Rhino Keepers' Workshop

2001

Sponsored By:

Zoological Society of San Diego

May 7-10, 2001

PROCEEDINGS OF THE RHINO KEEPER S' WORKSHOP 2001

Sponsored by Zoological Society of San Diego

May 7-10, 2001
Town and Country Resort
San Diego, California

Introduction

The Zoological Society of San Diego hosted a three-day Rhino Keepers' Workshop on May 7-10, 2001 in San Diego, California. This workshop marked the second gathering of keepers representing a number of facilities that are currently caring for rhino taxa. 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 both North American facilities and International facilities.

Further understanding of the captive propagation of rhino species, closer partnership of the keepers responsible for daily care of the species in captivity, and expanded networking of the keepers from different facilities were highlights of this workshop. Also, information sharing by the parks and organizations studying rhino taxa in situ was discussed.

The Rhino Keepers' Workshop 2001 was sponsored by the **Zoological Society of San Diego** and endorsed by the **American Zoo and Aquarium Association**, the **Center For Reproduction of Endangered Species**, the **International Rhino Foundation**, the **Rhinoceros Taxon Advisory Group**, the **South African National Parks**, and the **Save the Rhino Trust**.

The **Rhino Keepers' Workshop 2003** will be hosted at the **Denver Zoological Garden**.
Our colleague **Christine Bobko** is the Workshop Committee Chair person for this event.
For further information about this event, please contact Chris at: Rhinoqueen@yahoo.com

Rhino Keeper Workshop 2001

San Diego Wild Animal Park

WORKSHOP COMMITTEE

Lance Aubery, Chairman
Jane Kennedy
Michele Gaffney
Lynn Patton
Caroline Slobig
and
Farshid Mehrdadfar

Workshop Endorsements:

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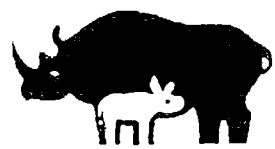

Regional Captive
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Rhino Keepers' Workshop 2001
Donor List

The Rhino Keepers' Workshop Committee would like to extend its gratitude and appreciation to the following corporations and individuals for their generous contributions.

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Gary Johnson

Sandra Jordan

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Lynn Patton

Randy Rieches

Rhino Keepers' Workshop 2001
Participants

Beck, Grady	Living Desert
Bunn, Nancy	Los Angeles Zoo
Briscoe, Jeff	Los Angeles Zoo
Blue, Andy	Disney's Animal Kingdom
Bobko, Chris	Denver Zoo
Cannon, Terry	Knoxville Zoo
Coleman, Phil	Houston Zoo
Clawson, Dave	The Wilds
Corcoran, Micki	Disney's Animal Kingdom
Davis, Tim	San Diego Zoo
Dupont, Bart	El Coyote Ranch
Eyres, Adam	Fossil Rim
Elam, Christopher	Dallas Zoo
Edmonds, Virginia	Living Desert
Fueglein, Cathi	St. Louis Zoo
Felts, Adam	Columbus Zoo
Forror, Suzanne	San Diego Zoo
Garrison, Bill	Knoxville Zoo
Gonzales, Art	Los Angeles Zoo
Hnath, Peter	Reid Park Zoo
Hren, Raymond	Milwaukee Zoo
Haight, Jay	Oregon Zoo

Harris, Kristin	Riverbanks Zoo
Hartney, Ingrid	San Francisco Zoo
Irby, Scot	El Coyote Ranch
Johnson, Janet	Glen Rose
Jewell, Erin	National Zoo
Jacobsen, Jeanne	Fort worth Zoo
Kendall, Gloria	San Diego Wild Animal Park
Leonard, Ike	Disney's Animal Kingdom
McGlothlin, Jefferey	CRES
Millwood, Angi	Disney's Animal Kingdom
Merkel, Jason	Disney's Animal Kingdom
McGilvray, Julie	San Francisco Zoo
Maki, Todd	Zoo Atlanta
Nester, Steven	Lion Country Safari
O'Brien, Karen	St. Louis Zoo
Otsu, Harou	ASA Zoo
Otsu, Takako	ASA Zoo
Pill, Linda	Baltimore Zoo
Pekarek, Ken	Cleveland Zoo
Pyatt, Doug	San Antonio Zoo
Peck, Jay	North Carolina Zoo
Pairan, Randy	Cincinnati Zoo
Preston, Ronda Planck	IRF
Reinhart, Paul	Cincinnati Zoo

Richner, Angelica	Busch Gardens
Rogers, Kelley	Birmingham Zoo
Roswell, Richard	Orana Wildlife Park
Ramasamy, Parmasivam	Singapore Zoo
Ryan, Deborah	Wildlife Safari
Shaffstall, Wendy	Kansas City Zoo
Sims, Charles Wesley	Tulsa Zoo
Stephens, Judy Lee	Detroit Zoo
Stringer, Megan	Little Rock Zoo
Sandor, Alisa	Cleveland Zoo
Sexton, Peggy	San Diego Wild Animal Park
Schroer, kelly	Buffalo Zoo
Stephens, Samantha	Auckland Zoo
Suppiah, Chidambaram	Singapore Zoo
Sills, John	Phoenix Zoo
Smith, Brett	Lincoln Park Zoo
Steele, Vickie	White Oak Conservation Center
Tennison, Harry	Game Conservation I.
VanSpronsen, Kim	Detroit Zoo
Villareal, Serapio	San Antonio Zoo
Vogle, Kathryn	Dallas Zoo
Weatherford, Derek	Fort Worth Zoo
Wynne, Janna	Los Angeles Zoo

Rhino Keepers' Workshop 2001 Agenda

Monday 07 May

4:00 - 9:00 PM Open Registration
7:00 - 9:00 PM Ice Breaker
7:00 - 8:00 PM Poster Presentation

- Weighing Juvenile Rhinos - Peggy Sexton
- Record Keeping - Estrus Cycle- Jane Kennedy
- Reproductive Cycle length in Southern Withe Rhinos - Lynn Patton
- Rhinoceros in Japan - Haruo Otsu

Tuesday 08 May

7:00 - 7:50 AM Open registration
7:30 - 7:50 AM Continental Breakfast
7:50 - 8:00 AM Call To Order - Farshid Mehrdadfar (Facilitator)
8:00 - 8:10 AM Opening Statements - Doug Myers (Executive Director ZSSD)
8:10 - 9:00 AM Status of Rhinos - Mike Dee
9:00 - 9:45 AM SRT & Rhino Projects in Namibia - Blythe Loutit
9:45 - 10:00 AM Break
10:00 - 10:45 AM Genetic Studies in Black Rhinos - Dr. Ollie Ryder
10:45 - 11:30 AM Reproductive Research and Technology - Dr. Terri Roth
11:30 - 12:45 PM Lunch **11:45 Group Photo*
1:00 - 1:45 PM Rhino Status in Kruger National Park - Danie Pienaar
1:45 - 2:30 PM Reproductive Anatomy - Dr. Thomas Hildebrandt
2:30 - 2:45 PM Break
2:45 - 3:30 PM Javan Rhinos in Viet Nam - Nico van Strien
3:30 - 4:15 PM Artificial Insemination in Rhinos - Dr. Robert Hermes

Wednesday 09 May
Field Tour, San Diego Wild Animal Park

10:00	AM	Arrival at Wild Animal Park
10:30 - 12:00	PM	Field Tour (behind Admin. Building)
12:00 - 12:30	PM	Lunch at Malawi Grove. ALL GROUPS (1-6)
12:30 - 2:00	PM	Free Time at Park
2:15	PM	Departure from Park to Hospital (Front Gate)
2:30 - 3:30	PM	Hospital Tour
3:30	PM	Departure from Hospital to Park
3:45 - 5:00	PM	Free Time at Park
5:00 - 6:00	PM	Silent Auction (Mombasa Pavilion)
6:00 - 7:00	PM	Dinner (Mombasa Pavilion)
7:00 - 7:45	PM	Sumatran Rhinos - Dr. Aidi Mohamad (Mombasa Pavilion)
7:45 - 8:45	PM	Video Presentation (s) (Mombasa Pavilion)
9:00	PM	Departure from Wild Animal Park to Resort (Front Gate)

Thursday 10 May

7:30 - 7:50	AM	Continental Breakfast
7:50 - 8:00	AM	Call to Order - Farshid Mehrdadfar (Facilitator)
8:00 - 8:40	AM	Training for Semen Collection - Adam Ayres
8:40 - 9:20	AM	Training for Blood Collection - Vicki Steele
9:20 - 10:00	AM	Utrasound Training of Black Rhinos - Micki Corcoran
10:00 - 10:15	*AM*	*Break*
10:15 - 10:55	AM	Measuring Stress Indices in Black Rhinos - Chris Bobko
10:55 - 11:35	AM	Chute Construction - Todd Maki
11:35 - 12:45	*PM*	*Lunch*
1:00 - 1:45	PM	Rhino Foot Care - Jeanne Jacobsen
1:45 - 2:30	PM	Hand-raising Rhino calves - Cat Avila & Denise Wagner
2:30 - 2:45	*PM*	*Break*
2:45 - 3:30	PM	Rhino Immobilization - Dr. Jack Allen
3:30 - 4:15	PM	Southern White Rhino Captive Behavior - Ron Swaisgood
4:15 - 5:00	PM	Discussion / Closing Statements - Randy Rieches
5:00 - 5:15	PM	Surveys / Feed Back

PAPER PRESENTATIONS

1. Population and Conservation of Rhinos
   Mike Dee, Director of Los Angles Zoo
2. Save the Rhino Trust & Rhino Projects in Namibia
   Blythe Loutit, President and founder of Save the Rhino Trust
3. Genetic Studies in Black Rhinos
   Dr. Ollie Ryder, Geneticist at Center for Reproductive of Endangered Species
4. Reproductive Research and Technology
   Dr. Terri Roth, Director of Research at Cincinnati Zoological and Botanical Garden
5. Rhino Status in Kruger National Park
   Danie Pienaar, Conservation Scientist at Kruger National Park
6. Reproductive Anatomy -
   Dr. Thomas Hildebrandt, Director of Reproductive Management, IZW, Germany
7. Javan Rhinos in Viet Nam
   Nico van Strien,Conservation Scientist, IRF & AsRSG, Indonesia
8. Artificial Insemination in Rhinos
   Dr. Robert Hermes, Senior Veterinarian, IZW, Germany
9. Training for Semen Collection
   Adam Ayres, Animal Care Supervisor at Fossil Rim Wildlife Center
10. Training for Blood Collection
    Vicki Steele, Animal Care Supervisor at White Oak Conservation Center
11. Utrasound Training of Black Rhinos
    Micki Corcoran & Ike Leonard, Animal Keepers at Disney's Animal Kingdom
12. Measuring Stress Indices in Black Rhinos
    Chris Bobko, Animal Keeper at Denver Zoological Garden
13. Chute Construction
    Todd Maki, Animal Keeper at Zoo Atlanta
14. Rhino Foot Care
    Jeanne Jacobsen, Lead Keeper at Fort Worth Zoo
15. Hand-raising Rhino calves
    Cat Avila & Denise Wagner, Animal Keepers at San Diego Wild Animal Park
16. Rhino Immobilization
    Dr. Jack Allen, Senior Veterinarian at San Diego Wild Animal Park
17. Southern White Rhino Captive Behavior
    Ron Swaisgood, Research Fellow, Center for Reproductive of Endangered Species
18. Discussion / Closing Statements
    Randy Rieches, Curator of Mammals at San Diego Wild Animal Park

Rhino Keepers' Workshop 2001
Speakers Networking System

1. Michael Dee - status of rhinos
    a. e-mail address for contact - MDEE@ZOO.CI.LA.CA.US
    b. see attached population numbers of captive and wild rhinoceros

2. Blythe Loutit - Save the Rhino Trust Rhino Project in Namibia
    a. e-mail address for contact - srt@rhino-trust.org.na
    b. wants more zoos to do more controlled eco-tourism in park
    c. funds for employing more rangers to guard rhinoceros
    d. keeper exchanges with their rangers

3. Dr. Oliver Ryder - CRES - Genetic studies in Black Rhinoceros
    a. e-mail address for contact- oryder@sandiegozoo.org
    b. genetic samples of all rhinoceros needs to be banked, someone needs to spearhead

4. Dr. Terri Roth - CREW - Reproductive Research and Technology
    a. e-mail address for contact - terri.roth@cincyzoo.org
    b. hormonal monitoring needed on all rhinoceros
    c. SW Rhino ultra sound needs to be done on all non producing animals
    d. Indian Rhinoceros semen samples needed for research

5. Danie Pienaar - Rhinoceros status in Kruger National Park
    a. e-mail address for contact - Dpienaar@parks-sa.co.za
    b. controlled tourism in Kruger
    c. poaching for meat still a problem - education information on bush meat trade needed

6. Dr. Thomas Hildebrandt - Reproductive Anatomy
    a. e-mail address for contact - hildebrand@izw-berlin.de
    b. availability of him and or his team for evaluation of animals in US zoos
    c. support for reproductive projects

7. Dr. Nico van Strien - Javan Rhinoceros in Vietnam
    a. e-mail address for contact - STRIEN@COMPUSERVE.COM
    b. educational materials on rhinoceros for villages needed
    c. funds for rangers to patrol rhinoceros habitat

8. Dr. Robert Hermes - Artificial Insemination in Rhinoceros
    a. e-mail address for contact - hermes@izw-berlin.de
    b. availability of him or his team for reproductive evaluation of animals
    c. support for reproductive projects

9. Adam Eyres - Fossil Rim - Training for Semen Collection
    a.. e-mail address for contact - adame@fossilrim.org
    b. tips for training animals to collect semen

10. Vickie Steele - White Oak Conservation - Training for Blood Collection
    a. e-mail address for contact - vickies@wogilman.com
    b. tips for training animals for blood collection

11. Micki Corcoran - Disney's Animal Kingdom - Ultrasound Training of Black Rhinoceros
    a. e-mail address to contact - michelle.e.corcoran@disney.com
    b. tips for training animals for ultrasound

12. Chris Bobko - Denver Zoo - Measuring Stress Indices in Black Rhinoceros
    a. e-mail address for contact - rhinoqueen@yahoo.com
    b. tips for evaluating stress in your animals environment

13. Todd Maki - Atlanta Zoo - Chute Construction
    a. e-mail address for contact - MakiTodds@Hotmail.com
    b. ideas for building a better rhinoceros restraint chute

14. Jeanne Jacobsen - Fort Worth Zoo - Rhinoceros Foot Care
    a. e-mail address for contact - jmjacob@cowtown.net
    b. tips for training animals for foot care
    c. database for rhinoceros foot problems and their treatments needs to be set up

15. Catherine Avila and Denise Wagner - SDWAP - Hand Raising Rhinoceros Calves
    a. e-mail address for contact - cavila@sandiegozoo.org / dwagner@sandiegozoo.org
    b. formulas for rhino calves and the effectiveness of different dilutions used

16. Dr. Jack Allen - SDWAP - Rhinoceros Immobilization
    a. e-mail address for contact - jallen@sandiegozoo.org
    b. tips for a good immobilization of rhinoceros

17. Dr. Ron Swaisgood - CRES - Southern White Rhinoceros Captive Behavior
    a. e-mail address for contact - rswaisgood@sandiegozoo.org
    b. captive behavior and how it correlates to reproduction

18. Randy Rieches - SDWAP - Wrap up
    a. e-mail address for contact - rrieches@sandiegozoo.org

Wild and Captive Populations of Rhinoceros
2001

Species or Subspecies	Wild Pop.	Captive Pop.
AFRICAN RHINOCEROS		
Southwestern Black Rhinoceros	>750	0
Northwestern Black Rhinoceros	>10	0
Eastern Black Rhinoceros	>500	>175
Southern Black Rhinoceros	>1,450	>65
Total Black Rhinoceros	>2,700	>240
Northern White Rhinoceros	30	10
Southern White Rhinoceros	~10,400	>730
Total White Rhinoceros	~10,430	>740
Total African Rhinoceros	**>13,100**	**>980**
ASIAN RHINOCEROS		
Total Nepalese/Indian Rhinoceros	~2,400	~140
Indonesian Javan Rhinoceros	≥60	0
Vietnamese Javan Rhinoceros	≥8	0
Total Javan Rhinoceros	~60	0
Eastern (Borneo) Sumatran Rhinoceros	~50	2
Western (Sumatran/Malayan)Sumatran Rhinoceros	~250	13
Total Sumatran Rhinoceros	~300	15
Total Asian Rhinoceros	**~2,760**	**~155**
TOTAL WORLD RHINO SPECIES	**~16,000**	**~1,100**

Papers Submitted

Hand-rearing Black and White Rhinoceroses: A Comparison

by
Denise C. Wagner, Mammal Keeper
Mark S. Edwards, Ph.D.; Nutritionist, ZSSD
San Diego Wild Animal Park
Escondido, CA

Abstract

The San Diego Wild Animal Park is home to one of the larger populations of captive rhinos representing three different species. As such, we have been successful breeding these animals. There are occasions, rare though they may be, which require that rhino calves be pulled for hand rearing. Since 1995, the Animal Care Center at the Wild Animal Park has had the opportunity to hand-rear two Eastern black rhinos (*Diceros bicornis michaeli*) and two Southern white rhinos (*Ceratotherium simum simum*). Prior to this time period the last black rhino was hand-reared in 1976 and the last white rhino hand-reared in 1988. While unusual that this number of calves have required hand-rearing recently, the staff of the Animal Care Center or the ACC, the Zoological Society of San Diego's nutritionist, and the veterinary staff have utilized these opportunities to learn more about these two species and refine the techniques used for hand-rearing.

Introduction

The reasons for hand-rearing of these four individual rhino calves vary. The Eastern black rhino calves were both pulled for medical reasons and the Southern white rhino calves for maternal neglect. Jomo, a male Eastern black rhino born on 22 July 1995, is the offspring of Cornelius and Judy. His front legs were weak and required casts for support. Jambia, a male Eastern black rhino born on 24 February 1997, is also the offspring of Cornelius and Judy. This calf was born late in the evening on a cold night. His was a normal, easy birth and he was almost able to stand but then got very cold. His temperature was 82° F when received at the care center. He was also hypoglycemic at this time.

Mbolo, a male Southern white rhino born 5 September 1998, is the offspring of Chuck and Mfolozi. He is a rather unusual case as he is the fourteenth calf from this dam. Prior to this calf, Mfolozi had been an attentive dam. There was a calf born in June of 1998 to another Southern white female, Komaas, and Mfolozi attempted to adopt this calf shortly before Mbolo was born. When he was born, the dam showed no interest in him and he was pulled. Uhuru, a male Southern white rhino born 2 March 1999, is the offspring of Chuck and Ujima. Ujima is a first time dam and was only four years of age at this birth. She initially showed signs of caring for the calf but the adult male, Chuck, was harassing her and she then neglected the calf. Ujima was also born at the park making Uhuru the first second-generation Southern white rhino born at the Wild Animal Park.

Formula protocols

Rhinoceros milk is more dilute than milks of other ungulate species. It is low in solids and proteins, very low in fat, and high in sugar (Oftedal, 1984). While different than rhino milk, non-fat and low fat cow's milk can be used as an appropriate substitute with the addition of other ingredients. Cow's milk is low in iron and an iron source is added to the formula once per day.

Vi-Sorbin is the product used at the ACC. Lactose (powdered, edible grade) is used to increase the sugar content. Dextrose (reagent grade) may be substituted for the lactose. Lactose is preferred, as that is the type of sugar found in rhino's milk. The feeding regimen will vary over time in terms of type of formula offered and number of times per day (see Table 1).

Table 1. Rhino Formula and Feeding Guidelines

Age	Formula	Ratios	Feedings per day[1]
1 day old	100% cow's colostrum		7 times, every 2 hrs.
2 days old	NFC:LFC:Lactose:H_2O w/ 50% colostrum	27:9:1:1[2]	7 times, every 2 hrs.
3 days to 1 month early lactation formula	NFC:LFC:Lactose:H_2O w/ 10% colostrum	27:9:1:1	7 times, every 2 hrs.
1 - 3.5 months early lactation formula	NFC:LFC:Lactose:H_2O	27:9:1:1	5 times, every 3 hrs.[3]
3.5 - 6 months mid-lactation formula	NFC:LFC:Lactose:H_2O	27:9:1:2	4 times
6 - 9 months mid-lactation formula	NFC:LFC:Lactose:H_2O	27:9:1:3	3 times
9 - 12 months mid-lactation formula	NFC:LFC:Lactose:H_2O	27:9:1:4	3 times
12 - 15 months late lactation formula	NFC:LFC:Lactose:H_2O	27:9:1:6	2 times
15 - 18 months late lactation formula	NFC:LFC:Lactose:H_2O	27:9:1:8	2 times

NFC: Liquid non-fat cow's milk (skim milk)
LFC: Liquid low-fat cow's milk (1% fat)
Lactose: powdered, edible grade; can substitute dextrose (reagent grade) for the lactose
[1] day consists of a twelve hour period from 6 am to 6 pm
[2]27 parts NFC to 9 parts LFC to 1 part lactose to 1 part water
[3]at roughly two months of age the calf can go to 4 times per day

For the first twenty-four hours 100% cow's colostrum is fed. This provides the calf with intact immunoglobulins (antibodies) which they would have received from the dam's milk. Do not overheat the colostrum as this will destroy proteins. Make the transition to formula over the next twenty-four hour period by feeding 50% colostrum and 50% formula. For continued gastrointestinal protection the calf is fed 10% colostrum and 90% formula for the next four weeks. Formula is offered at a rate of 15-20% of the body weight per day. The daily volume offered is maintained when dropping a feeding until the weaning process begins. Weaning begins at approximately one year of age with a target wean date of approximately eighteen months. The formulas are designed to come as close to rhino milk as possible in terms of composition during early, mid-, and late lactation periods (see Table 2).

This protocol is used as a guide and can be adjusted as needed to suit individual animal's needs. When mixing the above formula, reconstitute the lactose (measured by weight) with water (measured by volume) following the values in the ratio column. Lactose will readily go into

solution by heating the water. This can be made up in advance and added to the formula when cooled. Weigh out the lactose/water stock for the formula.

Example:	NFC	1350 ml
	LFC	450 ml
	Lactose/water stock	100 grams*
	Approximate total	1900 ml

*Note: 100 grams of lactose/water stock is not 100 ml.

Table 2. Percentage Composition of Rhino Milk and Formula

	Total solids	Fat	Lactose	Protein	Ash
White rhino* sample A	8.84	0.60	6.50	1.54	0.20
White rhino* sample B	8.26	trace	6.85	1.18	0.23
Black rhino**	8.10	trace	6.06	1.54	0.34
27:9:1:1	11.39	0.38	5.63	3.20	0.72
27:9:1:2	11.09	0.37	5.48	3.12	0.70
27:9:1:3	10.82	0.36	5.35	3.04	0.68
27:9:1:4	10.55	0.35	5.21	2.97	0.66
27:9:1:6	10.06	0.33	4.97	2.83	0.63
27:9:1:8	9.62	0.32	4.75	2.70	0.60

*Data from Wallach, 1969. Sample A is a cow with a five month calf; sample B is from a cow with an eighteen month old calf.

**Data from Aschaffenberg, et al., 1961. This sample is from a cow with a nineteen month old calf.

Jomo, Mbolo, and Uhuru were or are being raised on this formula and schedule. Jambia was raised on a slightly different formula. This change was based on information gained from a collaboration that our nutritionist (second author listed above) had with the staff of Fossil Rim Wildlife Center on black rhino milk analysis. The staff from Fossil Rim was able to milk a black rhino for a period of one year and analysis of these samples showed that rhino milk had a lower percentage of solids than did the formula. Formula components remained the same for Jambia, but the ratios were adjusted (see Table 3).

