Behavioral enrichment for African wild dogs (*Lycaon pictus*): response to stimuli used in an ongoing program at the Houston Zoo.

Jane M. Packard[1], Stephanie J. Turner[2], and Susan Shepard[3]

[1]Department of Wildlife and Fisheries Science, Texas A&M University, College Station, Texas
[2]Undergraduate student, Texas A&M University, College Station, Texas
[3]Senior Carnivore Keeper, Houston Zoo, Inc., Houston, Texas

Abstract: The purpose of this study was to provide information about the relative effectiveness of enrichment stimuli, for use by animal care staff in fine-tuning procedures in the ongoing program of carnivore behavioral enrichment. Behavioral assays (diversity of actions, duration of activity) were measured before, during and after treatments (presentation of enrichment stimuli). Non-invasive focal group observations were recorded (check-sheet and video). Staff will retain the data for in-house training and any research presentations.

INTRODUCTION

Environmental enrichment is a tool often used by the keepers of captive animal populations to prevent the development and display of stereotypical behaviors [Mason et al, 2007]. Stereotypies, the most common of which is pacing, can be an indication of a problem in the overall well-being of an individual animal. Various methods of preventing stereotypies have been developed but the most widespread and successful method is the introduction of enrichment. In successful enrichment programs, individuals will spend less time engaged in stereotypical behaviors and more time performing behaviors typical of the species in the wild [Swaisgood, 2007]. An added benefit of providing enrichment for captive animals is an increase in mental and physical condition. By requiring the animal to solve a puzzle or complete a physical task in order to receive a reward, enrichment encourages the development of the types of skills the animals would be using to survive in their natural environment [Meehan and Mench, 2007].

Through enrichment the staff at Houston Zoo attempt to improve the well-being of the animals in their care and to further educate the public about these species. By creating an environment which mimics the natural world as much as possible the zoo can better maintain the health of the animals while also demonstrating to guests how the animals' wild counterparts behave and interact with their environment [Clubb and Mason 2007]. This study will evaluate the effectiveness of an enrichment procedure that mixes stimuli from several sensory modalities (e.g. sight, sound, smell, touch, taste). This information can then be used to answer ongoing questions posed by the keepers, such as: (1) "How does enrichment help strengthen the bonds among members of the pack?" (2) "How can we increase the comfort level of the dogs in holding by observing reactions to enrichment while on exhibit?"

METHODS

Subjects and Housing

The African Wild Dog, *Lycaon pictus*, is the largest canine species found on the continent of Africa [Boggs and McNutt 1996; Creel and Creel, 2002]. Their historical range covered most of sub-Saharan Africa but is now mostly limited to southern Africa with the largest populations found in and around protected areas in Botswana, South Africa and Tanzania. The wild population is estimated to be below 5000 and the species is currently listed as Endangered by the International Union for Conservation of Nature [Stilleto-Zubiri et al. 2004]. Threats to the

species' survival include exposure to diseases carried by domestic canines, loss of habitat, and widespread extermination.

The African Wild Dog is the only remaining representative of the genus *Lycaon* which likely diverged from other modern canines between two and three million years ago [Creel and Creel, 2002]. They are cursorial predators which prey mainly on small and medium ungulates, hunting in packs and traveling great distances during much of the year. Packs consist of up to 50 related individuals including a breeding pair. They maintain social hierarchies within sexes mainly through displays of submission with fighting uncommon. Unlike most cooperatively hunting species, African Wild Dogs rarely fight over kills and the youngest pack members are often the first to feed. All pack members are involved in the care of offspring, from babysitting at the den site to regurgitating meat for pups being weaned.

The Association of Zoos and Aquariums approved a Species Survival Plan for the African Wild Dog in 1991 to manage the captive population in AZA facilities. The current target population in captivity is 150 individuals [Quick 2007]. This SSP focuses on maintaining genetic diversity in the breeding population while educating the public about the species and potentially releasing captive bred individuals into wildlife reserves in Africa. The SSP recommends that all movement of dogs between facilities be done in groups of siblings.

This study will focus on three adult male African Wild Dogs (*Lycaon pictus*), Blaze, Aries and Mikita. Blaze and Aries, who are littermates, are currently eight years old and were born at De Wildt Cheetah and Wildlife Research Center in South Africa. After they and some pack mates were relocated to the Bronx Zoo, Mikita was fathered by Blaze and Aries' brother. He is currently four years old. The three were moved together to the Houston Zoo at the end of 2007.

