Maximum price paid in captive Bush dogs

(Speothos venaticus)

Taina Thernström

Supervisor: Mats Amundin, Linköping University
Examiner: Matthias Laska, Linköping University
Assessing the maximum price paid in captive Bush dogs (*Speothos venaticus*)

**Författare/Author:** Taina Thernström

**Sammanfattning/Abstract:**
One way to investigate what animals in captivity might need is to conduct preference and motivational tests. These types of tests can help facilitate the animals to express different priorities. The motivation can be assessed by having the animals “pay an entry cost” (e.g. push a weighted door) that increases with time to get access to a resource. The highest price that the animals are willing to pay for this resource is called “the maximum price paid”. This study intends to test the maximum price paid to access for food in a group of bush dogs kept at Kolmården Wildlife Park. A simple choice test consisting of four different food items (meat, fish, vegetables and fruit) was first conducted to establish which resource the bush dogs preferred. The results showed that meat and fish were the preferred food items. Secondly, a push-door test was conducted to measure the maximum price paid for the preferred food item. At the most, one individual was willing to lift 11 kg (twice its weight) to get access to meat.

**Nyckelord/Keyword:**
*Bush dog, environmental enrichment, food preference, maximum price paid, push door experiment, simple choice test, Speothos venaticus.*
Table of Content

1. Abstract ................................................................................................................. 2
2. Introduction ............................................................................................................. 2
3. Material and method ............................................................................................. 7
   3.1. Animals and housing ....................................................................................... 7
   3.2. Apparatus ......................................................................................................... 8
   3.3. Training of the animals .................................................................................... 9
   3.4. Experimental procedure .................................................................................. 9
      3.4.1. Food preference ...................................................................................... 9
      3.4.2. Maximum price paid ............................................................................... 11
   3.5. Data collection and analysis .......................................................................... 12
4. Results ................................................................................................................... 12
   4.1. Food preference ............................................................................................. 12
   4.2. Maximum price paid ..................................................................................... 14
5. Discussion .............................................................................................................. 18
   5.1. Food preference ............................................................................................. 18
   5.2. Maximum price paid ..................................................................................... 19
   5.3. Method evaluation ......................................................................................... 22
6. Conclusion ............................................................................................................. 23
7. Acknowledgments .................................................................................................. 24
8. References .............................................................................................................. 24
1. Abstract

One way to investigate what animals in captivity might need is to conduct preference and motivational tests. These types of tests can help facilitate the animals to express different priorities. The motivation can be assessed by having the animals “pay an entry cost” (e.g. push a weighted door) that increases with time to get access to a resource. The highest price that the animals are willing to pay for this resource is called “the maximum price paid”. This study intends to test the maximum price paid to access for food in a group of bush dogs kept at Kolmården Wildlife Park. A simple choice test consisting of four different food items (meat, fish, vegetables and fruit) was first conducted to establish which resource the bush dogs preferred. The results showed that meat and fish were the preferred food items. Secondly, a push-door test was conducted to measure the maximum price paid for the preferred food item. At the most, one individual was willing to lift 11 kg (twice its body weight) to get access to meat.

Keywords: Bush dog, environmental enrichment, food preference, maximum price paid, push door experiment, simple choice test, Speothos venaticus.

2. Introduction

The bush dog (Speothos venaticus) is a canid species originating from South America (DeMatteo and Loiselle, 2008). Fossils of bush dogs that date back to the late Pleistocene have been found in caves in Brazil which suggests that bush dogs have inhabited South America for several hundred thousand years (Zuercher et al., 2005). Derived from these findings, their scientific name Speothos means “cave wolf” and venaticus means “hunter” (de Mello Beisiegel and Zuercher, 2005) The bush dog is considered to be the only species within its family (Bardeleben et al., 2005). Bush dogs belong to the South American canid clade and even though they morphologically differ a lot from the maned wolf (Chrysocyon brachyurus) these two species are believed to have shared a common ancestor (Bardeleben et al., 2005; Ivanoff, 2006). The bush dog was historically found in the eastern parts of Panama, Brazil, Paraguay and Argentina but the actual distribution today is unclear (Oliveira, 2009). The species is found in habitats such as rain forests, savannah (i.e. cerrado) (Zuercher and Villalba, 2002; Michalski, 2010) and flood plains (Oliveira, 2009). Silveira et al. (1998) estimate that the average home range for bush dogs is approximately 4.5 km² but in areas with little forest cover the home range might be even larger.
Bush dogs differ morphologically from other types of canids (DeMatteo et al., 2006) by having a compact body, short legs and a broad but short muzzle (Zuercher and Villalba, 2002). Adult bush dogs weigh between five and eight kg (Zuercher et al., 2005), they have a brown fur with no visual markings and they also have webbed feet (Oliveira, 2009).

Regarding communication, Porton (1983) suggests that bush dogs are more reliant on olfactory communication than visual communication due to their morphology and the habitat they live in. According to de Mello Beisiegel and Zuercher (2005) bush dogs have ten distinct vocalizations and these vocalizations facilitate the communication between the bush dogs in e.g. dense vegetation.

