

# Whole Carcass Feeding as a Source of Behavioural Enrichment for African Wild Dogs (*Lycaon pictus*) in Captivity at Western Plains Zoo, Dubbo

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## Abstract

The endangered African wild dog or painted hunting dog (*Lycaon pictus*) is a social hunting canid, and is the only living member of the monotypic genus *Lycaon*. African wild dogs are highly social animals, thriving on cooperation amongst pack members, with strong social bonding behaviours, which are highlighted while hunting and feeding. In captivity, the feeding of live prey to carnivores is not permitted and therefore this project examined whole carcass feeding versus traditional pieced meat, as a source of behavioural enrichment for African wild dogs at Western Plains Zoo, and its significance for the captive management of this species.

The display pack, two (2) females and seven (7) males, at Western Plains Zoo was studied from 18/03/01 to 30/06/01. Daily observations of the social interactions amongst pack members were recorded at five minute intervals an hour before, during and an hour after feeding. The devouring of carcasses and pieced meat as well as other social behaviours were filmed for analysis.

The results indicated that the feeding regime (whole carcass or pieced kangaroo meat) influenced both the level of activity and the behavioural repertoire of the pack. In particular, carcass feeds were found to increase time spent feeding, agonistic interactions and play, all of which contributed to greater pack dynamics and cooperation. This suggests that feeding whole carcasses rather than pieced meat may be a practical way of providing African Wild Dogs with beneficial environmental and behavioural enrichment, which in turn may improve their captive husbandry and management.

**Key Words:** African wild dog; pack, carcass; pieced meat; feeding regime; natural and social behaviour; activity

## Introduction

Many species throughout the world are currently facing the risk of extinction. As a consequence zoological institutions now realise their obligations towards these animals and the role they can play in helping to conserve wildlife, through the captive management and breeding of endangered species. This involves not only the appropriate captive husbandry systems but also effective genetic and demographic management of captive populations to ensure the availability of viable gene pools for future reintroduction programs (Young, 1998; Durrell and Durrell, 1996). However "to conserve only their genetic integrity, and ignore their behaviour, will produce animals that are unable to interact with their environment" (Bell, 1998 p. 39). For this reason, modern zoos are trying to develop captive environments, which will stimulate their animals to display a full range of normal behaviours.

### a) Enrichment

The key to providing captive wildlife with appropriate physical or psychological stimuli is conditioning and social or environmental enrichment (Tribe, 2001). Shepherdson (sited in Young, 1998 p18) defines

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environmental enrichment as “ a concept which describes how the environments of captive animals can be changed for the benefit of the inhabitants. Behavioural opportunities that may arise or increase as a result of environmental enrichment can be appropriately described as behavioural enrichment”

Therefore environmental enrichment can act as a tool to simulate a wide range of aspects of a species' natural habitat (Young, 1998). For instance many wild animals spend most of their active / waking hours feeding and foraging (Holst, 1998). Consequently it is important to allow them the opportunity to do this in captivity, and for most captive species feeding time can be made more interesting and challenging (Embury, 1993). However carnivores, especially those which hunt for food, are harder to cater for, even though being denied the opportunity to hunt may cause the development of stereotypic behaviours (Wooster, 1997).

#### **b) Feeding Regimes**

Captive carnivores, like the African wild dog (*lycaon pictus*) at Western Plains Zoo (WPZ), are starved one to two days a week to simulate non-successful hunts (Kroeger, 2000; Wood and Norris, 2000). Sequeira (1993) states that the primary role of a wild pack of painted hunting dogs or African wild dogs is to hunt, however this skill becomes undermined in captive dogs. This species has evolved to become highly co-operative and social predators, whose ability to hunt effectively has depended upon its social behaviour (Sequeira, 1993). Holst (1998) argues that the traditional chunk of meat feed does not promote a challenge and is devoured in a short period of time. Consequently although these viable metapopulations of captive African wild dogs can be of great genetic importance, they may be deprived of the essential stimuli required to bind pack members and to allow them to cooperatively face environmental challenges.

It would be natural for large carnivores such as cheetahs, leopards, lions, wolves and African wild dogs to feed on whole carcass, however most zoos refrain from using this feeding technique for a number of reasons (Holst, 1998). Firstly the public may perceive such acts as unethical and barbaric, creating a display to exploit the cruelty of nature (Holst, 1998), and secondly, due to occupational health and safety standards, some zoos are required to freeze whole prey species in order to kill pathogenic bacteria (Wooster, 1997). Therefore feeding of whole prey becomes an issue of practicality – it is easier to freeze rats, rabbits and meat pieces than large prey like goats and sheep. Thirdly, the feeding of live vertebrates other than fish is actually illegal in many countries (Wooster, 1997).