These individuals have been a part of the enrichment program for 3 years. The Houston Zoo has an ongoing program of environmental enrichment provided for all carnivores, including the African Wild Dogs. The variety of enrichment is changed daily with most focusing on one or more senses, such as visual or auditory. The specific enrichment device is selected according to the zoo's safety standards and availability of materials. As often as possible the enrichment is evaluated by zookeepers and given a score of 1 to 5. A score of 1 indicates that the enrichment was ignored by the animal while a 5 is scored when the animal interacts with the enrichment stimulus for an extended period of time. In this study the enrichment tools will be evaluated through behavioral observation and a comparison of the occurrence of stereotypical behaviors with and without enrichment present. The normal rotation of enrichment tools will not be modified.

All three African Wild Dogs lived together in a semi-naturalistic outdoor habitat with a small concrete pond, a few small trees and logs, a small thatched roof on top of four wooden supports, and a hill with two concrete tunnels. The exhibit was surrounded on two sides by a construction site. A third side was bordered by a sidewalk available to guests. On the fourth side was a gate which could be opened by zoo keepers to shift the African Wild Dogs into an indoor holding area adjacent to the indoor holding area used for African lions.

Data Collection and Analysis

This study was designed to evaluate the ongoing enrichment procedures for the African Wild Dogs at the Houston Zoo. Each month, keepers schedule enrichments for each day, rotating among these categories: (1) tactile/scent, (2) toy/scent, (3) produce, (4) move furniture, (5) bones, (6) food, (7) exercise, (8) visual/auditory, (9) toy/diet, (10) bedding, (11) diet on exhibit, (12) bone in meat, (13) substrate option, (14) free, (15) none. The enrichment treatment was usually given in the morning after the animals were fed (unless the enrichment involves feeding). The observer stood outside the cage in the viewing area for guests, with a video camera and notebook. Observations were made within the morning hours of 7:00 to 10:00, on two days per weekend.

Each observation period was divided into four 20-minute samples: (1) before treatment (video), (2) during treatment (video), (3) pause (notes with no video for 20 min) and (4) after treatment (video). These samples may not be "back to back" due to daily variation in the feeding schedule.

The observation rule was "focal group" [Martin and Bateson, 1993]. This means that all 3 individuals were observed at the same time, anticipating that not all individuals would be visible at all times. Notes and video were recorded such that information could be analyzed for each individual separately as well as for the group as a whole.

The recording rule was "all occurrences" of behavior [Martin and Bateson, 1993]. Each time a new behavior started, the time, individual and behavior was recorded. When a behavior such as sleeping continued for an extended period of time it was noted at 3-minute intervals.

Behaviors were predefined using a general canid ethogram [Packard, 2003]; the list of behaviors for this study was expanded as additional behaviors were observed. Except in cases of logistical problems (i.e. battery failure), the video was recorded continuously during samples. The video record was used to edit notes at the end of each weekend. Video was archived for future reference.

Table 1. Definition of variables that were measured as behavioral assays in this study of the effect of behavioral enrichment

Variable	**Description**	**Explanation**
Treatment[a]	The samples taken before, during and after presentation of the enrichment stimuli ("aba" sampling design).	Since each individual will vary in activity levels and activity may vary from day to day, the treatment needs to be compared with samples taken before and after for the same individual during the same morning observation period.
Stereotypy[b]	Count the number of minutes one individual was recorded pacing during each 20-min sample.	Pacing was the only stereotypical behavior observed during the pilot study. Our prediction is that pacing will be higher before than during or after treatment, for all individuals and enrichment stimuli.
Inactivity[b]	Same as above for the "lying on ground" posture not associated with enrichment stimuli (e.g. shavings)	Our hypothesis is that "inactivity" is an appropriate measure for what might be interpreted as "disinterest". Our prediction is that individuals will vary as to the effect of treatment on inactivity. For each individual, we will give each enrichment stimulus a "success" score based on how much inactivity declined during and after treatment. This will be compared with the separate keeper evaluation score recorded for each enrichment stimulus (as available).
Social activity[b]	Same as above for the activity "social interaction", referring to interactions between the wild dogs	Our hypothesis is that "social interaction" is an appropriate measure for what might be interpreted as a "social bond". Same as above, we predict this will vary by individual and by type of enrichment stimulus.
Behavioral diversity[b]	Count of all the behaviors on the ethogram that were checked as occurring at least once during a 20-min sample.	Our hypothesis is that "behavioral diversity" is an appropriate measure for what might be interpreted as a "normal and natural". Our prediction is that behavioral diversity will increase with treatment, across all individuals and types of enrichment stimuli.