Bush dogs are highly social dogs and live in extended families or packs including a parent pair (Biben, 1983) with group sizes varying from two to ten individuals (DeMatteo and Loiselle, 2008). Bush dogs are considered carnivorous with a diet consisting mainly of small mammals but they have been seen to predate on bigger mammals as well such as nine-banded armadillos (*Dasypus novemcinctus*) (de Souza Lima et al., 2009), capybaras (*Hydrochoerus hydrochaeris*), agoutis (*Agouti*) (Oliveira, 2009) and tapirs (*Tapirus terrestris*) (Wallace et al., 2002). Birds, reptiles, terrestrial invertebrates and *Cecropia* fruit are also known to be a part of their diet (Zuercher et al., 2005). Bush dogs hunt in packs (Zuercher and Villalba, 2002) and their hunting technique is similar to that of other social carnivores as for example the hyena (*Crocuta crocuta*) (Wallace et al., 2002). Bush dogs have been observed hunting prey down into water and they have also been observed diving into and swimming in water (Oliveira, 2009). Having webbed feet facilitates both when bush dogs hunt in water and when they are crossing over watercourses (Oliveira, 2009).

Due to the bush dogs living in dense vegetation and rugged terrain, they are hard to observe in the wild (DeMatteo and Loiselle, 2008) and this could be a reason for why not much research has been conducted. According to Ings et al. (1997) little is known about the time budget of wild bush dogs. Besides from being hard to find, bush dogs seem to avoid live-box traps which have been used in studies of them and this has led to insufficient data and the lack of radio collars on them (de Souza Lima et al., 2009) Since 1982, the species has been considered Vulnerable on the IUCN red list and is included in CITES appendix 1 (IUCN, 2012). Habitat destruction and fragmentation seems to be the major threats for the bush dogs’ survival in the wild (Zuercher and Villalba, 2002). About 30 zoos around the world are currently keeping approximately 140 bush
dogs (ISIS, 2012). It has been shown that captivity can have negative effects on the welfare of carnivores (Gilbert-Norton et al., 2009). Some carnivores seem to cope fine in captivity whereas others develop abnormal behaviour such as stereotypies (Clubb and Mason, 2007). Zoo housed animals that are unable to cope with their environment can suffer from severe or chronic stress which, in turn, may lead to reduced individual fitness- or reproductive success and the development of stereotypies (Vasconsellos et al., 2009). Adding structural and environmental enrichments in the enclosures of zoo housed animals have been shown to reduce abnormal behaviours (Kistler et al., 2010).

Unfortunately, the research about environmental enrichment in wild canids kept in zoos is scarce (Vasconsellos et al., 2009). A study by Carlstead and Seidensticker (1991) found that enriching the environment by hiding food promoted positive behaviours such as exploration and it also decreased the inactivity levels of carnivores in captivity. A study by Ings et al. (1997) showed that there were significant increases in bush dogs’ searching behaviour when food was hidden in the enclosure inside wood piles compared to basal conditions.

Since both the knowledge about wild bush dogs (Ings et al., 1997) and environmental enrichment for zoo housed canids (Vasconsellos et al., 2009) is scarce it is important to conduct scientific research on captive bush dogs and their behaviour to be able to improve their welfare in zoos. Animals’ emotions are considered to be an essential part of their welfare but an animal’s subjective experience and feelings are impossible to observe directly and has to be measured indirectly instead (Kirkden and Pajor, 2006). One way to assess an animal’s subjective experience and feelings is to measure their preferences and motivations by conducting preference (Kirkden and Pajor, 2006) and motivation tests (Galhardo et al. 2011; Rozek and Millam, 2011). However, assessing animals’ emotions is a process with two parts: first the behavioural response has to be measured and then it has to be interpreted (Kirkden and Pajor, 2006).

Preference can be defined as “the difference between motivations for alternatives” and motivation can be defined as “the process within the brain controlling which behaviours and physiological changes occur and when” (Kirkden and Pajor, 2006). Preference and motivation tests are powerful techniques when it comes to assessing welfare (Kirkden and Pajor, 2006). A preference test can address the question whether an animal has a preference regarding alternative resources and a motivation test can address how strong the animals’ motivation is to obtain this resource (Kirkden and Pajor, 2006). Preference and motivation tests can
allow animals to express different priorities (Rozek and Millam, 2011) and provide measurements of how valuable different resources are to the animals (Galhardo et al., 2011).

Preference tests can measure the animals’ preference between similar resources such as different types of substrates (deJong et al., 2007). deJong et al (2007) found that laying hens showed a stronger preference for dust bathing in peat moss compared to dust bathing on a wired floor, in sand or in wood shavings. The authors also found that the laying hens had no preference for either of the above mentioned substrates with respect to foraging behaviour (deJong et al., 2007). Scientific research like this provides valuable information about the animals’ preferences and the results may serve as foundations when it comes to establishing animal welfare regulations.

Within the field of economics, a model called the consumer demand theory that measures motivation has been developed. This model measures how much people are willing to pay for certain consumption goods. This type of test has proven to function well when measuring animal behaviour as well (Houston, 1997). Instead of paying with money as in economics, in behavioural economics the animals pay with energy or time invested in obtaining the resource (Houston, 1997). Consumer demand curves show the relationship between the quantities consumed and the price paid (Houston, 1997). The slope of the demand curve is often negative which means that as the price increases, the demand decreases (Houston, 1997). Demand curves can be obtained when animals perform operant tasks (Houston, 1997). An example of an operant task is when animals have learned to perform a task to obtain a reward (Seaman et al., 2008). To implement this in a motivation test, animals have to e.g. push a weighted door where the weights increase with time to get access to a resource (Seaman et al., 2008). The highest price that the animals are willing to pay for this resource is called “the maximum price paid” (Harlander-Matauschek et al., 2006). According to Jensen and Pedersen (2008) the higher the maximum price paid is, the higher the motivation is.