Table 3. Jambia's Formula Schedule

Day	NFC	LFC	Dextrose	Water
8	27	9	1	1
26	18	9	1	4
31	18	9	1	8
36	9	9	1	10
95	9	9	1	5

These formula ratios lowered the percentage of solids without affecting the other primary components. This formula was more dilute than the other and as was learned did not fill up the calf as readily. Prior to day 8, Jambia was receiving dam's milk mixed with formula, as the field crew was able to milk Judy before she dried up. Jomo also received dam's milk before going to straight

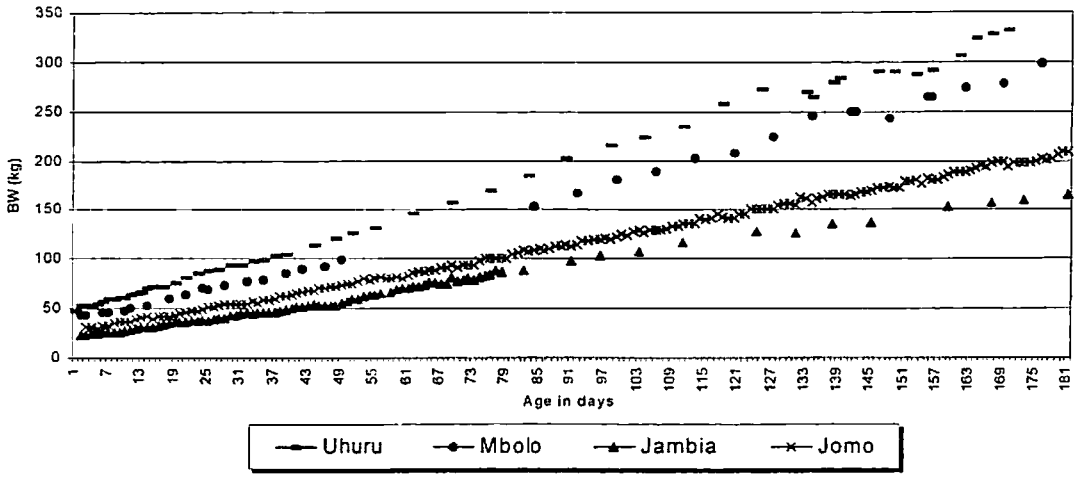
formula. It was not possible to milk either Southern white rhino dam so neither Mbolo or Uhuru received dam's milk.

Herbivore pellets, grains, acacia (*Acacia saliana*) browse and alfalfa hay were made available from the second week on. Once they started getting their teeth, an effort was made to place food in their mouths to encourage them to pick up solids. Tooth eruption began at roughly 1 week of age in black rhinos and roughly 1 month of age in white rhinos.

Growth

Rhinos in general tend to grow at a very fast rate. Depending on the species, it's not unusual for the calf to put on 25-50 kg per month for the first year of life. Black rhinos, being a smaller species, would not put on as much weight as the white rhinos. The Eastern black rhino calves, over the first six months of life, averaged 0.98 kg/day for Jomo and 0.79 kg/day for Jambia. Mbolo averaged 1.53 kg/day for the first six months and Uhuru averaged 1.79 kg/day for the first four months (he had not reached six months of age as of this writing).

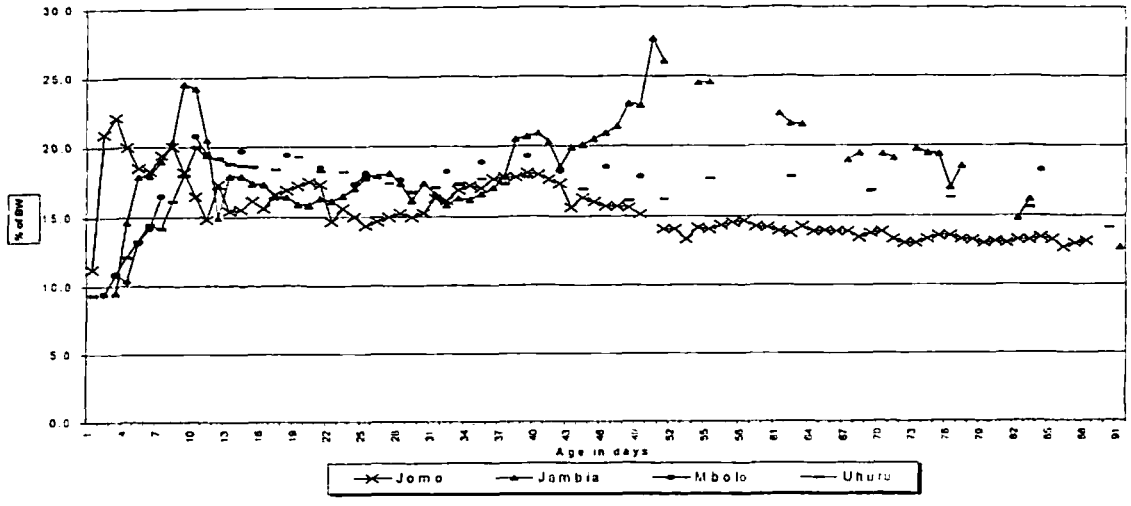
Chart 1. Rhino growth



In the first six months, both the Eastern black rhinos and the Southern white rhinos gained weight in an almost linear fashion (see chart 1). However, both white rhino calves started to have a definite upward trend in their growth at approximately sixty days of age. The black rhino calves' growth tended to stay more constant over time.

Formula was offered at the rate of 15-20% of their body weight per day. This was used as a guideline and the amounts did vary (see chart 2). Jambia reached the highest percentage at 27.7%. If the rhinos appeared hungry or frantic for formula then the percentage would be increased until they appeared satisfied. Instances of dirt eating occurred when these animals were not satisfied at their current amounts. Dirt eating was carefully monitored and when instances occurred, psyllium was added to their bottles to aid in moving the dirt through their systems.

Chart 2. Intake Percentages



Medical Problems

There were few medical problems encountered with any of these calves. Jomo came to the ACC with casts on his front legs because they were weak and would buckle under when standing after he was born. His rear legs were weak as well but did not require casts. Once the casts were removed, his legs continued to get stronger and he progressed normally and did not require any further support. His legs were in casts for less than a week. His primary problem while in the ACC's care was constipation. He was given several warm water enemas, which were successful, and he also, at times, received psyllium in his bottle twice a day to encourage the passage of stool.

Jambia encountered more medical problems than Jomo as he came to the ACC compromised. His temperature was very low (82° F) and he was also hypoglycemic requiring IV therapy. This therapy consisted of 5% dextrose in water, which was switched to 7.5% dextrose in water overnight, for the first night. He continued on 5% dextrose in water IV for five days. The first day he also received steroids IV as well as 50% dextrose. Antibiotics were prescribed for five days as a precautionary measure. Once over this initial hurdle, his primary problem came to be constipation as was seen in Jomo. He received several enemas to aid in stool passage. Psyllium was also given and was also added to his bottles when he developed a dirt eating habit. This was done as a precaution against sand in the stool.

The Southern white rhinos did not have the problems with constipation that the Eastern black rhinos had. Both white rhino calves, however, encountered problems with *Giardia lamblia.* Mbolo was diagnosed as *Giardia* positive as well as *Campylobacter spp.* positive at the same time. This initially manifested itself in the form of diarrhea and appetite loss. Until stool cultures came back with results, he was treated with antibiotics and a wormer as a precaution. The antibiotic helped to combat the campylobacteriosis. Once giardiasis was diagnosed, he was started on a proper treatment regimen. On recheck he was negative for both. All medications were given in his bottles with little difficulty.

Uhuru was also diagnosed as *Giardia lamblia* positive. He was treated and on recheck was negative for giardiasis but his diarrhea persisted. Several other tests were run to determine if another disease organism was at work but all tests came back negative. His formula was changed to a dextrose formula instead of lactose. It was thought that perhaps the enzyme, lactase, found on the villi in the gut had been stripped away during his initial bout with diarrhea rendering him unable to properly digest his formula. It was hoped that by changing him to dextrose, which is broken down by another enzyme, that this would allow the lactase to replenish. His diarrhea did not readily resolve and as of this writing was still not completely resolved although it is much improved. Unlike Mbolo, there was no appetite loss in Uhuru. He continued to eat normally although his attitude became somewhat depressed. His medications were given in his bottles with no trouble whatsoever. Uhuru would also on occasion eat dirt. This occurred during growth periods and, with the addition of psyllium to his bottles, there were no problems encountered.

Socialization

One of the more important elements in the hand-rearing process is the socialization of the calf. Socialization helps alleviate neurotic behaviors in the calf and eases reintroduction to conspecifics at a later date. This also helps to ease the dependency of the calf on its human caretakers. Whenever possible, a companion animal is placed with the rhino calf. It is best that the companion be a large animal, as rhinos tend to play rough. In addition to providing companionship for the calf, the companion animal helps to exercise the calf. Exercise is essential to proper bowel movement. Rhino calves will run along side keepers but usually do not exercise much on their own until older. As keepers cannot be with their charges twenty-four hours a day, the companion animal provides the needed stimulus to get the calf up and moving. When initially brought to the ACC for hand-rearing, the calves were kept isolated from other animals for 1-2 weeks. They were considered "scrubbies" during this time period which meant keepers wore gloves, booties, and coveralls when dealing with the calf. This was to prevent any cross-contamination from other animals being hand-reared. Since a companion animal cannot be provided at this time, a stuffed hippo was left in the stall with the calf and provided the young animal with a companion until such time as the calf comes out of isolation. (Note: Make sure that whatever stuffed animal is used, it is fairly large and definitely washable.)

Neither Eastern black rhino calf had an animal companion initially when being hand-reared. There were no suitably sized animals being hand-reared at the same time as they were. Jomo had fewer behavioral problems during this time period than Jambia. Jambia developed a dirt-eating problem early on and had to be moved to another holding area in the facility which had a grass substrate rather than DG to alleviate this problem. To help in the transition from the ACC to living with less keeper contact, it was decided to bring up a domestic goat from the Children's Zoo at the San Diego Zoo as a companion animal. Aja, a Cashmere goat (*Capra hircus*), was then brought up and introduced to Jambia. First introductions were a little rocky, but the goat quickly learned to get out of the rhino's way. Unfortunately the move to grass could not be a long-term holding area and Jambia and the goat were moved to a holding yard at the black rhino exhibit area. This area's substrate is dirt. Since the goat did not initially appear to be fulfilling the roll of companion it was decided to ship the goat back to the San Diego Zoo and they were separated for a short time. During this separation Jambia resumed eating dirt and it was decided to try the introduction once again. When reintroduced, Jambia's dirt eating decreased and the goat was left with him. These

two animals never formed a very close bond with one another but it now appears the goat is far more attached to the rhino than the rhino is to the goat.

Mbolo's animal companion was a female gaur (*Bos frontalis gaurus*) calf that had come into the ACC at about the same time. There was also a wisent (*Bison bonasus*) calf and a water buffalo (*Bubalus bubalis*) calf housed at the ACC as well. The water buffalo and wisent did not live with the rhino twenty four hours a day but were put together with the gaur and the rhino for several hours a day in a large yard for exercise. The rhino would challenge all three calves to which the gaur and water buffalo were basically oblivious or would simply move out of his way. The wisent, once a little larger, would actually go head to head with the rhino in play sparing. Mbolo and the gaur associated much more closely than Jambia and the goat and would lie together. Once the gaur was weaned, it was attempted to leave her with him as a companion but she proved to be a handful to the keepers and she was removed. Mbolo had a depressed attitude once she was gone even though he continued to associate with the wisent and water buffalo for several hours per day. He had not bonded with them as he had the gaur. It was not possible to house them together overnight because Mbolo would charge the water buffalo when she entered his stall. Despite his apparent unwillingness to share his stall with them, when separated from them and housed alone he would vocalize for long periods of time. He was given access to the stuffed hippo to help ease the transition and was often found sleeping on, next to, or using it as a pillow. Once he was too big to be housed at the ACC, it was decided to try to introduce him to Jambia at black rhino holding. Mbolo was moved to black rhino holding at just over six months of age. When initially introduced there was no real aggression and Mbolo would defer to the larger rhino. The two did not associate very much in this introduction period preferring to stay away from each other. Mbolo was also not fond of the goat and would charge when Aja ventured too close. However after approximately a week of being housed together, Mbolo developed diarrhea once again and a stool sample showed he was *Giardia* positive. He was separated from Jambia because it was felt that perhaps the situation was stressful for him, which led to a flare-up of giardiasis. This separation was also done to prevent Jambia from contracting giardiasis. After treatment, a reintroduction occurred roughly 3 weeks later, with Mbolo now being removed from Jambia at night. This nightly separation lasted about one week and then they were allowed to live together twenty-four hours per day. The reintroduction went very smoothly and they began to associate more with one another. Mbolo also would not back down to the larger Jambia as often. He still did not like the goat though. Mbolo and Jambia now closely associate with each other often lying next to one another when dozing.

Uhuru also had the stuffed hippo as a companion while he was in isolation. He would lay against it and use it as a pillow. During the first two weeks of his life, discussions among the staff occurred as to what sort of companion to give him. There were no large animals currently being reared at the ACC except for a Grevy's zebra (*Equus grevyi*) and a Somali wild ass (*Equus asinus somalicus*), both of which were deemed unsuitable as companions for him. They were both considerably older and the zebra in particular was a very flighty animal. The zebra and Somali wild ass were housed together and there was no wish to separate them from each other. When Uhuru was about two weeks of age, the ACC received a Patterson's eland (*Taurotragus oryx pattersonianus*) calf for hand-rearing. She was not pulled specifically as a companion but had been a dystocia birth. It was felt that she would make a suitable companion for him and once her isolation period was over, an introduction took place. Initially they were wary of one another with the eland assuming a head down position. She was clearly not going to be intimidated by the rhino.

For two days their interaction occurred only during the day and they were not housed together overnight. Once it was felt that they could safely be left together, they were housed in the same stall. There was not much association with each other initially although when one would get excited and run this usually led to the other following suit. While in the smaller stall off exhibit the rhino did not want the eland lying near him and would force her away from him. Gradually over a period of a few weeks they began to lay together and associate more closely. Once the Patterson's eland was weaned it was decided to keep her at the ACC for as long as safely possible to keep Uhuru company. Fortunately for the staff she is not as pushy as the gaur and as of this writing is still housed with Uhuru at the ACC.

Present disposition

At present, three of the four rhinos are still housed at the San Diego Wild Animal Park. Jomo was shipped to the Pittsburgh Zoo at just over one year of age. Mbolo and Jambia reside together along with the Cashmere goat, Aja, in an off exhibit holding area. Uhuru as of this writing is still housed at the Animal Care Center along with the Patterson's eland.

Discussion

Black and white rhinos do not differ significantly at least in terms of hand-rearing. Both species have milk that is similar in composition. The same formula can be used effectively for both types of rhinos. Jomo, Mbolo, and Uhuru were all raised on the same formula. Jambia's formula was more dilute than that of the other three. This more dilute formula did not appear to affect the growth rate as Jambia's rate almost mirrors that of Jomo (see chart 1) in being very linear in fashion. The major difference with the more dilute formula was that his overall intake percentage was higher (see chart 2) and there were more instances of dirt eating when he was not satisfied. This formula did not appear to fill him up as effectively as the more concentrated formula. When Mbolo was pulled for rearing this was taken into account and he was switched back to the more concentrated formula. This was also the case with Uhuru. There were fewer instances of dirt eating in these two animals. The white rhino growth rates are linear in fashion as well and mirror that of the black rhinos until roughly days 51-60 when there is a definite upswing in their growth rate (see chart 1). Being a larger species this is to be expected. The black rhinos picked up eating solids much sooner than the white rhinos did. Tooth eruption occurs sooner in the black rhinos than in the white rhinos. First teeth appeared at about a week of age in the black rhinos and roughly one month of age in the white rhinos. The first instances of solid consumption were at approximately one month of age in the black rhinos and three to four months of age in the white rhinos. Since the black rhinos did not have companion animals, keepers made an effort to place solid food in their mouths. This was also done with the white rhino calves but to a lesser degree as they had companion animals and it was hoped that they would mimic their companions in this respect. Whether placing the food in their mouths led to the black rhinos picking up solids earlier than the white rhinos is speculation at this point. This was also done with the white rhino calves but to a lesser degree. It could simply be species differences.

There were not significant medical problems encountered with these animals. The major problem seen in the Eastern black rhinos was that of constipation. Since exercise is necessary for proper bowel movement it is not surprising that these animals developed this problem. The black rhinos had much more limited access to larger exercise spaces than did the Southern white rhinos. The black rhinos also did not have companion animals with which to socialize and the stimulus for

getting up and moving was not there. Significant effort was made to get these animals up and exercising but with other animals to care for it was simply not possible for keepers to spend as much time as necessary with these two animals. The white rhino calves both had companion animals and more access to large exercise areas and constipation was not an issue with them. The major problem seen in the white rhino calves was that of giardiasis, and additionally campylobacteriosis in Mbolo. White rhinos are grazers and black rhinos are browsers. The white rhino calves spent more time with their mouths to the ground than did the black rhinos. Mbolo and Uhuru were continually putting their mouths on anything and everything on the ground. They were especially fond of any puddle of water on the ground and preferred to drink from puddles rather than water tubs if puddles were available. Both *Giardia lamblia* and *Campylobacter spp.* survive in moist environments such as dirt or DG and this is probably where the white rhinos picked up the organisms. Since black rhinos are browsers, the two black rhino calves did not spend as much time mouthing objects on the ground or drinking from puddles.

Socialization was very different for these four animals. The black rhino calves did not have companion animals initially and were far more dependent on their keepers and, to a much lesser degree, the public for stimulation. Aja, the goat, seemed to help Jambia as his dirt eating decreased when the goat was reintroduced to him. As he was older at this time, the dirt eating is believed to have been behavioral in origin and not linked to hunger as in his initial bouts of dirt eating. In comparing temperaments it is difficult to say whether they are significantly different as the black rhinos were raised without companions and became more dependent on their keepers. The white rhinos each had companions and were not as dependent on keepers for daily stimulation. Among individuals of a species there were definite differences. Of the two black rhinos, Jomo was far more dependent on keeper interaction as he was raised completely alone. Jambia eventually had a goat for company and because of his dirt eating habits had to be removed from the ACC at an early age and therefore did not see his keepers as often. The two white rhino calves did not differ significantly in temperament from each other. Neither Mbolo or Uhuru were completely dependent on their keepers for interaction and often would wander away from the keeper after feeding was done or fun toys (i.e. trash bags, rakes, and scoops) were put away. Frustrations tended to be taken out on their companion animals for which keepers were grateful.

Conclusions

Hand-rearing of Eastern black and Southern white rhino calves does not vary significantly between the two species. The same formula can be used to successfully rear both species. While raised under differing circumstances, it does appear important to provide companion animals for the calves if possible. This seems to significantly reduce the dependence of the calves on their human caretakers. In addition, a companion helps stimulate the calf to exercise and keep things moving through their systems. In having the opportunity over the course of four years to hand-rear four rhino calves, the mammal and veterinary staffs of the San Diego Wild Animal Park have been able to expand their knowledge of these animals. This opportunity has also allowed for the refining of techniques for hand-rearing, including formula composition and feeding protocols, medical problems encountered, and socialization of these calves. A great deal of knowledge regarding growth rates has been gained. Even though much has been learned regarding the care of these animals there is still much to be learned in the future. It is best to leave the calves with their dams but if that becomes impossible the knowledge gained from these calves and others reared elsewhere will only help in the survivability of future calves.

Acknowledgements

Raising four rhino calves takes a tremendous amount of time, energy and dedication and is truly a team effort. The authors wish to give many thanks to the mammal staff of the Wild Animal Park, especially the Animal Care Center. Their input on this paper and their time and effort in rearing these calves is greatly appreciated.

Products Used

Vi-sorbin[R]: Vitamin-Iron Preparation with Sorbitol
Distributed by Animal Health
Exton, PA 19341, USA
Div. of Pfizer, Inc.
New York, NY 10017

Equi-Aid[R]
Natural Psyllium Fiber
Equi-Aid Products, Inc.
Phoenix, AZ 85027

Lactose (Edible grade)
AMPC, Inc.
2325 North Loop Dr.
Ames, IA 50010

Dextrose
D-(+)-Glucose
(Dextrose; corn sugar)
Sigma Chemical Co.
P.O. Box 14508
St. Louis, MO 63178
314-771-5750

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Reproductive assessment and development of artificial insemination in the white rhinoceros (*Ceratotherium simum simum*)

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A rapidly aging captive southern white rhinoceros (*Ceratotherium simum simum*) population and problems associated with the low rate of reproduction are of great concern (San Diego Workshop, 1998). Increased evaluation of the reproductive soundness of male and female white rhinoceroses and the development of assisted reproduction techniques may help to understand and overcome long standing difficulties in breeding rhinoceros in captivity. Ultrasonographic assessment of the reproductive status of zoo animals has become a widely established technique which, using suitable modifications, is feasible in all rhinoceros species. This technique has proven to be an efficient tool for reproductive health assessment and for selecting potential candidates for natural or artificial breeding in other species. Different phases and aspects in the development of AI in the white rhinoceros are described and their potential implication for natural breeding efforts is assessed.

Long-term endocrinological monitoring gives invaluable information on the cyclicity, erratic cyclicity or acyclicity of breeding aged females. In order to evaluate the health status of the reproductive tract, not accessible by endocrinological methods, and to select potential AI candidates, a transrectal ultrasonographic examination was performed in 29 females aged 4 – 30 years. Animals were either examined lateral recumbent or examined in standing position in a restraint chute. Different forms of progressive ovarian and uterine pathologies were found. Independent from whether females were cycling or acyclic, single up to hundreds of uterine cysts, uterine fluid accumulation, chronic endometritis, uterine leiomyoma and adenoma and para-ovarian tumors were imaged. Causes for these alterations might be based on individual disposition or age related. Due to the advanced status of the alterations, 8 females were considered post reproductive. The females considered post reproductive were $\geq$ 27 years. Females free of genital tract alterations were aged $\leq$ 12 years.
In females with no estrous cycle different sonographic types of these so called "flatliners" were characterized. The type I flatliner was characterized by small inactive ovaries with no functional structures, type II by persistent luteal structures, type III by ovarian cysts and type IV found in subadults with constant follicular development. The sonographic identification of the cause of flatlining appeared as an essential prerequisite for a potential hormonal intervention and the successful attempt of an estrous cycle induction.

Electroejaculation was applied in 14 males to evaluate the reproductive condition in immobilized, mature breeding bulls. Imaging of the sex glands prior to semen collection provided information on the development, status and location of the accessory sex glands for precise positioning of the electrostimulation probe. A stimulation probe designed for megavertebrates was rectally inserted and manually positioned on the accessory sex glands. A control panel regulated current and voltage of each applied stimulus and recorded mucosal temperature during the ~5 min of total stimulation time. 3-7 ejaculatory fractions were collected with a maximum volume of 5 - 300 ml. The reproductive assessment categorized males in satisfactory, questionable and unsatisfactory potential breeders according to spermatological results. The cause of reduced or poor reproductive condition in 9 males

remained speculative but management changes, translocation or introduction to unfamiliar breeding aged females may have positive influence on the current breeding status of each potential breeder.

The reproductive assessment of potential female and male breeders by means of endocrinology, ultrasonography and electroejaculation was a prerequisite for the selection of suitable AI candidates with a sound reproductive tract and good reproductive condition. In three flatlining females estrous induction protocols based on the long term application of synthetic progestins and hcG were applied to obtain the exact timing for AI. In two females AI was timed according to behavioral signs and sonographic findings of estrous.
The two main anatomical obstacles for assisted reproduction in the female rhinoceros were the hymenal structure in nulliparous animals and the dense and tortuous cervix. Video-chip-endoscopy, ultrasonography and customized insemination catheters were simultaneously used to deposit the fresh semen deep inside the female's genital tract. Ultrasonography verified the intra-cervical or intra-uterine position of the insemination catheter. Two semen donors had been electroejaculated to ensure a semen sample on the day of AI. The semen samples had been assessed, extended and transported between collaborating institutions. So far one female was successfully impregnated but did not maintain the pregnancy.