[a] Cause variable (independent)
[b] Effect variable (dependent)

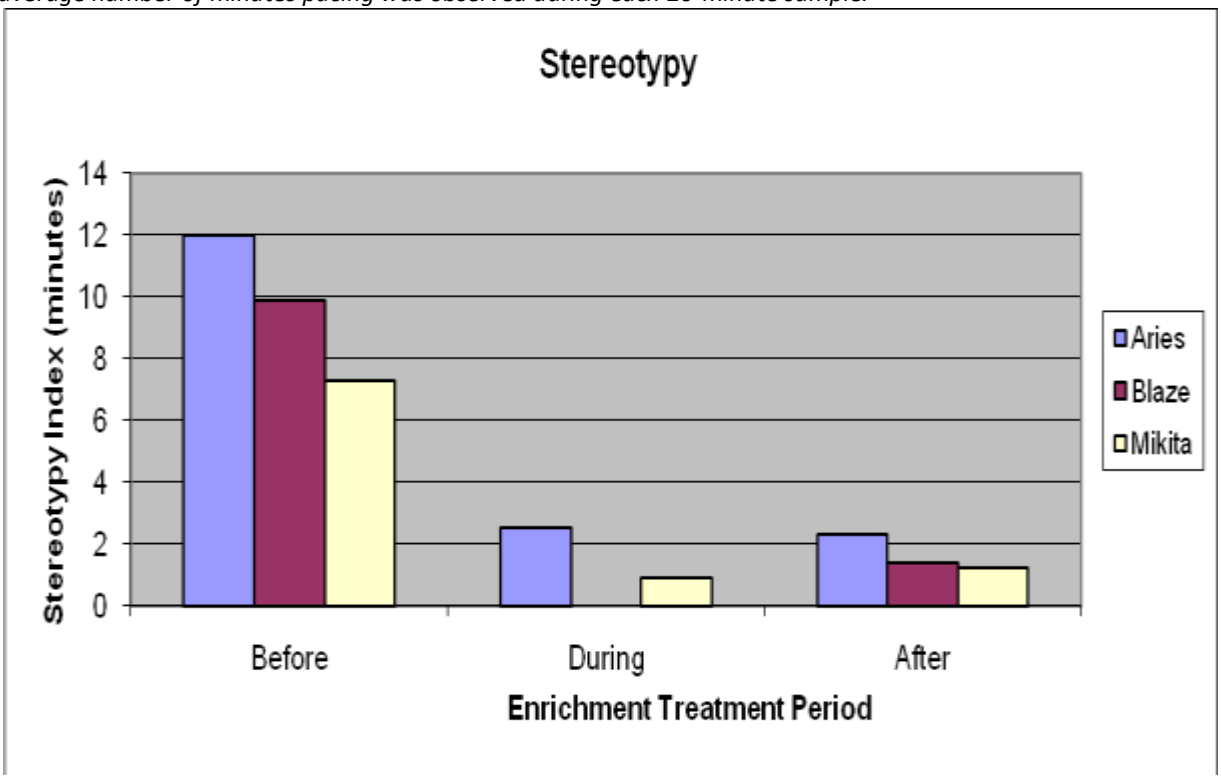
The database was analyzed to examine the effect of treatment (causal variable) on four behavioral assays (effect variables): (1) stereotypy, (2) inactivity, (3) social activity and (4) behavioral diversity (Table 1). The data were compiled separately for each individual, such that the columns in the data table are: enrichment type, before, during and after. The rows correspond to each day that individual was observed.

RESULTS

Stereotypy

The amount of time each individual spent displaying stereotypical behaviors declined during and after enrichment (Figure 1). This was a significant change for Aries ($W = 1.08$, $p < 0.05$) and Blaze ($W = 1.01$, $p < 0.05$), but not for Mikita ($W = 0.48$, $p > 0.05$).