When conducting motivation tests, food is considered as a high-value resource (Hovland et al., 2007). Several tests have measured how much animals are willing to work for food under food restrictions (Bokkers et al., 2004; Verbeek et al., 2011; Hovland et al., 2006). The results showed that animals with long food restrictions were often more motivated to get access to food compared to animals with shorter food restrictions.
(Bokkers et al., 2004; Verbeek et al., 2011; Hovland et al., 2006). This is an example of a closed economy which means that the animal only can access the resource, or in this case food, during the test situation (Ladewig et al., 2002). The opposite is termed an open economy where the animals also can access the resource outside the test situation (Ladewig et al., 2002). Food can also be used as a measure for comparing how animals value different resources (Hovland et al., 2007). For example, the motivation to get access to different resources such as food, social contact or to go to a platform has been tested in laboratory rabbits (Seaman et al., 2008). The results from that study showed that the motivation was highest for food whereas social contact and to reach a platform came on second and third place respectively (Seaman et al., 2008). Similar tests have been conducted with minks in which food also was considered as the significantly preferred resource (Warburton and Mason, 2003).

Most scientific research about animal welfare has been conducted on laboratory and farm animals (Mason and Veasey, 2010). To my knowledge, not much research about motivation in zoo animals has been carried out. In a review by Mason and Veasey (2010), the authors discuss that the well-being of zoo housed elephants could be enhanced by investigating the motivations of elephants. A few studies on motivation in wild canids (foxes) kept in captivity have been conducted and they showed that the foxes paid a high maximum price for social contact but they paid an even higher maximum price for food (Hovland et al., 2011). Like preferences tests, scientific research about motivation provides valuable insights into the animals’ subjective states and the results can be used to improve their welfare.

The aim of this project was to assess the maximum price paid for a preferred food type in a group of bush dogs kept at Kolmården Wildlife Park. To implement this, a food preference test was conducted at first which measured which out of four different food items the bush dogs prefer (meat, fish, vegetables and fruit). Secondly, the preferred food item was offered as the resource in a push-door test which measured the maximum price that the bush dogs were willing to pay to gain access to the resource. This study intended to contribute to our knowledge about and understanding of bush dogs and hopefully improved their welfare in captivity.
3. Material and method

3.1. Animals and housing

The study was carried out on a group of bush dogs (*Speothos venaticus*) that had been kept in Kolmården Wildlife Park, Sweden since 2008. The group consisted of 15 individuals; the parent pair (Antonio and Salma) and their 13 offspring. Three of the youngest dogs (Inka, Ecuador and Chile) were taken out of the group in November and December respectively. Since it was done late in the process of data collection i.e. when the door weights were too heavy for them, it did not affect the results. Two of the males, Tabasco and Xavier were taken out of the group in January after the data collection had ended. Information about the 15 individuals is listed in Table 1. Figure 1. shows the group of bush dogs at Kolmården Wildlife Park. The bush dogs had access to both indoor quarters and an outdoor enclosure which measured 35-40 and 800 m², respectively. They were kept in indoor during the night and also during the coldest days in the winter. The bush dogs were fed meat in the afternoon on Mondays, Wednesdays and Fridays, they were fed dog pellets and fruit a few times a week and they had ad libitum access to water.

Figure 1. The 15 bush dogs at Kolmården in their outside enclosure.
Table 1. Information about the bush dogs’ gender and age

<table>
<thead>
<tr>
<th>Bush dog</th>
<th>Sex</th>
<th>Born</th>
<th>Weight (kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Antonio</td>
<td>Male</td>
<td>20060813</td>
<td>6.2</td>
</tr>
<tr>
<td>Salma</td>
<td>Female</td>
<td>20070730</td>
<td>5.8</td>
</tr>
<tr>
<td>Xavier</td>
<td>Male</td>
<td>20090704</td>
<td>6.0</td>
</tr>
<tr>
<td>José</td>
<td>Male</td>
<td>20090704</td>
<td>6.0</td>
</tr>
<tr>
<td>Tabasco</td>
<td>Male</td>
<td>20090704</td>
<td>5.5</td>
</tr>
<tr>
<td>Jalapeño</td>
<td>Male</td>
<td>20090704</td>
<td>6.2</td>
</tr>
<tr>
<td>Havanna</td>
<td>Female</td>
<td>20090704</td>
<td>5.4</td>
</tr>
<tr>
<td>Cuzco</td>
<td>Male</td>
<td>20100825</td>
<td>5.2</td>
</tr>
<tr>
<td>Kronk</td>
<td>Male</td>
<td>20100825</td>
<td>5.1</td>
</tr>
<tr>
<td>Ysma</td>
<td>Female</td>
<td>20100825</td>
<td>5.2</td>
</tr>
<tr>
<td>Peru</td>
<td>Male</td>
<td>20110608</td>
<td>3.3</td>
</tr>
<tr>
<td>Chile</td>
<td>Male</td>
<td>20110608</td>
<td>3.3</td>
</tr>
<tr>
<td>Ecuador</td>
<td>Male</td>
<td>20110608</td>
<td>2.5</td>
</tr>
<tr>
<td>Inka</td>
<td>Female</td>
<td>20110608</td>
<td>~1</td>
</tr>
<tr>
<td>Lima</td>
<td>Female</td>
<td>20110608</td>
<td>3.2</td>
</tr>
</tbody>
</table>

3.2. Apparatus

Three boxes which measured 80x80x40 cm were used in the experiments (figure 2 shows the design of the boxes). The boxes were made out of 13 mm plywood and had a solid floor, a hinged ceiling and four walls. The smaller box in the upper right corner shown in figure 2 is the entrance tunnel, with a hinged diagonal gate, which could be loaded with weights. In the lower left corner is the one-way exit door. A frame around the outside of the exit door prevented the bush dogs from opening it from the outside.

