It is important to continue data collection after the initial drop for several days to make sure it is a trend rather than a fluke.

Though this model has been successfully used at DAK, it needs more testing to see if, in fact, it will work in different situations or for different species. Because of inter-observer reliability the number of people collecting data should be kept to a minimum. To initiate multi-institutional testing with somewhat consistent use of the model, the

development of a training video is being planned. The video will show how to collect data using the one-zero check sheet developed in this study and demonstrate behaviors in a video ethogram, providing a common vocabulary.

As mentioned earlier, zoos today are moving from the 'art' of animal management to the 'science' of animal management. This data-driven approach is part of this theme. The advantage to this trend is that we will have a common language and quantitative measurements for sharing with coworkers and other zoological institutions. For years zoos have been managed using the art of animal management. By moving to the science of animal management we are documenting peoples experience and putting it into a form that can be analyzed. Often times science proves the art is right. There is no replacement for 20 years of experience in this field, but what happens to that 20 years when someone retires? Using science increases professionalism and credibility and provides a backbone for professional growth and development.

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If your institution is planning to conduct an introduction and you would like more information please feel free to contact any one of the following people:

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Appendix I
Ethogram for the Study of White Rhino Introductions at Disney's Animal Kingdom

Active Aggression:
Spar: Rhino(s) use horns in offensive/defensive contact to another's head or horn. Ears are back, tail tucked indicating an aggressive act (vs. tail wag).
Horn Strike: Aggressive horn contact to another anywhere other than the head.
Gore: An aggressive puncture to the surface of another animals skin with horn.
Charge/Chase: Locomotes rapidly w/ head lowered toward another rhino/following in a trot or run while the other animal retreats.

Passive Aggression:
Snort: Air forced through nasal passages quickly, usually aggressive context.
Face to Face Stare: Rhinos are within a body length apart and facing another directly.
Mock Charge: Animal abruptly moves toward another in an aggressive way and then suddenly stops (usually ears back, often accompanied by bellow, but not always).
Open-Mouth Threat: Threat in which the animal faces another w/ mouth open (also often accompanied by bellow, but not always).
Bellow: A long, low guttural grunting sound often emitted in a charge or open-mouth threat.

Stress:
Pacing: Repetitive walking for no apparent reason in a pattern. Begin recording after the end the second pattern (walks same pattern twice, record at end of 2nd lap).
Excessive Running: Animal runs same pattern twice with tail tucked (often accompanied by being chased by another individual).
Squeal/Scream: High-pitched panic vocalization often accompanied with being aggressively challenged by another individual.
Diarrhea: Excessively loose stool production
Panting: Raspy/heavy breathing often repetitive and associated with anxiety or aggression.

Affiliative:
Social Sniffing: Smell investigation of another individual.
Touch/Rub/Lick: Non-aggressive contact with another individual
Follow: Focal animal is behind, within one body-length of another animal purposefully walking after the other animal has initiated movement.
A/G investigate: Sniffs ano/genital region of another animal
Call: Vocalization emitted that resembles a cry. Often sounded between mother and a calf or in a separation of a socially bonded group.
Proximity: Focal animal is within one body length to any other animal.

Institution:_____
Observer:_____
Date:_____

Appendix 2
White Rhino Introduction
Start Time:_____
Page_____

Focal Animal:_____
Observed w/:_____

Interval# (30seconds):	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Active Aggression																				
Spar																				
Horn Strike																				
Gore																				
Charge/chase																				
Passive Aggression																				
Snort																				
Face to Face Stare																				
Mock Charge																				
Open-mouth Threat																				
Bellow																				
Stress																				
Pacing																				
Excessive Running																				
squeal/scream																				
Diarrhea																				
Panting																				
Affiliative																				
Social Sniffing																				
Touch/Rub/Lick																				
Follow																				
A/G ivestigate																				
Call																				
(Scan 5min) Proximity																				

Notes:
Method=1/0 30min focal
score focal initiations only
use initials of receiving

Rhino Training and Enrichment at Disney's Animal Kingdom

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Disney's Animal Kingdom
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Lake Buena Vista, FL 32830

Introduction

At Disney's Animal Kingdom, training and enrichment are as fully integrated into our rhino management program as other basic husbandry practices such as exhibit cleaning and maintenance, nutrition, health and propagation. It is an expectation of keepers in all areas that they be involved in both the training and enrichment of the species that they work with. The focus of the training program is to use operant conditioning techniques and positive reinforcement to train rhinos to shift on and off display and between stalls and yards and the training of routine husbandry behaviors. The focus of the enrichment program is to promote species-appropriate behaviors. We believe that all interactions with animals are opportunities to affect the animal's behavior in a positive way.

Program Support

There is strong program support for both training and enrichment efforts from all members of the animal management team, including Keepers, Zoological Managers, Curators and Veterinarians. Our Curator of Behavioral Husbandry, who serves as a resource property-wide for training and enrichment, oversees staff development. Within four months of hire, each Keeper is required to complete a Husbandry Training Methods Class. Basic training terminology and operant conditioning concepts are taught, as well as trouble-shooting and problem-solving techniques. Keepers are presented with real-life training challenges to solve, focusing on the process and skills necessary to problem-solving as a team. After attending this class, Keepers are gradually inserted into the training process in their work areas by going through a new trainer integration plan. New trainers participate in a "train-the-trainer" program that is fostered by the Curator of Behavioral Husbandry, their Zoological Manager and other Keepers already established

as trainers. They begin by first observing a number of training sessions being conducted by other Keepers. From there, they partner with an experienced trainer to do sessions with animals on previously learned behaviors. After many such sessions, they are allowed to begin training new behaviors on their assigned animals. All trainers have sessions regularly reviewed by Zoological Managers, co-workers and Veterinarians. A sub-set of the Zoological Managers, representing most of the taxa at Disney's Animal Kingdom, have formed an advanced training group that meets regularly to brainstorm new ideas, trouble-shoot problem areas and share best practices. Often times, techniques and solutions for one species or taxa can be just as applicable to another.