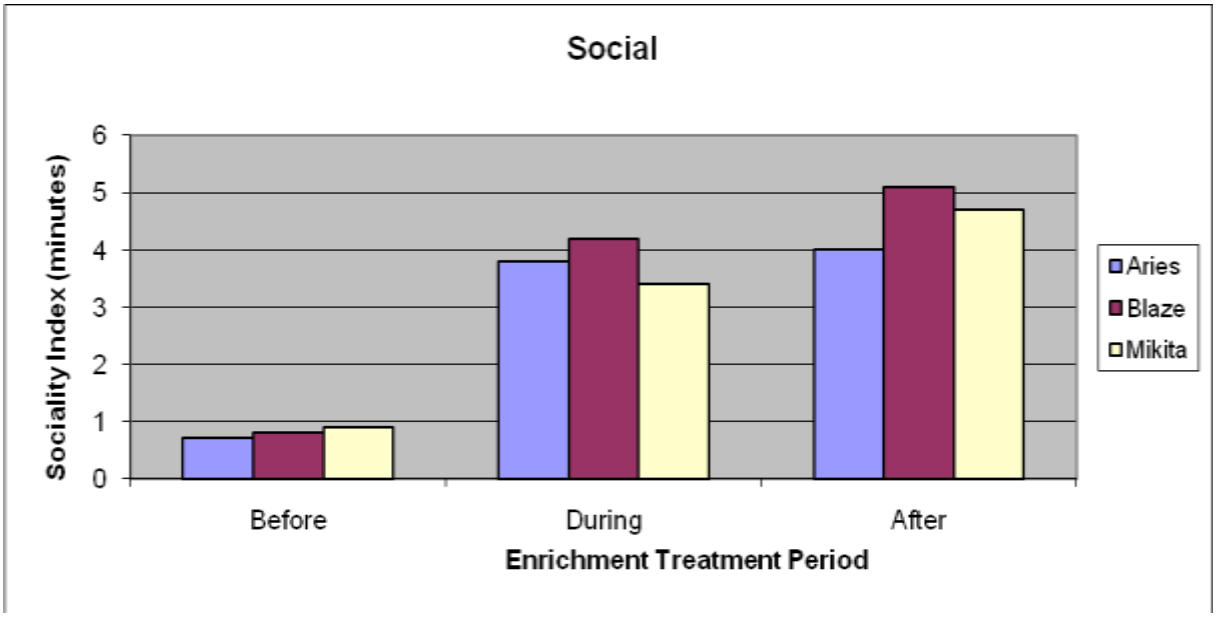
Figure 1. Stereotypy Index: comparing individuals before, during and after treatment. The index represents the average number of minutes pacing was observed during each 20-minute sample.



Social Activity

Social activity increased during and after the enrichment (Figure 2). This was a significant change for all individuals (Aries, W = 0.66, $p < 0.05$; Blaze, W = 0.77, $p < 0.05$); Mikita, W = 0.66s, $p < 0.05$).

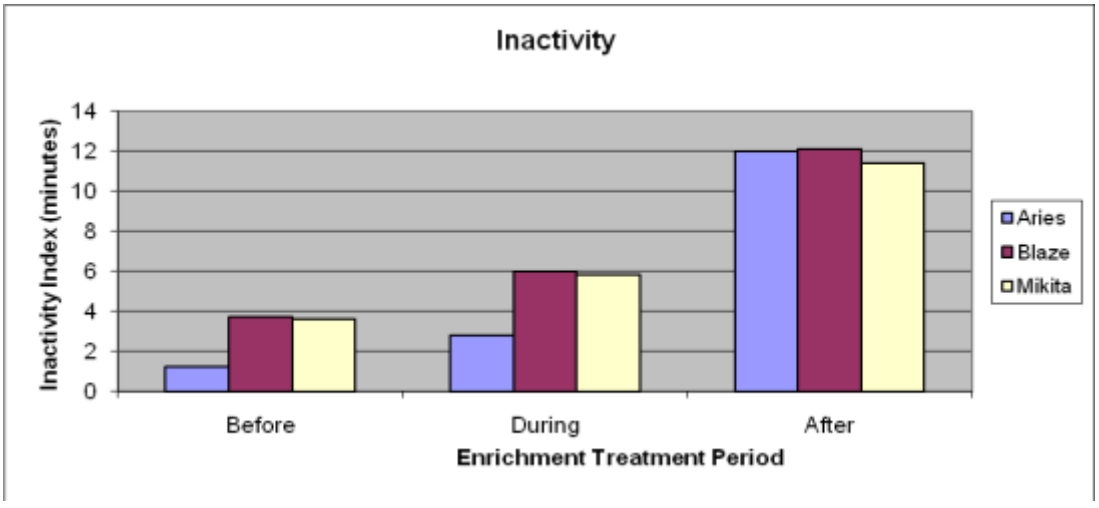
Figure 2. Sociality Index: comparing individuals before, during and after treatment. The index represents the average number of minutes social behavior was observed during each 20-minute sample.