#### **c) Existing Carnivore Enrichment**

Due to these restrictions, feeding enrichment for hunting carnivores has usually been attempted through the use of mechanical devices. For instance Litchfield (1993) and Tudge (1991) both describe pumas receiving meat rewards for chasing mechanical marmots. The application of a mechanical lure, has also been used for targeting the cheetahs ability to chase prey at high speeds (Gewalt, 1992). For the African wild dog a “run and fun lift” was created simulating hunts through the use of a dummy zebra winched along a cable way with a section of meat hanging from the device, for the dogs to attack (Gewalt, 1992).

#### **d) Rationale for this Study**

Wood and Norris (2000) have underlined the importance of recognising that physical forms of foods greatly influence the feeding behaviour of captive carnivores. *In-situ* African wild dogs hunt as packs, cooperating to bring down large prey required to feed their pups (Woodroffe and Ginsberg, 1999). Feeding of whole carcasses in captivity may therefore promote natural behaviours such as cooperation amongst pack members and ritualised feeding frenzies essential for a packs social and reproductive well being (Estes, 1992). This has been observed in timber wolves fed road kill deer, at Knowsely Safari Park, America, where carcasses encouraged cooperation amongst these captive canids.

At Western Plains Zoo (WPZ) it was believed that the feeding of whole carcass as opposed to pieced meat may stimulate captive African wild dogs to develop and display a more natural range of feeding and social behaviours (Blyde pers. com.). The aim of this study was therefore to determine the effects of

carcass feeding as a source of behavioural enrichment for the African wild dog in captivity. However very few captive behavioural enrichment studies focus on these social carnivores.

### **The African Wild Dog**

The African wild dog was declared an endangered species in 1990 by the International Union for the Conservation of Nature (IUCN) (Ginsberg, 1994). This species represents the only living member of the monotypic genus *Lycaon* (Mills, 1999). Once widespread throughout African south of the Sahara, population are estimated ranging between 2,500 to 3,000 dogs (McNutt and Boggs, 1996) having disappeared from 25 out of 39 countries that consisted of its former range (Mills, 1999). "Painted wolf-like animal" is the translation of its scientific name, conspicuously labeled so due to its black, gold, tan and white markings (Rasmussen, Nd).

This medium sized canid is characterised through its large, broad rounded ears, blunt muzzle, deep chest and long legs. There is no sexual dimorphism however each individual has a unique asymmetrical coat pattern (Wood and Norris, 2000; Sheldon, 1992).

### **Pack Structure and Reproduction**

Painted dogs live in packs ranging in up to 49 members, however "4-8 adults, 2-6 yearlings and 5-11 pups" (Mills, 1999 p144) is most common given the low population numbers today. As diurnal, cooperative hunters, packs consist of an alpha (dominant) breeding pair, their brothers and sisters (non-breeding adults) who assist in feeding and caring for the pups. Strong bonds between pack members are displayed through their care for the sick and injured pack members by licking wounds and regurgitating food (Rasmussen, Nd). Rasmussen (Nd), Kingdon (Nd), Mills (1999) and Estes (1992) refer to a group of dogs with a breeding pair amongst them as a "pack" and an aggregation of animals without a breeding pair, are referred to as a "group."

Wild dogs are seasonal breeders (depending on the rainy season), with a 69 – 73 day gestation period (Estes, 1992). Litter sizes range from 2 to 12 pups, remaining in a den site for three months. The pups' first contact with the pack coincides with the primary attempts of them eating solid food. The social and reproductive system is based on cooperative hunting and food sharing through regurgitation continually reinforced by behaviour patterns originating from infantile begging (Estes 1992, and Vucetich and Creel 1999). Painted hunting dog pups have "priority to the kill for the first year of their life" until a new litter is born in the proceeding year (Rasmussen, Nd). Continuous switching between pack members taking on the role of provider to that of the dependent, establishes the unique system of interdependence (Kingdon, Nd).

### **Pack Hunting**

African wild dogs display diurnal activity patterns being most active during the morning and early evening, with hunting occurring at dawn and dusk (Estes, 1992). *Lycaon* are active four to five hours of the day as they seek shelter from the heat in dens or available shade spots (Grizmek, 1972).

Hunts are instigated by hungry pack members: an individual dog will rise and run to a group of dogs, resting, exciting them to stand up (Scott, 1991). A greeting ceremony or "Pep rally" (also see Appendix 3) is initiated, during which *Lycaon* stimulate each other's adrenal responses. These performances reinforce social bonds between pack members prior to a hunt and after a resting period (Mills, 1993). Scott (1991, p49) states that "the ceremony is explicitly friendly in nature, an unambiguous and exuberant reaffirmation of the strong social bonds forged between pack members".

The predators will select a weak or sickly prey species, running it down to exhaustion (Woodroffe and Ginsberg, 1997<sup>b</sup>). One dog will lead the pack chase with others trailing behind, ready to cut across if the prey species doubles back (Estes, 1992). Pack members that catch up with the quarry tear at the thin skin of the groin and stomach disemboweling their prey (Fox, 1983). Packs have been observed to feed twice a day, according to Kingdon (Nd) only 10 to 30 percent of chases result in failure.