Figure 2. Display of the inside of the box with the lid open. Two stainless bowls (12cm in diameter) are attached to the floor. The diagonal hinged entry
3.3. Training of the animals

The adult bush dogs had participated in a previous experiment conducted by a former master student. They were thus accustomed to the boxes in their enclosure and to enter them. In addition, the bush dogs had an indoor den that was similar to the boxes used in this study. This den had the approximately same height as the other boxes, but it was bigger and had holes instead of doors for entries and exists.

3.4. Experimental procedure

3.4.1. Food preference

The first test was a simple choice test with two alternatives. Four different food items (meat, fish, vegetables and fruit) were presented to test which food item the bush dogs preferred i.e. consumed first. The experiment was conducted in the outdoor enclosure and the bush dogs were observed from 09:00-12:00 on Monday-Friday during two weeks in August.

Four food items in pair-wise presentations allowed for a total of six combinations: meat-fish, meat-vegetables, meat-fruit, fish-vegetables, fish-fruit and vegetables-fruit. The four food items were beef (*Bos taurus*), herring (*Clupea harengus*), potatoes (*Solanum tuberosum*) and grapes (*Vitis vinifera*) (see figure 3a). Hereafter I will mostly refer to the beef, herring, potatoes and grapes as the meat, fish, vegetables and fruit respectively. One session consisted of the six food combinations presented in each of the three boxes and the combinations were randomly alternated at every trial. Each combination was presented 30 times and thus every food item was presented in a total of 90 times. All food items were given raw and the potatoes and the grapes had been washed before they were presented. The food items were also cut into similar sizes to eliminate the bush dogs selecting the biggest piece of food (see figure 3b). Three boxes were lined up next to each other below a concrete barrier (see figure 3c).
The picture to the left (figure 3a) shows the four food items before they are being cut into proper sizes. The picture in the middle (figure 3b) shows the four food items in similar sizes. The picture to the right (figure 3c) shows an overview of the three boxes with holes in the roof and the wood border connecting the three lids to each other.

The food items were delivered into the boxes from outside of the enclosure due to safety issues. The food was placed in the stainless bowls through two holes in the ceiling via a plastic pipe (see figure a). The plastic pipe measured six cm in diameter and was three meter long. Mineral powder was sprinkled over the meat and fish to facilitate the passage through the pipe. The entry doors were closed and locked so the only way in for the bush dogs was to jump over the walls into the boxes when the lids were open. The lids were connected to each other with a wood batten and a metal loop was attached to the lid in the middle to enable the opening of all of the lids (see figure 4a). After the food items were placed in the bowls, the lids were opened with the help of a 3 m long hook, so the bush dogs could get access to the food (see figure 4b and c).

The picture to the left (figure 4a) shows how the food was placed in the boxes through a pipe. The picture in the middle (figure 4b) shows how the lids were opened with the help of an elongated hook. The picture to the right (figure 4c) shows the sire Antonio investigating the bowls with food in them.
3.4.2. Maximum price paid

The second test was a lift-door experiment which measured how much the bush dogs were willing to pay (the maximum price paid) to get access to a desired resource (meat). The experiment took place in the bush dogs’ indoor quarter and was carried out during September to December to enable the observations to take place even during bad weather. The observations took place just prior to the dogs’ usual feeding time to make sure that they were as hungry as possible. The dogs were observed for one hour between 09:00-12:00 on Mondays, Wednesdays and Fridays and between 13:00-15:00 during some Tuesdays and Thursdays.

One of the boxes used in the food preference test was also used in this experiment (see figure 5a). The box was placed and fixed parallel to the metal bar fence which prevented the bush dogs from moving it (also see figure a). In front of the entry door, a chip reader (Destron Fearing, FS2001) was installed during the first two months to identify which individual were entering (see figure 5b for a picture of the chip reader). The entry door was designed to be loaded with weights and the weights were increased until the maximum price paid was reached i.e. the heaviest weights the bush dogs could or chose to lift. After 1 kg, the interval of the weight increase by two kg every third observation day (i.e. 0, 1, 3, 5, 7). After 7 kg, the interval of the weight increase was only one kg every third observation day (i.e. 7, 8, 9, 10 etc). Each weight was tested for three consecutive days to get sufficient data. The preferred food item from the preference test (the meat) was used as the resource in this experiment (see figure 5c). In order to push the meat through the metal pipe- it was cut into smaller pieces and then three of those pieces were lined up next to each other inside the metal pipe and pushed into the box. In this way, the bush dogs were reinforced with the same amount of meat every time.

The picture to the left (figure 5a) shows the entry side of the box. The box was fixed to the metal bars to prevent the bush dogs from moving it. The picture in
The middle (figure 5b) shows the antenna (to the left) and the chip reader (to the right). The antenna was placed in a frame in front of the entry door during data collection. The picture to the right (figure 5c) shows the meat with the smaller pieces lumped together in larger piles.

The meat was delivered into the box via a pipe through a hole in the wall between the bars as soon as the box was empty (see figure 6a). During the time the box was recharged with meat the bush dogs showed a lot of interest in it (see figure 6b). After the box had been recharged with meat, the bush dogs entered it (see figure 6c).

3.5. Data collection and analysis

The data was obtained using focal sampling and continuous recording in both experiments. In the food preference test, the analysis of the data was done with a chi-square test. In the maximum price paid test, a chip reader, Destron Fearing, FS2001, was used to initially distinguish between the individuals. The analysis of the data was done with a chi-square test.

4. Results

4.1. Food preference

The result from the choice behaviour of the bush dogs in the food preference test is shown in figure 7. When the bush dogs could choose freely out of the four different food items, the meat and the fish were clearly the preferred food items. The meat was chosen as the first
alternative in all the combinations including the meat-fish combination. The vegetables and the fruit were the least preferred food items, in fact they were never chosen at all in any of the combinations.

