White Rhino Introductions,
A Data Driven Approach

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I. Introduction:

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

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

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

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

II. Methods

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

Subjects

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

Table 1. Subject descriptions

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

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

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

Table 2: The Introduction order

a) Maggie (M) → Julie (J)

b) Edith(E) → M, J

c) Gloria (G) → M, J, E

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

Data Collection

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

Introduction phases were as follows:

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

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

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

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

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

Facility

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

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

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

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

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

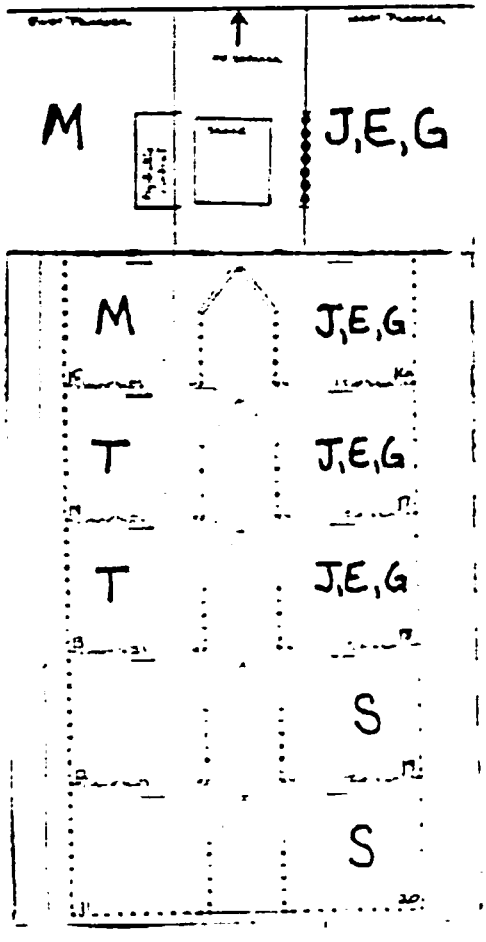
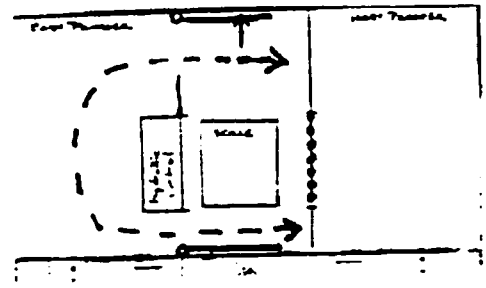


Figure 2: Night Stall Set-up



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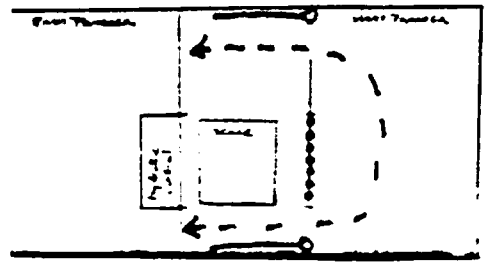