Following a successful hunt the pack will gorge themselves on the kill dispatched through disembow-

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element (Rasmussen, Nd). When feeding African wild dogs show very little aggression in comparison to wolves or lions who viciously defend their catch (Scott, 1991). Painted hunting dog adults eat approximately 1.2 up to 5.9 kg of meat per dog a day from a carcass (Bothma, Nd.). Adults have a stomach capacity of approximately 9kg (Rasmussen, 1999).

Dogs will regurgitate almost one kilogram of every meal to the hungry pups awaiting the return of the gorged pack members. There is a hierarchy at the scene of a kill, with the weaker dogs and the pups having priority to feed, then the yearlings, followed by the alpha pair, other adults and subordinates (Bothma, 1998). According to Estes (1992) dogs rarely return to a kill or cache surplus food, hence their name hunting dogs.

### **Captive Populations of African Wild Dogs in Australia**

As natural populations of *Lycan pictus* are at risk it is important to establish viable metapopulations in the captive situation. Management strategies need to encompass the animals' physical and psychological well being to ensure the well being of a pack. It is therefore imperative that management regimes are implemented to promote natural behaviour and social organisation of a pack.

### **Methodology**

#### **The Study Site**

The study was carried out at Western Plains Zoo, Dubbo in central west New South Wales (NSW) which lies approximately five hours south west of Sydney. Facilities to maintain African wild dogs at WPZ consist of an exhibit, breeding facilities, holding yards and restraint area. The display pack roams on an 8,000m<sup>2</sup> exhibit separated from the public through a water moat and enclosed by a weld mesh fence of 2.4 meters. Casurina trees line the banks of the central moat to the right of the feeding platform, an elevated-viewing tower which protrudes onto the exhibit. In front of the platform grows a large box tree. The animals have access to a denning site on display however pregnant bitches are removed prior to whelping (Kroeger, 2000).

#### **The Animals Studied**

Western Plains Zoo (WPZ), Dubbo, currently holds the largest number of African wild dogs, consisting of an off limits group of five (3:2) and a display pack of nine (7:2). Contraception is currently administered to control oestrous cycles in the females. All dogs are administered with an ear tag, transponder chip and have been given individual identification numbers as part of a computerized record keeping system. A photographic identification file has been established, as described further on in this report.

Over the duration of the study the display pack fluctuated, initially consisting of seven males and three females, until one of the two female pups was removed and trans-located. The present alpha female is also the mother of all the other dogs making up the display pack, the current alpha male was born on the 11/05/98 and the eight pups, six males and two females, in April 1999 (Lemon, 2000, pers. comm.).

#### **WPZ Feeding Regime**

At WPZ all dogs are fed pieced meat four days a week and a carcass (red or fallow deer or kangaroo) once a week. The captive diet at WPZ consists of approximately 2kg of pieced kangaroo meat per dog including a supplement mix consisting of 10gr Thiamine, 10gr FERAMO Greyhound Supplements and 10gr Calcium Carbonate (Lemon, 2000, pers. comm.).

Carcass feeding is followed by a starve day. The animals starved two days a week (Kroeger, 2000). Starving carnivorous animals is a common practice in captive situations, as it mimics unsuccessful hunting days or days of rest after a big kill. In nature acquiring food can be challenging and time consuming, leading to the physical well being of the animals.

### ***Individual Picture Identification File***

Individual picture identification records were established in November 2000 in order to facilitate the individual identification of pack members during the behavioural observations. African wild dogs have unique coat pattern colourations for each individual animal, the only consistent trait in all dogs is the white tip of the tail and the tanned forehead with a black muzzle. Photos were taken of both the left and the right side of each individual animal, in order to accurately identify the animals during observations when ear tags are not highly visible.

A list of identification numbers and ear tag colours were obtained of individual dogs kept at WPZ. Rasmussen (Nd) identifies packs of wild dogs through drawings of coat patterns on a sketch/outline of a hunting dog provided to locals by the Painted Dog Research project. Combining the use of these sketches and ear tags of individuals at WPZ an accurate collection of photos was established. After the photos have been taken of each hunting dog, data was collected from zoo records on the individual animals in collaboration with WPZ staff.

### ***Implementing the Revised Feeding Regime***

A revised feeding regime was implemented over the study period from the 19<sup>th</sup> of March to the 30<sup>th</sup> of June, 2001. In order to implement such a feeding regime approval first needed to be obtained from the senior veterinarian. The Ethics Committee of the Zoological Parks Board of NSW was informed of the research project, and their authorisation to carry this study was obtained. All staff working with the African wild dogs needed to be briefed on the intentions of the project and the importance of consistency throughout the project in regards to feeding times.

As carcasses could only be obtained by a number of qualified staff, therefore the feeding and feed times for whole carcass varied depending on staff availability and time. Therefore times for the pieced meat feeds were scheduled in order to stay consistent with the carcass feeding times. The following revised feeding regime, as seen below in Table 1, was implemented over the four-month, three trial study period.