Reproductive tract ultrasonographic examination and electroejaculation proved decisive as tools for the assessment of the reproductive condition in male and female white rhinoceros. Ultrasonographic and spermatological evaluation of potential breeders paired with endocrinological monitoring yielded essential information for future breeding recommendations. To date, AI attempts in the rhinoceros have been rare because of the complexity of such procedures. Thanks to a collaborative effort of several individuals and institutions combined expertise on endocrine activity, reliable anaesthesia protocols, the evaluation of the reproductive soundness of AI candidates and prediction of ovulation have contributed to first AI attempts in this species. The successful development of an AI technique in one rhinoceros species might be the key to enhance conservation efforts in other rhinoceros species in future, increasing the genetic diversity and breeding success in captive and wild populations.

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Southern White Rhinoceros Captive Behavior

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In the fall of 2000 the endocrinology and behavior departments joined forces to conduct the zoo's first long-term field study of a rhinoceros species in a study aimed at understanding the reproductive biology and behavior of the white rhinoceros. Our previous research efforts with the captive population generated a host of new questions that could only be adequately addressed by detailed studies of wild rhinos. Over the past four years we collected behavioral and hormonal data at the San Diego Wild Animal Park and other zoological institutions and found that the female reproductive cycle was highly variable. Sometimes these data pointed to an estrous cycle recurring about every 35 days, and sometimes about 70 days passed between cycles. In each case progesterone metabolites found in feces remained high between fertile periods, dropping to low levels at the same time that the female began to show behavioral signs of estrus and became the target of male courtship overtures. Some of the long cycles appeared to be associated with uterine pathology and/or premature termination of a pregnancy, suggesting that long cycles might be abnormal. However, researchers in Europe made similar findings, but suggested that the long cycle was typical for the species. Data from the field were too limited to provide an answer to this controversy. It is surprising that we do not yet fully understand this basic aspect of reproductive biology in the white rhino in the new millennium. Clearly, this issue must be resolved if we are to adopt an informed management strategy for dealing with cases of reproductive failure. What is normal for this species? Which female cycles should be considered pathological and merit remedial intervention? The answer lies waiting for discovery in a healthy, reproductively active wild population.

We found just such a population at the Umfolozi Game Reserve in Kwazulu-Natal, South Africa. Early in this century the white rhino population had been decimated by poaching, reducing their numbers to about 50 individuals, and it was only through the efforts of enlightened managers at Umfolozi that the species was saved from extinction. Under their protection the population grew rapidly, and subsequently were translocated to many other reserves. Today they number nearly 10,000. Umfolozi is comprised of bushveld habitat, characterized by open short and long grass grazing areas interspersed with dense acacia thickets. The reserve harbors one of the densest populations of game in all of Africa, and common species include black rhino, cape buffalo, giraffe, zebra, impala, nyala, cheetah, lion, and elephant. Behavioral ecologist Angela White was hired by CRES to radio-track white rhinos to collect both behavioral data and fecal samples to be analyzed in the endocrinology lab at CRES. Small transmitters are implanted near the base of the horn, which will emit a signal for approximately two years. Tracking rhinos has proven difficult, as they are extremely wary of humans; one must always approach the rhino from downwind and, although rhinoceros vision is poor, take care not to be seen by the ever-present oxpeckers. These birds live in a mutualistic arrangement with rhinos, feeding on ectoparasites living on the rhino's skin and signalling alarm to the rhinos when they detect the approach of a human.

Although this project has been underway for only SEVEN months, several females have already come into estrus, perhaps stimulated by the flush of fresh green growth that followed the beginning of the rainy season in September. PRELIINMARY DATA FROM BEHAVIORAL OBSERVATIONS SUGGEST THAT THESE WILD FEMALES DO INDEED EXPERIENCE APPROXIMATELY 30-DAY CYLCES. Estrous females are easily recognized by the sustained presence of a dominant territorial male, which often accompanies the female for up to two weeks prior to mating. At this time observations are intensified to be sure that data are gathered during the brief 1-2 day fertile period. During the period leading up to peak estrus the female generally rebuffs the male's advances, keeping him at a distance by snorting, snarling and lunging at the male. The male appeases the female by making a hiccing sound when he approaches her. Eventually, the female will allow the male to advance and rest his chin on her hindquarters, and mating follows soon thereafter. We hope to obtain detailed data on these behavioral processes that predict impending estrus, and determine how they relate to levels of reproductive hormones. In addition to providing conclusive data regarding the length of the estrous cycle, we hope to obtain a better understanding of reproductive strategies, competition, mate choice, and acoustic and olfactory communication in wild rhinos, and make comparisons with similar processes observed in captivity. Fecal metabolites of corticoid hormones, which can be an indicator of stress, will also be assayed to provide a basis for comparison with captive populations. These data may provide new insight into the potential role that stress may play in inhibiting reproduction in captive populations. Ultimately, we hope that this research will make meaningful contributions to the conservation of the species, both in the wild and in captivity.

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The *In Situ* and *Ex Situ* Program of Sumatran Rhinoceros *(Dicerorhinus sumatrensis)* in Peninsula Malaysia.

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Introduction

Sumatran rhinoceros *(Dicerorhinus sumatrensis)* or the lesser two horned rhinoceros is one of the three rhinoceroses that living in Asia. The other two are the Javan *(Rhinoceros sondaicus)* and the greater one horned rhinoceros, the Indian/Nepali *(Rhinoceros unicornis)*. This Sumatran rhinoceros is the smallest and hairiest species of rhinoceros in the world. It is also critically endangered and threatened compared to the other rhino species and needs intensive management to survive (Schaffer *et. al.*, 1994; Khan, 1989).

The population of the Sumatran rhinoceros in the wild is less than 400 animals and is mainly found in Malaysia and Indonesia and the number has declined dramatically due to poaching and habitat destruction (Foose, 1999). As the declined in current population continues at a rapid rate, this rhino species is at high risk of extinction and is listed on Appendix I of CITES (Heistermann et. al., 1998). This species also is categorised as a totally protected animal under the Malaysian Wildlife Protection Act76/72 (Samsudin, 1994).

In Peninsula Malaysia, it is estimated about 70 animals roaming in the wild and the Sumatran rhinoceros are concentrated mainly in four primary location, namely Taman Negara, Endau Rompin, Belum and Selama (Samsudin, 1994). However, there is also evidence that some of the rhinoceroses were found outside those areas which including Ulu Besut, Kuala Balah, Sg. Depak, Ulu Lepar, Gunung Belumut and Gunung Inas (Khan, 2000; pers.com).

A lot of efforts had been done to sustain the survival of the Sumatran rhinoceros. Anon (1993) stated that the Department of Wildlife and National Parks (DWNP) had introduced the Sumatran Rhinoceros Action Plan for the conservation of this species in Malaysia. The plan concentrates on the survival and recovery of viable populations and it consists of both the *in situ* and *ex situ* components. The *in situ* program has been initiated to protect the rhinos in the wild from being poached and the *ex situ* program has been conducted to breed this species in captivity.

In Situ Program

The objectives of this program are to do the in situ protection and secondly to manage the viable population in the wild. Monitoring of the rhinoceros in the wild is conducted by routine patrolling to protect the rhino population especially in the areas known to have

rhinoceros. The Rhino Patrolling Units (RPU) is formed to conduct the patrolling at the designated areas and they are important in providing updates on the rhinos and encroachment of their habitat.

Currently, there are 7 groups of RPU and each unit consist of 10 personnel which involving the states of Pahang, Perak, Johor, Trengganu and Kelantan.. This RPU mainly patrolled the four primary locations as well as the areas suspected to have rhinoceros. This program has been successful to prevent any encroachment and surveys done by the RPU showed that the rhinos are also found outside the four primary locations. However, the safety of this rhino is questionable since they are vulnerable to the poachers. Therefore, efforts had been taken to overcome the problems by reducing and/or eliminating the threat in those areas.

The RPU consists of the rangers from the DWNP and also staff hired by the International Rhino Foundation (IRF). Sometimes, the aborigines are hired to show the location that suspected to have rhinoceros during the patrolling or survey. Usually, the patrolling or survey is conducted for 7 to 10 days.

Ex situ Program

The program is mainly conducted at the Sumatran Rhinoceros Conservation Centre (SRCC) in Sg. Dusun, Selangor. This centre is located inside the Sg. Dusun Wildlife Reserve (SDWR), which used to have wild rhinoceros in the past. The reserve is about 10 400 acres and bordered by two rivers, Sg. Dusun in the south and Sg. Tengi in the north which are connected by a canal.

Sumatran Rhino Conservation Centre (SRCC)

The DWNP has established this centre in 1991. The centre consists of the night stalls, administrative buildings, staff quarters and also the natural enclosure. This centre has a captive population of 2 males and 5 females. These animals were housed in a pie-shaped enclosure with 8 night stalls; each connected to a paddock. One paddock is connected to a quarter-acre electric fence enclosure and subsequently to 10-acre enclosure, fenced up in the forest. The enclosures were mainly used for breeding purposes. An additional education centre and another 100 acres fence natural enclosure was built up last year.

There are a few objectives of this centre including to provide refuge for displaced rhinos captured from threatened areas in Peninsula Malaysia and also to breed the species in captivity (Zainal, 2000, per. com). The centre also provides a lot of information on this species especially in captive management. Another role is to create the public awareness of the rhinoceros and its ecosystem.

Captive Diet

Dicerorhinus sumatrensis is known as generalist herbivore and prefer more nutritious leafy material when available (Yusnita, 1998; Flynn, 1983; Mohd Tajuddin, 1985). In captivity, Zainal (1989) stated that these animals were fed on variety of forage including napier grass (*Pennesetum purpureum*), carpet grass (*Axonopus compresses*), leaves such as jackfruit leaves (*Artocarpus heterophyluss*), kelompong gatal (*Ficus glossolaridus*),

kelompong hijau (*F. variegata*), tapak gajah (*Macaranga gigantia*) and daun tapai (*M. triloba*). Fruits such as banana and papaya were given beside sweet potatoes and horse pellets.

However in SRCC, the rhinoceroses are fed browses, fruits and also concentrates. The feed was supplied by a contractor, which delivered every morning. The feed consists of a few types of browses, which could be found around the reserve area. Although only selected browses were given, these nutritional leaves are among the favourite of the rhinos. To ensure that the rhinos get adequate nutrition, fruits and concentrate are given to them.

In this centre, the rhino are fed twice daily. The first feeding is at 9.00 a.m., where the animals are fed 1.5kg of concentrates, about 20-25 kg of browses and 2.5kg of produces (Table 1). The second feeding time is at 3.30 p.m. The amount and type of food given is the same as the first feeding, excluding the concentrates (Zainal et. al, 1999). Fruits are also used to bait the rhinos into the chute and also to calm them during the routine program such as bleeding, ultrasound and physical examination.

Table 1: The daily captive diet of the Sumatran rhinoceros in SRCC

TYPE OF FOOD	WEIGHT (KG)
Concentrates: Horse Pellets (Cargill (M) Sdn. Bhd.)	1.5
Browses: Nangka / Jackfuit leaves *(Artocarpus rigidis)* Pulai *(Alstonia specilata)* Mahang *(Macaranga triloba & M. gigantea)* Kelompong *(Ficus variegata & F. glossolariodus)*	40.0 – 50.0
Produces/Fruits: Banana Papaya Sweet potatoes	 2.0 2.0 2.0

Breeding management

There are seven rhinos in the centre comprising of two males and five females. The two males are namely Ara and Shah and these males will be bred with the five females namely; Rima, Seputeh, Mas Merah, Panjang and Minah. Usually, Ara will be paired with Rima, Seputeh while Shah will be mixed with Mas Merah, Panjang and Minah for breeding purposes.

The rhinos will be paired either based on the result of progesterone hormone profile or by daily introduction. Based on the hormone level, Rima and Seputeh are mixed with Ara when their progesterone level is low. About ten successful breeding has been recorded since January 2001 i.e. Rima (6) and Seputeh (4). The rhinos were mixed inside the quarter acres and the breeding took place on 21 days interval for both females.

As for daily introduction, the procedure was carried out on Shah and two females; Mas Merah and Panjang. The procedure was carried out on Shah because the male has a history of aggression towards the females. He will attack the female and cause a serious injury wounds by using his sharp canine teeth. Fruits were used to control the aggression during the procedure. In some occasions, plywood was used as baffle boards to separate the rhinos when fighting occurred. The daily introduction was also carried out on females with irregular estrus cycle to establish breeding. Once the breeding is achieved, the female will be mixed with the male on 21 days interval.

Blood Collection & Progesterone Hormone Profile

Blood was collected twice weekly from all females to establish the progesterone hormone profile. A few methods had been tried on all females including the ear marginal vein, the cephalic vein and the coccygeal vein. The blood was collected via coccygeal vein at two sites, at the base and the tip of the tail. However, all rhinos tolerated well to the collection from the tip of the tail. This method is proven the easiest compared to the other methods and was initiated by Dr. Zainal Zahari. The blood samples were pooled before sending them to Universiti Putra Malaysia (UPM) for analysis.

The blood was analysed using the radio immunoassay (RIA) kit. The result then was used to tabulate the progesterone hormone graph. Based on the result, the rhinos will be mixed when the progesterone level is low. This is to ensure that the female is ready and to avoid any aggression by the male. Based on this graph, it can be concluded that Rima and Seputeh had a regular cycle and they were bred on 21 days interval. Mas Merah and Panjang had an irregular cycle and they were paired daily with the male to establish breeding. As for Minah, she had a basal level of progesterone and she is being monitored closely.

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Ultrasound Training of Black Rhinoceros (*Diceros bicornis*) at Disney's Animal Kingdom

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At Disney's Animal Kingdom (DAK), training is as fully integrated into our black rhinoceros management program as other basic husbandry practices such as exhibit cleaning and maintenance, diet presentation, and behavioral observation. Our training program is designed to comply with AZA standards for rhinoceros management and to meet our husbandry and propagation goals. The focus of the training program is using operant conditioning techniques to train routine husbandry behaviors and facilitate veterinary procedures. One procedure important to our management program is performing transrectal ultrasonography on non-anesthetized animals. Using ultrasound to assess reproductive function in rhino species may be considered to be a critical component to any captive breeding program. It is possible to visualize and measure all critical components of both the female and male reproductive tract, providing an accurate reproductive profile. Assessments of reproductive health, sexual maturity, and pregnancy can be verified immediately, and monitored over time.

DAK currently houses 3.2 Black rhinoceros. Our three males are aged 12 years, 5 years, and 6 months. Our two females are aged 8 years and 5 years. All animals participate in the training program, and ultimately all rhino will be trained for the ultrasound procedure. This presentation will focus on the training of our 8-year old female, Kit, who is the first animal with whom we achieved this goal.

Each team within Disney's Animal Kingdom organizes their training program based upon the most effective method of achieving their husbandry goals. These goals are determined collectively by the entire animal management team, which includes keepers, managers, curators, and veterinarians. For the

black rhino, the veterinarians compiled a list of requested procedures. Then, with input from managers and keepers, this list was further prioritized for each animal. This individualized list was based upon the animal's health history, current training status, and the specific desired goals for that animal. It then became the responsibility of the keepers to achieve progress toward those goals, with assistance from the managers and veterinary staff as required.

The Ituri Forest team, responsible for the black rhino, assigns each animal a training team composed of three members, one of who is designated as team coordinator. Each member of the team has a clearly defined role, and the team coordinator is responsible for overseeing all issues related to the training of their animal.

All rhino are expected to first learn basic body positioning behaviors, such as "Come", "Target", "Steady", "Back", and "Over". These behaviors are critical to the success of many veterinary procedures, such as blood and temperature collection, annual vaccinations, and of course, ultrasounds. These behaviors allow us greater flexibility in working with the rhino, as we are able to perform procedures either in the stall or in the adjustable restraint chute. Without these behaviors, positioning the animal in the stall for safe access to them is much more difficult. Training our rhino to perform these behaviors allows us to easily and quickly accomplish many routine husbandry procedures in the stalls.

Although we have a restraint chute in the black rhino barn, the decision was made to begin training Kit for the ultrasound procedure in the stall. This was due to minor modifications necessary before the chute could be successfully utilized, and a belief that she would willingly participate in the training without being restrained. This would not have been possible without Kit knowing the basic body-positioning behaviors described earlier.

The training for the ultrasound procedure incorporated three elements: ensuring the rhino was capable of reliably performing each of these body positioning

behaviors, rectal desensitization for the sensations felt during the procedure, and environmental desensitization for the atmospheric stimuli experienced during the procedures. At the time training for this procedure began, this animal was reliable on the positioning behaviors "Come", "Target", "Steady", and "Back". The behavior "Over" was in the process of being shaped, with Kit stepping to her right when cued, and learning how to step to her left on cue. Progress on this behavior continued while rectal desensitization training began. The animal was reliably performing this behavior, stepping in either direction on cue, by the time the first ultrasound was attempted.

Rectal desensitization approximations included: tactile around the rectum, holding and manipulating the tail, application of ultrasound gel, progressive insertion of the arm up to the shoulder, repositioning of the arm, hand movement, withdrawal of feces, and pressure applied with the hand. The first two approximations were trained by the entire training team. The training of the remaining approximations was restricted to our veterinarian advisor and the training team coordinator, who received instruction on the appropriate methodology. This restriction was necessary to insure consistency with the progression of sensations the animal would be feeling, as well as concern that only specially trained individuals would be allowed to participate in this type of invasive procedure.

Environmental desensitization included: increasing the number of people present during sessions, increasing the number of people directly behind the rhino, increasing noise levels during sessions, increasing the amount of equipment present during sessions, and increasing the movement of people and equipment around the rhino while she maintained her body position. It was imperative that the rhino maintain a strong focus on the trainer in the midst of these distractions, and additionally that she remain stationary and focused for a duration of approximately 30 minutes.

It was decided by the veterinarian and the training team that desensitization of

the ultrasound probe would be accomplished by the veterinarian performing the actual procedure. This was due to the difficulty of finding a suitable substitution for the head of the probe, the desire to avoid using the expensive equipment itself, and the possibility of losing or damaging the equipment during the desensitization process.

Throughout the entire training process, the veterinarian advisor frequently attended training sessions. This enabled the vet to assess the animal's progress, and advise the team on adjustments that would more accurately simulate sensations experienced by the animal during the procedure. Additionally, frequent attendance of training sessions enabled the veterinarian to familiarize herself with the behavioral idiosyncrasies of the animal, and plan for how to accommodate them during the procedure.

As training progressed, it became necessary to adjust our training to accommodate challenges we had not anticipated. For example, an unforeseen necessity was training the rhino to accept warm water enemas. We found it necessary to do multiple enemas prior to the procedure. The initial enema was used to clean the rectum of fecal matter. To obtain a clearer picture, a final enema was done immediately before the procedure to provide a better medium for transmission of the ultrasound waves. Approximations for the enema included: moving the hose in close proximity to the animal, running the water behind the animal, shallow insertion of the hose with the water off, deeper penetration of the hose with no water, and finally, insertion of the hose and running the water. Training for the enema proved relatively easy. Our biggest challenge was keeping the animal in a steady position with the sound of running water behind her. Our rhino are given baths as enrichment, and are not required to be under stimulus control at that time. When enema desensitization began, Kit would anticipate a bath at the sound of the water, and attempt to move out of position.

The first few ultrasound attempts yielded valuable information about how to improve upon our process. Adjusting the temperature of the water before each enema facilitated Kit's acceptance of them. In between enemas, the water in the hose cooled down. This seemed uncomfortable for the rhino, as she was more likely to move out of position unless we adjusted the temperature. We were able to conduct enemas much more easily with a water temperature similar to the body temperature of the animal. We learned that performing the ultrasound within one half hour of an enema was necessary, as a longer period of time would require an additional cleansing enema. Finally, stationing a second person at the animal's hip became an important factor in easing communication between the trainer and the veterinarian. Communication between these two individuals was critical, with the vet alerting the trainer to upcoming movements and sensations the animal would be feeling, and the trainer providing information to the veterinarian on Kit's attitude and cooperation level. This detailed communication allowed us to maximize the success of each ultrasound.

It is difficult to approximate a time frame for the entire training process for this procedure. On average, our rhinos are trained for approximately 15 minutes twice a day, or a total of 3.5 hours per week. However, training for the ultrasound procedure did not preclude training for other procedures or behaviors, or preclude routine husbandry practices such as blood collection. In other words, no additional time was allotted to train for this procedure; the time spent training for the ultrasound was incorporated into our regular training schedule. Although the body positioning behaviors were critical to the success of the procedure, as mentioned earlier, the majority of these behaviors were reliable by the time we began the desensitization process. With regard to rectal and environmental desensitization, training began in April of 1999, and our first ultrasound attempts began six months later in October 1999. Enema desensitization began in January 2000, and we considered the entire ultrasound procedure reliable by April 2000.

The ultrasound procedure has been a tremendously useful management tool for us. We were able to confirm and monitor Kit's first pregnancy, and have, since parturition, been able to view and monitor an intrauterine mass, and observe evidence of renewed estrus cycles. To date, we have performed approximately two dozen ultrasounds on Kit. We have conducted them as frequently as once a week, or as infrequently as once every two months. No additional training has proven necessary to maintain her cooperation with this procedure. Additionally, the human participants in this procedure may be interchanged freely with no adverse reaction from Kit.

At DAK, meeting our husbandry and propagation goals for black rhinoceros is facilitated by the incorporation of training into our management program. Behavioral training of rhino to participate in transrectal ultrasonography should be viewed as an important component of successful captive propagation programs. Ultrasonography is an important tool for verifying reproductive health, sexual maturity, and pregnancy. More widespread use of reproductive examinations via transrectal ultrasound will be instrumental in establishing and maintaining the success of additional captive propagation programs.

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BLOOD COLLECTION

by Vickie Steele White Oak Conservation Center

To achieve the goal of learning more about the physiology of any and all rhino species requires a hands on approach. Many facilities have added a specially designed chute to their new or existing rhino quarters.. Chutes allow for the rhinos to be conditioned into a small confined area. Once conditioned, the benefits of having a calm rhino in a chute situation include the ability to collect blood, semen and vaginal swabs, to perform reproductive exams on females and trans-rectal ultra sound examinations; to administer vaccinations or treatments as well as to be able to perform close visual observations of individuals.

All rhino facilities are different as is the way they are managed. Some facilities have great chutes, some have less than adequate chutes and some have no chutes. Management varies regarding daily, monthly and seasonally routines of the rhinos. Many facilities have extended indoor housing for cold weather, day yards and night quarters while other facilities do minimal rotating between housing areas. It is hoped, through this presentation to encourage keepers to find ways within their own facilities by which basic conditioning can be helpful and possible even if their facility does not have a chute system.

At the first Rhino Workshop at Disney's Animal Kingdom in 1999, the Disney keepers showed a video of the conditioning routine of their rhinos done within their indoor quarters. Today, my talk will be about conditioning rhinos at White Oak Conservation Center for blood collection with and without the use of chutes.

At White Oak Conservation Center the white rhino enclosure designs and sizes are as follows:

- 1.0 sub adult - .7 acre cable yard and a 3562 ft.^{2} horizontal pipe corral
- 4.5 - including adults, calves and sub- adult - 6 acres with access to 1-5 corrals totaling 27, 640 ft^2 The corrals have horizontal bars with a total of 2 chutes. The chutes are the permanent pass-through design that can be used from either end.
- 1.0 adult - access to 3 horizontal pipe corrals of 20,016 ft^2

Our black rhino enclosure designs and sizes are:

- 1.1 adults - 1.5 acre, cable yard plus 1 large horizontal pipe corral (4453 ft^2) and two smaller corrals (4433 ft^2)
- 3.0 - 1 mature, 2 sub-adults - 3.4 acre cable yard with access to 3 horizontal pipe corrals 18,983 ft^2
- 1.0 adult - .3 acre horizontal pipe yard with access to 2565 ft^2 corral that has vertical pipes.