Figure 3: "Tactile/Howdy" Set-up for Paddocks

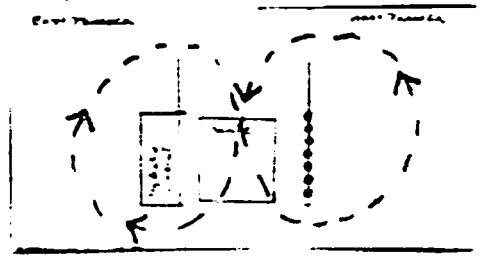

Figure 4: "Figure 8" Set-up for Physical Introduction

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

III. Results

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

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

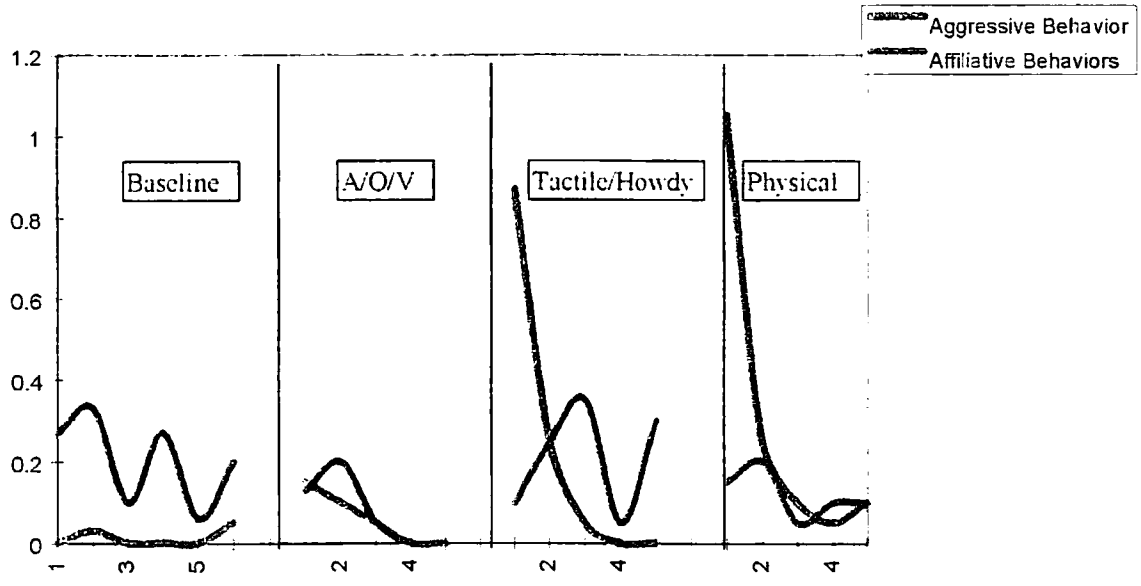

Figure 5: Hypothetical model for Introductions (Burks, 1998)