The feeding regime was implemented as three trials, Trials 1 and 2 consisting of six weeks and Trial 3 of only three weeks. The individual six-week trials consist of three feeding regimes; two consecutive weeks of mixed feed (meat and carcass), two consecutive weeks of whole carcass only feeds and two consecutive weeks of pieced meat feeds. Trial 3 was made up of only one week of each feeding regime. This trial was established in order to make up for any days on which observations may have been hampered due to husbandry practices, enclosure maintenance, moving of animals or bad weather conditions.

As whole carcass feeds include the weight of bones, skin and offal, the actual weight of meat eaten was estimated. The time of feeding and the delivery of the food was kept the same, at approximately 3:30pm time every day. However Trial 3 was carried out in the morning, when the dogs were fed approximately at 8:00am to facilitate other husbandry procedures later in the day.

### ***Behavioural Observations***

Observations of individual dogs were conducted with the aid of the previously mentioned Individual Picture Identification file and through the initial establishment of an ethogram. Ethograms according to

*Table 1. Revised feeding regime.*

<b>Week</b>	<b>Mon.</b>	<b>Tues.</b>	<b>Wed.</b>	<b>Thurs.</b>	<b>Fri.</b>	<b>Sat.</b>	<b>Sun.</b>
1	Meat	<b>Carcass</b>	Starve	Meat	<b>Carcass</b>	Starve	Meat
2	Meat	<b>Carcass</b>	Starve	Meat	<b>Carcass</b>	Starve	Meat
3	<b>Carcass</b>	<b>Carcass</b>	Starve	<b>Carcass</b>	<b>Carcass</b>	Starve	<b>Carcass</b>
4	<b>Carcass</b>	<b>Carcass</b>	Starve	<b>Carcass</b>	<b>Carcass</b>	Starve	<b>Carcass</b>
5	Meat	Meat	Starve	Meat	Meat	Starve	Meat
6	Meat	Meat	Starve	Meat	Meat	Starve	Meat

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McDonnell and Haviland (1995) is a list of species specific behavioural repertoires and interactive sequences. The ethogram established for this project depicts interactions between pack members based on field observations by Scott (1991), van Lawick Goodall and van Lawick Goodall (1970), Estes (1992) and Ammann and Ammann (1989), as well as the author's personal observations and photographs of African wild dogs at WPZ.

Observations were made from the 19<sup>th</sup> of March, 2001 until the 1<sup>st</sup> of July, 2001. For each of the three trials these were carried out one hour prior to feeding, during feeding and for an hour after the recorded time at which the dogs stopped feeding.

Feeding time was recorded being from the time when the food was thrown into the enclosure from the feeding platform until all dogs stopped feeding or chewing and directed their attention towards other things.

Scans of behaviours were carried out and recorded at five-minute intervals. Twenty-one behaviours were recorded, as well as all the behavioural interactions observed amongst pack members in between the five-minute scans. Other uses of the carcass were also recorded.

## Visitor Survey

A visitor survey was also established to determine the public's opinion about carcass feeding in the captive environment. This survey was distributed mainly during the Easter school holiday period. Forty-four members of the public were selected at random to fill out the visitor survey. The only information given prior to filling out the survey was the definition of whole carcass and pieced meat, although most visitors were given the survey after a carcass feed.

## Data Analysis

Collectively data from the 100 observation days, totaling 227.35 hours, was entered into Microsoft Excel, spreadsheets. The data entered into the original spreadsheets included interactions between pack members, behaviours performed individually or with other pack members, behavioural observations outside of the five-minute scans and time taken to feed. In order to facilitate the analysis of the large volume of data, patterns of behaviour were summarised using Microsoft Excel, with the help of University of Queensland Statistician, Mr. Allan Lisle.

Data from the three trials was lumped together for analysis and tabulated in order to determine the total number of behaviours observed as well as how the feeding regimes affected these. Observational data of interactions before a feed, during feeding and after a feed were also summarised allowing for the analysis of a wide range of feeding behaviours. All summarised data was tabulated and also displayed in the form of bar graphs.

Deeper analysis is of course possible due to the vast amount of data entered into the spreadsheets. However after consultation with Mr. Lisle and the project supervisor Mr. Tribe, it was decided that further implementation of statistical analysis was beyond the scope of this paper. The data displayed in this paper is thus of a descriptive nature and yet sufficiently covers the aim of the project. It was taken into consideration that these observations were not independent measures and values.

## Results

Table 2 shows the maximum time taken to devour a whole carcass is 63.60 minutes compared to 5.03 minutes the longest time spend feeding on pieced meat.

Figure 1 illustrates that over the three feeding trials, the total time taken to feed on whole carcasses was considerably longer than feeding of pieced meat. As can be seen in Table 2 and depicted in Figure 1

Table 2. Average time taken to feed on whole carcass versus pieced meat.

<b>Trials</b>	<b>Whole Carcass</b>	<b>Pieced Meat</b>
Trial 1	54.93	5.03
Trial 2	61.17	2.28
Trial 3	63.60	1.90
Overall	58.74	3.19

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the time taken to feed on pieced meat is reduced over the duration of the trial while the time taken to feed on a carcass rises slightly.