Training Program Framework

The training program framework consists of six steps: goal setting, planning, implementing, documenting. evaluating and re-adjusting.

Goal-setting and Planning

The initial goals of the rhino training program were the basic ones of getting the animals to shift between stalls and yards within the barn complex and getting them on and off exhibit on cue. From there, the animal management team (Keepers, Zoological Managers, Curators and Veterinarians) collectively set husbandry goals such as:

- Target training
- Stationing/steady
- Scale training
- Tactile desensitization/complete body inspection
- Voluntary blood draws and injections
- Foot present
- Mouth open/oral exams
- Desensitization to rectal palpations/transrectal ultrasonagraphy

- Chute training/scale training
- Other husbandry behaviors as identified by animal management and veterinary staff

The black rhino and white rhino training programs have been developed in parallel with only a few species-specific variations. Although we have not had the opportunity to work with other rhino species here at Disney's Animal Kingdom, we feel the program framework and training steps are easily transferable to other species, including other types of rhinos.

Planning is the next step in the training program. There is an approval process that is initiated by the Keeper. A training proposal is submitted which identifies which animal is going to be trained which behavior and why and the training steps or approximations that will be used. The Zoological Manager, area Curator and Veterinary Staff all comment on and approve the proposal. A Veterinarian is assigned to act as an advisor for each species of animals and participates in each phase of the training program. Next, all members of the training staff collaborate on setting cues and criteria for each of the behaviors to be trained. This helps to ensure consistency and to avoid confusion or frustration for either the animal or the trainer. The AZA Rhinoceros Husbandry Resource Manual includes suggestions and definitions of some standard training commands.

Disney's Animal Kingdom Cues and Criteria for Rhinos

- Behavior: Come
  - ⇒ Verbal cue: "Come"
  - ⇒ Criteria: Animal begins to approach trainer's position immediately and positions itself in front of the trainer

- Behavior: Target
  - ⇒ Verbal cue: "Target"
  - ⇒ Visual cue: Presentation of object used as target
  - ⇒ Criteria: Animal touches object or area specified by trainer with muzzle, keeping mouth closed

- Behavior: Steady
  - ⇒ Verbal cue: "Steady"
  - ⇒ Physical cue: Pressure/touch on muzzle with hand
  - ⇒ Criteria: Animal remains in position and relaxed

- Behavior: Back
  - ⇒ Verbal cue: "Back"
  - ⇒ Physical cue: Pressure/touch on shoulder area
  - ⇒ Criteria: Animal locomotes backward in a straight line, moving each foot back one step

- Behavior: Over left/Over right
  - ⇒ Verbal cue: "Left" or "Right"
  - ⇒ Criteria: Animal pivots on front legs, moving hindquarters one complete step in direction indicated by trainer

- Behavior: Foot (front)
  - ⇒ Verbal cue: "Foot"
  - ⇒ Physical cue: Pressure on back of wrist/pressure to front of foot above toes
  - ⇒ Criteria: Animal lifts and positions foot as guided by trainer

- Behavior: Down
  - ⇒ Verbal cue: "Down"
  - ⇒ Visual/physical cues: To be developed
  - ⇒ Criteria: Animal lies in partial lateral position on side indicated by trainer

- Behavior: Open (mouth)
  - ⇒ Verbal cue: "Open"
  - ⇒ Physical cue: Pressure/touch on upper and lower lips at corners of mouth
  - ⇒ Criteria: Animal opens mouth by dropping lower jaw and keeping upper lip elevated, with little to no head movement

- Behavior: End Session
  - ⇒ Verbal cue: "All Right"
  - ⇒ Physical cue: Three pats on the muzzle
  - ⇒ Criteria: Animal is released from session

Documentation and Evaluation

It is critical to record the results of training sessions, in order to document the progress of both the animal and the trainer. Disney's Animal Kingdom utilizes a computerized record-keeping system, which has been tailored to our training program and refined over time. On the training form, Keepers identify the trainer, animal and behavior that was trained. They also note and describe any occurrences of aggression and rate the animal's response to the training session on a 1-5 scale. The rating is based on how focused the animal was on the session and how well the animal performed the behavior. The animal's overall progress towards learning the behavior is tracked on a scale of 0-100%. This data can be graphed to produce a visual display of an animal's progress. When a behavior is complete with both primary and secondary trainers, it can then be turned over to other trainers and is considered to be in the maintenance phase rather than the learning phase.

Evaluation is the next basic program element. Zoological Managers, Veterinarians and other Keepers observe training sessions regularly and offer input and constructive criticism. Sessions are also videotaped periodically for review. A videocassette is designated for each individual rhino and training footage is added to the tape over time. In this way, a video chronicle of each animal's training history is created. The staff routinely discusses progress towards training goals and looks for trends in the data as part of the evaluation process. Trends in the training data can identify how an animal's performance is scored over time, how long it takes to train a particular behavior, whether or not training success is associated with an individual trainer, any increases or decreases in aggression and whether or not it is associated with an individual trainer or behavior. This information could potentially be linked to where an animal is in it's reproductive cycle, based on available serum or fecal hormone enzyme immunoassay results. Studying trends in the data can help to establish training consistency and will assist in determining if and when adjustments are necessary.

Good communication in every phase of the training program is critical. Regular team meetings and regular review of training sessions can promote effective communication. Each rhino barn is equipped with a dry/erase training board, which tracks animals, trainers and behaviors at a glance. While a behavior is in the learning phase, it is listed in red marker. Once a behavior has been completed, it is listed in green marker. This is a signal that new trainers can come in behind the primary and secondary trainers and work the rhino on behaviors in the maintenance phase. Besides communication, some of the other challenges in the training program include finding time to train, working around trainers' schedules and establishing consistency with multiple trainers. Working around the animals' schedules is also a consideration, as the rhinos are required to be out "on show" from 45 minutes after sunrise until 45 minutes after sunset. Training sessions are basically restricted to very early in the morning or very late in the day. Subjectively, the morning sessions seem to be more successful, as the animals appear to be more focused on the training than in the evenings, when they are more focused on coming into the barn to receive their diets.