- 2.2 females and calves have 1.7 acres with horizontal pipes and access to 3 vertical pipe corrals of an additional 7245 ft^2

General:

It takes a team effort from the staff to collect the samples. First you need a volunteer donor. In most cases, the veterinarians or technicians collect the blood samples, although all the rhino keepers are trained to collect blood.

When working with the rhinos, one must always be aware of the surroundings. Rhinos have a very good sense of sound and smell. One should always be aware that even though the keepers normally don't wear cologne there may be visiting personnel that will come to the procedure that do. Also, the rhinos tend to react more to whispering than normal levels of talking, and they can also get spooked from an unfamiliar voice or a different sounding vehicle. The rhinos may also react to the sound of wrappers on the vet equipment, extension sets, butterfly set ups, etc. Even though the rhino has poor vision, it is still important for the staff to be aware of the location of personnel and their activities so as to try to not distract the rhino.

When lining up the rhino into position, he is maneuvered to be parallel to the railings. It is very important to get the rhino as close to the railing as possible. The blood collector must reach in under the rhino to the medial side of the opposite leg. When collecting from a leg vein, the collector must be able to react to the rhino's stepping forward or backward. Communication between the keepers and the blood collector is very important since the keeper may be able to anticipate any movement by the rhino.

Except when it is warm, it helps if the collector uses a warm, moist towel on the leg to make the vein more visible. The actual stick is done very quickly in an upward, but not deep motion. Sometimes, the needle needs a little adjusting by twisting or slightly pulling the needle out.

Once the blood is dripping through the needle, the tubing is attached with the vacu-tube on the end. When the blood is flowing through the tubing, it works best if the vials and tubing are held down towards the ground and not high in the air so gravity can help fill the vial. The first vial will not fill up completely due to the amount of air that usually collects in the tubing. When all the needed vials are filled, the needle is removed and a small red-topped vial collects all the remaining blood in the tubing so as to not waste any blood.

When collecting from an ear vein, a shallow stick is done towards the top of the head. A butterfly setup is used. Blood is collected via syringe, then injected into the vials. A disadvantage of using an ear vein and a butterfly setup is that the attached tubing must be kept away from the ear as much as possible because the ears are very sensitive. If the rhino feels the tubing touching the ear, it will often flip the ear back and forth and this usually means the setup is flung a few yards away.

White Oak:

The rhinos at White Oak Conservation Center are given access to their yards on a 24 hour basis, though they are usually fed in the corrals. If work needs to be done in their yards then it is easy to lock them in the corrals due to their being conditioned to eat in the corrals. We do not have any completely solid enclosures for our rhinos. All corrals have a heat source, windbreaks, and suitable grass for grazing. Due to their large size, many of the corrals have mud wallows.

It is the rhino keepers' responsibility to setup the rhino in a good position in the chute or along the corral or yard bars or cables. White rhinos are offered hay and grain, and black rhinos are offered browse, grain or cut up fruit. Both the white and black rhinos are offered tactile contact to keep them in the proper position. Informal verbal commands are used as needed such as "Move up" and "back up." When working in the corrals it is best to separate the rhino to be treated from other rhinos except when collecting from a dam and/or her calf.

Sometimes we work the adult rhinos to come up head first then have them follow us along the barrier to get them parallel to the cable or bars. The keeper feeds the rhino from the side, or from the front, standing close to the head, while the vet or technician collects the blood.

Sometimes on cold days the rhinos are more sensitive to the stick and don't stand well. We may try a couple times but if it is all negative re-enforcement we stop. Some animals are particular as to who is doing the collecting, so we have to have the individual staff member present on the day we plan to collect from that particular animal.

For the past year, we have tried to get all the rhinos collected every other month. Additional blood may be collected for various other reasons.

We have a running calendar that is used to keep track of the rhinos collected and is updated weekly by the lead keeper and field vet technician. We use the following codes:
"√" for bleeding attempted, but no blood collected;
"c" for complete blood sample collected;
"s" for serum only collected;
"b" for whole blood only collected;
"i" for iron sample collected.

White Rhinos:

We received 1.5 white rhinos from Kruger National Park South Africa in November 1998. Only one was approachable upon arrival, but within a few weeks, there were 3 individuals that approached us for contact. We have a total of 6.5 white rhinos of which we are collecting from 4.4.

Due to the possible medical problems, and the observation of abnormal behavior, the first rhino of the group was collected from 5 months after her arrival. The other rhinos were conditioned for collection from 6 to 18 months after arrival.

Chute conditioning started by working the white rhinos using alfalfa hay which is a treat and not part of their usual diet. When working with our white rhinos in the chutes, the first goal was to

have them remain calm while standing in the chute. We start with tactile contact to the nose, face, head, back, ear and eventually pinching the ears to simulate a needle prick Then, we continue to make tactile contact to the rear legs and front legs and, begin pinching the front legs to simulate a needle prick. After pinching the skin on the leg successfully we introduce the warm, damp towel to help the vein be more visible. Next we introduce a field vet technician with the blood draw tray, full of the items needed. . Most of the items do not make additional sounds except for the voice of the tech and the crinkly noise from taking the plastic wrapper off the extension set. This always gets a nervous reaction from the rhinos until they are conditioned to it. Most of the white rhinos were easy to condition to stop in the chutes due to the fact that they walk through them to get from one corral to the next.

We use the "free stall" method, allowing the rhino to leave at anytime by backing out. The front gate remains closed during the session. When finished with the conditioning or procedure, the rhino has the option to back out or the front gate is opened and the rhino can leave moving forward.

With the white rhino calves we start to make tactile contact as soon as possible. They are usually curious at a younger age than the black rhinos. Once the calf approaches, we make contact with the head first, then move the contact back along the body and to their legs. The calves already have the "target spots" (chest area and inside the rear legs) that relaxes them to stretch their rear leg back and eventually squat or lay down.

What appears to have helped with one of the less friendly females is that her calf became very interested in the keepers, and enjoyed the contact. The dam seemed to calm down more because of the calf being calm.

We are hoping that our most difficult rhino female will be more accepting towards us if her calf allows the keeper contact.

Black Rhinos:

At White Oak, even though we don't have chutes in our black rhino areas, the concept of conditioning remains the same, though the setup is different than with the white rhinos.

We start working with the calves at about 1 -2 months of age. The first step is to condition them to approach keepers at the corral bars. Once the animal approaches the keeper, tactile contact is started with the calf's face and nose, and progresses as time and calf allow. Eventually the keeper is able to touch the head, ears, back, side, then the legs. The calf usually approaches for sliced apples and the keeper can begin touching the calf at that time. At first the calves only come towards the keepers head first, remaining close to their dam. Once we can touch them on a regular basis, we start working them towards a corner of the corral so we can feed them straight ahead. This also allows another keeper to give contact from the side. Eventually it will be the keeper in front and the blood collector at the side, with the possibility of another keeper giving tactile contact around the belly and rear legs.

When working in the corrals the rhino who needs to be collected from is separated from the other

rhinos. There are exceptions, when we are collecting from the 3 black rhino bachelors, or when collecting from a female with a calf. With the 3 males, they work better with the other males close by. What works best is to have 2-3 keeper/feeders and 2 - 3 blood collectors. The keepers must keep the rhinos occupied until all are collected from. If they are done individually, there is a chance of one getting satisfied with food before collecting is completed. Sometimes we can use one male to help keep another male closer to the corral bars by just his body on the other side of the rhino and both remaining parallel to the corral bars.

When collecting from a female with a calf, we keep them together to avoid needless stress to the situation.

Equipment:

The equipment that is in the blood collecting kit includes 1 and 1 ½ inch needles, vacutainer luer adaptor, vacutainer holder, extension set 30", butterfly 21 x 3/4 12" tubing infusion set, tray,6-12 ml luer tip syringe, pen for labeling, tube tray, 2 x 2 alcohol gauze, a cooler with warm towels, and assorted tubes.
Large red top: VB10 mls SST gel and clot; used for serum.
Large green top: VB 10 mls sodium heparin; spin down for plasma.
Small purple top: VB K2 EDTA 7.2mg/ml; for CBC (complete blood count).
Small blue top: buffered CIT.Na 3.2%; Spin down for plasma for fibrinogen; once collected tube should be put in a slushy ice bath.

The staff should know what testing is needed and what kinds of samples are needed for various lab work in order to have the correct tube selection. The label on each tube should have the species, ID# and name (if needed), date and time of collection and location.

I hope my talk today has demonstrated that at White Oak Conservation Center, we have been able to successfully collect blood and perform health examinations on the rhinos through conditioning. If your facility does not have a chute system, there may be ways to condition your rhinos to perform the basic behaviors needed to collect blood.

Chute Construction
For Black Rhinoceros at Zoo Atlanta

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Introduction

Zoo Atlanta's rhino facility fulfills the majority of the needs to adequately care for 1.1 eastern black rhinoceros, but we felt that a rhino restraint or "chute" could further benefit our program. One of the first challenges of the project was to keep the cost as low as possible and still have a safe and adequate environment for the rhino and staff.

Chute Design History

Zoo Atlanta built its current rhino exhibit in 1989. The facility consists of a barn with two stalls and a shared transit corridor into a single corral. The corral connects to a single exhibit yard.

Keeper staff implemented an operant conditioning program in 1994 to facilitate movement of the rhinos between enclosures. Their success paved the way for on-going training that has allowed new staff to accomplish reliable transfer of animals, immunization and manual blood collection from the male, limited foot-work, full ophthamological examination of the male, oral exams, daily saliva collection from the female, daily tail bandaging of the female for over 3 months, and regular treatment of skin lesions.

With the accomplishments of these training efforts and support of the management staff, in 1995 Zoo Atlanta began looking to build a rhino chute. The zoo submitted a grant proposal to the Institute of Museum Services for a restraint. The grant was part of a metabolic research study led by Dr. Vaughan Langman from Louisiana State University-Shreveport and in conjunction with the Denver Zoo. The budget for the restraint was approximately $25,000. We did not receive the grant and the restraint was not built that year.

In 1996, the Animal Restraint Company was brought in for consultation and was asked to submit a proposal for a hydraulic squeeze restraint. Their original design would have cost approximately $45,000. They were asked to cut back some of the cost and redesign.

After compromising on the design the final estimate was $38,000. A restraint was not built that year either.

In 1999, with new staff and new ideas, Zoo Atlanta began thinking about the design of a rhino restraint once again, but this time it was a little different. It was going to be designed and built "in-house."

We were particularly interested in safer, more routine immunizations, blood collections, skin care, footwork, and health exams/treatment. We also hoped the chute would facilitate new veterinary procedures, including transrectal ultrasonography, semen collection/evaluation, and possibly artificial insemination efforts. Coupled with a scale and custom fabricated platform we expected to obtain body weights regularly in the chute. It would also assist Dr. Vaughan Langman's research efforts with routine rectal body temperature measurements and by conditioning acceptance of facemasks that would allow accurate sampling of exhalations for metabolic studies.

Design process

Rich Sartor, Assistant Curator of Large Mammals, was the project manager. Jim Mitchell, former zoo welder, assisted with design and was the principal fabricator. Todd Maki was a key project assistant. We relied extensively on the support and teamwork of all our maintenance and Large Mammal Department staff.

We wanted to design a basic chute that would be manually operated, steel framed, confine the rhinos into a smaller more secure space, give us 360 degree access to them, and keep the budget low.

"Before you purchase or build something new....first talk to someone who has one!!!"

Having the opportunity to travel and visit other zoological institutions throughout the United States, we had the opportunity to see a few of the restraints that were currently being used. We were able to see, talk to the staff, and get ideas about rhino chutes at Fossil Rim, Glen Rose, TX; Kansas City Zoo, Kansas City, MO; Riverbanks Zoo, Columbia, SC; Denver Zoo, Denver, CO; Milwaukee County Zoo, Milwaukee, WI. After sharing the information with everybody working on the project, we decided that many of these ideas, once modified, would work for what we wanted.

Ground Breaking

We would have preferred to have a run-through chute or a side that opened up into another corral, but we had to keep in mind a limited budget and available space. We decided on a walk-in and back-out design.

One of our own ideas was to make it transportable in case the current space was to be used for other construction in the future. We embedded ¾-inch anchor bolts "L" shaped (Figure 1) into a 15-ft X 12-ft X 6-inch thick concrete pad. This gave us the capability of fastening the frame of the chute to the pad without it being permanently secured into the concrete.

Frame Work

For the frame we took in consideration the design from the Riverbanks Zoo. The frame stands 7-ft high X 9-ft long X 4-ft wide. We used 4-inch X ½-inch steel plates across the bottom to secure to the anchor bolts, 3½-inch steel square tubing for the top and corner rails, and 3-inch diameter steel pipes positioned vertically 12 inches apart for the sides. All steel is Schedule 40 thickness (Figure 1, Figure 2).

Movable Sides

Six of the seven vertical steel pipes (3-inch diameter) that make up each side are coupled together making 3 separate movable sections. Every other pipe has a 3½-inch diameter X 4-inch long steel pipe sleeve around the top and the bottom. The sleeved pipe is welded to the framework. The next pipe is connected to the sleeves by 3½-inch square steel tubing at the top, and a 3½-inch X ½-inch steel plate at the bottom, making swinging horizontal armatures. The movable pipe can be secured to the top of the framework and to the concrete pad by 1-inch solid steel pins (Figure 1). This enables us to have three pipes on each side that can be swung open and away from the chute giving us a larger opening to examine the rhino or to maneuver large equipment.

Head Chute

The head of the chute was designed in two sections.

The bottom section is based on the design used for the sides of the chute at the Riverbanks Zoo. It is constructed of three 2½-inch diameter X 3-ft long steel pipes positioned vertically and 12 inches apart. A piece of 3½-inch diameter square steel tubing 4-ft long was secured horizontally 3-feet off the concrete pad. The bottoms of the three steel pipes are hinged to the framework, while the tops are secured to the horizontal square tubing using 1-inch solid steel sliding pins (Figure 2). This feature allows us to lower these pipes, and gives us more space to examine the front feet and chest of the rhino.

The top section was based on a design at the Milwaukee County Zoo. Here we used three 2½-inch diameter X 4-ft long steel pipes positioned vertically and 12 inches apart. The 1st and 3rd pipes were welded at the top to the framework and at the bottom to the horizontal 3½-diameter square tubing. The center pipe was made removable by welding a 3-inch diameter X 3-inch long steel pipe sleeve to the outside of the framework for the top and to the outside of the horizontal square tubing for the bottom. The sleeve secured to the horizontal square tubing also had a steel plate welded underneath to make a cup to hold the bottom of the removable center pipe.

Extending from the outside of the horizontal square tubing and centered with the removable pipe, we attached a 15-inch X 21-inch shelf or chin rest constructed of 3-inch diameter square steel tubing (Figure 2b). This gives us the ability to bring the rhino farther into the chute by extending their heads through the front of the chute. In this position we are able to fully examine the features of the head. The design also protects anyone examining the front feet from a rhino lowering its head.

Back Gate

The back gate evolved from many contributing ideas, starting with the design from the Riverbanks Zoo, with an additional concept from Fossil Rim and an added feature of our own.

The back gate's frame is 4-ft X 7-ft and constructed of 4-inch diameter square steel tubing. It is suspended by two 1-ton trolleys from an 8-ft long, 6-inch steel I-beam. A 1-inch square steel tube was cut diagonally in half to make a triangular strip and then welded to the bottom of the I-beam. The trolleys were attached to the top corners of the back gate using ½-inch X 3½-inch steel plates. The wheels slide along the triangular track guiding the top of the gate as it slides up and down the I-beam. It also prevents the rhino from lifting the gate upward. On the gate's bottom piece of square tubing, a ½-inch X 9-inch steel plate was welded to both sides, overlapping the bottom edge by 1½-inches. The gate then slides over a 2-inch X 3-inch X 7-ft long rectangular steel tube that is secured to the concrete pad. This works to guide the bottom of the gate and prevents it from swinging back and forth. A 1-inch diameter solid steel pin, which slides through 1¼-inch diameter steel pipe, was fastened to the bottom, outside portion of the gate's framework. This pin slides into four holes cut into the bottom track at one-foot increments, giving us the ability to secure the gate in different positions (Figure 3). Using the gate one-third closed gives us a barrier to work behind the rhino for rectal examinations, and gives the rhino the comfort of not feeling trapped (Fossil Rim).

An original design feature was added to the back gate by crafting a slide gate within the gate itself. It is a 2-ft X 6-ft secondary gate using 3-inch diameter square tubing built into the main gate's frame. The bottom of this secondary gate slides along steel rollers held by the ½-inch X 9-inch steel plates that are welded to the square steel tubing of the main gate's frame. The top of the secondary gate slides along steel rollers held by ½-inch X 6-inch steel plates that are welded to both sides of the square steel tubing that makes up the top of the main gate.

The secondary gate has three 2½-inch diameter steel pipes. The center post can be removed. To secure it in place, the ends of the pipe are inserted into 3-inch diameter X 3-inch long steel pipe sleeves that are secured to the underside of the top steel square tubing and the topside of the bottom steel square tubing of the secondary gate (Figure 3). This added feature was designed as a safety device. During a rectal examination if the rhino shifts sideways the secondary gate can then be moved in the direction of the shifting rhino. This would prevent the examiner's arm from being pressed against a stationary pipe. The removable post gives more available space for examinations and equipment.

Shade Structure

We added a 10-ft high X 15-ft X 12-ft pitched roof, supported by 4 X 4 wooden posts (Figure 1). The shelter keeps the direct sun and rain off the rhinos, equipment, and staff

Privacy Fence

We added a 6-ft wooden privacy fence around two sides of the chute that faced the service road (Figure 1). This prevents visual distraction from anything moving along the road.

Electricity

The final touch to the chute was to have electrical outlets installed. giving us opportunity to power exam equipment.

Scale/Platform

To weigh our rhinos we purchased a RB-100P portable platform GageTek scale. The scale includes four stainless steel Helix Load Cells, display console, cabling sufficient for 10-ft X 10-ft platform, and a rechargeable battery pack power supply. The RB-100P scale has a maximum capacity of 15,000 lbs.
(www.gagetek.com) (916)853-1265

We designed a 4-ft X 9-ft platform of 4-inch square tubing and double sheets of ½-inch aluminum sheeting, with the heaviest pieces weighing 80 lbs. The platform can be assembled and disassembled into ten pieces by one person.

For more details about rhino or giraffe platform designs contact us by phone or e-mail.

Cost

Projected budget, to which we mostly adhered...

Steel chute on a concrete pad	$5,000
Electronic scale (GageTek)	$2,500
Weighing platform	$2,500
Shade structure	$3,000
Total	$13,000

Video

- Zoo Atlanta's Rhino Facility
- Pre - rhino chute training
- Walk through of rhino chute design & operations
- 1st rhino introduction to chute
- Rhino one year later with chute
- 1st attempts at closing back gate 100%
- Scale & platform assembly
- Rhino weighing

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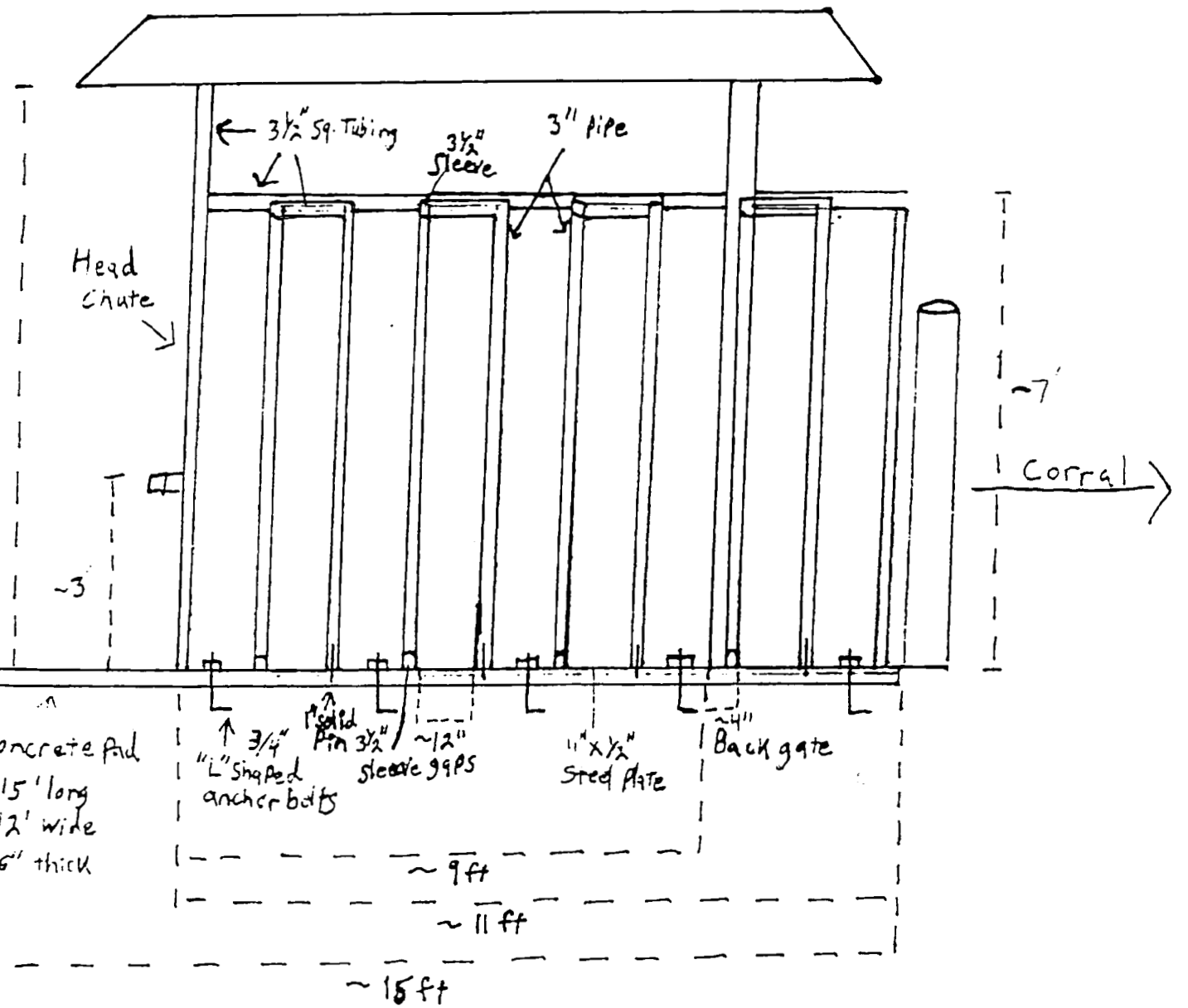
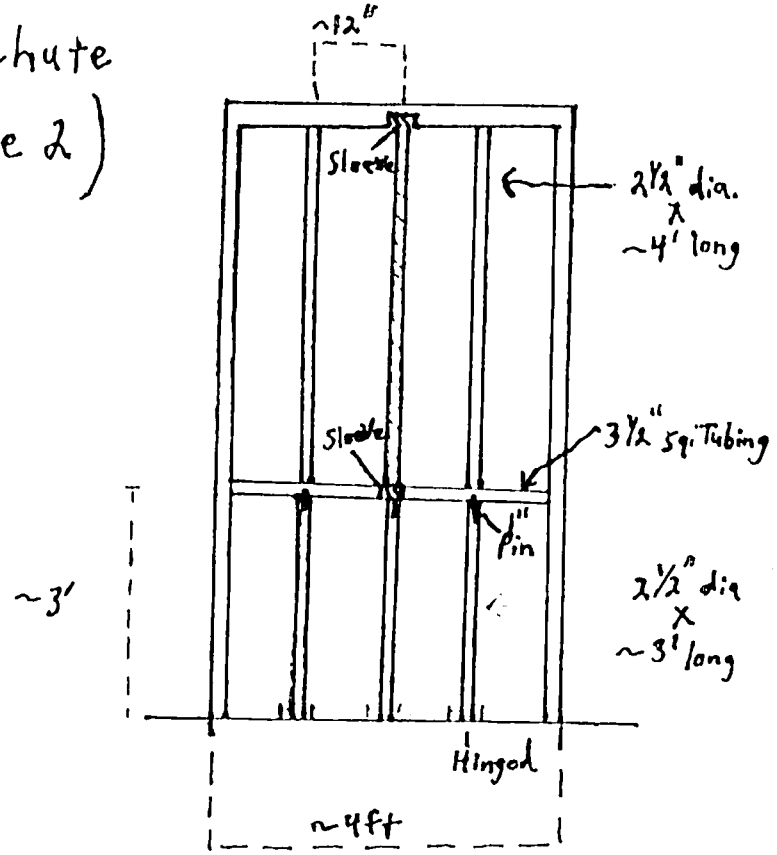
- Fossil Rim, Glen Rose, TX
- Milwaukee County Zoo, Milwaukee, WI
- Dr. Vaughan Langman, LSU-Shreveport, LA
- Zoo Atlanta Conservation Action Resource Center (ARC)
  - Richard Hezlep