Table 3 shows a summary of all the behaviours observed throughout the study divided into data observations recorded before feeding (Pre), during feeding and after feeding (Post) for both pieced meat feeds and whole carcass feeds.

Inactivity was the most commonly observed behaviour, regardless of the feeding regime used, although inactivity seems to be highest post feeding. The results show that pacing was highest pre-feeding, with an equally high figure obtained for this behaviour on a starve day. Exploratory behaviour was highest during feeding of pieced meat. Begging behaviour was also more frequently observed during pieced meat feeds. Once again the data represented in Table 3 shows a larger amount of time is spend feeding on a carcass. Figures also indicate the tugging at carcass was observed throughout the study, with a low figure indicating the tugging at pieced meat.

The figures shown in Table 4 are collectively illustrated in Figure 2. Table 4 indicates that inactivity was highest when fed pieced meat while pacing and exploring were lowest on carcass feeds. At 69.69% inactivity is also quite clearly distinguishable in Figure 2. Figure 2 shows the clear difference in amount of pacing performed on the different feeds, highest being observed on a starve. Carcass meat produced the highest amount of feeding related behaviours at 25.05 %. Differences between play fighting and other behaviours observed were fairly similar given the values in Table 4 and their illustration in Figure 2.

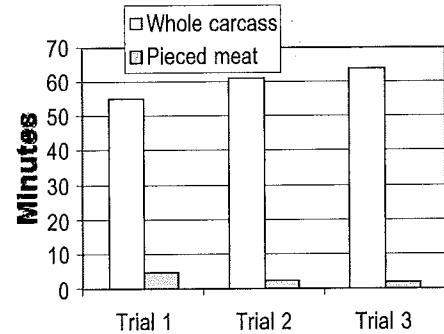


Figure 1. Summary results of time taken to feed on carcass versus pieced meat.

Table 3. Summary of the total behaviours observed for all feeding regimes.

Behaviour	Feeding Regime						Starved
	Whole carcass			Pieced meat			
	Pre-feeding	Feeding	Post-feeding	Pre-feeding	Feeding	Post-feeding	
Inactive/resting	62.09	17.21	82.86	66.36	2.31	76.24	59.41
Pacing	17.64	1.11	1.61	17.01	6.92	5.85	17.08
Exploring	9.23	13.02	5.88	9.10	18.46	12.50	14.36
Drinking/bathing	0.36	1.34	0.30	0.20	-	0.38	0.74
Head low approach	0.32	0.23	0.34	0.22	-	0.46	0.34
Rolling	0.14	0.62	0.34	0.11	-	0.22	0.18
Greeting	1.62	1.31	0.61	1.35	-	0.40	0.92
Chin rubbing on head	0.00	0.00	0.00	-	-	0.00	0.01
Grooming/licking	0.14	0.30	0.50	0.24	-	0.22	0.48
Feeding frenzy	4.78	0.59	0.00	2.74	11.15	0.46	1.70
Begging	0.40	8.46	0.50	0.09	13.85	0.42	0.14
Regurgitate	0.00	0.00	0.03	-	-	0.04	0.07
Urinating	0.04	0.23	0.10	0.13	0.38	0.12	0.13
Defecating	0.07	0.10	0.27	0.07	-	0.04	0.18
Reprimand	0.04	0.20	0.10	-	0.38	0.06	0.03
Aggression	0.00	0.00	0.07	-	1.15	0.24	0.03
Feeding	0.18	41.38	3.06	0.17	36.92	0.12	0.21
Play fighting	2.08	2.36	1.31	1.54	5.38	1.94	3.28
Tugging at meat	0.00	0.20	0.00	-	3.08	0.00	0.00
Tugging at carcass	0.43	11.31	1.68	-	-	0.00	0.08
Playing with other objects	0.43	0.03	0.44	0.67	-	0.30	0.63
n	2783	3050	2975	4602	260	5008	7138

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Table 4. Percentages of total behaviours observed for all feeding regimes. \*Note: Feeding-related behaviour includes: feeding frenzy, feeding, tugging at meat and tugging at carcass.

Behaviour	Feeding Regime		
	Carcass	Pieced	Starve
Inactive	53.56%	69.69%	59.41%
Pacing	6.51%	11.08%	17.08%
Exploring	9.41%	11.07%	14.36%
Feeding related*	25.05%	3.62%	2.13%
Play fighting	1.92%	1.84%	3.28%
Other	3.55%	2.70%	3.74%

Table 5. Percentages of total behaviours observed prior to carcass and pieced meat feeds.

PRE-FEEDING		
Behaviour	Feeding Regime	
	Carcass	Pieced
Inactive	62.09%	66.36%
Pacing	17.64%	17.01%
Exploring	9.23%	9.10%
Greet & Feeding frenzy	6.40%	4.09%
Play fighting	2.08%	1.54%
Other	2.55%	1.89%

Figure 3 (Pre feeding data). Behaviours include; greeting and greeting frenzy, begging and tugging at food. Figure 4 clearly illustrates that observations during feeding hours were dominated by "feeding" behaviour.