Training Successes

Although we still consider the rhino training program to be fairly new, we have enjoyed several successes. All rhinos shift between their exhibits and holding areas on an audio cue. All rhinos are target-trained. All of the rhinos are scale-trained so that we can obtain regular weights on them. All of the black rhinos and some of the white rhinos are trained to stand for voluntary blood draws and injections. All of the black rhinos are chute-trained and have been desensitized for rectal palpation. All rhinos are in various stages of learning other husbandry behaviors.

Enrichment Program Framework

The framework for the enrichment program at Disney's Animal Kingdom includes the same steps as the training program: goal-setting, planning, implementing, documenting, evaluating and re-adjusting.

Goal-setting and Planning

The primary goal of the enrichment program is to promote opportunities for the expression of species-appropriate behaviors. For rhinos, these include, among other things, opportunities for foraging, wallowing, scratching, olfactory investigation, interacting with their environment, and manipulating items with their horns. A secondary goal of enrichment is to decrease or eliminate undesirable behaviors.

The planning phase begins with the brainstorming of enrichment ideas. This can be done in a variety of forums including team meetings or informal keeper discussions. Additionally, a group of interested parties from all areas and representing all taxa of Disney's Animal Kingdom has been formed, the B.E.E.R group (Behavioral Environmental Enrichment Rendezvous). This group meets on a regular basis to share best practices from both within our organization and from other zoological institutions, to

trouble-shoot, problem-solve and share enrichment resources. While enrichment is most often thought of as being the addition of novel objects, such as boomer balls, scents and food items, the concept of enrichment is much broader and can include such things as keeper interactions, husbandry training, exhibit utilization and modification, and both intra- and inter-specific social interactions. The Keepers initiate the enrichment approval process by submitting a proposal that identifies the animal to be enriched and the behaviors that the enrichment is meant to promote, describes the enrichment and identifies any necessary resources. The Zoological Manager, the Curator of Behavioral Husbandry, the Area Curator and the Veterinary staff must approve the proposal. If food items are involved, the proposal is also submitted to the Forage Warehouse Manager for approval and to initiate the procurement and delivery process of the forage items. Keepers advance-plan the delivery of the enrichment items on a computerized calendar system.

Documentation and Evaluation

The results of the enrichment are documented in a computerized record-keeping system in which the animal(s) and the enrichment provided are recorded. The animal's response to the enrichment is rated and recorded on a 1-5 scale, from showing no interest at all to spending a substantial amount of time interacting with the enrichment item. Keepers also make comments on the specific behaviors observed or any other items of note. The evaluation process includes routinely discussing progress towards the enrichment goals, looking for trends in the data and making adjustments when necessary. Some of the trends that can be established from the documentation data include the frequency of delivery of a particular enrichment item, the animal's response to an enrichment item over time and the relative "success" of particular items. The scheduling, documenting and evaluating of an enrichment item does not require a complex record-keeping system, but can all be accomplished on one simple paper form. Keeping records on the computer can offer more possibilities, such as graphing animals' responses to enrichment over time or retrieving specific types of data.

Additional Enrichment Efforts

At Disney's Animal Kingdom, a long-term browse/vegetation study is underway. Data is systematically recorded on the amount of time animals spend consuming the planted landscape versus provided browse. From this data, decisions can be made to increase the amount of cut browse offered to the animals in order to decrease the negative impact on the landscape by the animals. There is also a long-term animal visibility study that the Keepers participate in to view the animals from the Guest perspective. Keepers measure animal visibility four times a day from the safari ride vehicle. They record what species they see, how many of each species they see, and plot the animals' locations on a polygon map. These measurements can be correlated with and affected by the timed addition of enrichment items. Thus the enrichment program can be used not only to enrich the animals' lives but also to enrich the Guest experience.

Conclusion

In conclusion, training and enrichment should be integral to all rhino management programs. Training enables the Keepers to provide a better quality of care for their rhinos and can prove invaluable in treating illness or injury or in reproductive and research efforts. Every zoological institution should train their animals to the extent their facility and manpower will allow. Similarly, enrichment should be considered just as basic to every animal management program as other husbandry practices. Not only will the lives of the rhinos be enhanced, but also the Keeper staff will be richly rewarded and the Guests will be provided with a satisfying and more educational experience.

Suggested Readings

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First Rhino Keepers' Workshop Husbandry Survey

Hosted by Disney's Animal Kingdom May 1999

Information Compiled by: Farshid Mehrdadfar

Institution: Fossil Rim Wildlife Center **Name of Participant:** Adam Eyres

email address: rhinoridge@ifexas.net **Phone Number:** 254-897-2960 Ext: 308 **Fax Number:** 254-897-3785

Rhinoceros Species Currently cared for and Collection Inventory:
White Rhino 4.4 (1 male calf born on 10-1-98) Black Rhino 1.2

Diet Offered to Animals: White Rhinos: ADF16 30# + Coastal Hay 25# + Alfalfa 10#
Black Rhinos: ADF 16 30# + Coastal Hay 20# + Alfalfa 20#

Approximate Size of Each Exhibit: White Rhinos: 10 acres herd yard + 1 acre Bull pen
Black Rhinos: 2-4 acres / animal

Other Animal (s) Exhibited With Rhino (s) In each Habitat (s):
White rhinos: Free range Black buck , Sable , Tommies , Blesbuck , White tailed Deer
Black Rhinos: Free range White Tailed Deer

Description of Husbandry Training in Practice: Shift Training , Blood Draws , Foot Work , Ultra Sound

Description of Research Conducted or Ongoing: Blood Research , Ultra Sound , Milk Analysis

---

Institution: Houston Zoological Gardens **Name of Participant:** Colleen Schlough

email address: N/A **Phone Number:** 713-284-8306 **Fax Number:** N/A

Rhinoceros Species Currently cared for and Collection Inventory:
White Rhinos 1.1