(Figure 1)

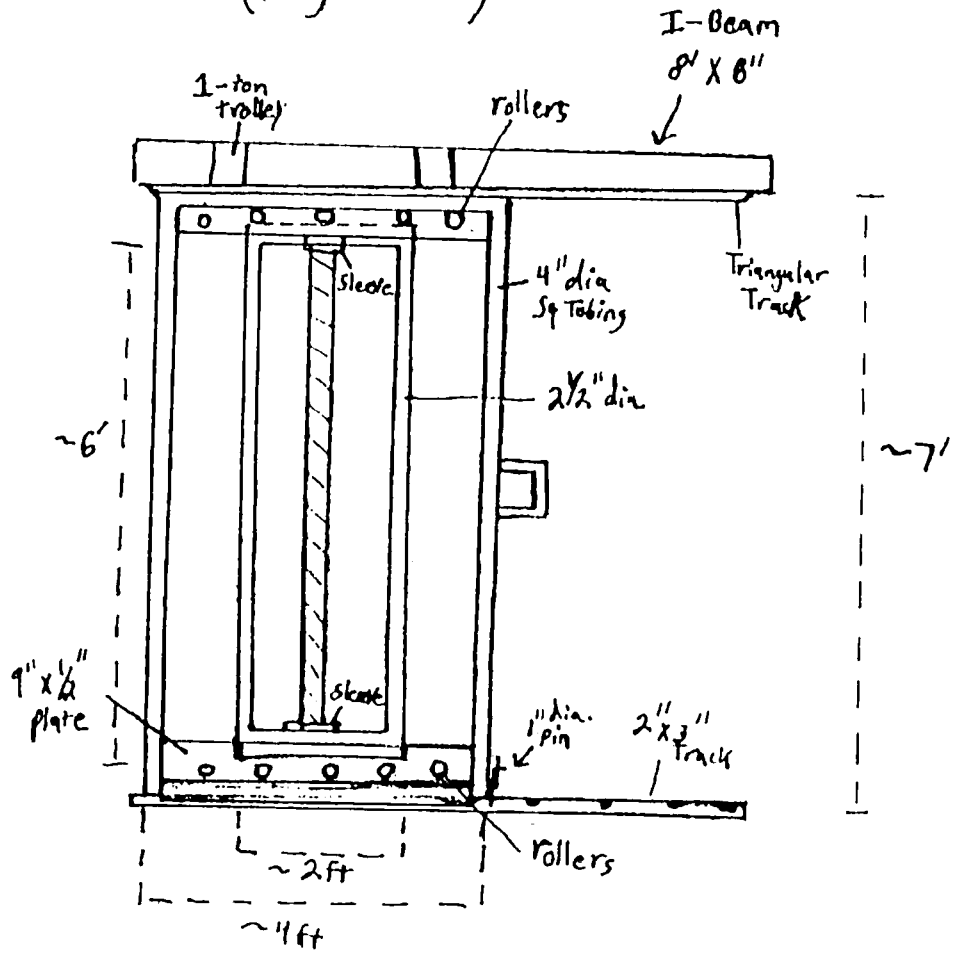
* All Steel - Schedule 40 thickness



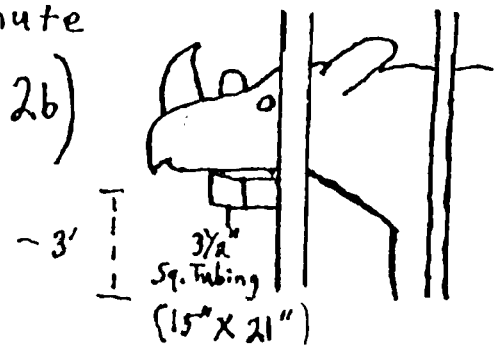
Head Chute
(Figure 2)



Back Gate
(Figure 3)



Head chute
(Figure 2b)



A REVIEW of RHINO FOOT PROBLEMS

Jeanne Jacobsen, Senior Keeper
Fort Worth Zoo

Captive rhinos are vulnerable to many serious and life-threatening diseases and conditions: hemolytic anemia, fungal pneumonia, idiopathic hemorrhagic vasculopathy syndrome (IHVS), and ulcerative dermatitis, to name a few. It is almost surprising in animals of such size, weight, and activity levels, that rhinos do not suffer from major foot diseases more frequently. The rhino foot is subject to many stressors such as trauma, substrate impact, climate, obesity, and nutritional imbalances. Conditions that cause lameness affect the quality of life, inhibit breeding programs, and may lead to more serious illnesses.

The Fort Worth Zoo exhibits three species of rhino, Black, White, and Greater One-Horned. This discussion will focus on foot problems we have experienced over the past ten years : nail cracks, laminitis, and chronic foot disease.

Early detection by daily observations of the feet and gait is important. Rhinos in zoos are usually tractable and will often cooperate with invasive procedures such as foot trimming and even blood collection without immobilization. Building a relationship based on trust allows keepers to form bonds with their animals which will assist with treatment options. Conditioning and consistent training are also valuable tools in manipulating behaviors and communicating with the rhinos.

Prevention is undoubtedly the first step in dealing with foot conditions and literally begins from the ground up. Suitable substrate is vital to the health of the rhino foot since extremely hard or abrasive surfaces can damage the soles and nails. Routinely wet or muddy enclosures can be a source of infections or overgrowth from lack of normal wear. Year round access to a combination of smooth, firm ground and softer, grassy areas with good drainage would be ideal. In addition, pools or mud wallows which can be drained are essential. Ample opportunity for exercise is beneficial for natural trimming of the nails, weight control, and stress reduction. When rhinos are confined to winter quarters, behavioral enrichment helps reduce stereotypic pacing, pawing, and swaying by relieving boredom and stress. Heavy duty rubber matting and abundant bedding provide protection from concrete flooring. Proper nutrition also has a direct bearing on the overall health of rhinos, and a deficiency or imbalance in vitamins, minerals, protein, and fats may compromise the condition of skin and nails.

Nail Cracks :

The most common problem seen in all species is vertical cracking in the nail wall, which can range from mild quarter cracks to more extensive splitting up to the corona. Trauma to the bottom of the nail or the coronary band can generate cracks, and concrete flooring aggravates this by wearing and thinning the nail walls of the lateral toes while the rhino is laying down.

Hooves have a natural waterproof, external layer called the periople which provides a protective coating and regulates evaporation or absorption. The periople can be damaged by concrete, sandy soils, chemicals, or improper filing. Dry, brittle nails lose resiliency and are more prone to splitting. Excess moisture can also cause damage. This moisture balance is influenced by the external environment or affected by an inappropriate diet. Less prevalent are horizontal cracks in the nail which may occur after a serious illness, laminitis, or nutritional disorder.

Treatment for cracked nails starts with cleaning the foot and carefully removing mud, grit, or feces. This allows for closer inspection and keeps debris from wedging and opening the crack further. Topical antiseptics may be prescribed to prevent infection. Commercial hoof dressings should only be used with veterinary approval since some of these products contain turpentine or petroleum compounds, and the splitting nails may not be caused by dryness. Corrective trimming by experienced personnel could be used to relieve pressure on the bottom of the nail and enable the crack to grow out. However, by making changes in environment and husbandry most of these cracks can be allowed to grow out without intervention.

Laminitis :

Also referred to as founder, laminitis is a metabolic and vascular disease which can affect rhinos and other hoofstock. The disease begins when the blood supply to the corium, the sensitive laminae of the foot, is interrupted. Damage to the coronary corium causes bands of irregular horn growth called laminitic rings. In severe cases the union between the horny and sensitive laminae breaks down and progresses to separation of the nail at the coronary band. Some common causes of this disease are excessive feeding of concentrates, enteritis, chronic renal failure, and IHVS.

An occurrence of laminitis at the Fort Worth Zoo resulted from a case of IHVS in a Black rhino. IHVS is identified by acute swelling of the neck, shoulders and limbs, lameness, oral or nasal ulceration and non-hemolytic anemia. The first signs of laminitis are lameness and inflammation or discharge at the coronary band. Gradually a gap appears at the top of the nail. It is possible for the affected nail to remain while the new nail grows and displaces it. With total separation the nail is only attached at the sole and tends to fold under the foot as the rhino walks. In this case, the nail is removed under anesthesia. Post-op treatments include good hygiene, keeping the foot and exposed laminae clean, topical antiseptics and pain management. New nail growth is usually completed in six months.

Chronic Foot Disease :

Chronic foot disease (CFD) involving the sole or nail/sole junction is a common problem in Greater One-Horned rhinos and can become a significant disability. According to an international survey conducted in 1996, this disease affects nearly twenty-five percent of the captive population. Male rhinos are twice as likely to suffer from CFD as females. CFD usually occurs in one or both hind feet, but all four feet are vulnerable.

The primary characteristics of CFD are fissures in the foot pad behind the middle toe and excessive tissue growth between the toes. These cracks in the pad initially appear as ragged edges of overgrown sole. Trauma to the loose edges expands the opening and promotes separation, with resulting scar tissue. The lesions may be exposed to secondary bacterial infection due to their location. A majority of cases also document overgrowth of the toenails, although it is not certain whether this is a cause or a consequence of pad separation. Pain associated with CFD will cause lameness or frequent weight shifting from the affected feet. Pressure sores on the flanks also develop due to the animal's reluctance to stand.

Various reasons are proposed as the cause of this disease. Overgrowth of the toenails is cited as a source of infection and fissure development, promoted by wet, muddy enclosures. These elongated nails may put added stress on an area of the pad which is inherently weaker. Another possible cause of CFD is persistent trauma to the feet from abrasive or extremely hard surfaces such as stony ground or concrete. The higher incidence in males may be explained by their greater weight, and increased agitation and mounting when females are in estrus. It has also been suggested that a lack of humidity in heated winter quarters can reduce the elasticity of the foot pads. Since the natural habitat of the Greater One-Horned rhino is grassland in flood plains, limited access to pools for wallowing may contribute to chronic foot disease.

Treatment for CFD is complicated by the location of the lesions and the temperament of the rhinos. Training the rhinos to accept routine footwork such as trimming and applying topical medications is very important and may prevent the need for more drastic surgery under chemical immobilization. Boots and bandages have been tried but do not last and can increase the risk of infections. Providing soft surfaces such as deep sand and twenty-four hour access to pools aids the healing process and assists in prevention of future episodes.

As the name implies, CFD can become a lifelong problem for the Greater One-Horned rhino. It can result in deep seated soft tissue and bone infections needing multiple veterinary interventions, can interfere with breeding programs, and in severe instances can cause the death of the animal. Knowledge and use of appropriate management is essential for the prevention of chronic foot disease.

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THE ROLE OF REPRODUCTIVE RESEARCH AND TECHNOLOGY IN FACILITATING CAPTIVE BREEDING PROGRAMS FOR THE RHINOCEROS

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The rhino taxon comprises a group of related species each with distinct reproductive characteristics and facing different reproductive challenges in captivity. Reproductive research and technology could facilitate the captive breeding programs for all species and, in several cases, they already have. However, based on the reproductive biology, behavior and associated problems of the four captive rhino species, the most logical approach for helping to conserve each of them differs.

Of the reproductive technologies available for use in the rhino taxon, hormone monitoring has been the most broadly employed both in efforts to understand the reproductive biology of these species and to facilitate management strategies. Fortunately, many animals can be conditioned to allow blood collection, and it is becoming common practice at many institutions for veterinary and keeper staff to develop routine blood collection protocols. Although somewhat species dependent, it is possible to collect blood from the foreleg, ear and tail of the rhinoceros. However, most endocrine data has been collected through noninvasive (fecal and urine) hormone metabolite monitoring. The responsibility for accurately collecting, labeling and sending these samples to the scientists for analyses lies primarily with the daily keeper staff. Progesterone, estrogen, testosterone and corticosterone metabolites all can be measured in rhino urine or fecal samples (Kasman & Lasley, 1981; Kasman et al., 1986; Hodges & Green, 1989; Hindle & Hodges, 1990; Hindle et al., 1992; Schwarzenberger et al., 1993; Schwarzenberger et al., 1996; Berkeley et al., 1997; Radcliffe et al., 1997; Garneira et al., 1998; Heistermann et al., 1998; Roth et al., 1998; Schwarzenberger et al., 1998; Patton et al., 1999; Roth & Brown, 1999; Brown et al., 2001; Roth et al., 2001). Thus, noninvasive hormone monitoring provides one method for evaluating ovarian activity, sexual maturity, pregnancy and adrenal function as a potential indicator of stress.

Ultrasound technology is becoming another valuable reproductive tool for the rhinoceros, in part, because animals can be conditioned to allow the procedure (Schaffer et al., 1994; 1998; Radcliffe et al., 1997; Radcliffe, 1998; Roth & Brown, 1999; Roth et al., 2001). Therefore, ultrasound examinations can be conducted at the specific times and frequencies necessary to produce accurate data on reproductive tract dynamics. The role of keepers in conditioning animals for these procedures is critical to the long-term success of research projects. Once the animals are conditioned to tolerate ultrasonography, researchers continue to rely on the animal staff to handle the rhinos during exams. Ultrasonography already has been used to directly monitor ovarian activity throughout the reproductive cycle in white (Radcliffe et al., 1997), Sumatran (Roth et al., 2001) and Indian (Roth & O'Brien, 2000) rhinoceros and has been used to detect uterine pathology (Schaffer et al., 1994; Radcliffe et al., 1997; Radcliffe 1998; Roth et al., 2001) and early pregnancy loss (Radcliffe et al., 1997; Radcliffe, 1998; Roth et al., 2001). In males, ultrasonography has been used to evaluate reproductive tracts and to monitor changes associated with artificially stimulated ejaculation (Schaffer et al.,1994; 1998; Hermes et al., 2000).

The potential benefits of developing assisted reproduction for rhinoceros were recognized years ago, but progress has been slow. For artificial insemination (AI) or in vitro fertilization (IVF),

semen is required, and semen collection in rhinoceros has proven difficult. Early efforts employed a manual penile and/or rectal massage technique that resulted in some success with a few animals (Schaffer & Beehler, 1988; Schaffer et al., 1990; Schaffer et al., 1991), but could require up to 3 years of animal conditioning. In other cases, manual massage yielded seminal fluid but no true ejaculate (O'Brien & Roth, 2000). The general problem with the penile massage method is that conditioning the animals can be extremely time consuming and some rhinos never do ejaculate in response to it. However, it is a technique that several keepers have started using in attempts to check their bull's fertility and/or to cryopreserve his gametes.

Although electroejaculation can be successful (Platz et al., 1979; Schaffer et al., 1990; 1998), it has been somewhat unreliable. However, recent attempts with rectal probes that have been modified to better fit the rhino's anatomy have shown promise both in our laboratory and by others (Hermes et al., 2000). Opportunistic methods that have proven successful for obtaining rhino spermatozoa include post-coital semen collection from the female (Roth et al., 2001) and epididymal sperm rescue post-mortem (Williams et al., 1995; O'Brien & Roth, 2000). Initially, rhino spermatozoa appeared challenging to freeze (Platz et al., 1979; Schaffer & Beehler, 1988; Williams et al., 1995), but spermatozoa from both a Sumatran and black rhinoceros now have been cryopreserved successfully using a standard hoof stock semen freezing protocol (O'Brien & Roth, 2000). This same protocol recently proved equally effective for cryopreserving epididymal spermatozoa from two white rhinoceros.

Recently, AI was attempted in the white rhinoceros using cold stored semen collected by electroejaculation (Hermes et al., 2000). The procedure was conducted on anesthesized females pre-treated with exogenous hormones (progesterone and hCG). Endoscopic and ultrasonographic visualization indicated the insemination procedure was successful, but no sustained pregnancies have yet been confirmed following these attempts. The use of exogenous hormones to induce or synchronize estrus in the rhinoceros is, in itself, still very experimental (Patton et al., 1998). However, the regimen employed for the AI trial holds promise as it does appear to induce ovulation (Walzer & Schwarzenberger, 1995; Hermes et al., 2000).

Rhino IVF has been attempted opportunistically on a few occasions in conjunction with gamete rescue efforts, but no embryos have been produced (Godfrey et al., 1990). There are no reports of embryo collection and transfer attempts in any rhino species and, due to the complicated and invasive procedures required for these ARTs, they may not become research priorities for the rhinoceros any time soon. However, several of the reproductive tools described above have immediate application to resolving problems that currently hinder rhino captive breeding programs.

The African black rhinoceros (*Diceros bicornis*) has been the most prolific of the captive rhinoceros. Most female black rhinoceros exhibit reproductive cycles that average 25 d in length but range from 20-30 d (Hindle et al., 1992; Schwarzenberger et al., 1993; Schwarzenberger et al., 1996; Berkeley et al., 1997; Roth & Brown, 1999; Brown et al., 2001). With reproductive success relatively high, this species is not likely to require high-tech reproductive approaches to improve captive propagation. However, to facilitate efficient management of the species, endocrine and ultrasound monitoring should be employed to detect pregnancy, pregnancy loss and pathology, especially in those few individuals that breed repeatedly without producing offspring (Roth & Brown, 1999; Brown et al., 2001).

In contrast to the black rhinoceros, the southern white rhinoceros (*Ceratotherium simum simum*) has not reproduced well in captivity. Endocrine monitoring studies indicate that

approximately 50% of captive female white rhinoceros are acyclic, whereas the remaining females are exhibiting either 5 wk, 10 wk or a mixture of 5 and 10 wk cycles (Hindle & Hodges, 1990; Hindle et al., 1992; Radcliffe et al., 1997;1998; Roth et al., 1998; Schwarzenberger et al., 1998; Patton et al., 1999; Roth & Brown, 1999; Brown et al., 2001). The 10 wk cycles are characterized by an extended luteal phase, and data suggest these cycles are infertile (Roth et al., 1998; Patton et al., 1999; Brown et al., 2001). Determining the causes of both acyclicity and extended cycles are research priorities for the southern white rhinoceros and probably will require studies that combine hormone monitoring and serial ultrasound examinations. Ultrasonography already has allowed the detection of early pregnancy loss and uterine pathology in the white rhinoceros (Radcliffe et al., 1997; Radcliffe, 1998) and may hold the key to understanding reduced fertility in this species. In the interim, exogenous hormone administration in conjunction with AI may provide a means of producing pregnancies in otherwise acyclic animals (Hermes et al., 2000).

The reproductive cycle of the Indian rhinoceros (*Rhinoceros unicornis*) varies among and within individuals but averages 43-48 d in length (Kasman and Lasley, 1981; Kasman et al., 1986; Roth & O'Brien, 2000). A long-term, serial ultrasound study on one animal revealed the development of 10-12 cm pre-ovulatory follicles that persisted approximately 10 d before spontaneously ovulating (Roth & O'Brien, 2000). Although reproduction generally has been good, aggressive behavior exhibited by males towards seemingly estrual females has limited our ability to genetically manage the captive Indian rhino population, and the sire gene pool is largely restricted to males of a particular founder line (Foose & Reece, 1998). Therefore, the justification for developing AI to genetically manage rhinos may be strongest for this species.

In the last century, captive breeding efforts with the Sumatran rhinoceros *(Dicerorhinus sumatrensis*) have failed, largely due to a lack of knowledge about their reproductive biology and aggressive interactions between pairs introduced for mating (Khan et al., 1999). However, in a recent study, a female monitored intensively by ultrasound and endocrine analyses was found to be an induced ovulator with a 21 d reproductive cycle (Roth et al., 2001). This information has greatly facilitated a natural breeding strategy that involves timed introductions based on progesterone concentrations and follicle size. Furthermore, ultrasound has been used to detect early pregnancy, pregnancy loss and uterine pathology in the Sumatran rhinoceros (Schaffer et al., 1994; Roth et al., 2001). Due to the limited number of animals in captivity (n=15), AI someday may be required, and spermatozoa has been cryopreserved for that eventual purpose (O'Brien & Roth, 2000). But, for now, reproductive technology is most valuable in this species as a tool for facilitating natural breeding and for detecting and monitoring resulting pregnancies.

Reproductive research already has contributed significantly to our understanding of rhino reproductive physiology and the challenges we face in trying to breed these species in captivity. Species specific characteristics are diverse, as are the problems facing each species. Additional research and the application of reproductive technology will facilitate rhino propagation efforts, but there is no universal approach that can be applied to all species. Instead, priorities must be customized to address the particular set of circumstances surrounding each species. Decisions on how and when to use reproductive techniques must reflect logical and practical considerations. Only then, will reproductive research and technology truly be working for conservation.

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CONSERVATION PROGRAMS FOR SUMATRAN AND JAVAN RHINO IN INDONESIA AND MALAYSIA

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ABSTRACT

There is an intensive and international program in progress to try to conserve the two most endangered Rhino species: the Sumatran Rhino and the Javan Rhino, both occurring in Southeast Asia. The effort is employing a diversified and integrated strategy that is attempting (1) to protect the species in the wild using anti-poaching teams known as Rhino Protection Units (RPUs) and (2) to breed the species under managed conditions in breeding centers in native habitat.

BACKGROUND

Of the five extant Rhino species, the Sumatran (*Dicerorhinus sumatrensis*) and Javan (*Rhinoceros sondaicus*) rhino of South East Asia are the most endangered and acutely threatened with extinction. The third Asian species, the Indian Rhino (*Rhinoceros unicornis*) is more secure in India and Nepal, where it has recovered through good conservation and protection to viable levels. Nevertheless the three Asian rhino species together number fewer than the rarest of the African Rhinos, the Black Rhino (*Diceros bicornis*), while the most numerous African species, the Wite Rhino (*Ceratotherium simum*) is three times more numerous than all other species combined (See Table 1 below).

As recently as the early 20th century, both the Sumatran an Javan species were widespread over South Eastern Asia from eastern India through Indochina, the Malay Peninsula and selectively on Sumatra (the Sumatran and the Javan), Java (the Javan), and Borneo (the Sumatran, and Javan until about 12,000 years ago).

Today, the only confirmed, significant populations of Sumatran rhino survive in three geographically distinct areas of two range states: in Indonesia on Sumatra; in Malaysia, on the Peninsula; and in the Malaysian State of Sabah on the island of Borneo. Recent evidence suggests that some Sumatran rhino still exist in Thailand along the border with Malaysia, in northern Myanmar, and perhaps in India on the border with Myanmar, but the significance and validity of these reports has yet to be confirmed (See Map 1).