![Choice of food item in preference test](chart.png)

**Figure 7.** shows an overview of the results from the food preference test. The results showed that meat and fish were the preferred food items. The vegetables and fruit were the least preferred food items and were never eaten at all.

The results from the chi-square tests are summarized in table 2. The analysis showed that meat and fish were the significantly preferred food items. Meat was preferred over both the vegetables and the fruit (p= 0.0001) and the fish was also preferred over vegetables (p= 0.0015) and fruit (p= 0.0005). The analysis also showed that there was no significant difference between the meat and the fish (p <0.07). The vegetables and the fruit were the least preferred food items.
Table 2. Food preference of bush dogs. The table presents the different food combinations, the results (number of choices for the two alternatives, the chi-square values, the p-values and whether the p-values are significant or not at 95 % (df1).

<table>
<thead>
<tr>
<th>Food combinations</th>
<th>Results</th>
<th>$X^2$</th>
<th>$P$-value</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Meat-Fish</td>
<td>30:17</td>
<td>1.31</td>
<td>0.252</td>
<td>Not sign.</td>
</tr>
<tr>
<td>Meat-Veg.</td>
<td>30:00</td>
<td>17.42</td>
<td>0.0001</td>
<td>Significant</td>
</tr>
<tr>
<td>Meat-Fruit</td>
<td>30:00</td>
<td>17.42</td>
<td>0.0001</td>
<td>Significant</td>
</tr>
<tr>
<td>Fish-Veg.</td>
<td>19:00</td>
<td>10.14</td>
<td>0.0015</td>
<td>Significant</td>
</tr>
<tr>
<td>Fish-Fruit</td>
<td>22:00</td>
<td>12.12</td>
<td>0.0005</td>
<td>Significant</td>
</tr>
<tr>
<td>Veg.-Fruit</td>
<td>00:00</td>
<td>0</td>
<td>1</td>
<td>Not sign.</td>
</tr>
</tbody>
</table>

| Total             | Meat-Fish | 90:58 | 3.46 | <0.07 | Not sign. |

In total, meat was chosen ninety out of ninety times and the fish was chosen fifty-eight out of ninety times. Even though there was no significant difference between meat versus fish in total ($p <0.07$) the meat was, however, the first food item of choice every time it was presented and it was chosen, in total, more times than the fish. Thus, meat was chosen to be used as the desired resource in the maximum price paid test.

4.2. Maximum price paid

The result from the maximum price paid test is illustrated in figure 8. Six individuals chose not to participate in the experiment and thus they are not included in the graph. The results showed that four of the nine participating individuals (Jalapeño, Kronk, Cuzco and Inka) reached their maximum price paid at 0 kg i.e. they only opened the door when it was free of weights. Two of the five remaining individuals (Ecuador and Lima) reached their maximum price paid at 1 kg and Peru reached it at 3 kg. The two individuals that had the highest maximum price paid were José and Tabasco at 5 and 11 kg, respectively.
Figure 8. The results from the maximum price paid test for the nine individuals that chose to participate in the experiment. The number of observations are presented on the y-axis. The different weights are presented on the x-axis.

The results are also described as demand curves in figure 9. Almost all the curves have a negative slope for all the individuals i.e. as the cost increases the response decreases. Tabasco’s curve is different compared to the others; like the others, his response decreases as the cost increases except between three levels; from 0-1 kg, from 3-5 kg and from 7-8 kg his response increases as the cost increases.
Figure 9. The results from the maximum price paid test for the five individuals that were willing to pay a price in the experiment. The number of observations are presented on the y-axis and the different weights are presented on the x-axis.

The five individuals that opened the door when it was weighted were Ecuador, Lima, Peru, José and Tabasco. The results from the chi-square tests are summarized in table 3. The success rates at given weights are either considered significant or not significant which means that either the participants had a success rate that was significant or they managed to open the door by chance. The chi square analysis showed that Ecuador and Lima’s success rates at 1 kg were not significant (p < 0.4). Peru’s result at 1 kg (p <0.05) was significant but his success rate at 3 kg was not significant (p < 0.5). José’s success rates were all significant at 0, 1 (p <0.001), 3 and 5 kg (p <0.005). Tabasco’s success rates were significant up to 8 kg (p <0.001) but between 9-12 kg the success rates were not significant (p <1). Tabasco was the one individual that had the highest maximum price paid, 11 kg, even though his success rate at 11 kg was not significant.
Table 3. Maximum price paid for Ecuador, Lima, Peru, José and Tabasco. The table presents the different weights, the individuals’ results of successful and failed attempts to open the door, the chi-square values, the p-values and whether the p-values are significant or not at 95% (df1).