Inactivity

All individuals were more likely to be inactive after the treatment than before the enrichment (Figure 3). Inactivity differed significantly for Aries, (W = 1.02, $p < 0.05$) and Blaze, (W = 0.65, $p < 0.05$), but not for Mikita (W = 0.47, $p > 0.05$).

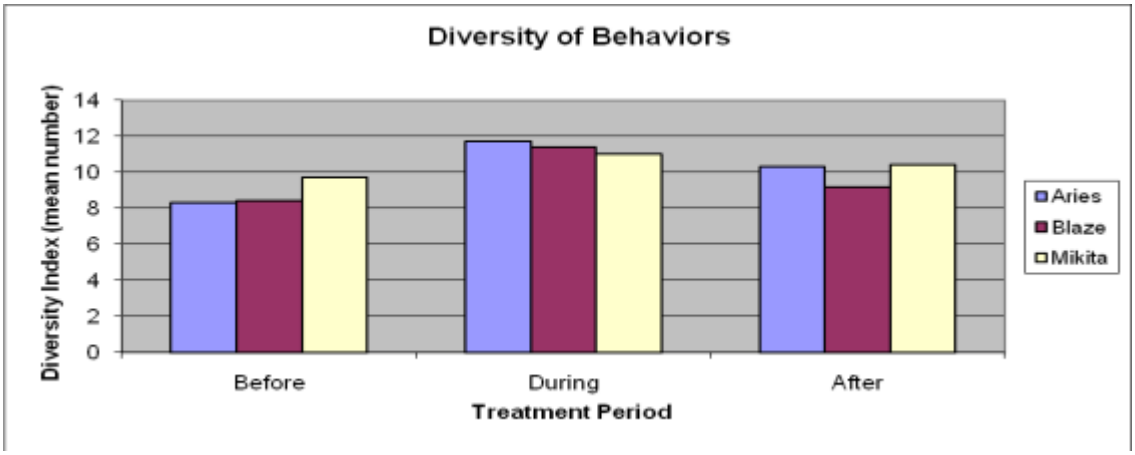
Figure 3. Inactivity Index: comparing individuals before, during and after treatment. The index represents the average number of minutes inactivity was observed during a 20-min sample.



Diversity of Behaviors

The diversity of behaviors did not change with treatment (Figure 4). The effect of treatment was insignificant for all individuals (Aries, W = 0.26, p > 0.05; Blaze, W = 0.10, p > 0.05); Mikita, W = 0.10, p > 0.05).

Figure 4. Inactivity Index: comparing individuals before, during and after treatment. The index represents the average number of minutes inactivity was observed during a 20-min sample.



Variation in Effectiveness of Enrichment Stimuli

There were clear differences in the effectiveness of the various forms of environmental enrichment used during this study period, based on both social activity (Table 2) and diversity of behavior (Table 3). The enrichment that resulted in the greatest amount of social activity and diversity of behavior was the pine shavings and seasoning given on 28 March 2010. In contrast, the mirror used as enrichment on 21 February 2010 elicited relatively little social interaction or behavioral diversity.