Diet Offered to Animals:
Coastal Hay + Alfalfa Hay + ADF 16

Approximate Size of Each Exhibit:
1 Acre

Other Animal (s) Exhibited With Rhino (s) In each Habitat (s):
None

Description of Husbandry Training in Practice:
Body palpation , Shift Training

Description of Research Conducted or Ongoing:
N/A

Institution: Denver Zoological Garden

Name of Participant: Christine Bobko

email address: N/A **Phone Number:** N/A **Fax Number:** N/A

Rhinoceros Species Currently cared for and Collection Inventory:
Eastern Black rhino 2.1

Diet Offered to Animals:
Mixture of 50/50 Alfalfa & Timothy Hay + New Pellet (Aspen Pellet) + Vitamin E Supplement + Phosphorous + Cannola Oil ** Apples and Carrots for Treats**

Approximate Size of Each Exhibit:
Indoor Stalls : 20ft x 15ft (3 of these stalls) , Out door yard: 400ft x 200ft, Front Exhibit: 30 x 20

Other Animal (s) Exhibited With Rhino (s) In each Habitat (s):
None

Description of Husbandry Training in Practice:
Monthly blood collection by keepers from ear and leg vein . Urine collection (free catch).
Commands used during training includes; Over, Foot, Back, Sit, Down, Hold, Fetch / Pick up, Pee, Mouth

Description of Research Conducted or Ongoing:
Nutritional project in conjunction with white oak and Fossil Rim
MBA survey
Infant / Mother Behavioral Project

*** This Zoological Facility has had experiences on Dealings with following Diseases in black rhinos:

- *Hemolytic anemia*
- *Encephalmalyasia*
- *Salmonella*
- *Mucasal ulcers*

Institution: White Oak Conservation Center

Name of Participant: Vickie A. Steele

email address: vickies@wo.gilman.com **Phone Number:** 904-225-3396 **Fax Number:** 904-225-3395

Rhinoceros Species Currently cared for and Collection Inventory:
5.3 Southern Black Rhino , 4.5 Southern White Rhino

Diet Offered to Animals:
White Rhino: Coastal Bermuda hay, 17lbs ADF16 cubes (AM Hay; PM Hay & Grain)
Black Rhino: 1 flake Alfalfa + 2 flake timothy (AM) , 1 flake Alfalfa + 2 flake timothy + 15 lb. ADF 16 + 4 apples + 4 carrots (PM) PER ANIMAL
** 4 animals are currently on Ellen Dierenfelds Rhino grain**

Approximate Size of Each Exhibit:
White rhinos: flat grassy with mud wallows. Enclosure has 3.5 animals ; corral adjacent to enclosure has 1.0
Black rhinos: flat grassy with wallows; 1.0 adjacent to 0.1 ; 3.0 together ; 1.2 together
** All enclosures have trees, dead fall, boulders and shelters **

Other Animal (s) Exhibited With Rhino (s) In each Habitat (s): None

Description of Husbandry Training in Practice:
White rhinos are currently being acclimated to chute
Some white and some blacks are conditioned to stand parallel to corral or enclosure for blood collection from ear and or leg veins.

Description of Research Conducted or Ongoing:
We have been involved with a nutrition study for black rhinos with Dr. Dierenfeld (that study is complete , waiting on results).
We have been involved with the study on hormone / PG status extracted from feces with CRC (front Royal).
1997-98 we were involved with fecal study on Whites with San Diego Zoo CRES.

Institution: Western Plains Zoo (Australia)

Name of Participant: Andrew Thorne

email address: athorne@zoo.nsw.gov.au **Phone Number:** 02-6882-5888 **Fax Number:** 02-6884-1722

Rhinoceros Species Currently cared for and Collection Inventory:
Black Rhino 6.6
1.2 White Rhino

Diet Offered to Animals:
Black Rhino:
10-15 kg grass / clover hay (mainly rye grass)
2-4 kg alfalfa
1 kg horse pellets (commercial mix)
0.2 kg apples, 0.2 kg bananas , 0.1 kg sweet potato , 0.8 kg carrots
0.5 kg wheat germ
1-5 kg browse (acacia , willow)
Bread as a treat

Number of animals exhibited in habitat:
Black rhinos: 2 animals are displayed individually (each exhibit is ~1/3 acre)
Others are displayed in off exhibits according to breeding status : breeding pairs / trios share 2-4 acre yards.

Approximate Size of Each Exhibit:
2 public exhibits , ~1/3 acre each
15 off exhibit day yards ~1/2 acre each
18 night yards ~1/6 acre each

Other Animal (s) Exhibited With Rhino (s) In each Habitat (s): None

Description of Husbandry Training in Practice:
All females are shift trained.
1 female is conditioned to regular ultrasound , blood collection
1 female is conditioned to blood collection (irregular)
1 female is conditioned to stand in chute
2 males are conditioned to blood collection (unreliable) along fence / free standing
1 male is conditioned to semen collection (unreliable)

Description of Research Conducted or Ongoing:
Ongoing Ultrasound investigation of female , anatomy / physiology of reproductive status.
Fecal hormone analysis to assess estrus / pregnancy status
Salivary hormone analysis to aces estrous / pregnancy status

Institution: Fort Worth Zoo

Name of Participant: Jeanne Jacobsen

email address: jmjacob@flash.net **Phone Number:** 817-924-7632 / 817-871-7041 **Fax Number:** NA

Rhinoceros Species Currently cared for and Collection Inventory:
Black Rhino (Southern) 1.2
White Rhino (Southern) 1.1
Indian Rhino 1.1

Diet Offered to Animals:
Black Rhino: Alfalfa + Coastal Hay + 17% Protein Pellets
White Rhino: Coastal Hay + 12% Protein Pellets
Indian Rhino: Coastal & Prairie Hay + 17% Protein Pellets

Number of animals exhibited in habitat:
Black rhinos: 1.2
White Rhinos: 1.1
Indian Rhino: 1.1

Approximate Size of Each Exhibit:
Black Rhinos: ~1/2 Acre
White Rhinos: ~ 1/4 Acre
Indian Rhino: ~1/4 Acre

Other Animal (s) Exhibited With Rhino (s) In each Habitat (s): None

Description of Husbandry Training in Practice:
Black Rhinos: Target Training, Blood Collection, Chute Training, Ultrasound Training.