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

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

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

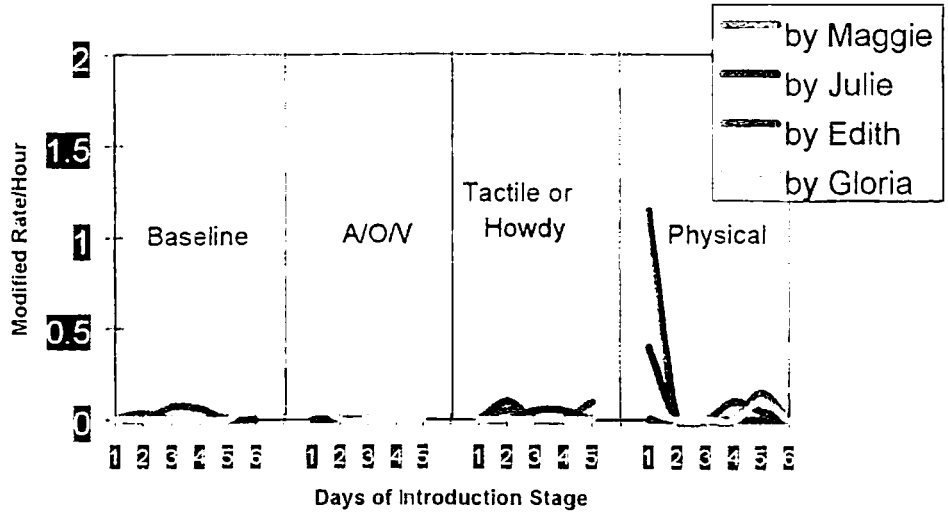

Figure 6: Active aggression results for 0.4 introduction

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

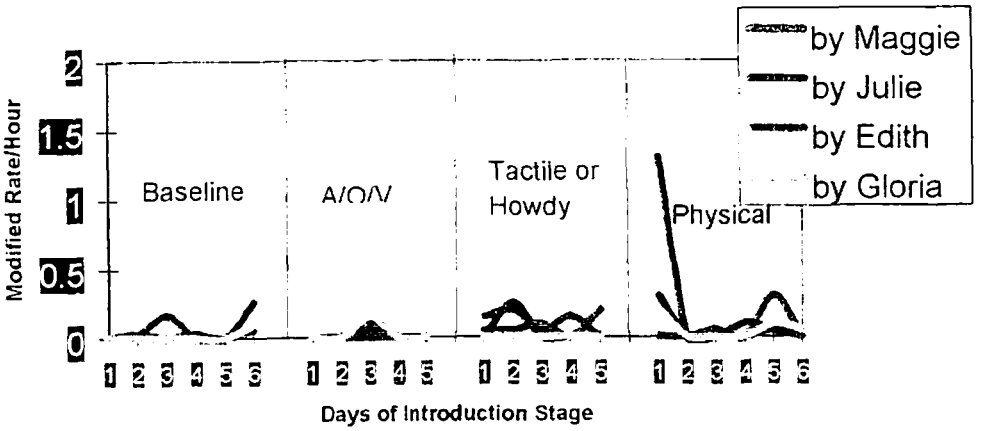

Figure 7: Passive aggression results form 0.4 introduction

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

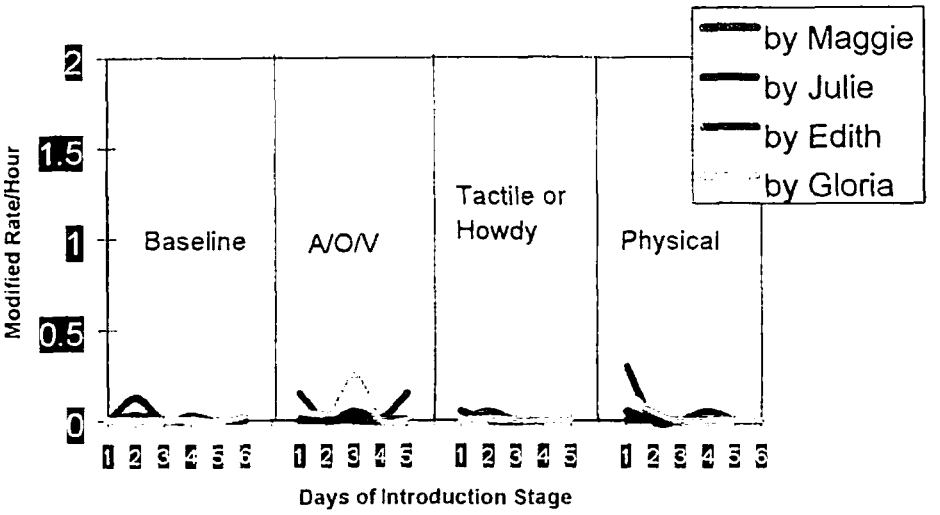

Figure 8: Stress measurements for 0.4 introduction

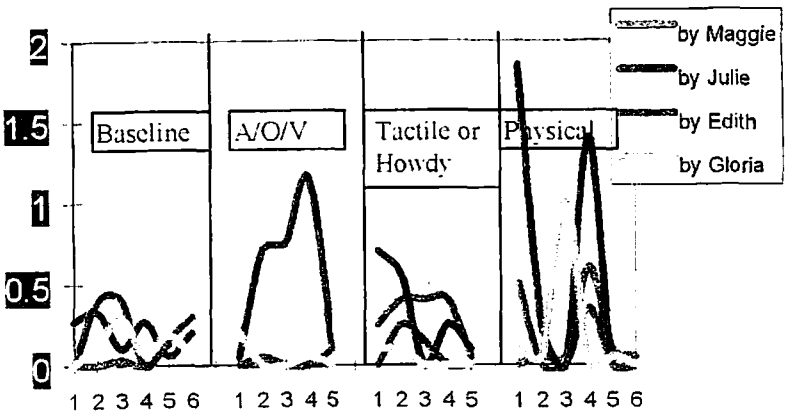

Figure 9: Summary of affiliative behaviors for 0.4 introduction

IV. Discussion and Conclusions

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

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

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

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

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

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

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

collection, data entry, and analysis) may help.

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

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

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

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

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

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

V. References

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Read, B. (1995). Training zoo professionals for studbook and Species Survival Plan programs. Zoo Biology. 14(2):149-158.

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

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

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

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

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

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

Institution:_____
Observer:_____
Date:_____

Appendix 2
White Rhino Introduction
Start Time:_____
Page_____

Focal Animal:_____
Observed w/:_____

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

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