Table 2. Average time (minutes) spent engaging in social activity for each enrichment stimulus during treatment

Enrichment Stimulus	Aries During	Blaze During	Mikita During	Average across all individuals
Mirror	0	2	2	1
Lion urine on brushes	2	2	0	1
None	2	3	2	2
None	3	3	3	3
Chunk meat and rats	3	4	3	3
Rats tossed over fence	4	4	3	4
Hay/catnip/cinnamon in boxes	5	4	3	4
Rearranged logs	4	6	4	5
Chunk meat and rats	6	5	5	5
Pine shavings/seasoning	9	9	9	9

Table 3. Average number of behaviors for each enrichment stimulus during treatment

Enrichment Stimulus	Aries During	Blaze During	Mikita During	Average across all individuals
None	7	9	6	7
Chunk meat and rats	9	7	10	9
Mirror	8	11	8	9
Lion urine on brushes	9	9	12	10
Rats tossed over fence	13	13	10	12
Hay/catnip/cinnamon in boxes	13	14	10	12
Chunk meat and rats	13	13	11	12
Rearranged logs	15	10	12	12
None	12	13	14	13
Pine shavings/seasoning	18	15	17	17

Both the mirror and brushes dipped in lion urine resulted in less social activity than the two control days on which no enrichment was given, though the lion urine did moderately well in the category of behavioral diversity. On days when the enrichment was diet placed in the exhibit instead of in the holding area the pack spent most of their time in holding pacing along the fence. Once they were released into the exhibit, however, this enrichment resulted in high levels of social activity and behavioral diversity.

DISCUSSION

This study evaluated the ongoing enrichment procedures for the African Wild Dogs housed at the Houston Zoo. The data collected during this study indicated a considerable ability for the introduction of enrichment stimuli to affect the rate of occurrence of stereotypies as well as non-stereotypical behavior. All three individuals displayed a significant decrease in stereotypy during and after the treatment period. This was accompanied by increases in both social interaction and periods of inactivity.

The most striking and consistent changes were seen in the category of inactivity. For every individual the mean ranks showed a pattern of 1 (before), 2 (during), 3 (after). This is consistent with natural behavior [Boggs and McNutt 1996; Creel and Creel, 2002]. African Wild Dogs are crepuscular, meaning that they are typically most active during the hours of dawn and dusk, so a decrease in activity as midday approaches is expected. Rates of inactivity are also affected by the weather; the day on which the Wild Dogs spent the greatest amount of time being inactive was also the hottest day of the study. On this day, 3 April 2010, the pack spent an average of 37.3 minutes either lying or sleeping, over half of the 60-minute observation period.

All three dogs spent a large proportion of time pacing before treatment. This was most often done in a single file line along a visibly worn down path at the front of the enclosure. This pacing was mostly anticipatory for the arrival of zoo keepers and subsequent morning feeding. Typically the rate of pacing increased shortly before keepers arrived at the enclosure and the pack often paused to look in the direction from which the keepers invariably approached the exhibit before continuing in their pacing. It has been shown that species which typically travel great distances and control large territories in the wild are most likely to display stereotypy in captivity [Clubb and Mason 2007]. Wild Dogs are known to patrol home ranges of hundreds of square kilometers, only reducing their territory size when young pups are present and confined to a den [Creel and Creel, 2002]. They travel daily in order to hunt, beginning at a slow rate early in the morning and increasing their rate of travel as they prepare to chase and capture prey [Boggs and McNutt 1996]. The pattern of pacing observed during the study could be considered analogous to hunting behavior seen in the wild.

There was clear individual variation in patterns of stereotypy for each Wild Dog. Blaze was least likely to begin pacing during or after treatment; he was recorded as pacing for only one minute during these two time periods for the entirety of the study. Aries spent the most time pacing overall. He was much more likely to pace alone, often while Blaze and Mikita appeared to be sleeping. Mikita only once paced by himself; on all other occasions he was accompanied by Aries or both Aries and Blaze.

There was also a prominent change in levels of social activity between sampling periods. There was typically little or no social interaction during the period prior to treatment. On almost every day of observation the arrival of a zoo keeper resulted in a great amount of excitement in the pack; all three dogs would begin running along the side of the enclosure closest to the indoor holding area, often in a cluster with their heads close together and twittering. However, this behavior generally did not occur during the before treatment sampling period and was therefore not considered for analysis.