Description of Research Conducted or Ongoing:
Black Rhinos / White Rhinos: Behavior and Fecal Progesterone studies of reproduction (Dr. T. Roth)
Indian Rhino: Correlation of behavior and reproductive hormones (M. McInnch)

Institution: Oregon Zoo

Name of Participant: Michael Illig

email address: Illig@aol.com **Phone Number:** 503-226-1561 **Fax Number:** 503-226-0074

Rhinoceros Species Currently cared for and Collection Inventory:
Black Rhino: 1.2
1.0 -12 years old, 0.1 - 10 years old, 0.1 - 20 months old

Diet Offered to Animals:
Black Rhino:
Alfalfa + Timothy Hay Mix + Herbivore Pellets + Vitamin E supplement + Mineral Salt + Multi Vitamin supplement + Browse (when available)

Number of animals exhibited in habitat:
Black rhinos: 1.1 adults or 0.2 mother and offspring

Approximate Size of Each Exhibit:
~80' x 200'
Gunnite wall with pool at viewing area / ~25% public view access

Other Animal (s) Exhibited With Rhino (s) In each Habitat (s): None

Description of Husbandry Training in Practice:
Both adults are trained for blood collection and Rectal Temperature collection
Female is trained for milking
Both Adults are trained to Target & Steady
Mailed is trained to "OVER" Command.

Description of Research Conducted or Ongoing:
Progesterone level monitored by blood collection
Comparing behavioral data with known estrus cycle by blood collection
Participated in Dr. Carlstead exhibit / behavior study
Measurement of males response to females urine and feces to determine estrus (conducted by Farshid Mehrdadfar)
Measurement of vaginal swelling to determine estrus (conducted by Farshid Mehrdadfar)

Institution: Memphis Zoo **Name of Participant:** Houston Winbigler

email address: Hwinbigler@memphiszoo.org **Phone Number:** 901-725-3400 ext:330 **Fax Number:** NA

Rhinoceros Species Currently cared for and Collection Inventory:
White Rhino 1.2

Diet Offered to Animals:
Horse Chow + Coastal / Bermuda Hay + alfalfa cubes + Produce

Number of animals exhibited in habitat:
1.2 White Rhinos (1.1 adult in mid twenties , 0.1 calf is ~6 months old)

Approximate Size of Each Exhibit:
Irregular , ~ 250' long x 80' wide

Other Animal (s) Exhibited With Rhino (s) In each Habitat (s):
None

Description of Husbandry Training in Practice:
Animals are trained to Target for palpation exam, blood drawing and foot work

Description of Research Conducted or Ongoing: NA

Institution: Kansas City Zoological Garden **Name of Participant:** Wendy Shaffstall

email address: Wsrhino@aol.com **Phone Number:** 816-871-5700 ext: 4744 **Fax Number:** NA

Rhinoceros Species Currently cared for and Collection Inventory:
Eastern Black Rhino 2.2

Diet Offered to Animals:
12lb moose maintenance + 10-60 vitamin E + 500-800 gm missing link + alfalfa hay + Prairie hay
Number of animals exhibited in habitat:
Generally 1 animal in exhibit, upon successful introduction of the pair , 1.1 will be exhibited together.

Approximate Size of Each Exhibit:
~1/2 Acre

Other Animal (s) Exhibited With Rhino (s) In each Habitat (s):
None, but part of the larger African Plains exhibit. Rhinos are separated by dead fall from hoofstock and giraffes.

Description of Husbandry Training in Practice:
Blood draw, Mouth inspection, Foot care, Ultrasound, Body palpation, Shift training

Description of Research Conducted or Ongoing:
NA

Institution: Reid Park Zoo

Name of Participant: Gale Ferrick

email address: NA **Phone Number:** 520-741-3204 **Fax Number:** NA

Rhinoceros Species Currently cared for and Collection Inventory:
Southern White rhino : 1.1

Diet Offered to Animals:
Bermuda hay & alfalfa hay (75% & 25%)
alfalfa pellets + sweet feed

Number of animals exhibited in habitat:
1.1 white rhinos

Approximate Size of Each Exhibit:
~1/4 Acre

Other Animal (s) Exhibited With Rhino (s) In each Habitat (s):
None (a feral cat lives with the rhinos!!)

Description of Husbandry Training in Practice:
Operant conditioning

Description of Research Conducted or Ongoing:
NA

Institution: Bronx Zoo

Name of Participant: Gina Savastano

email address: Gmsava@aol.com **Phone Number:** 718-220-5161 **Fax Number:** NA

Rhinoceros Species Currently cared for and Collection Inventory:
Indian Rhino : 3.4

Diet Offered to Animals:
6 qt. of herbivore grain + 1/2 bale of timothy hay + Fruit / veggies + Browse
Number of animals exhibited in habitat:
1.1 (mother and calf) or 0.3

Approximate Size of Each Exhibit:
Exhibit is ~1/2 acre , there are 3 holding yards (size unknown)

Other Animal (s) Exhibited With Rhino (s) In each Habitat (s):
None

Description of Husbandry Training in Practice:
NA

Description of Research Conducted or Ongoing:
Neonatal comparison of Indian Rhinos (1.1 siblings)

Institution: Baltimore Zoo

Name of Participant: Chris Bartos

email address: cmbaltzoo@aol.com **Phone Number:** 410-396-7636 **Fax Number:** 410-396-3829

Rhinoceros Species Currently cared for and Collection Inventory:
Southern White Rhino 1.1 (1.0 is 5 years old & 0.1 is 34 years old)

Diet Offered to Animals:
75% Timothy hay + 25% alfalfa hay + ADF 16 pellets
Produce and alfalfa cubes for training

Number of animals exhibited in habitat:
1.1 Southern white rhinos (exhibited together , separated at night)

Approximate Size of Each Exhibit:
~ 1/2 Acre

Other Animal (s) Exhibited With Rhino (s) In each Habitat (s):
0.4 common zebra + pink-backed pelicans

Description of Husbandry Training in Practice:
Both animals are target trained
Both animals are trained to hold "Steady" for vaccination , blood draws
1.0 is trained to "back up" , open his mouth on command , goes to remote target , lifts his feet one at a time
1.0 is currently being trained to step up on a scale

Description of Research Conducted or Ongoing:
Dr Nan Shaffer has done semen collection from our old male (got viable semen).