Values for exploratory behaviour, begging and feeding frenzies depicted in Table 4 seem to be quite high in comparison to the figures given for carcass feeding. It should also be pointed out that inactivity during a carcass feed is clearly higher 17.21% compared to the lower 2.31% indicated during a pieced meat feed. Tugging at Food was more frequently observed in association with the carcass feed as depicted in Figure 3.

When referring to Figure 5 the data illustrates that post feeding behaviours are dominated by inactivity. Table 8 depicts that the values for exploratory behaviour of animals fed pieced meat is 6.62% higher than the listed 5.88% when fed carcasses. Pacing is still listed in Table 7 as being more frequently observed when the animals are fed pieced meat.

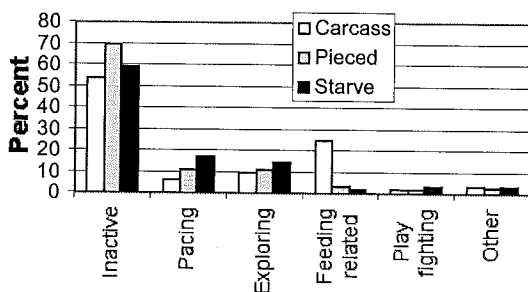


Figure 2. Total behaviours observed for all feeding regimes.

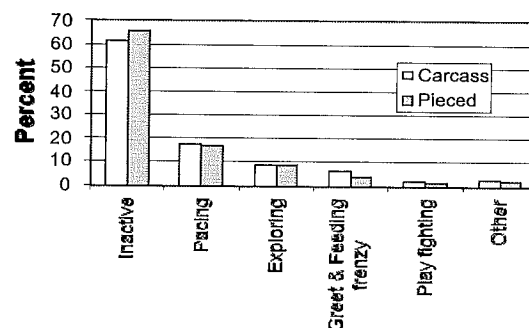


Figure 3. Total behaviours observed prior to carcass and pieced meat feeding.

The data listed in Table 5 is illustrated in Figure 3. The pre feeding data illustrated in Figure 3 depicts that similar behaviours were observed for either feeding regime. A slight difference can be noted in values for inactivity as depicted in Table 5; carcass feeding at 62.09% and 66.36%. Pacing is also quite high when compared to other behaviours, however it seems to be observed at an equal number of times regardless of the diet.

The percentages of total behaviours observed while feeding carcass and pieced meat listed in Table 6 are illustrated as a bar chart in Figure 4. Table 6 indicates a variety of different behaviours observed during feeding which were not individually addressed in Table 5 and



Table 6. Percentages of total behaviours observed during carcass and pieced meat feeding. \* Tugging at food contains the combined data for the behaviours tugging at carcass and tugging at meat.

FEEDING		
Behaviour	Feeding Regime	
	Carcass	Pieced
Inactive	17.21%	2.31%
Pacing	1.11%	6.92%
Exploring	13.02%	18.46%
Greet & Feeding frenzy	1.90%	11.15%
Begging	8.46%	13.85%
Feeding	41.38%	36.92%
Tugging at food*	11.51%	3.08%
Play fighting	2.36%	5.38%
Other	3.05%	1.92%

Table 7. Percentages of total behaviours observed post carcass and pieced meat feeds. \* Feeding-related behaviour includes: feeding frenzy, feeding, tugging at meat, tugging at carcass and begging.

POST-FEEDING		
Behaviour	Feeding Regime	
	Carcass	Pieced
Inactive	82.86%	76.24%
Pacing	1.61%	5.85%
Exploring	5.88%	12.50%
Feeding related*	5.24%	1.00%
Play fighting	1.31%	2.36%
Other	3.09%	2.05%

### Visitor Survey

A total of 44 visitors were picked at random and given a survey to fill out. The total results show that 65.9% approve of Western Plains Zoo feeding out whole carcasses. Out of the 44 visitors surveyed 95.4% were not offended by the practice of carcass feeding. Only 2.3% of the visitors believed there was no educational value to the feeding of carcasses to the African wild dogs and an equal percentage was listed for visitors who were unsure about the practice.