One of the most common social activities observed was chasing. Chasing was often initiated when one individual, with the head low and ears laid back, approached another individual. It was common for the chaser and the individual being chased to change roles. There were no instances of aggressive chasing recorded; all pursuits were playful. It was also not uncommon for an instance of chasing involving all pack members to end in Blaze mounting Mikita. Blaze and Mikita spent more time interacting with each other than with Aries, who often appeared to be more of a spectator.

The number of different behaviors displayed during each treatment period was relatively consistent. However, the type of behavior did vary. The time before treatment was dominated by pacing and postures of alertness in anticipation of the arrival of zoo keepers. The zoo keepers themselves act as a stimulus eliciting various behaviors from the Wild Dogs. While guests and keepers working in other departments are mostly ignored, the sight or sound of a carnivore keeper consistently resulted in a reaction from the Wild Dogs, varying from turning the head toward the keeper to running in the direction of the keeper. This was true for all treatment periods. During and after treatment pacing was mostly replaced by social activities and interactions with enrichment stimuli.

The amount of time each individual spent interacting with a given enrichment stimulus was largely determined by the amount of time the other individuals spent interacting with that stimulus. African Wild Dogs are extremely social so much of their time is spent acting as a group. Because of this, the most used enrichment stimuli are those which can be used by more than one individual at a time. This includes objects which can be carried during chasing and stimuli such as pine shavings which multiple individuals can interact with at once

CONCLUSIONS

1. All of the environmental enrichment stimuli in use at the Houston Zoo significantly decreased the occurrence of stereotypical behaviors.

2. Inactivity increased significantly as the sun rose and as days became hotter, likely due to the African Wild Dogs' naturally crepuscular lifestyle.

3. An increased level of social activity was observed during and after treatment.

4. The pacing observed before treatment was mainly due to anticipation of the arrival of zoo keepers and feeding.

5. Enrichment stimuli which can be utilized by multiple individuals at once are most effective in reducing stereotypy.

REFERENCES

Boggs, L. and McNutt J. 1996. Running Wild: Dispelling the Myths of the African Wild Dog. Smithsonian Institution Press, Washington, D.C.

Clubb, R., and G. J. Mason. 2007. Natural behavioural biology as a risk factor in carnivore welfare: How analysing species differences could help zoos improve enclosures. Applied Animal Behaviour Science 102:303-328.

Creel, S. and Creel, N.M. 2002. The African Wild Dog Behavior, Ecology, and Conservation. Princeton University Press, Princeton and Oxford.

Martin, P. and Bateson, P. 1993. Measuring behaviour: an introductory guide, 2nd ed. Cambridge: Cambridge University Press.

Mason, G.; Clubb, R.; Latham, N.; Vickery, S. 2007. Why and how should we use environmental enrichment to tackle stereotypic behaviour? Applied Animal Behaviour Science 102:163-188.

Meehan, C. L.; Mench, J. A. 2007. The challenge of challenge: Can problem solving opportunities enhance animal welfare? Applied Animal Behaviour Science 102:246-261.

Packard, J.M. 2003. Wolf behavior: reproductive, social and intelligent. Pp. 35-65 In: Wolves: Behavior, Ecology and Conservation. L. David Mech and Luigi Boitani (eds.). Chicago: The University of Chicago Press.

Quick, M. 2007. African Wild Dog SSP Report. Philadelphia: AZA National Conference Procedings.

Sillero-Zubiri, C, Hoffmann, M and Macdonald, DW. (editors) 2004 Canids: Foxes, Wolves, Jackals and dogs. Status Survey and Conservation Action Plan. Cambridge: IUCN Publication Services.

Swaisgood, R. R. 2007. Current status and future directions of applied behavioral research for animal welfare and conservation. Applied Animal Behaviour Science 102:139-162.

Watters, J.V., Margulis, S., and Atsalis, S. 2009. Behavioral monitoring in zoos and aquariums: a tool for guiding husbandry and directing research. Zoo Biology 28:35-48.

Prepared in the format of Zoo Biology

PROPER CITATION FOR THIS REPORT:

Packard, J.M., S.J. Turner, and S. Shepard. 2010. Behavioral enrichment for African wild dogs (*Lycaon pictus*): response to stimuli used in an ongoing program at the Houston Zoo. Biodiversity Stewardship Report Series. No. BS10-2. Biodiversity Stewardship lab, Texas A&M University, College Station, Texas 2258