Institution: Montgomery Zoo

Name of Participant: Kimberly Hazelet

email address: NA **Phone Number:** 334 - 365 - 5196 **Fax Number:** NA

Rhinoceros Species Currently cared for and Collection Inventory:
Indian Rhino: 1.0

Diet Offered to Animals:

~ 3/4 bale of Coastal hay / grass hay + ~ 15 lb. fruit / veggies + ~15lbs Herbivore Cubes + 10 lb. senior horse chow + Biotin supplement + various browse (when available)

Number of animals exhibited in habitat:
1.0 Indian Rhino

Approximate Size of Each Exhibit:
~ 1/4 Acre

Other Animal (s) Exhibited With Rhino (s) In each Habitat (s): None

Description of Husbandry Training in Practice:
Daily work in chute for veterinary maintenance (i.e. Body palpation)
Blood sample has been collected from this animal

Description of Research Conducted or Ongoing:
NA
Interested in research project

Institution: El Coyote Ranch

Name of Participant: Bart Dupont

email address: elcoyote@vsta.com **Phone Number:** 361-568-3388 /3384 **Fax Number:** 361-568-3580

Rhinoceros Species Currently cared for and Collection Inventory:
Southern Black rhino 1.0
Southern white Rhino 2.5 (1.0 adult male , 1.0 juvenile male , 0.2 juvenile female , 0.3 adult female)

Diet Offered to Animals:
Elephant supplement cubes (9072 ST) ACCO feeds
Alfalfa hay + Red Top hay
Browse : Huisache + Acacia farnesiana
Produce : Apples , Sweet potato
Vitamin E supplement , Equine electrolyte supplement (Electro - Dex)
Salt block , 12-12 equine mineral block

Number of animals exhibited in habitat:
4 habitats
Habitat 1 - 1 adult female
Habitat 2 - 1 adult female , 1 juvenile male , 1 juvenile female
Habitat 3 - 1 adult male
Habitat 4 - 1 adult female , 1 juvenile female

Approximate Size of Each Exhibit:
~1.75 Acre
Other Animal (s) Exhibited With Rhino (s) In each Habitat (s): None

Description of Husbandry Training in Practice:
Conditioning for blood draw

Institution: Wildlife Conservation Society **Name of Participant:** Dr. Ellen Dierenfeld

email address: edierenfeld@wcs.org **Phone Number:** 718-220-7102 **Fax Number:** 718-220-7126

Rhinoceros Species Currently cared for and Collection Inventory:
Black Rhino 1.0
Indian Rhino

Diet Offered to Animals:
Black Rhino : Mixed grass hay / legume hay , Fresh Browse , Experimental rhino pellet
Indian Rhino : Grass hay , fresh browse , Herbivore pellets

Number of animals exhibited in habitat:
Black rhinos: Single male
Indian Rhino : Mother and calf

Approximate Size of Each Exhibit:
Indian Rhino : ~1/2 Acre
Black Rhino: 100 m x 50 m
Other Animal (s) Exhibited With Rhino (s) In each Habitat (s):
None

Description of Husbandry Training in Practice:
Unknown

Description of Research Conducted or Ongoing:
Numerous
Interested on posting the following on listserve (for nutrition) :

- *Browse list from different institutions*
- *Handrearing protocol for review by keeper staff*
- *List of current nutrition articles on rhinos*

Institution: Lincoln Park Zoo **Name of Participant:** Brett Smith

email address: BSCC1972@aol.com **Phone Number:** 312-742-7680 **Fax Number:** NA

Rhinoceros Species Currently cared for and Collection Inventory:
Black rhino : 1.2

Diet Offered to Animals:
Black Rhino: Mazuri herbivore pellets + Alfalfa hay + 6lb produce (fruit and veggies)

Number of animals exhibited in habitat:
Black rhinos: 1 animal in one exhibit at one time

Approximate Size of Each Exhibit:
NA

Other Animal (s) Exhibited With Rhino (s) In each Habitat (s):

None

Description of Husbandry Training in Practice:
Black rhinos:
Blood drawing , crate training

Description of Research Conducted or Ongoing:
A behavior study to determine estrus cycle

Institution: Lion Country Safari **Name of Participant:** Brian Kohler

email address: NA **Phone Number:** 561-793-1084 **Fax Number:** NA

Rhinoceros Species Currently cared for and Collection Inventory:
Southern White Rhino: 6.8

Diet Offered to Animals:
Free choice coastal hay + 10lb "elephant" pallet per animal (12%) + Access to trace mineral blocks
Animals are given bran once a week , animals graze in section entire day

Number of animals exhibited in habitat:
White Rhinos: varies from 2.8 to 4.8 depending on circumstances and bulls

Approximate Size of Each Exhibit:
Main exhibit yard is ~70 Acres

Other Animal (s) Exhibited With Rhino (s) In each Habitat (s):
White rhinos: Herd of 50 -70 Zebra & 1.5 gemsbuck

Description of Husbandry Training in Practice:
White Rhinos:
All have been conditioned to walk in chute and stand for short intervals to allow for vaccinations, body palpation and securing of restraint doors.

Description of Research Conducted or Ongoing:
NA. Future research plans and goals are currently being discussed.