### Discussion

#### Time Taken to Feed for Carcass and Pieced Meat Regimes

Holst (1998) argues that the traditional "chunk of meat feeds," the pieced meat feeding regime, do not promote a challenge and is

devoured in a short period of time. The result listed in Table 2 and illustrated in Figure 1 supports this. Table 2 shows that the mean overall time taken to feed on carcasses was 58.74 minutes compared to the average feeding time of 3.19 minutes taken on pieced meat feeds. The longest time spent feeding on a carcass feeding regime was found in Trial 3, where an average of 63.60 minutes was taken to feed. The latter result shows a substantial difference when compared to the lowest average time spent feeding on pieced meat, 1.90 minutes

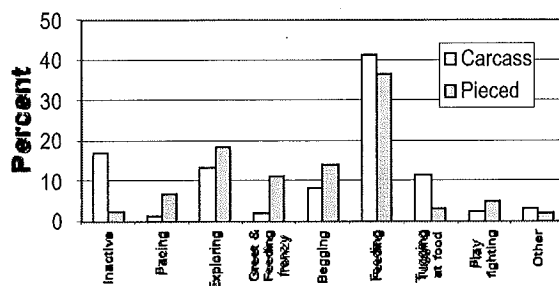


Figure 4. Total behaviours observed during carcass and pieced meat feeding.

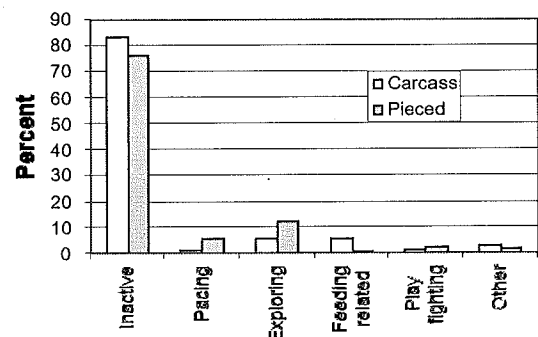


Figure 5. Total behaviours observed post carcass and pieced meat feeding.

## Carcass Feeding for African Wild Dogs

Table 8. Visitor opinion of whole carcass feeding.

Visitor Opinion	Visitor Gender		Total
	Male	Female	
Approve of Carcass feeding	43.2%	22.7%	65.9%
Think it's a Necessity	6.8%	25.0%	31.8%
Dislike	-	2.3%	2.3%
Offended	2.3%	2.3%	4.3%
Not Offended	47.7%	47.7%	95.4%
Believe it is of Educational Value	47.7%	47.7%	95.4%
Don't believe it is of educational value	-	2.3%	2.3%
Unsure	2.3%	-	2.3%

Results indicate that there is an obvious influence of feeding regime on the level of time actively spent feeding. These results were to be expected as more cooperation, skill and energy is required to tear apart a carcass (Winkler, 1998) then to consume pieced meat. The time taken actively feeding on pieced meat reduced from 5.03 min to 1.90 min over the course of the trials. This decrease in feeding time may have been instigated through the observer effect. After completing Trial 1 the dogs started associating my arrival at the site with feeding time. This caused the dogs to remain alert around the feeding platform waiting for food to arrive.

Conversely, the time taken to devour whole carcass slightly increased from 54.93 min to 63.60 min during the trials. A possible explanation for this could be that slightly larger carcasses were fed during the last trial. The dogs did not know which feed they were going to be receiving, therefore even though they may have been waiting for their food, a carcass still tested their skill and cooperation in order to be devoured.

### Total Behaviours Observed for All Feeding Regimes

A wide range of species-specific behaviours were observed throughout the study. However attention should be drawn to the high figures listed for the behaviour known as Inactive/resting. Although inactivity is greatly reduced during feeding it seems to be quite high in comparison to other behaviours observed, before and after feeding times. African wild dogs *insitu* are only active for approximately four to five hours per day, as the rest of the time is spent resting in the shade (Sheldon, 1992). These results therefore indicate that, as in the wild where activity levels bracket the daily hunts (Sheldon, 1992), the behavioural patterns of dogs in captivity are also based around feeding times.

Results indicate that pacing is high during the observations prior to a feed however this could have been instigated through an observer effect. The dogs were quick to realise that my presence would mean the arrival of food. This reasoning can then be applied to the high figure recorded for pacing on a starve day as seen in Table 4. On starve days the pack was often seen pacing as a result of the food trucks driving past the exhibit or past the back of the holding yards.

Exploratory behaviour was highest during the pieced meat feeds because as soon as the dogs had gorged down their food the search for left over morsels was initiated. It was during these periods of exploration that it became clear that the African wild dog as stated by Sheldon (1992), Estes (1992) and Scott (1991) rely heavily on vision for hunting and not smell as they often missed chunks of pieced meat hidden by long grass.

It must be noted that pacing and exploratory behaviour was lowest when fed carcass meat. This could be because social interactions like tugging at a carcass as well as other feeding related behaviours were higher. The animals were kept actively occupied with carcass remainders allowing them to practice means of obtaining bones from each stimulating behaviours used to establish pack orders.

### Behaviours Observed Prior to Carcass or Pieced Meat Feeding

The behaviours which characterise the hour of observations prior have been discussed under previous headings, however in this section the values recorded for greeting and feeding frenzies will be alluded to.

These behaviours are of great importance in establishing pack harmony and in the wild are performed prior to a hunt (Fox, 1983). Greeting behaviours were frequently observed during Trial 3 as the dogs awoke in the morning after a night's rest. These greeting ceremonies seemed to reunite the dominant animals that were found resting together separated from the subordinate pack members, in a similar fashion as observed in the field by van Lawick Goodall and van Lawick Goodall (1970).