<table>
<thead>
<tr>
<th>Individual</th>
<th>Kg</th>
<th>Results*S:F</th>
<th>X²</th>
<th>P-value</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ecuador</td>
<td>0 kg</td>
<td>16:0</td>
<td>8</td>
<td>&lt;0.01</td>
<td>Significant</td>
</tr>
<tr>
<td></td>
<td>1 kg</td>
<td>2:0</td>
<td>1</td>
<td>&lt;0.4</td>
<td>Not sign.</td>
</tr>
<tr>
<td>Lima</td>
<td>0 kg</td>
<td>19:0</td>
<td>9.5</td>
<td>&lt;0.01</td>
<td>Significant</td>
</tr>
<tr>
<td></td>
<td>1 kg</td>
<td>2:0</td>
<td>1</td>
<td>&lt;0.4</td>
<td>Not sign.</td>
</tr>
<tr>
<td>Peru</td>
<td>0 kg</td>
<td>13:0</td>
<td>7.5</td>
<td>&lt;0.01</td>
<td>Significant</td>
</tr>
<tr>
<td></td>
<td>1 kg</td>
<td>8:0</td>
<td>4</td>
<td>&lt;0.05</td>
<td>Significant</td>
</tr>
<tr>
<td></td>
<td>3 kg</td>
<td>1:0</td>
<td>0.5</td>
<td>&lt;0.5</td>
<td>Not sign.</td>
</tr>
<tr>
<td>José</td>
<td>0 kg</td>
<td>75:0</td>
<td>37.5</td>
<td>&lt;0.001</td>
<td>Significant</td>
</tr>
<tr>
<td></td>
<td>1 kg</td>
<td>26:0</td>
<td>13</td>
<td>&lt;0.001</td>
<td>Significant</td>
</tr>
<tr>
<td></td>
<td>3 kg</td>
<td>18:0</td>
<td>9</td>
<td>&lt;0.005</td>
<td>Significant</td>
</tr>
<tr>
<td></td>
<td>5 kg</td>
<td>17:0</td>
<td>8.5</td>
<td>&lt;0.005</td>
<td>Significant</td>
</tr>
<tr>
<td>Tabasco</td>
<td>0 kg</td>
<td>34:0</td>
<td>17</td>
<td>&lt;0.001</td>
<td>Significant</td>
</tr>
<tr>
<td></td>
<td>1 kg</td>
<td>36:0</td>
<td>18</td>
<td>&lt;0.001</td>
<td>Significant</td>
</tr>
<tr>
<td></td>
<td>3 kg</td>
<td>24:0</td>
<td>12</td>
<td>&lt;0.001</td>
<td>Significant</td>
</tr>
<tr>
<td></td>
<td>5 kg</td>
<td>32:0</td>
<td>16</td>
<td>&lt;0.001</td>
<td>Significant</td>
</tr>
<tr>
<td></td>
<td>7 kg</td>
<td>14:0</td>
<td>7</td>
<td>&lt;0.01</td>
<td>Significant</td>
</tr>
<tr>
<td></td>
<td>8 kg</td>
<td>18:0</td>
<td>9</td>
<td>&lt;0.005</td>
<td>Significant</td>
</tr>
<tr>
<td></td>
<td>9 kg</td>
<td>4:5</td>
<td>0.05</td>
<td>&lt;0.9</td>
<td>Not sign.</td>
</tr>
<tr>
<td></td>
<td>10 kg</td>
<td>3:3</td>
<td>0</td>
<td>1</td>
<td>Not sign.</td>
</tr>
<tr>
<td></td>
<td>11 kg</td>
<td>3:1</td>
<td>0.5</td>
<td>&lt;0.5</td>
<td>Not sign.</td>
</tr>
<tr>
<td></td>
<td>12 kg</td>
<td>0:5</td>
<td>2.5</td>
<td>&lt;0.15</td>
<td>Not sign.</td>
</tr>
</tbody>
</table>

*S and F are abbreviations for successful and failed attempts.
5. Discussion

The aim of this project was to test the maximum price paid in a group of bush dogs. To implement this, a food preference test was conducted at first to establish which reinforcer would be most suitable in the maximum price paid test. The results clearly showed that the meat and the fish were the preferred food items. The meat was the bush dogs’ first choice and in total was chosen more times than the fish and was thus chosen to be the reinforcer in the maximum price paid test. Secondly, the maximum price paid concept was used to assess how much the bush dogs were willing to pay to get access to the reinforcer. The results showed that one of the bush dogs was willing to push 11 kg (twice his body weight) to get access to the meat. This study intends to contribute to our knowledge about and understanding of bush dogs in captivity and to provide a method for evaluation of different environmental enrichments.

5.1. Food preference

Even though there was no significant difference in the choices between the meat and the fish (p<0.07), the meat was chosen as the first alternative and it was also chosen more times in total than the fish. This result is congruent with bush dogs being considered a purely carnivorous species (Oliveira, 2009). de Souza Lima et al. (2009) found that bush dogs, in the Northern Pantanal in Brazil, fed almost exclusively (94.1%) on nine-banded armadillos. Similar results were shown by Zuercher et al. (2005) who found that bush dogs, in the eastern parts of Paraguay, had a diet that consisted of agoutis and pacas to 91%. de Souza Lima et al. (2009) suggest that bush dogs are exclusively carnivorous or hypercarnivorous since their diet consists of over 70% meat. Bush dogs have a modified set of carnassial teeth (reduced quantity of molars) which is congruent with them having a carnivorous diet (Zuercher et al., 2005).

The results from the food preference test showed that the fish was preferred over vegetables (p= 0.0015) and fruit (p= 0.0005). That bush dogs include fish as a part of their diet is contrary to the findings of Zuercher et al. (2005) and de Souza Lima et al. (2009) who neither report of remains of fish found in wild bush dogs’ faeces. Wild bush dogs often inhabit areas near flood plains (Oliveira, 2009) and the possibility that they should have encountered fish is quite high. The fact that they have webbed feet and are known to hunt their prey into water (Oliveira, 2009) may suggest that, if available, bush dogs could take advantage of fish as a food source.
The vegetables were one of the least preferred food items. In fact, the vegetables were never chosen or eaten at all in the food preference test. This is congruent with the results of the studies of wild bush dogs’ diets by both Zuercher et al. (2005) and Lima et al. (2009) who neither reports of vegetables being part of bush dogs’ diets. However, several other canids e.g. zoo housed maned wolves (Crissey et al., 2000) and domesticated dogs (Canis lupus familiaris) (Sallander et al., 2010) are known to eat vegetables including potatoes.