Institution: Lowry Park Zoo **Name of Participant:** Virginia Edmonds

email address: v.edmonds@gte.net **Phone Number:** 941-603-0275 **Fax Number:** NA

Rhinoceros Species Currently cared for and Collection Inventory:
Indian Rhino : 1.0

Diet Offered to Animals:
20lb ADF 16 herbivore + 10-15lb fruit & veggies + 30-40 lb Coastal / T.A hay

Number of animals exhibited in habitat:
One
Approximate Size of Each Exhibit:
70'x40'

Other Animal (s) Exhibited With Rhino (s) In each Habitat (s):
None

Description of Husbandry Training in Practice:
Chute trained , Target Trained, Blood collection. Open Mouth trained, "Dropping penis" (for semen collection)

Description of Research Conducted or Ongoing:
Study on horn rubbing - observations of animal in exhibit (night enclosure) and survey of other zoos

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Institution:Zoological Society of Buffalo

Name of Participant: Daryl Hoffman

email address: NA **Phone Number:** 716-837-3500 **Fax Number:** 716-837-0738

Rhinoceros Species Currently cared for and Collection Inventory:
Indian Rhino : 1.0 born 7-91 - came to Buffalo in 1993
Indian Rhino: 0.1 Born 12-96 came to Buffalo in 1998

Diet Offered to Animals:
Timothy hay + Low fiber grain + Alfalfa hay + Apples + Banana + Carrot + Sweet Potato + Celery + romaine Lettuce + Oranges + Corn on cub (Produce is used in training sessions, as well as in their diets.

Number of animals exhibited in habitat:
Each rhino has its own yard and 2 indoor stalls which each is housed during the night.

Approximate Size of Each Exhibit:
Each yard is ~3/4 Acre, each holding is ~ 20'x20'

Other Animal (s) Exhibited With Rhino (s) In each Habitat (s):
1.0 rhino shares the habitat with 13 Axis deer and 8 Peafowl (the peafowl often fly into habitat with 0.1 rhino also).
0.1 rhino will eventually share her yard with Axis deer as well.
(When rhinos are in the barn, they share the barn with one domesticated dog).

Description of Husbandry Training in Practice:
1.0 rhino is used to daily baths which he will lay down on cue. The same animal is trained for keepers to perform foot care when he is in down position.
0.1 rhino is currently being trained on target (this training started few months ago).

Description of Research Conducted or Ongoing: NA

Institution: San Diego Wild Animal Park

Name of Participant: Lance Aubery

email address: Laubery@sandiegozoo.org **Phone Number:** 760-747-8702 ext:5189 **Fax Number:** 760-480-9573

Rhinoceros Species Currently cared for and Collection Inventory:
Indian Rhino : 10
Eastern Black rhino: 3.0
Northern White Rhino: 1.2
Southern White Rhino: 12

Diet Offered to Animals:
Black rhino: Alfalfa pellet + Alfalfa hay + Bermuda hay + Browse
Northern White rhino: Alfalfa pellet + Alfalfa hay + Sudan hay + Bermuda hay + Vegetable tub
Southern White Rhino: Alfalfa pellet + Alfalfa hay + Sudan hay + Bermuda hay
Indian Rhino: Alfalfa pellet + alfalfa hay + Sudan hay + Bermuda hay + Browse

Number of animals exhibited in habitat:
Black rhino: 1 male per habitat
Northern White rhino: all together in one habitat
Southern white rhino: all together in one habitat
Indian Rhino: all together in one habitat

Approximate Size of Each Exhibit:
Black rhino: ~2 Acre
Northern White rhino: ~60 Acre
Southern White rhino: ~90 Acre
Indian Rhino: ~50 Acre

Other Animal (s) Exhibited With Rhino (s) In each Habitat (s):
Black rhino: None
Northern White rhino: 10 different species of mammals
Southern White rhino: 12 different species of mammals
Indian Rhino: 10 different species of mammals

Description of Husbandry Training in Practice:
All Northern White rhinos are chute trained

Description of Research Conducted or Ongoing:
Black rhinos: fecal collection for hormone assay
Northern White rhino: fecal collection for hormone assays, trans rectal ultrasound, attempted semen collection. attempted estrus inducement via drug therapy
Southern White rhino: fecal collection for hormone assays, attempted semen collection, trans rectal ultrasound
Indian Rhino: fecal collection for hormone assays, transrectal ultrasound

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Institution: Peace River Refuge

Name of Participant: Jeb Borsh

email address: NA **Phone Number:** 941-993-4529 **Fax Number:** NA

Rhinoceros Species Currently cared for and Collection Inventory:
Southern White rhino: 3.3
(we are planning to care for black rhinos and Indian rhinos in future)

Diet Offered to Animals:
Southern White rhino: 10lb Elephant supplement pellet + 70% grass hay + 30% alfalfa hay
** Bran , once a week**

Number of animals exhibited in habitat:
2.0 each in their own habitat alone, 1.3 in one habitat

Approximate Size of Each Exhibit:
1.0 - 5 Acres , 1.0 - 1 Acre , 1.3 - 13 Acre

Other Animal (s) Exhibited With Rhino (s) In each Habitat (s):
None

Description of Husbandry Training in Practice:
Chute trained , shift trained, needle desensitized.

Description of Research Conducted or Ongoing:
NA

Institution: Milwaukee County Zoo

Name of Participant: Dana Nicholson

email address: NA **Phone Number:** 414-771-3040 **Fax Number:** NA

Rhinoceros Species Currently cared for and Collection Inventory:
Southern Black Rhino: 2.2

Diet Offered to Animals:
Mazuri high fiber pellets
Alfalfa / Timothy hay

Number of animals exhibited in habitat:
Dependent on season. At this time adult male alone in yard, adult female & calf together , new 2 year old female alone. Alternate yards.