Feeding frenzies as observed in the field by Scott (1991), Estes (1992) and van Lawick Goodall and van Lawick Goodall (1970) excite pack members to go on a hunt. In captivity a similar behaviour is instigated on arrival of the feeding truck at the sight of the feed buckets or carcass. Dogs were observed to jump over one another while frantically producing their high pitched twitter vocalisations. However once the food was thrown into the exhibit these ritualised frenzies stopped.

### ***Behaviours Observed During Carcass or Pieced Meat Feeding***

Table 6 shows that a great deal of time is spent inactive during the feeding of a carcass. These observations refer to the pack members that are taking a rest in between bouts of active feeding and therefore lying or standing. Pacing behaviour observed during pieced meat feeds seems to be mainly performed by pack members who have gorged their food and revert to pacing shortly after the act of feeding. It was suggested by Murray (pers. com) that the pacing observed in association with pieced meats was another means for the dogs to release energy which would otherwise be released in the act of tearing at a carcass.

Begging behaviour performed on pieced meat diets is considerably higher than when fed whole carcasses. The value listed in Table 6 mainly consists of begging behaviour performed by the alpha female during Trial 3. This behaviour was initially interpreted as aggression as the alpha female would run whining in a high pitch tone, corners of her lips pulled up and her tail high towards the alpha male who consequently regurgitated for her until he could produce no further food for her. This behaviour although very similar to the "infantile begging" (Fox, 1983 p 137) shown when performing a feeding frenzy however it was continuous and only observed on pieced meat diets. Craig Murray (pers.com.) defines this behaviour as passive dominance or controlling through submission. In this case the alpha female may have been trying to gain control over a particular individual or the whole pack, reinforcing her dominance. Behavioural observations of the African wild dog have shown that these animals rarely use aggression however they will emphasise pack structure through submissive behaviour (Estes, 1992).

Other behaviours related to the period during feeding have been discussed in previous sections.

### ***Behaviours Observed Post Carcass or Pieced Meat Feeding***

Post feeding observations are commenced as soon as all pack members turn their attention to other events once all major feeding activities have ceased. However some feeding behaviour is still illustrated in Figure 5 this is due to dogs returning to chew on left over bones found lying around the exhibit. Levels of inactivity rise as the dogs settle down for the nights rest some animals were frequently observed to play fight prior to joining the other dogs all huddled up together. The levels of pacing and exploratory behaviour post feeding have been discussed previously.

### ***Visitor Survey***

Holst (1998) states that zoo management is often of the opinion that feeding of whole carcasses during public visiting hour may be perceived as unethical and barbaric, creating a display to exploit the cruelty of nature. Gewalt (1992) on the other hand found that an increase in public interest was shown through the implementation of the "Run and Fun lift" stimulating African wild dogs at Duisburg Zoo to demonstrate natural feeding behaviours.

Results from a visitor survey distributed over the Easter holiday period (12/04/01 till 29/04/01) at Western Plains Zoo showed that the majority of the visitors approved of whole carcass feeding in order to demonstrate natural species specific behaviours. Contrary to popular belief most visitors stated they were not offended by the practice of whole carcass feeding, and some even encouraged the feeding of live prey.

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The visitor survey also indicates that people believe that there is an educational value or component attached to the feeding of whole carcass. This is significant as it indicates that through implementing appropriate interpretive programs the existing negative public opinion could be rectified. Therefore zoos should consider whether the benefits of carcass feeding outweigh the very small percentage of negative public perception.

## Conclusions and Recommendations

The most natural way to serve food for carnivores in captivity is to supply these animals with a whole carcass. While it may not be feasible to feed captive African wild dogs their natural diet of impala, kudu or wildebeest, the results of this study provide sufficient evidence to show that feeding of kangaroo carcasses to this species in captivity, can result in the performance of a wide range of species specific feeding related behaviours.

Carcasses are degutted and gorged down in a similar fashion as described in the numerous literary sources of animals observed in the field. Social interactions between pack members' rose when they were given the opportunity to practice these natural behaviours during carcass feeds. However when the traditional pieced meat feeds were supplied the dogs showed a greater tendency to pace, suggesting that they may have felt a form of frustration.

The results indicated that the feeding regime (carcass or pieced meat) influenced both the level of activity and the behavioural repertoire of the pack. In particular, carcass feeds were found to increase time spent feeding, agonistic interactions and play, all of which contributed to greater pack dynamics and cooperation. This suggests that feeding whole carcasses rather than pieced meat may be a practical way of providing African wild dogs with beneficial environmental and behavioural enrichment, which in turn may improve their captive husbandry and management. In addition, the short visitor survey reported here indicates that the zoo visitors may respond well to a carcass based feeding regime. It is also possible that such enrichment practices may have longer-term benefits for the captive breeding and conservation of this endangered. However such benefits will only be identified from a more detailed research program conducted over a longer time frame.

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