As for the vegetables, the fruit was the other least preferred food item. It was also never chosen or eaten at all in the food preference test. According to the study of bush dogs’ diet by de Souza Lima et al. (2009), bush dogs are considered exclusively carnivorous and no fruit was found in the bush dogs’ diet which supports the result in this study. However, a study by Zuercher et al. (2005) found that wild bush dogs had parts of Cecropia fruit in their feces. Cecropia is a common species of tree found in the Neotropics which produces fruit every year and a lot of frugivorous species e.g. bats rely on this fruit as a common food source (Lobova et al., 2003). The study by Zuercher et al. (2005) found the same percentage of invertebrates, reptiles and Cecropia fruit in the faeces from a population of bush dogs. The results from that study suggest that, if available, bush dogs may include fruit as a part of their diet (Zuercher et al., 2005). On the other hand, how the Cecropia fruit ended up in the bush dogs’ feces, whether the bush dogs intentionally ate the fruit or whether they ate a prey that in turn had eaten the fruit, remains unclear. The carnivore keepers at Kolmården Wildlife Park have observed the bush dogs eating grapes prior to this study being conducted (Olander, 2012). Grapes have been thrown into the little pool in the bush dogs’ outside enclosure and the bush dogs have been seen diving after and eating the grapes (Olander, 2012). Banana (Musa) (commonly considered as a fruit but is in fact a berry) is a frequently used food item in the daily diet of the bush dogs at Kolmården. It is even used as way to entice the bush dogs to enter the inside enclosure (Olander, 2012).

The food preference test provided an insight into what bush dogs preferred to eat when they could choose freely out of four different types of food without having to “pay” for the food.

5.2. Maximum price paid

Food is considered as a high-value resource in motivation tests (Hovland et al., 2007) and the results from the maximum price paid test showed that nine out of fifteen individuals chose to participate in this maximum
price paid test for food. Five out of those nine individuals were willing to pay a cost (> 0kg) to get access to the meat. The results varied between the five participating individuals; Ecuador and Lima had significant success rates at 0 kg but not on 1 kg; Peru had significant success rates at 0 kg (p <0.01) and 1 kg (p < 0.05) but not at 3 kg (p <0.5). Ecuador, Lima and Peru were only 3 months old during the time of the experiment which could explain why they had relatively low maximum price paid results compared to their older siblings. José had significant success rates up to 5 kg (p< 0.005) and he was the most active participant up to the 5 kg level. Hence it was surprising that he suddenly stopped trying to enter the box or even go near it after the 5 kg level. One plausible explanation is that something scared him even though nothing unusual was observed. A study by de Souza Lima et al. (2009) suggests that bush dogs are generally skittish which could explain the sudden halt of José’s participation. Tabasco had significant success rates up to 8 kg (p < 0.01) but between 9-11 kg the success rates were not significant. Nevertheless, Tabasco managed to open the door three times at 11 kg and with a body weight of 5.5 kg at the time, he lifted twice his own weight. Ecuador, Lima, Peru, José and Tabasco’s demand curves had a negative slope i.e. their responses decreased as the cost increased, which is considered common according to Houston (1997).

The fact that Tabasco managed to push a door open that weighed twice his own weight seems to be congruent with studies performed on their wild conspecifics. Wild bush dogs are known to hunt and kill preys that are quite large compared to their body size. A group of six wild bush dogs were observed to hunt and kill an adult tapir (Tapirus terrestris) (Wallace et al., 2002). Adult tapirs may weigh between 200-250 kg (Clauss et al., 2009) which divided by the average bush dogs’ weight is equal to 30-40 kg/bush dog. A study by Zuercher et al. (2005) found that a wild population of bush dogs in Paraguay had ingested prey with a body weight of as much as 39% of the mean body mass of bush dogs. That percentage is more similar to large felids such as the jaguar compared to other South American carnivores (Zuercher et al., 2005). Adult bush dogs seem to be able to push a lot more weight compared to other species. The results from studies on motivation in rabbits showed that female rabbits that weighed about 2 kg were able to push a 1.1 kg heavy door to get access to food (Seaman et al., 2008). That result is more similar to the results performed by the puppies in this study.

The results also showed that Tabasco tried but failed to open the door at 12 kg several times. This indicates that he was still very much motivated
to get access to the meat but was limited by his own physical capacities. After Tabasco had failed to open the door at 12 kilos, he showed signs of frustration which he had never been observed showing before. He started to bite the box and he tried to tear it apart, presumably in an attempt to get access to the food in another way. According to Jensen and Pedersen (2008) animals may perceive costs so high that working for the reinforcer is not considered worthwhile. The animals may instead avoid the increasing costs by changing and rescheduling their behaviour instead (Jensen and Pedersen, 2008). Frustration was shown by several other individuals especially by the alpha male, Antonio. Antonio approached the entrance door several times but never tried to push it open, instead he went around to the back door and started biting and pulling it and eventually he managed to pull off one of the walls of the box.

Six of the bush dogs chose not to participate in the maximum price paid test. Three of these individuals were the adult females and the fact that none of them entered the box is surprising. A study by Ings et al. (1997) investigated if there were any differences in searching behaviour between siblings in a group of captive bush dogs. The results showed that all bush dogs participated in the experiment and there were no differences in searching behaviour between the sexes (Ings et al. 1997). The two female puppies, Lima and Inka, showed interest in the box which is more congruent with the study by Ings et al. (1997). Lima managed to open the door nineteen times at 0 kg which was more times than any of the males managed or to chose to do. Inka was born as a runt and had thus disadvantages compared to her bigger litter mates. Overall, she had to work harder to get access to food and compete with the rest of the group.