Approximate Size of Each Exhibit:
Large exhibit = 1/3 acre
Small exhibit = 1/4 acre

Other Animal (s) Exhibited With Rhino (s) In each Habitat (s):
None

Description of Husbandry Training in Practice:
Basic husbandry / medical training.
Chute trained , shift trained, tactile / body palpation, blood collection.
Description of Research Conducted or Ongoing:
Collaboration: Serum collection for reproductive / endocrinology
Semen collection
Medical blood collection

Institution: Tulsa Zoo

Name of Participant: Mark Swanson

email address: NA **Phone Number:** 918-669-6202 **Fax Number:** NA

Rhinoceros Species Currently cared for and Collection Inventory:
Southern White Rhino: 1.1

Diet Offered to Animals:
Mazuri Elephant cubes: 5 lb each
Herbivore Diet: 5 lb each
Prarie hay + Alfalfa hay

Number of animals exhibited in habitat:
1.1 white rhino

Approximate Size of Each Exhibit:
~80' x 160' yard

Other Animal (s) Exhibited With Rhino (s) In each Habitat (s):
None

Description of Husbandry Training in Practice:
NA

Description of Research Conducted or Ongoing:
NA

Institution: Busch Gardens

Name of Participant: Pandy Sokol

email address: PandyLSokol@anheuserbusch.com **Phone Number:** 813-987-5266 **Fax Number:** NA

Rhinoceros Species Currently cared for and Collection Inventory:
Black Rhino: 1.2
White rhino: 1.0

Diet Offered to Animals:
Black Rhino: Timothy / Alfalfa blend hay + Browser pellet grain + Oats + Vit. E supplement
White Rhino: ADF 25 pellet + Coastal hay

Number of animals exhibited in habitat:
1.2 black rhinos together
1.0 white rhino alone

Approximate Size of Each Exhibit:
White rhino exhibit = ~2000 sq feet
Black rhino exhibit = ~1/2 acre

Other Animal (s) Exhibited With Rhino (s) In each Habitat (s):
None

Description of Husbandry Training in Practice:
Blood drawing (from leg vein), xray. foot work, injections and routine medical examination with rhinos standing in chute.

Description of Research Conducted or Ongoing:
Collaboration: Fatty acids study ("missing Link")
M. Worley into basic immunology of Black rhinos
Looking into the role of Anti phospholipid syndrome in Black Rhino.

Institution: Riverbanks Zoo & Garden

Name of Participant: Kristin LaHue

email address: (W) kristinl@riverbanks.org (H) Brazzamnky@aol.com **Phone Number:** 803-779-8717
Fax Number: 803-253-6381

Rhinoceros Species Currently cared for and Collection Inventory:
Black Rhino: 1.1

Diet Offered to Animals:
Each animal receives: 25lb of ADF 16 (Mazuri brand) + 7-9 flakes of Alfalfa hay + 10ml vitamine E

Number of animals exhibited in habitat:
1.1 Black rhino

Approximate Size of Each Exhibit:
~ 2 acres (one exhibit)

Other Animal (s) Exhibited With Rhino (s) In each Habitat (s):
None

Description of Husbandry Training in Practice:
By utilizing tactile stimulation we are able to draw blood from 1.0 rhino tail.

Description of Research Conducted or Ongoing:
Fecal hormone research on male and female.

Institution: Birmingham Zoo

Name of Participant: Elven McMicken

email address: NA **Phone Number:** 205-879-0409 **Fax Number:** 205-879-9426

Rhinoceros Species Currently cared for and Collection Inventory:
Southern White Rhinos: 1.2

Diet Offered to Animals:
1.5 bale to 2 bales of Coastal hay (for 1.2 animals)
15 lb of ADF16 + 7 to 10 carrots + 1to 3 sweet potatos + 1 cup of trace mineral salt (per animal)

Number of animals exhibited in habitat:
1.2 animals together.

Approximate Size of Each Exhibit:
Exhibit = ~70 yard x 85 yard
Holding stall = ~20 to 25 ft x 30 to 40 ft

Other Animal (s) Exhibited With Rhino (s) In each Habitat (s):
None

Description of Husbandry Training in Practice:
Blood drawing , working toward semen collection.

Description of Research Conducted or Ongoing:
Behavioral studies
Enrichment studies

Institution: Cincinnati Zoo & Botanical Gardens **Name of Participant:** Paul Reinhart

email address: beacon-rhinos@fuse.net **Phone Number:** 513-232-1556 **Fax Number:** NA

Rhinoceros Species Currently cared for and Collection Inventory:
Black Rhino: 2.1
Indian Rhino: 1.1
Sumatran Rhino: 1.2

Diet Offered to Animals:
Mazuri ADF16 pellets
Alfalfa / Timothy hay / orchard grass
Browse

Number of animals exhibited in habitat:
NA

Approximate Size of Each Exhibit:
NA

Other Animal (s) Exhibited With Rhino (s) In each Habitat (s):
NA

Description of Husbandry Training in Practice:
NA

Description of Research Conducted or Ongoing:
Dr. Roth studies

Institution: Disney's Animal Kingdom **Name of Participant:** Ike Leonard. Micki Corcoran, Angela Cecil, Deanna Debo

email address: **Phone Number:** 407-938-2814 **Fax Number:** 407-939-6391

Rhinoceros Species Currently cared for and Collection Inventory:
Southern Black rhino : 2.2
Southern White Rhino: 2.5

Diet Offered to Animals:
Black Rhino: alfalfa and grass hay mix , ADF 16 Pellets , Variety of fresh browse (Acacia , willow, banana leaf , bamboo), Produce for training and enrichment
White Rhino: grass hay (75%) , ADF16 Pellets , Alfalfa hay (25%)

Number of animals exhibited in habitat:
Black rhinos: 1.2 in one habitat , 1.0 in second habitat

White Rhinos: 1.3 in one habitat , 1.0 in off exhibit yard , 0.2 (mother and calf) in off exhibit yard

Approximate Size of Each Exhibit:
2 public exhibits for black rhinos: 1= ~1/2 acre , 2= ~3/4 acre
White Rhino: ~10 acre

Other Animal (s) Exhibited With Rhino (s) In each Habitat (s):
Black rhinos: Yellow billed storks & Pink backed pelicans
White rhinos: Waterbuck (0.6), Greater Kudu (1.4), Scimitar-horned oryx (1.5), Mhorr gazelles (1.4)

Description of Husbandry Training in Practice:
Black rhinos:
Trained for blood draw (ear and leg vein), target trained, rectal temperature collection, open mouth on command, enter chute for rectal and body palpation and weight measurement, trained for command "OVER" and "Steady".
White Rhinos:
All have been trained to Target and station
Working toward blood collection

Description of Research Conducted or Ongoing:
Activity Budget of Black rhinos
Olfactory behaviors of male toward females urine and feces , correlated with blood and fecal assays for estrous detection (black rhinos)
Introduction of white rhinos