About 300 Sumatran rhino are estimated to survive worldwide. Although not as rare as the Javan rhino, poaching pressure is more intense on the Sumatran rhino, whose populations have declined considerably in the last decades, almost entirely due to poachers. The remaining populations are fragmented and small, with not a single area that has more than about 50-75 animals. Thus, the Sumatran Rhino is considered the most critically endangered species of rhino by the IUCN/SSC Asian Rhino Specialist Group (AsRSG).

The Javan Rhino is confirmed in only two populations: about 50-60 in Ujung Kulon National Park on the western tip of Javan in Indonesia and another 5-8 in the Cat Loc area that is now part of Cat Tien National Park in southern Vietnam. Hence, there are fewer than 70 Javan rhino alive on

the planet. However, the Indonesian population at least is consolidated in a relatively well protected Park and the population has remained unchanged in numbers for the last two decades (See Map 2).

The predominant cause of decline of both of these rhino species is poaching for the horn. Considerable habitat loss has occurred throughout their ranges as ever more forest is destroyed for timber or converted to agriculture, but the AsRSG estimates that there is still enough habitat for at least several thousands of both species, even within the two range states of Indonesia and Malaysia. Consequently, while habitat and ecosystem conservation are vital for long-term viability, direct protection of rhinos from poachers is much more critical over the short term.

In response to this crisis, the action plan for conservation of these two species in Indonesia and Malaysia emphasizes two major components:

(1) Anti-poaching teams known as **Rhino Protection Units** (RPUs) for both Sumatran and Javan Rhino, and

(2) **Managed Breeding Centers in Native Habitat**, currently for Sumatran Rhino but

		WILD	CAPTIVE
African Rhinoceros			
Black Rhino	***Diceros bicornis***		
South-central Black Rhino	*Diceros bicornis minor*	>1,450	>65
Eastern Black Rhino	*Diceros bicornis michaeli*	>500	>175
South-western Black Rhino	*Diceros bicornis bicornis*	>750	0
North-western Black Rhino	*Diceros bicornis longipes*	>10	0
	TOTAL	>2,700	>240
White Rhino	***Ceratotherium simum***		
Southern White Rhino	*Ceratotherium simum simum*	~10,400	10
Northern White Rhino	*Ceratotherium simum cottoni*	30	>730
	TOTAL	~10,430	>740
	TOTAL AFRICAN RHINOS	>13,100	>980
Asian Rhinoceros			
Indian Rhino	***Rhinoceros unicornis***		
Eastern population	*(Assam & West Bengal)*	~1,800	
Western population	*(Nepal & Uttar Pradesh)*	~670	
	TOTAL	~2,470	~140
Javan Rhino	***Rhinoceros sondaicus***		
Southern Javan Rhino	*Rhinoceros sondaicus sondaicus*	50-60	0
Indochinese or Eastern Javan Rhino	*Rhinoceros sondaicus annamiticus*	5-10	0
Northern Javan Rhino	*Rhinoceros sondaicus inermis*	0	0
	TOTAL	55-70	0
Sumatran Rhino	***Dicerorhinus sumatrensis***		
Southern Sumatran Rhino	*Dicerorhinus sumatrensis sumatrensis*	~250	13
Bornean or Eastern Sumatran Rhino	*Dicerorhinus sumatrensis harrissoni*	~50	2
Northern Sumatran Rhino	*Dicerorhinus sumatrensis lasiotis*	0?	0
	TOTAL	~300	15
	TOTAL ASIAN RHINOS	~3,830	~155

Table 1

eventually perhaps for the Javan as well, both to propagate the species as a back-up for wild populations and to serve as centerpieces for a conservation tourism program that can generate funds to support the RPUs and other *in situ* efforts for the rhino.

RHINO PROTECTION UNITS (RPUs)

Under the conditions that have prevailed in Indonesia and Malaysia over the last five years, Rhino Protection Units (RPUs) appeared to be the best method to effectively protect tropical forest rhinos. The current RPU program in Indonesia and Malaysia was initiated with and catalyzed by a grant from the Global Environment Facility (G.E.F.) through the United Nations Development Programme (UNDP). The International Rhino Foundation (IRF) and the IUCN/SSC Asian Rhino Specialist Group (AsRSG), for which IRF operates as the financial and administrative agent under an M.O.U. with IUCN-The World Conservation Union, coordinated and facilitated the GEF Project.

To supplement the GEF funds during the initial three years and particularly to continue the program after the expiration of the GEF grant in December 1998, the International Rhino Foundation (IRF) and the IUCN/SSC Asian Rhino Specialist Group (AsRSG) have contributed funds and recruited a number of other donor partners.

Under the IRF/AsRSG-initiated program, RPUs have been formed in all areas where Sumatran rhinos exist. As of late 1998, RPUs have also been formed for Javan rhino as a result and at the recommendation of a Javan Rhino Colloquium organized by the AsRSG and IRF. There are a total of 41 RPUs (including a few Tiger and bufferzone units) operating in Indonesia and Malaysia under the two auspices described above.

In Indonesia and Malaysia, each RPU usually consists of 4-5 persons and is engaged in anti-poaching patrol and intelligence operations. The RPUs are attempting to create intensive protection zones (IPZs) for the rhino in each area. The emphasis for the RPUs is to patrol in the Rhino core areas, to destroy traps and snares, and to interdict intruders. The RPUs also engage in community outreach efforts as well as intelligence operations to identify poachers in the local area. In all cases, the RPUs coordinate closely with the existing staff of the National Park but are concentrating specifically on anti-poaching in Rhino core areas.

IRF and its partner organizations provide the funds for RPUs in Ujung Kulon NP, Way Kambas NP, Bukit Barisan Selatan NP in Indonesia and for Taman Negara NP, Endau Rompin NP, and several smaller areas in Peninsula Malaysia. In Gunung Leuser NP, where probably the largest number of Sumatran rhinos survive, RPUs are organized by the Leuser Development Program with financial support from the EU and technical assistance from the IRCP. RPUs also operated during the GEF sponsored phase in the Tabin Wildlife Reserve and the Danum Valley Conservation Area in Sabah, and currently they are being re-established with support from SOS Rhino.

The RPUs have been effective over the last three years. Poaching has been eliminated or drastically diminished in areas where the RPUs have been operating. The current political end economic uncertainties in Indonesia have increased the pressure on the natural resources and also the rhino poachers appear to be encouraged by the deteriorating security situation. Recently two cases of rhino poaching, in which one rhino was unfortunately killed, have been detected in Bukit Barisan Selatan NP in areas guarded by the RPUs and the anti-poaching efforts may have to be further intensified in some areas.

The major problem with the RPU program is the high costs of deploying a sufficient number of RPUs to provide adequate coverage of the total area of the Parks. The RPUs have the objective of protecting the other large mammals as well as the rhino in the Parks, but have to restrict their activities to areas where rhinos occur. In most areas rhinos occur in only a small part of the conservation area, and therefore large parts of the Parks remain unprotected. Recently with supplementary grants a few units have been added to cover bufferzones in Taman Negara in Malaysia and important tiger areas in Bukit Barisan Selatan in Sumatra, which are outside the rhino areas.

The RPU program is costly as it involves much personnel and currently there is about one person employed for every 1-2 rhinos protected and costs per rhino are above $ 1000 per year. The financial sustainability of the program is an ongoing concern, as its is not likely that the demand for rhino horn and therewith the pressure for poaching of rhino will diminish or disappear in the near future. The RPU program will need to continue for as long as rhinos need protection, and that might be for many more years. If such a program cannot be sustained because of lack of funds rhino poaching will intensify immediately and the former RPU members may not be able to resist the temptation of providing services to poachers.

MANAGED BREEDING CENTERS IN NATIVE HABITAT FOR SUMATRAN RHINO

The second major component of the conservation program for Sumatran and Javan rhinos are Managed Breeding Centers in Native Habitat. Currently, these centers are being developed only for Sumatran rhino, but if successful they may be extended to Javan rhino in the future.

The managed breeding centers have two major components:

I. Biological Component:

The breeding centers for Sumatran rhinos are attempting to propagate this species under managed conditions as a back-up to the *in situ* protection efforts. Since protection *in situ* has proven so challenging, a back-up through managed breeding could be critical. On this premise and in response to the dire status of this species, an *ex situ* captive propagation program was initiated in 1984 as an integral component of the conservation strategy for this species under auspices of the Species Survival Commission (SSC) of the IUCN using rhinos in areas where they could never be protected or be part of a population large enough to be viable.

Three separate captive programs were initiated in the major and geographically disjunct regions where appreciable populations of Sumatran rhino still survive: Indonesia, Peninsular Malaysia, and Sabah (on the island of Borneo). The Indonesian program was the most international of the programs with rhinos rescued being placed in captive facilities in Indonesia, the United Kingdom, and the United States.

Unfortunately, traditional captive methods have not worked for the Sumatran rhino. The Sumatran rhino has proven a much more formidable challenge than anticipated. Since 1984, 40 rhino have been collected from the wild. However, mortality has been high: 25 of the 40 have died (~65%). Today only 15 (5 males and 10 females) survive in 4 captive facilities. Moreover, to date no reproduction has occurred although a female in the USA is currently pregnant.

A number of reasons have been proposed for the problems with the captive program:

- Many of the mortalities seem consistent with nutritional difficulties.
- Mortalities may also be related to the size and configuration of captive enclosures.
- The small size and configuration of enclosures may also be inhibiting the breeding.
- The reproductive biology of the species causes it to be one of the most difficult that captive managers have ever tried to reproduce.
- A final cause of problems that has been strongly suggested is stress due to exposure, both to human activities and to environmental factors, especially intense sunlight (especially its ultraviolet component), for these normally deep forest animals.

The conclusion from consideration of the program performance and suspected problems has been a recommendation that the surviving rhinos in captivity be consolidated in the most spacious enclosures and natural conditions possible consistent with continuation of the intensive protection and management believed necessary because of the precarious situation in totally free-ranging situations in the wild. By providing much larger enclosures and more natural conditions in a managed breeding center in natural habitat, the hope is that propagation can succeed.
Three managed breeding centers in native habitat are already in operation:

(1) The Sumatran Rhino Sanctuary/Suaka Rhino Sumatera (SRS) in Way Kambas National Park, Sumatra, Indonesia.

The SRS complex comprises 10,000 hectares (25,000 acres) within Way Kambas National Park , divided into two parts: a **Rhino Conservation Zone** of 9,000 hectares and a **Conservation Tourism Zone** of 1,000 hectares.

Within the conservation zone, the first set of enclosures has been completed and encompasses 250 acres (100 hectares) in native forest.
Three rhino from zoos in the UK and Indonesia were moved to the SRS in January 1998. The rhino have re-adapted well to their native environment after many years in captivity. An old unreproductive female died early 2001 and the remaining pair comprise all but three of the five surviving rhino of the 18 (7 males and 11 females) originally captured in Indonesia as part of the effort to establish a captive propagation program for this species. The other 3 surviving Sumatran rhino from Indonesia in captivity are in zoos in the United States.

The IRF provided the initial capital (about $ 500,000) for development of the rhino facilities and is supporting operation of the biological program (about $ 50,000/year)

(2) The Sumatran Rhino Conservation Center - Sungai Dusun (SRCCSD) at Sungai Dusun Wildlife Reserve in Peninsula Malaysia.

This center is currently smaller in size than the SRS in Way Kambas but has more rhino: two males and five females. The original facilities consisted of a barn with seven yards. With funds from and through the IRF, a larger enclosure of four hectares contained by electric fence has been constructed to extend the facilities into the adjacent forest. A project by the Malaysian government has enclosed another 40 hectares of forest by the end of 1999.

The IRF and AsRSG have now an assumed joint financial and managerial responsibility with the Department of Wild Life and National Parks of Peninsula Malaysia for this center. An objective is to manage the two breeding centers at Way Kambas and Sungai Dusun in as integrated and interactive a way as possible. It is likely that there may be some movement of rhino between the Way Kambas SRS and the Sungai Dusun Center to manage the surviving rhino as a single population to maximize propagation.

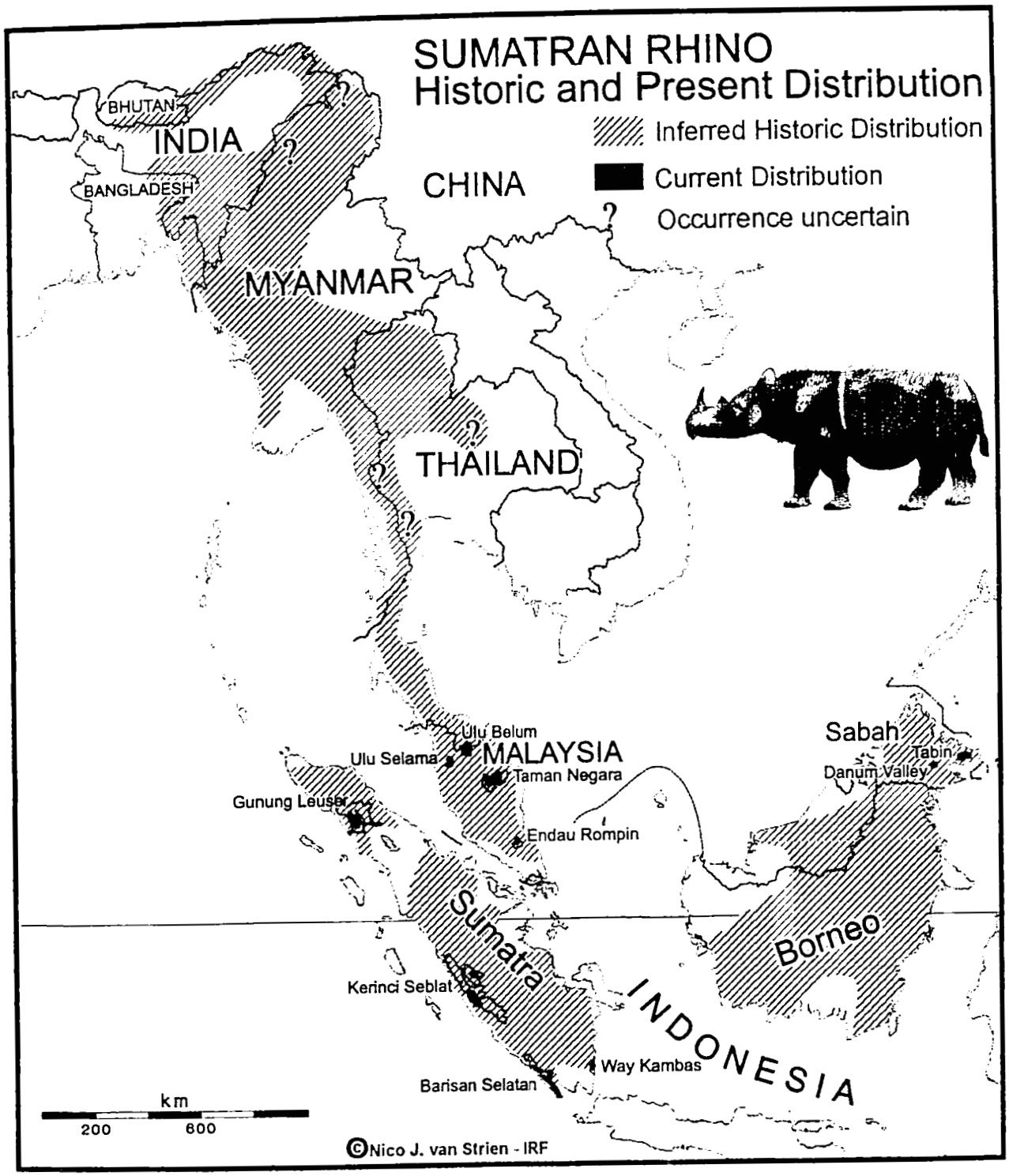
(3) The Sepilok Sumatran Rhino Breeding Center in Sabah.

This is the smallest of the three centers and has just a pair of Sumatran rhino currently. The centre is currently being upgraded with support of SOS Rhino.

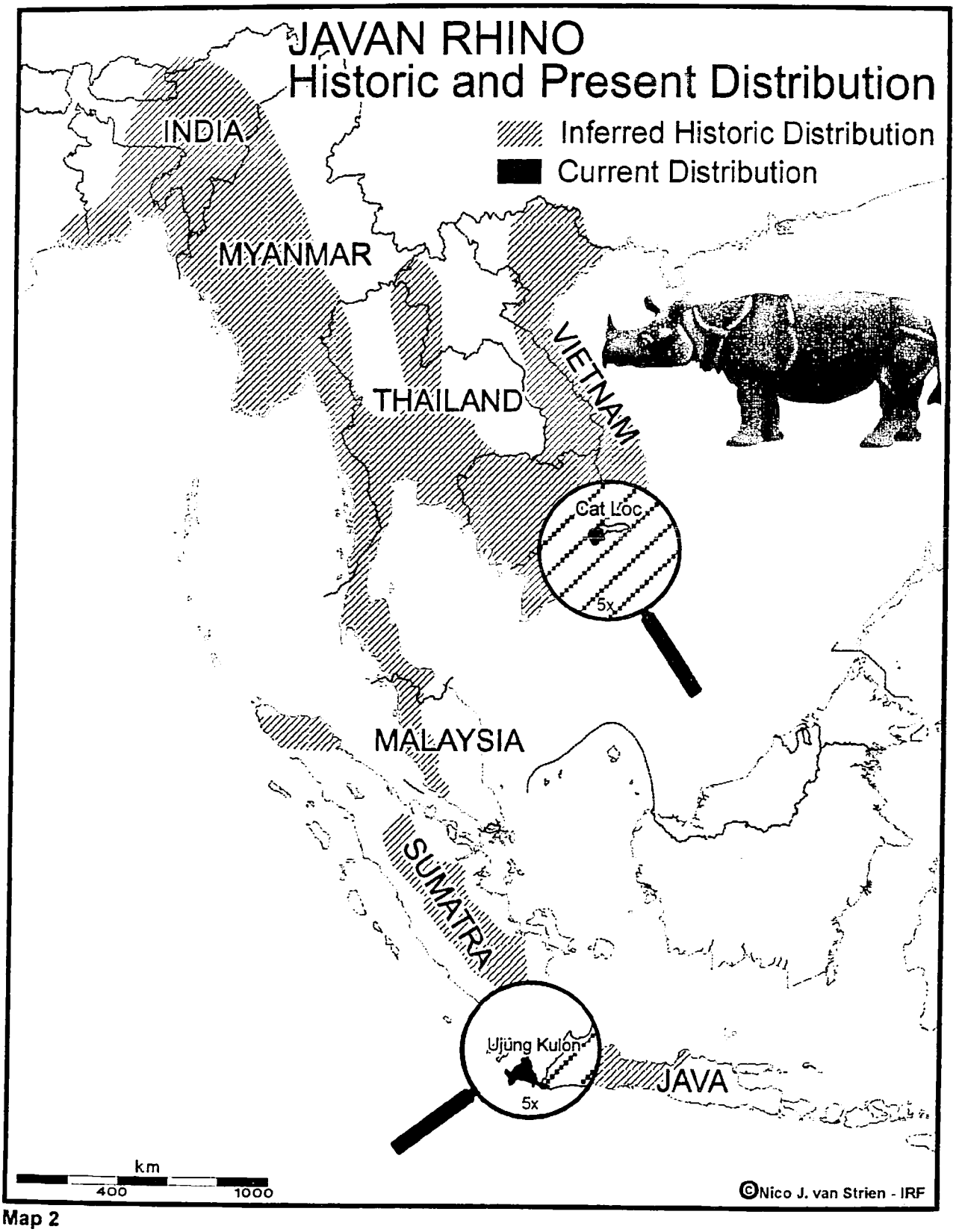
CONCLUSION

The Conservation Programs for Southeast Asian rhinos are of vital importance for the survival of two species of Rhinoceros. These programs are complementary to the long-term efforts for preservation of wildlife and biodiversity that are ongoing in the Rhino Range States and include protected areas, legislation, law enforcement, public awareness, education, and fund raising by the Range State Governments and National and International Conservation Agencies.

The Rhino Conservation Program has been supported by the International Rhino Foundation(IRF) and its member institutions (including especially the Howard Gilman Foundation and the Walt Disney Company Foundation), World Wide Fund for Nature - Indonesia (WWF-I), the Rhino and Tiger Conservation Fund of the US Fish and Wildlife Service (RTCF). AAZK Bowling for Rhinos, and the Anna Merz Trust.


SUMATRAN RHINO
Historic and Present Distribution
Inferred Historic Distribution
Current Distribution
Occurrence uncertain
BHUTAN
INDIA
BANGLADESH
CHINA
MYANMAR
THAILAND
Ulu Belum
MALAYSIA
Ulu Selama
Taman Negara
Gunung Leuser
Endau Rompin
Sabah
Tabin
Danum Valley
Sumatra
Borneo
Kerinci Seblat
INDONESIA
Way Kambas
Barisan Selatan
km
200
600
©Nico J. van Strien - IRF

Map 1


JAVAN RHINO
Historic and Present Distribution
Inferred Historic Distribution
Current Distribution
INDIA
MYANMAR
THAILAND
VIETNAM
Cat Loc
5x
MALAYSIA
SUMATRA
Ujung Kulon
5x
JAVA
km
400
1000
©Nico J. van Strien - IRF

Map 2

REPRODUCTIVE FAILURE IN SOUTHERN WHITE RHINOCEROS: TESTING HYPOTHESES WITH BEHAVIORAL AND HORMONAL DATA FROM CAPTIVITY AND THE FIELD

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SUMMARY

In the fall of 2000 the endocrinology and behavior departments joined forces to conduct the zoo's first long-term field study of a rhinoceros species in a study aimed at understanding the reproductive biology and behavior of the white rhinoceros. Our previous research efforts with the captive population generated a host of new questions that could only be adequately addressed by detailed studies of wild rhinos. Over the past four years we collected behavioral and hormonal data at the San Diego Wild Animal Park and other zoological institutions and found that the female reproductive cycle was highly variable. Sometimes these data pointed to an estrous cycle recurring about every 35 days, and sometimes about 70 days passed between cycles (Patton et al. 1999). In each case progesterone metabolites found in feces remained high between fertile periods, dropping to low levels at the same time that the female began to show behavioral signs of estrus and became the target of male courtship overtures. Some of the long cycles appeared to be associated with uterine pathology and/or premature termination of a pregnancy, suggesting that long cycles might be abnormal. However, researchers in Europe made similar findings, but suggested that the long cycle was typical for the species. Data from the field were too limited to provide an answer to this controversy. It is surprising that we do not yet fully understand this basic aspect of reproductive biology in the white rhino in the new millennium. Clearly, this issue must be resolved if we are to adopt an informed management strategy for dealing with cases of reproductive failure. What is normal for this species? Which female cycles should be considered pathological and merit remedial intervention? The answer lies waiting for discovery in a healthy, reproductively active wild population.

We found just such a population at the Umfolozi Game Reserve in Kwazulu-Natal, South Africa. Early in this century the white rhino population had been decimated by poaching, reducing their numbers to about 50 individuals, and it was only through the efforts of enlightened managers at Umfolozi that the species was saved from extinction. Under their protection the population grew rapidly, and subsequently were translocated to many other reserves. Today they number nearly 10,000. Umfolozi is comprised of bushveld habitat, characterized by open short and long grass grazing areas interspersed with dense acacia thickets. The reserve harbors one of the densest populations of game in all of Africa. Common species include black rhino, cape buffalo, giraffe, zebra, impala, nyala, cheetah, lion, and elephant. Behavioral ecologist Angela White was hired by CRES to radio-track white rhinos to collect both behavioral data and fecal samples to be analyzed

in the endocrinology lab at CRES. Small transmitters are implanted near the base of the horn, which will emit a signal for approximately two years. Tracking rhinos has proven difficult, as they are extremely wary of humans; one must always approach the rhino from downwind and, although rhinoceros vision is poor, take care not to be seen by the ever-present oxpeckers. These birds live in a mutualistic arrangement with rhinos, feeding on ectoparasites living on the rhino's skin and signaling alarm to the rhinos when they detect the approach of a human.