The design of the maximum price paid test was an ‘open economy’-situation in which the meat also was provided outside of the test situation. An open economy situation was used to exclude the situation that only a few individuals got access to all the food (Ladewig et al., 2002). The ration of meat that was used in the study was given in addition to the bush dogs’ usual diet and hence all the individuals were guaranteed their rations. However, those individuals that were participating in the experiment were being “paid” with food for their efforts. The downside of having an open economy test situation is that the animals get access to the resource whether they participate in the study or not (Ladewig et al., 2002). This may decrease their motivation since they might not be hungry enough during the observations. However, a closed economy test situation would be in conflict with the Swedish Board of Agriculture’s regulations on keeping animals at zoo, the so called L 108, concerning
feeding. This regulation states that all individuals, at the same time, shall have access to food. To be able to conduct the maximum price paid test when the bush dogs were supposed to be the most motivated, observations took place immediately prior to the bush dogs being fed. This means that observations took place approximately 36 hours after the bush dogs previously had been fed.

The scientific research on bush dogs is scarce and several important elements such as their basic ethology and activity budgets are poorly investigated. Additionally, the research on environmental enrichment in wild canids kept in zoos is also scarce (Vasconsellos et al., 2009). Keeping wild animals in captivity might expose them to stress. It has been known for a long time that zoo housed animals that suffer from severe or chronic stress can lead to the animals developing stereotypies (Vasconsellos et al., 2009). The results from preference and motivational tests may shed some light on how animals value their needs (Galhardo et al., 2011). According to Kirkden and Pajor (2006) to be able to determine how strong a motivation is, it has to have something to be compared with. Food is often considered as a high-value resource and can be used as a measure in studies comparing different resources (Hovland et al., 2007). This test only measured how much bush dogs were willing to pay for food and even though one individual lifted as much as twice its body weight it is difficult to assess how strong its motivation was. Considering that bush dogs live near flood plains and have webbed feet (Oliveira, 2009) it would be interesting to test how much the bush dogs are willing to work to get access to water in a suitable pond or pool. Since studies have found that animals may pay differently for similar resources (deJong et al., 2007), future preference and motivation studies could provide valuable insights into what kind of nesting materials and type of dens bush dogs prefer.

5.3. Method evaluation

The previous study by Jöngren (2011) regarding the maximum price paid test in bush dogs at Kolmården Wildlife Park had had some troubles with the bush dogs entering the backdoor without any weights to get access to the reinforcer. That was prevented in this study by a frame around the backdoor that made it impossible for the bush dogs to open it and enter it from the wrong side. The bush dogs were, however, capable of entering the backdoor from the wrong side if and when another bush dog left the box via the backdoor. Since the bush dog that had entered the box via the entrance door already had eaten the meat inside, the bush dogs that
sneaked in were not reinforced for the “undesired behaviour” and those entries were thus not taken into account.

Only nine out of the fifteen dogs entered the box in the maximum price paid test. Three out of those nine only entered it only once. The alpha male and the three adult females avoided entering the box at all even if they showed interest in it. A study by de Souza Lima et al. (2009) which reported on the habitat use and diet of bush dogs in the Northern Pantanal in Brazil, attempted to capture and put radio collars on the bush dogs in that area. Unfortunately, these trapping efforts were unsuccessful since the bush dogs avoided the live-box traps that were used in the study (de Souza Lima et al., 2009). The authors argue that the reason for the bush dogs not entering the traps is that the bush dogs are being skittish. de Souza Lima et al. (2009) describe studies during which 6000 hours were spent trying to capture bush dogs with no successful results. In summary, the design of the box used in this study was not ideal or optimal for bush dogs: it was dark and rather small and these features might have discouraged more cautious individuals from entering it. According to de Souza Lima et al. (2009) in 2009, no successful methods for capturing bush dogs were known. For further experiments, it might be preferable to design an apparatus that is large and bright and that is located in such a way that humans can control and manage it from a distance to eliminate the possibility that human presence scares the dogs away. Perhaps a see-through “cat-door” leading into a lit room, with metal bars separating the two rooms would make it less scary for cautious individuals to enter the “cat-door”. In this way, more cautious animals can watch more daring animals entering the room instead of not knowing what is happening inside the non-transparent box. Other factors worth taking into consideration when designing an apparatus is that bush dogs can be very aggressive towards humans and objects and as seen in the maximum price paid test, are capable of pushing twice their own weight. Hence, a lot of emphasis should lie on constructing an apparatus that the bush dogs neither can get hurt by or be able to destroy.

6. Conclusion
The results from this study showed that the bush dogs preferred meat and fish significantly over both vegetables and fruit. The results also showed that the maximum price paid differed between individuals. Two of the highest maximum price paid were 5 and 11 kg respectively. The individual that was capable of lifting 11 kg weighed 5.5 kg which means
that he lifted twice his body weight. Further studies assessing how bush dogs value other resources are desirable.

7. Acknowledgments
I would like to thank my supervisor adj. prof. Mats Amundin who both has helped me through this project and helped me come up with new ideas and innovative tools to keep the project going when the bush dogs outsmarted us on several occasions. I would also like to thank the carnivore keepers and the carpenters at Kolmården Wildlife Park for assisting and helping me conducting this study. Last but not least I would like to thank the bush dogs for all the challenges that they have put me through, because it has contributed to my personal development. I am grateful to have had the opportunity to be working together with these wonderful animals.

8. References


(Chrysocyon brachyurus) group and individual effects. Animal Welfare. 18, 289-300.


Internet sites


Welfare regulations

Regulations from the Swedish Board of Agriculture concerning keeping animals at zoos. (SJVFS 2009:92) Dnr L108.

Personal communication