Although this project has been underway for only seven months, several females have already come into estrus, perhaps stimulated by the flush of fresh green growth that followed the beginning of the rainy season in September. Preliminary data from behavioral observations suggest that these wild females do indeed experience approximately 30-day cycles. Estrous females are easily recognized by the sustained presence of a dominant territorial male, which often accompanies the female for up to two weeks prior to mating. At this time observations are intensified to be sure that data are gathered during the brief 1-2 day fertile period. During the period leading up to peak estrus the female generally rebuffs the male's advances, keeping him at a distance by snorting, snarling, and lunging at the male. The male appeases the female by making a hiccing sound when he approaches her. Eventually, the female will allow the male to advance and rest his chin on her hindquarters, and mating follows soon thereafter. We hope to obtain detailed data on these behavioral processes that predict impending estrus, and determine how they relate to levels of reproductive hormones. In addition to providing conclusive data regarding the length of the estrous cycle, we hope to obtain a better understanding of reproductive strategies, competition, mate choice, and acoustic and olfactory communication in wild rhinos, and make comparisons with similar processes observed in captivity. Fecal metabolites of corticoid hormones, which can be an indicator of stress, will also be assayed to provide a basis for comparison with captive populations. These data may provide new insight into the potential role that stress may play in inhibiting reproduction in captive populations. Ultimately, we hope that this research will make meaningful contributions to the conservation of the species, both in the wild and in captivity.

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IDENTIFYING POTENTIAL ENVIRONMENTAL AND BEHAVIORAL STRESSORS THROUGH BLOOD CORTISOL IN THE BLACK RHINOCEROS *(DICEROS BICORNIS)*

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ABSTRACT

Environmental and behavioral stressors have potentially negative effects on the captive management of the black rhinoceros. Overcrowding, pair incompatibility, and poor nutrition are just a few of the factors facing this species in a zoological setting. The black rhino is considered to be the most nervous and stress-susceptible of the 5 rhino species (Carlstead, 1999). There are several disease syndromes that are specific to the black rhinoceros including, hemolytic anemia, oral and skin lesions, IHVS, encephalomalacia, iron storage, and fungal pneumonia.

At the Denver Zoo, we have experienced each one of these syndromes, along with mortalities in our black rhino population. Stress has been implicated as one of the causal factors in these specific syndromes in the black rhino (Fouraker, Wagener, 1996). A research project was developed to identify and evaluate potential stressors that may initiate some disease factors, by comparing behavioral observations to blood cortisol levels before and after predefined events.

METHODS

Observations of each animal's reactions to different situations over many years were used to identify baseline data for focal sampling. These observations were then used to test the hypothesis that specific events might cause stress levels to increase in the animals. Potential stress events identified for evaluation were two adult males kept in close proximity to one another, the appearance of the veterinarian for medical management, and finally high exposure to the public. A behavioral checklist was developed to record behaviors before, during, and after each stressor test was performed. A scale was implemented to score the behavioral state of the animal during the collection process, from 1 (very calm) to 5 (very agitated). Baseline cortical values were determined by sampling at two set times during the day over the course of three days. Other data collected, included weather conditions and crowd size throughout the testing period. The method for obtaining the cortisol was through blood. The animals in this study had been trained through operant conditioning for the collection of blood via ear or caudal leg vein. Blood collection was performed on a regular basis, and was therefore a reliable means of sampling for cortisol. Blood samples, rectal temperatures, and time were recorded before the test occurred and 20 minutes after the event. Each event was recorded on video for accurate documentation of behavior before, during, and after the predefined event.

DISCUSSION

Stress can be defined as an event that produces an adaptive response. Animals respond to these challenges through various mechanisms including physiologically, biochemically, immunologically, and behaviorally (Tuck, 2000). Stress responses include increased heart rate, increased blood pressure, and secretion of the glucocorticoid hormone cortisol. The secretion of cortisol is controlled by the hypothalamus. The stressor or event transfers information in the chemical form of (corticotrophin) CRH releasing hormone. CRH travels to the pituitary gland, which releases (adrenocorticotrophic) ACTH hormone. This is circulated to the adrenal cortex where it stimulates the production of cortisol (Tuck, 2000). Six to fifteen percent of the cortisol is unbound and biologically active. It can be found in blood, sweat, tears, and saliva (Kirshbaum, 2000). Increase in cortisol levels effects glucose metabolism, and suppresses the immune system. It is known that stress can suppress reproduction, impair immune function, and result in aberrant behaviors (Carlstead, 2000).

Data collected thus far includes sixty-five cortisol samples from eight predefined stressor events. Preliminary data includes baseline cortisol levels for both male rhinos. Normal circadian changes in cortisol levels will peak in the early morning hours, and then gradually decline from late morning to midnight where they start to slightly increase towards the morning levels (Kirshbaum, Laudenslager 2000). Preliminary results on this project show a marked difference in each individual's reaction to certain stressors through three predefined events. Future goals of this project are; expanding data by collection of more biomaterials and assessment of behavioral and physiological parameters to accurately evaluate stressors in the captive environment.

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Nutritional Aspects of Hand-rearing Rhinoceros Calves

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The decision to hand-rear any species, let alone a rhinoceros, should not be approached lightly. Nutritionally, as well as behaviorally, remaining with the dam is the ideal situation. Additionally, in the case with rhinoceros, the financial commitment to provide a calf with milk replacer, appropriate housing, and socialization is considerable. Consequently, hand-rearing should be considered after other options have been exhausted. Once the decision to hand-rear has been made, the best nutritional strategy is to replicate dam's milk and follow the natural pattern of nursing intervals and lactation length. The gross nutrient composition of rhinoceros milk has been reported. Many of the gaps in information can be extrapolated from data collected from similar species.

Colostrum

The first feed item to provide is colostrum, the first milk. Relative to mature (midlactation) milk, rhino colostrum is higher in total solids, protein and fat (Figure 1). As with other ungulate species, rhinos do not receive placental transfer of antibodies, but require passive transfer of colostral immunoglobulins. The window of opportunity for the intestinal absorption of the immunoglobulins is short: the reported time spans are up to three days for piglets and 24 hours for calves, kids, and foals, with maximum absorptive capabilities in the first 12 hours. Colostrum has been shown also to contain bioactive substances, such as hormones and growth factors and is reported to produce a laxative effect, helping to expel meconium. The San Diego Wild Animal Park procures and processes cow colostrum (modified pasteurization) on site to be fed after arrival into the nursery. Additionally, with the assistance of the excellent keeper staff, rhino colostrum has been milked from the respective dams when possible. Colostrum is maintained in the diet (10% v/v) through at least one month of age to provide systemic protection of the gut.

Milk Analysis

Analyses have been performed on the milks of relatively few nondomestic species. Luckily, many samples from black rhinos (*Diceros bicornis*) have been collected, and the few collected from Asian (Indian, *Rhinoceros unicornis*) rhinos and a single reported sample from a white rhino (*Ceratotherium s. simus*) are consistent with the values obtained for black rhinos. It has been shown, as well, that milk composition can be grouped phylogenetically. The gross composition of the mature milk of black rhinoceros is similar to that of Przewalski horse (*Equus przewalski*) and domestic horse despite diverging some 54 million years ago (Table 1). Of particular note is the low fat and high carbohydrate, primarily lactose, content of the milk of perissodactyls. Thus, where data for rhinoceros milk is lacking, milk of the domestic horse can be used as the model.

Milk Replacer

To develop a milk replacer, a base milk must be selected. In the United States, cow and goat milk are readily available. The following outlines factors to consider:

Protein

Cow milk forms a firm curd and requires more than 6 hours to empty from the stomach. The formation of the curd in the stomach is largely determined by the casein content of the milk. Both rhino and horse milk contain about 70% casein. Horse milk forms a flocculent curd, and is reported to empty from the stomach in about 2 hours. Goat milk also forms a more friable curd than does cow milk. The Wild Animal Park has used cow milk successfully without symptoms of lactobezoars. Furthermore, the slow breakdown of the curd may facilitate the nursing schedule, which includes a 12-h overnight fast.

Fat

The size of milk fat globules may affect the digestibility of fat in the intestines. Fat globules in horse milk average approximately 2 μm, similar to that of goat milk fat globules. While the range and mean size of milk fat globules of raw cow milk are greater than that of raw goat milk, homogenization reduces the range and average size to a fraction of the original (0.7 μm). The fatty

acid profile of horse milk fat shows a high proportion of medium chain and long chain polyunsaturated fatty acids. Goat milk fat contains a higher medium chain, but lower polyunsaturated long chain fatty acid content than cow milk fat.

Cost

Goat milk is 4 to 5 times more expensive than cow milk (US). The price differential is not insignificant due to the volume necessary to feed a rhino calf upwards of 15 to 25% of its body weight in formula each day. An additional benefit of cow milk is the availability of skim, or nonfat, milk in order to keep the fat content of the formula low.

Where refrigeration is an issue, spray-dried powdered milks can be utilized. We do not recommend the use of canned evaporated milk, in part due to the added phosphates. Rhino and equid milks have a Ca/P ratio of 1.4: 1, while cow and goat milks are lower at 1.2: 1, so additional phosphate would skew it further.

Modifications of the base milk to simulate dam milk include increasing the lactose and including iron and vitamins. In order to increase the lactose content, using food-grade lactose would be ideal. However, dextrose, a breakdown product of lactose, is acceptable and easier to get into solution. Whey, a by-product of the cheese industry, has been suggested as lactose source. Whey, however, increases protein and ash content as well as the lactose content. Rhinoceros milk is reported to be 0.3 to 0.4% ash, while goat and cow milks, without any addition of whey, are 0.6-0.7% ash. High fructose corn syrup has also been suggested, but we have observed a possible osmotic effect, and do not recommend it. It is universally agreed that table sugar, sucrose, is not a viable option. It has been shown in domestic species that the sucrase enzyme is not produced until about 1 month of age. Milks of domestic species are low in iron. The formula can be supplemented easily with proprietary blends formulated for livestock, such as Vi-Sorbin®. At the Wild Animal Park, a commercial probiotic, Probios®, is added to the milk replacer daily until weaning. Adult feces has been used in several species as an inoculant, but must be first be screened for parasites and other pathogens.

Nursing Intervals

Rhino dam's milk and the milk replacer are low calorie (energy) foods. Thus, the calf needs large volumes daily. Natural nursing intervals are reported to be hourly or less in Asian (Indian) rhinos. Due to labor needs, we have fed every 2 hours over a minimum of a twelve-hour period without problems. It is important to maintain the natural frequency as best as possible so as to give the calf sufficient volumes without exceeding stomach capacity and causing digestive upset. If labor permits, an increased nursing day length would support an improved growth rate. As the calf ages, feeding intervals can be increased.

Solid Feed

The calf should be bedded on high-quality edible grass hay, such as Sudan or Bermuda grasses as they will begin mouthing the hay and have incidental consumption from a very early age. Adult feed items should be made available by at least one month of age. Treat items such as produce can be used to initiate solid feed consumption, but the calf should not be allowed to consume it at the expense of other feed items.

Weaning

Feeding milk replacer through a normal course of lactation provides the young herbivore a source of highly digestible food and permits the animal time for the development of the gastrointestinal tract. The digestibility of milk replacers far exceeds that of plant materials. Early weaning may prove difficult for the young animal if it cannot obtain sufficient energy and protein to support growth. Furthermore, the nutritional and psychological stress can reduce immunocompetency, complicating any reintroductions, etc.

In order to provide the hand-reared rhinoceros calf with the best nutritional base, the diet as well as the delivery of the diet should reproduce that which the dam would provide. Modifications should be made

thoughtfully, with regard to the possible consequences. Good nutrition requires the cooperation and active participation (feedback) of keepers with the veterinarians and nutritionists.

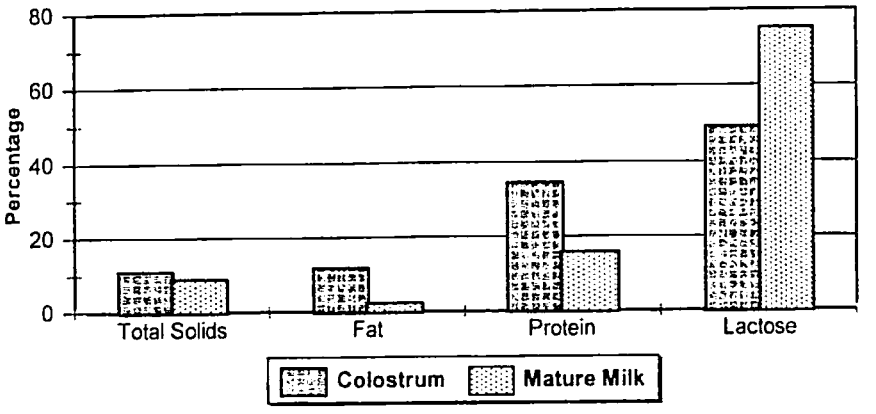

Figure 1. Gross nutrient composition (%DM basis) of colostrum[2] and mature milk[3] of black rhinoceros (*Diceros bicornis*).

Table 1. Gross nutrient composition (%DM basis) of the mature milk of black rhinoceros (*Diceros bicornis*)[3], Przewalski horse (*Equus przewalski*)[5], and domestic horse (*Equus caballus*)[6].

Species	Total Solids	Fat	Protein	Lactose
Black Rhinoceros	8.82	2.27	15.87	75.06
Przewalski Horse	10.50	14.29	15.10	64.00
Domestic Horse	10.50	12.10	18.30	65.60

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Rhinoceros Immobilzation at the San Diego Wild Animal Park

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Abstract: Immobilization of rhinoceros is challenging. A successful procedure will include careful planning, knowledge of anesthetic agents, familiarity with darting systems, monitoring equipment, general equipment (ropes, blindfold, ear plugs, etc.) and an experienced veterinary/ keeper staff. Immobilization of rhinoceros is complicated by their exquisite sensitivity to narcotic agents, respiratory depression while under anesthesia, large body mass and peculiar anatomic features. Narcotic agents used include etorphine and carfentanil. Supplemental agents used to extend anesthesia include: ketamine, propofol, GG, and a GG-ketamine mixture. Narcotic antagonists include naltrexone and diprenorphine. The phenomena of renarcotization is rare but does occur in rhinoceros. If possible, a 24 hour food fast and 12 hour water fast is ideal prior to immobilzation. Various case scenarios will be discussed to illustrate these points.

Conditioning a Southern Black Rhino (*Diceros bicornis minor*) For Semen Collection

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The question is often asked, "How long did it take to condition that rhino for that behavior?" A seemingly simple answer is complicated by the fact that no one behavior is conditioned by itself. All previous conditioning contributes to future conditioning. This paper will explain the semen collection conditioning at Fossil Rim Wildlife Center in the context of other conditioning that contributed to its success.

Fossil Rim Wildlife Center has been conditioning rhinos since 1987 when the first white rhinos arrived. These initial animals were from zoos where they had been housed in pairs and had never bred. The goal was to place these non-breeders in a ten acre yard as a multi-female herd including two bulls that were in visual, auditory and olfactory proximity and hope that the examples set by places like the San Diego Wild Animal Park would translate to Texas and lots of rhino babies would be born.

The primary conditioning was simply to train the white rhinos to go to the yard in the morning and back to the barn in the evening. The large yard has a small feed area (24.4 m x 30.5 m [80 feet x 100 feet]) where the animals are fed. If the ambient temperature is 4.5C (40F) degrees or colder the rhinos are moved to the barn which is 182.9 m (600 feet) from the yard down a 3 meter (10 foot) wide pipe lane. This is accomplished by opening and closing splitting gates that allow the rhinos to move in the desired direction, but does not allow them to go the wrong direction. The rhinos soon learned this and the splitting gates were no longer used except to train new arrivals, calves, and on occasions when the rhinos were not cooperating (e.g. bad weather, distractions, etc.)

Working with non-sedated rhinos is facilitated by the use of chutes. Fossil Rim uses two different types of chutes—the 'closed chute' and the 'free stall chute'. The closed chutes have gates in the front and rear, forcing the rhino to remain until the door is opened. The free-stall chute is open in the back and allows the rhino to come and go as it pleases. The inclusion of chutes within the animals' daily routine made chute conditioning easier (2,3,17). These chutes (one in the lane between the barn and the yard, another in the barn, and several in the yards) have been used for blood collection, urinary tract infection treatment, hoof work, serial ultrasonography, and basic skin and foot care. The conditioning was half complete prior to the chute construction because the animals were already moving through the area. The only challenge then was desensitizing the rhinos to being in the chute and to having people near them (12).

With the initial training in place, all future training was shaped fairly easily. The conditioning for the black rhinos was similar in its initial steps to the conditioning of the white rhinos with some exceptions. The first work was to bring the animals to the fence

where they would be more tractable. Most of the white rhinos had already been in captivity and were used to tactile rewards—rubbing on the face, under the back legs, or on the ears--so getting them to the fence was simple. Once at the fence the bridge from saying 'good' to the tactile reward was instant. The black rhinos, however, had come directly from Zimbabwe and weren't nearly as comfortable with people as the whites. The work with them required a considerable amount of time and several additional training steps.

Fossil Rim Wildlife Center acquired black rhinos in the spring of 1992 and utilized many of the training techniques already proven successful with the white rhinos. Unfortunately, participation in a feed palatability study early in 1993 that involved blood collections and measurements of the animals, required quarterly chemical immobilizations. The bull was not tractable, the female was not much better, and after multiple chemical immobilizations they became worse. In the fall of 1994, the bull was crate trained for a move to Australia and this was the only real training that was done with this animal. The inability to work closely with these animals because of time restrictions contributed to the need for the rhino internship.

Beginning in 1995, Fossil Rim Wildlife Center began the Rhino Research Intern Program. This position provided a full time person who worked solely with the black rhinos. Each internship lasts about four months, and among other things, each intern is responsible for a project that they will choose based on their interests and the needs of Fossil Rim. The first intern's project was clear: "to make the remaining female, a somewhat wild animal, tractable to collect blood, do foot work, and ultimately perform transrectal ultrasonography." Future projects focused on conditioning work because of its importance in the reduction of stress levels in the animals (6,7), but also included browse studies, cow/calf relationships, crate training, and studying the effects of separation of a calf from the mother for management purposes. One of the great benefits of this program is that each intern is trained on the specific conditioning protocol, assuring consistency in the training of the rhinos. This has proven very important in the rapidity and reliability of rhino conditioning. Each person has different mannerisms and the rhinos react differently to them, but the training schedule and methods remain consistent.

At the inception of the conditioning program, there was only the one rhino, the original female from Africa named Sinampande (studbook # 0466). She came to the fence for apples and alfalfa and could be moved from pen to pen in this manner, but she was not tractable for hands on care. From January 1995 until July 1995 she was the sole subject for training by the intern. In July 1995, another female, Coco (studbook #0462) and a male, Gota Gota (studbook #0401) came in from a ranch in south Texas. There were several health concerns with them that required immediate conditioning for blood collections, and more importantly, chute conditioning so that we could do foot work. Gota Gota had several hoof cracks, and Coco had a hole in the sole of her foot about the diameter of a quarter and approximately 3 centimeters deep.

From these beginnings, the training program was expanded specifically for semen collection from Gota Gota. A number of observations led to this decision. He had already successfully bred with Coco and produced two offspring with a third pregnancy

due in July of 2001. It was determined by the Rhino Taxon Advisory Group (TAG) that this pairing should not produce anymore offspring. Following two unsuccessful and aggressive introductions between Gota Gota and Sinampande, a third introduction was attempted utilizing hormone therapy. It was determined that her fecal progestin levels were always much higher than Coco's, and that this might have contributed to the fighting (9). There was less aggression during this introduction, but there was still no breeding despite coordinating the introduction with the most likely time frame for estrus based on ultrasound. Fossil Rim had already done work documenting the female reproductive cycle with fecal analysis and ultrasound and hoped that if we could collect semen, we could perform artificial insemination (AI) (9,10).

In the spring of 1997, the intern had an interest in artificial insemination and began conditioning Gota Gota for semen collection. He researched what had already been attempted in this field and based his conditioning on what had been successful. Digital manipulation was tried back in 1967 (18) with some positive results, and Columbus Zoo had conditioned and collected Clyde, a hand-raised male black rhino from 1979 to 1982 (12). Dr. Nan Schaffer and her extensive work in the male reproductive field was a constant source of information as well (14, 15, 16, 17). The proceedings from the 1991 Rhino Conference in San Diego, several articles in the Animal Keeper's Forum, and many of the papers and posters that Dr. Nan Schaffer produced were the foundation of our training program. We were fortunate to already have a somewhat tractable black rhino bull, good conditioning protocol, and excellent chutes. We had also done a very brief conditioning regiment on one of the white rhino males that had been worked with at Milwaukee County Zoo for years by Dr. Schaffer. With his previous conditioning we were able to move quickly with the schedule and see the results of an already trained bull back in 1990--even though we never successfully collected semen from him.

Gota Gota was already comfortable in the free stall chute. He had been coaxed to the fence with apples, sweet potatoes, browse--sumac or willow, or COB (corn, oats, barley), then led into the chute until he would stay in for as long as we chose, usually 10-15 minute sessions (1). Once comfortable in the chute, we would pile the fruit, COB, or browse in front of him and begin to desensitize him from the head to the tail, touching him until he no longer reacted. This took several weeks with one person working with him, and then several more weeks to allow multiple people to be present during the sessions. On occasion Gota Gota was better with multiple people than he had been with a single technician. The second person could offer the fruit more consistently, adapt to the changes Gota Gota made and keep his attention longer, thereby keeping him in the chute. As with most rhino work, it is important to have the animal comfortable with as many people as will be necessary for the procedure. When blood is collected it takes a minimum of three people, and there are usually four or five. The semen collection work currently requires two people, but we hope to expand it to several so that he can be worked for longer periods of time. It is too tiring for one person to work him for the duration of the session.

Cleaning the penis with warm water and cotton.

After he was desensitized to the people present and to the touching of other parts of his body, conditioning began for the actual semen collection. It was important to gain Gota Gota's trust in the chute before going to this stage. During the first months, time was spent trying to determine which techniques would work best to attain the goals. Planning to do everything without sedation meant we had to spend time getting the conditioning to elicit the best responses quickly. We began with penile massage and have expanded since then, but it was this beginning that took us to where we currently are. After just a few weeks Gota Gota would unsheathe when he entered the chute, sometimes attaining a full erection even before being massaged.

The next step was to actually work with the erect penis. The chute was modified to allow better access to the penis. Originally the pipes were horizontal, spaced with only 15 centimeters (6 inches) between them. One rung was removed from a 90 centimeter (3 foot) section to allow total access to the penis. Warm water and cotton were brought to the chute in an ice chest to clean the penis after unsheathing. KY Lubricant was used judiciously and the manipulation was performed for as long as the bull would stand in the chute, or until he was no longer erect. After the session, the penis would again be cleaned with the warm water. Using these methods, we were able to collect minimal samples, but none that were considered true ejaculates, or that were worth saving (2-5 cc's at most per sample). There were some attempts made to utilize urine and feces from females in heat as additional enticement but were unsuccessful at the time.

In the fall of 1997 we were forced to chemically immobilize Gota Gota for a large quantity blood collection for a transfusion to a sick animal. This set us way back in our training. Each negative occurrence would require extra training time with positive reinforcement to get back to where we were before the negative event. Also the other animals took a priority over our semen work and we didn't get back to working with him until the fall of 1999, and even then it was not as high a priority as it had been in 1997. Finally, in the summer of 2000, we began in earnest again with his conditioning and re-educated ourselves on what had happened in semen collection work throughout the world since 1997. Again, the intern put in time conditioning Gota Gota to the chute and to the tactile aspect of semen collection. He was called into the chute three times per day for training of about 10-15 minutes per session, based partly on what others had done in their training programs (1,7,12). He did well with a single technician but with multiple people he was nervous and wouldn't stand for any conditioning. It was decided to make the first attempt in the chute, but if he remained nervous, to move the conditioning to the back fence line where he traditionally seemed more comfortable. The main focus of the semen collection now occurs at the fence line. Gota Gota will stay parallel to the fence for as long as the session lasts and is released from training--as opposed to finishing the training because he has wandered away. Another benefit has been that with the comfort zone at the fence, he will allow multiple people near him, and will usually get an erection immediately. He has also allowed blood collections and hoof work in the same area without problems.

When he was again working well, we attempted to use an artificial vagina (Colorado A/V, distributed by Har-Vet) designed for use on the horse. The A/V uses warm water and pressure to simulate the female. Different temperatures and pressures that are based on the weight of water in the A/V were used to determine the most effective combination. Unfortunately, Fossil Rim faced the same shortfalls other institutions using A/V's had experienced (15); they are heavy, about 11.4 kg (25 pounds) and awkward to use. Also, since the A/V must be underneath the animal, it is difficult to remove quickly if the animal becomes uncomfortable in the chute and backs out, or moves away from the fence and is out of reach.

Application of the A/V.

There are some other options available that haven't been tried yet, but are likely substitutes. Susan Inkster utilized an A/V similar in structure to a blood pressure cuff (4) With some minor modifications this may be a good option. Fossil Rim Wildlife Center is also experimenting with air splints designed to immobilize fractured bones in humans (Moore Medical Corp. 389 John Downey Dr. New Britain, CT). These are inflatable, vinyl bladders that are designed to immobilize different fracture sites. The best size has been the 'hand/wrist' splint which weighs less than one pound including the latex lining. The latex lining is inserted as in the horse A/V and the splint can be inflated to the desired pressure. This will be a very lightweight and portable option that should work as well as the commercially available A/V for pressure, but without the option of warming it with water.

There is another possibility for better success in collecting—the use of phantoms. A phantom is a life size model designed to simulate the female. There is no such phantom designed as an artificial mount for rhinos, but one could be built. These are widely used for horses, and Gota Gota is very receptive when the female is in heat. If the phantom were to be built where the closest the bull could get to the female was by mounting the phantom with the A/V built into the phantom, a technician could monitor the A/V and determine that it was placed properly. The bull could then mount the phantom, ejaculate into the A/V, and the semen could be collected. Coco always backs up to the fence when she is in heat, so the use of the phantom may have potential at Fossil Rim.

Some other types of collection have been tried (successfully and unsuccessfully) in the rhino (and the horse). Dr. Terri Roth has been collecting semen post coitally from the female Sumatran rhino (8). This is a great, non-invasive option that Fossil Rim will definitely try on our white rhinos, and possibly our blacks. Unfortunately, it won't work for Gota Gota while he is at Fossil Rim since he won't breed here again. Administering Oral Imipramine followed by Intravenous Xylazine has been used in equine research with mixed results (5). There are a couple of concerns at Fossil Rim about this. First, the study showed that results in horses were inconsistent and that Imipramine has been associated with hemolysis in some horses, which would obviously be a negative side effect considering the already high occurrence of hemolytic events in the black rhino. Also, it showed that other aspects were still necessary (e.g. teasing with a mare). We feel that we can get ejaculates without immobilization or electroejaculation, and are hesitant to give other drugs (due to possible adverse reactions) especially with such inconsistent results and potential risks.

The irony of all this is that Fossil Rim Wildlife Center has not successfully collected semen from any of the rhinos. The conditioning protocol here is consistent and effective. We have serially collected blood and done ultrasound exams for seven years, and feel confident that semen collection is around the corner, but right now it is all still just academic--and experimental.

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First and most importantly Fossil Rim Wildlife Center deserves credit for their commitment to rhino conservation, especially through the rhino intern program. Marc Criffield who began this project, Reanna Streater who picked up where he left off, all the other interns who played a role in the conditioning of the rhinos, and to all who provided guidance in the writing of this paper.

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Rhino Keeper Workshop 2001

San Diego Wild Animal Park

Rhino Keepers' Workshop 2001 Husbandry Survey

Hosted at San Diego wild Animal Park May 2001

Information Compiled and Workshop Facilitated by: Farshid Mehrdadfar

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Name of Participant: Adam Eyres

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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

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Institution: Houston Zoological Gardens

Name of Participant: Phil Coleman JR.

email address: philcole2001@aol.com **Phone Number:** 713-284-8306 **Fax Number:** 713-284-1329

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

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

Approximate Size of Each Exhibit:

~1/3 Acre

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

Description of Husbandry Training in Practice:
Body palpation . Shift Training. Blood draws from ear

Description of Research Conducted or Ongoing:
N/A

Institution: Denver Zoological Garden

Name of Participant: Christine Bobko

email address: rhinoqueen@yahoo.com **Phone Number:** 303-376-4900 **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 (Nutrena Oak Pellet) + Vitamin E Supplement + Phosphorous + Canola 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: 40' 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), rectal temp.. weighing, footwork.
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
Identifying stress through blood cortisol
Behavioral

*** 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@wogilman.com Phone Number: 904-225-3396 Fax Number: 904-225-3395

Rhinoceros Species Currently cared for and Collection Inventory:
7.3 Southern Black Rhino . 5.5 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, vaccinations & Tx's.

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.
Iron study in black rhino.

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 & Derek Weatherford

email address: jmjacob@flash.net / D,weather@lwon.com
Phone Number: 817-924-7632 / 817-871-7041/817-263-9680 **Fax Number:** NA

Rhinoceros Species Currently cared for and Collection Inventory:
Black Rhino (Southern) 1.1
Asian Greater One Horn 1.1

Diet Offered to Animals:
Black Rhino: Alfalfa + Coastal Hay + 17% Protein Pellets
White Rhino: Coastal Hay + 12% Protein Pellets
Asian Greater One Horn: Coastal & Prairie Hay + 17% Protein Pellets

Number of animals exhibited in habitat:
Black rhinos: 1.1
Asian Greater One horn: 1.1

Approximate Size of Each Exhibit:
Black Rhinos: ~1/2 Acre
Asian Greater One Horn: ~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)
Asian Greater One Horn: Correlation of behavior and reproductive hormones (M. McIninch)

Institution: Oregon Zoo Name of Participant: Michael Illig & Jay Haight

email address: Illig@aol.com / haight@metro.dst.or.us Phone Number: 503-226-1561 Fax Number: 503-226-0074

Rhinoceros Species Currently cared for and Collection Inventory:
Black Rhino: 1.1
1.0 -14 years Old. 0.1 - 12 years 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

Approximate Size of Each Exhibit:
~100' x 300'
Gunite 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
Measurement of vaginal swelling to determine estrus

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 palpate 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: 24628 **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:
Vit. E study, Stress Study, hormone study

Institution: Reid Park Zoo

Name of Participant: Peter Hnath & Gale Ferrick

email address: zooclosers@mindspring.com **Phone Number:** 520- 616-7553 **Fax Number:** 520-616-7557

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

Diet Offered to Animals:
Bermuda hay & alfalfa hay (75% & 25%)
ADF 16 pellets + Oats

Number of animals exhibited in habitat:
1.1 white rhinos

Approximate Size of Each Exhibit:
~2 Acres

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 (blood draws from ear), 3 commands : Target, back up, open (mouth)

Description of Research Conducted or Ongoing:
Vit E study

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:
Asian Greater One Horn : 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: Linda Pill

email address: zeebrachick@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

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):
0.3 common Zebra + Pink backed pelicans + 0.2 Ostrich

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

Description of Research Conducted or Ongoing:
Participated in fecal analysis through San Diego last year to assess reproductive potential of 30 year old female.

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:
Asian Greater One Horn 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 Asian Greater one horn

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 whit 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 & Erin Jewell

email address: edierenfeld@wcs.org / jewelle@nzp.si.edu Phone Number: 718-220-7102 / 202-673-4743

Fax Number: 718-220-7126

Rhinoceros Species Currently cared for and Collection Inventory:

1.1 Indian Rhino

Diet Offered to Animals:
Asian Greater one horn : Grass hay , fresh browse , Herbivore pellets ADF 16, Leafeater Biscuts for training.

Number of animals exhibited in habitat:
1 in each yard / enclosure

Approximate Size of Each Exhibit:
Asian Greater One Horn : ~1/2 Acre

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

Description of Husbandry Training in Practice:
Targeting, stationing, backing up, open mouth, foot training, skin treatment

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*
- *Saliva collection to chart estrous cycle*

Institution: Lincoln Park Zoo

Name of Participant: Brett Smith

email address: lionhouse@lpzoo.org **Phone Number:** 312-742-7681 **Fax Number:** NA

Rhinoceros Species Currently cared for and Collection Inventory:
Black rhino : 1.1 ** Due to facility construction 0.0 in collection

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 branned 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:
Asian Greater One Horn : 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:** Kelly Schroer

email address: countsheep17@aol.com Phone Number: 716-837-3900 Fax Number: 716-837-0738

Rhinoceros Species Currently cared for and Collection Inventory:
Asian Greater One Horn : 1.0 born 7-91 - came to Buffalo in 1993
Asian Greater One Horn: 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, Farshid Mehrdadfar, Jane Kennedy, Michele Gaffney, Lynn Patton, Denise Wagner

email address: Laubery@sandiegozoo.org, Fmehrdadfar@sandiegozoo.org, Dwagner@sandiegozoo.org

Phone Number: 760-747-8702 ext:5189, 760-738-5027, 760-738-5026 **Fax Number:** 760-480-9573

Rhinoceros Species Currently cared for and Collection Inventory:
Asian Greater One Horn : 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
Asian Greater One Horn 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
Asian Greater one Horn 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
Asian Greater One Horn 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
Asian Greater One Horn 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
Asian Greater One Horn rhino: fecal collection for hormone assays, trans rectal ultrasound
Refining of hand-rearing techniques

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 will planning to care for Black rhinos and Asian Greater One Horn 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: Raymond Hren / Dana Nicholson

email address: raynomon@msn.com **Phone Number:** 414-771-3040 ext:134 **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
12cc vit E
2-3lbs sweet potatoes, apples, carrots and pears

Number of animals exhibited in habitat:
Dependent on season. 1.1 exhibited in one yard and one alone in adjacent yard

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 / vaccination / foot presentation / mouth presentation
Description of Research Conducted or Ongoing:
Collaboration: Serum collection for reproductive / endocrinology
Semen collection
Medical blood collection

Institution: Tulsa Zoo

Name of Participant: Charles W. Sims

email address: cwessimg@aol.com**Phone Number:** 918-669-6240 **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 Haris

email address: kristinl@riverbanks.org **Phone Number:** 803-779-8717 **Fax Number:** 803-253-6381

Rhinoceros Species Currently cared for and Collection Inventory:
Black Rhino: 1.1, 0.1 born Feb 2000

Diet Offered to Animals:
Grass hay mix, browse, new diet just started from White Oak (pellet)
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:
Blood draws

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

Institution: Birmingham Zoo

Name of Participant: Kelley Rogers

email address: simum315@hotmail.com **Phone Number:** 205-879-0409 **Fax Number:** 205-879-9426

Rhinoceros Species Currently cared for and Collection Inventory:
Southern White Rhinos: 1.0

Diet Offered to Animals:
ADF16 + 7 to 10 carrots + 1to 3 sweet potatos + 1 cup of trace mineral salt
Grass hay

Number of animals exhibited in habitat:
1.0

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 & Randy Pairan

email address: beacon-rhinos@fuse.net **Phone Number:** 513-281-4700 ext: 8363 **Fax Number:** NA

Rhinoceros Species Currently cared for and Collection Inventory:
Black Rhino: 2.1
Greater Asian One Horn Rhino: 1.1
Sumatran Rhino: 1.3

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:
Conditioning for weighing, blood collection, crate training, ultrasound exam

Description of Research Conducted or Ongoing:
Dr. Roth studies (ultrasound exams, blood immunity profiles

Institution: Disney's Animal Kingdom **Name of Participant:** Ike Leonard, Angela Yang, Micki Corcoran, Angi Millwood, Jason Merkel,

email address: michelle.e.Corcoran@disney.com, Angela.d.millwood@disney.com , Ike.a.Leonard@disney.com

Phone Number: 407-938-2814, 407-938-2701 **Fax Number:** 407-939-6391

Rhinoceros Species Currently cared for and Collection Inventory:
Southern Black rhino : 4.2
Southern White Rhino: 3.6

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 Rhino: Social grouping change frequently, White Rhinos: rhinos rotated onto exhibit in groups of 2-5 individuals

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: Water buck , Greater Kudu , Oryx , Mhore gazelles

Description of Husbandry Training in Practice:
Black rhinos:
All have been trained for blood draw (ear and leg vein). All have been target trained, All have been trained for foot care. All have been trained for rectal temperature collection. All have been trained to open mouth on command. All have been trained to enter in chute for rectal and body palpation and weight measurement, All have been trained for command "OVER" and "Steady". Ultrasound training.
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

Institution: Los Angeles Zoo **Name of Participant:** Nancy Bunn and Art Gonzales

email address: nabrhino@aol.com, briscoejeff@hotmail.com

Phone Number: 323-644-6400 ext:46021 / 314-781-0900 ext: 451 **Fax Number:** N/A

Rhinoceros Species Currently cared for and Collection Inventory:
Black Rhino: 1.1 & 1.1 Indian Rhino
Diet Offered to Animals:
Mazuri ADF16 pellets
Alfalfa / Timothy hay / moose maintenance, greens and produce
Browse

Number of animals exhibited in habitat:
2 black rhinos

Approximate Size of Each Exhibit:
NA

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

Description of Husbandry Training in Practice:
Conditioning for weighing, blood collection, crate training, body palpate.

Description of Research Conducted or Ongoing:
Clinical management of TB, hypophosphatemia and san colic in black rhino

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Institution: Wildlife Safari **Name of Participant:** Deborah Ryan

email address: jdryane@mcsi.net Phone Number: 541-679-6763 Fax Number: 541-679-9201

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

Diet Offered to Animals:
Hi-Pro sweet feed, ele supplement. Alfalfa pellets, alfalfa, grass hay, senior horse diet

Number of animals exhibited in habitat:
1.1

Approximate Size of Each Exhibit:
100 Acres

Other Animal (s) Exhibited With Rhino (s) In each Habitat (s):
Eland, gemsbok, waterbok, Ankole cattle, Giraffe, Wildebeest, Chapman zebra, Ostrich, T. Gazelle

Description of Husbandry Training in Practice:
Blood collection, crate training, calling rhino down for feeding
Description of Research Conducted or Ongoing:
N/A

Institution: St. Louis Zoo Name of Participant: Cathi Fueglein

email address: Cfueglein@stlzoo.org Phone Number: 314-781-0900 ext: 451 Fax Number: NA

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

Diet Offered to Animals:
Herbivore pellets
Alfalfa / Timothy hay / elephant "Mazuri" pellet
Greens: produce

Number of animals exhibited in habitat:
2

Approximate Size of Each Exhibit:
Exhibit currently under construction

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

Description of Husbandry Training in Practice:
Conditioning for weighing, blood collection, crate training, ultrasound exam, body palpation

Description of Research Conducted or Ongoing:
Vit. E , tracked progesterone levels & testosterone .

Institution: Detroit Zoo Name of Participant: Judy Stephens & Kim vanSpronsen

email address: N/A Phone Number: 248-398-0903 Fax Number: NA

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

Diet Offered to Animals:
Alfalfa / Senior Equine / Trace Mineral Salt / Produce

Number of animals exhibited in habitat:
1

Approximate Size of Each Exhibit:
11/2 acres, Indoor 20'x40'

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

Description of Husbandry Training in Practice:
Conditioning for body palpation

Description of Research Conducted or Ongoing:
N/A

Institution: Little Rock Zoo Name of Participant: Megan Stringer

email address: mlstringer@aol.com Phone Number: 501-666-2406 Fax Number: NA

Rhinoceros Species Currently cared for and Collection Inventory:
Black Rhino: 1.0
S. White Rhino: 1.1

Diet Offered to Animals:
Herbivore pellets
Alfalfa / Bermuda hay / Mineral block / Produce

Number of animals exhibited in habitat:
1.0 Black rhino
1.1 White rhino

Approximate Size of Each Exhibit:
23,000 sq.ft.

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

Description of Husbandry Training in Practice:
Conditioning for bathing, brushing, open mouth, target, chute and scale, laying down

Description of Research Conducted or Ongoing:
N/A

Institution: San Francisco Zoo

Name of Participant: Ingrid Hartney & Julie McGluray

email address: IngridH@Sfzoo.org , Zoontech@prodigy.net Phone Number: 415-753-3146 Fax Number: NA

Rhinoceros Species Currently cared for and Collection Inventory:
Black Rhino: 2.1
Greater Asian One Horn Rhino: 1.0

Diet Offered to Animals:
Mazuri ADF16 pellets
Alfalfa / Timothy hay / vit-E / Produce
Browse (acacia)

Number of animals exhibited in habitat:
I-rhino: 1.0
2.1 Black rhino

Approximate Size of Each Exhibit:
B-rhino ~1/2 acre
I-rhino ~1/3 acre

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

Description of Husbandry Training in Practice:
Conditioning for target training, foot work

Description of Research Conducted or Ongoing:
N/A

Institution: The Living Desert

Name of Participant: Grady Beck

email address: gradybecktld@aol.com Phone Number: 760-346-5694 Fax Number: 760-340-2064

Rhinoceros Species Currently cared for and Collection Inventory:
Currently do not hold any rhino species

Diet Offered to Animals:
N/A

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:
N/A

Description of Research Conducted or Ongoing:
N/A

Institution: Cleveland Metro park Zoo

Name of Participant: Ken Pekarek & Alisa Sandor

email address: Kep@clevelandmetroparks.com Phone Number: 216-635-3372 Fax Number: 216-661-3066

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

Diet Offered to Animals:
Herbivore pellets
Alfalfa / Produce

Number of animals exhibited in habitat:
1.0 alone / with adult female during breeding, calf is separated during breeding.

Approximate Size of Each Exhibit:
NA

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

Description of Husbandry Training in Practice:
Target training, blood draws, vaccinations, rectal temp., filing nails, open mouth

Description of Research Conducted or Ongoing:
Estrous cycle

Institution: Singapore Zoo

Name of Participant: Ram & Paramasivaro

email address: WWW.nightsafari.com.sg Phone Number: 2693411 Fax Number: 3652331

Rhinoceros Species Currently cared for and Collection Inventory:
White Rhino: 2.4

Greater Asian One Horn Rhino: 2.1

Diet Offered to Animals:
Pellets / Oat brand
Grass hay / orchard grass / leaves / produce
Browse

Number of animals exhibited in habitat:
W-rhino 2.4
I-rhino 2.1

Approximate Size of Each Exhibit:
NA

Other Animal (s) Exhibited With Rhino (s) In each Habitat (s):
Sambar and Hog deer / Eland and hartbeest

Description of Husbandry Training in Practice:
N/A

Description of Research Conducted or Ongoing:
Developing system of introduction for different species to be exhibited with rhinos.

Institution: San Antonio Zoo **Name of Participant:** Doug Pyatt

email address: mdpyatt@cvl.net **Phone Number:** 210-734-7184 ext: 152 **Fax Number:** NA

Rhinoceros Species Currently cared for and Collection Inventory:
Black Rhino: 1.2
White Rhino: 1.3
Diet Offered to Animals:
Mazuri ADF25 and ADF 16 pellets
Alfalfa / Timothy hay / coastal hay, bran, elephant chow
Browse

Number of animals exhibited in habitat:
0.2W-rhino
1.0 B-rhino
0.2 B-rhino

Approximate Size of Each Exhibit:
W-rhino yard ~500'x500' with 2, 20'x20' stalls
B-rhino yard 50'x300' with 20'x20' stall

Other Animal (s) Exhibited With Rhino (s) In each Habitat (s):
Egyptian Goose with W-rhinos

Description of Husbandry Training in Practice:
Target training, crate training, Mouth / foot training with B-rhinos, 1.0 B-rhino is trained to "finger paint" using his upper lip!

Description of Research Conducted or Ongoing:

N/A

Institution: Columbus Zoo Name of Participant: Adam Felts

email address: afelts@columbuszoo.org Phone Number: 614-645-3423 Fax Number: NA

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

Diet Offered to Animals:
Mazuri ADF 16 pellets
Alfalfa / Timothy hay
Produce

Number of animals exhibited in habitat:
2

Approximate Size of Each Exhibit:
~7.5 acres

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

Description of Husbandry Training in Practice:
Target training, blood draw from leg, foot work

Description of Research Conducted or Ongoing:
N/A

Institution: Knoxville Zoological Gardens Name of Participant: Terry Canon

email address: tcanon@knoxville-zoo.org Phone Number: 865-637-5331 ext: 388 Fax Number: 865-637-1943

Rhinoceros Species Currently cared for and Collection Inventory:
White Rhino: 2.3.1

Diet Offered to Animals:
ADF 16 pellets
Mixed grass hay

Number of animals exhibited in habitat:
W-rhino 6

Approximate Size of Each Exhibit:
2 exhibits, 1.5 acres, and ¼ acre (used only for temporary holding)

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

Description of Husbandry Training in Practice:

Target training, Tactile work

Description of Research Conducted or Ongoing:
N/A

Institution: North Carolina Zoo Name of Participant: Jay Peck

email address: jpecks@yahoo.com Phone Number: 336-879-7661 Fax Number: NA

Rhinoceros Species Currently cared for and Collection Inventory:
White Rhino: 2.2

Diet Offered to Animals:
Mazuri herb. pellets
Alfalfa (small amount) / Timothy hay

Number of animals exhibited in habitat:
W-rhino
Each pair exhibited on alternate days

Approximate Size of Each Exhibit:
~3 acres

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

Description of Husbandry Training in Practice:
Blood Collection

Description of Research Conducted or Ongoing: N/A

Institution: Dallas Zoo Name of Participant: Katie Vogle & Chris Elam

email address: N/A Phone Number: 214-642-8274 Fax Number: NA

Rhinoceros Species Currently cared for and Collection Inventory:
Black Rhino: 3.1

Diet Offered to Animals:
Mazuri ADF25 and ADF 16 pellets
Alfalfa / coastal hay / missing link / Cmcelle / Produce
Browse

Number of animals exhibited in habitat:
1 animal per yard – 2 animals per barn (separate stalls) , total: 4 exhbits
0.2 B-rhino

Approximate Size of Each Exhibit:
N/A

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

Description of Husbandry Training in Practice:
Blood draws. mouth check, scale training, chute training

Description of Research Conducted or Ongoing:
Fecal collection for hormonal study in female.

Institution: Auckland Zoo, New Zealand

Name of Participant: Samantha Stephens

email address: mojodog99@extra.co.nz **Phone Number:** 64-09-3603800 **Fax Number:** 64-09-3603818

Rhinoceros Species Currently cared for and Collection Inventory:
White Rhino: 2.3

Diet Offered to Animals:
Grass hay, alfalfa, horse & pony pellets. Vit E , salt block

Number of animals exhibited in habitat:
W-rhino
3 Groups rotated on exhibit

Approximate Size of Each Exhibit:
~3/4 acre

Other Animal (s) Exhibited With Rhino (s) In each Habitat (s):
Springbok, Ostrich, zebra. guineafowl

Description of Husbandry Training in Practice:
Bridge training (Whistle), alfalfa reward. foot work, weighing, body palpation, chute training.

Description of Research Conducted or Ongoing:
N/A