

Appendix 1: Okapi leaves served at the Epulu Station, Congo

N°	Local Name (Swahili)	Gender / Species	Family	Type
1	Aguba	<i>Pynanthus angolensis</i>	Myristiaceae	A
2	Alubasa	<i>Celtis brieiyi</i>	Ulmaceae	A
3	Amakawakawa	<i>Rareuna laurentii</i>	Rubiaceae	Arb
4	Amakuakua	<i>Macaranga sp</i>	Euphorbiaceae	L
5	Amambaka	<i>Nesogorolonia kabingaensis</i>	Sterculiaceae	Arb
6	Amboku	<i>Macaranga schweinfurtii</i>	Euphorbiaceae	A
7	Amedokodoko	<i>Phyllanthus muellerinus</i>	Euphorbiaceae	L
8	Anbgongbolia	<i>Cola acuminata</i>	Sterculiaceae	Arb
9	Atekisa	<i>Whitfieldia arnoldiana</i>	Acanthaceae	H
10	Avelope	<i>Anthocleista achweinfurtii</i>	Longaniaceae	Arb
11	Beletu	<i>Massularia acuminata</i>	Rubiaceae	Arb
12	Bodokomu			H
13	Bundje-Bundje	<i>Alchornea cordifolia</i>	Euphorbiaceae	Arb
14	Busima	<i>Erythrococca oleracea</i>	Euphorbiaceae	Arb
15	Bwanamuzuri	<i>Rinorea oblongifolia</i>	Violaceae	Arb
16	Efolo	<i>Ancistrocarpus bequaertii</i>	Tiliaceae	
17	Enjeku	<i>Bridelia atroviridis</i>	Euphorbiaceae	Arb
18	Epalu	<i>Hallea stipulosa</i>	Rubiaceae	A
19	Esuba	<i>Glyphea brevis</i>	Tiliaceae	Arb
20	Hoyo			
21	Kakina			
22	Kobokobo	<i>Macaranga spinosa</i>	Euphorbiaceae	A
23	Kolongo	<i>Celtis mildbraedii</i>	Ulmaceae	A
24	Kombokombo	<i>Musanga cecropioides</i>	Moraceae	A
25	Kpelekpele	<i>Tarenona laurentii</i>	Rubiaceae	A
		<i>Trilepisium</i>		
26	Kpungbu	<i>madagascarinsis</i>	Moraceae	A
27	Lima	<i>Tabernaemontana</i>	Apocynaceae	Arb
28	Malingi	<i>Maesopsis eminii</i>	Rhizophoraceae	A
29	Malumalu	<i>Ficus vallisichoudae</i>	Moraceae	A
30	Mapokupoku	<i>Macaranga schweinfurtii</i>	Euphorbiaceae	A
31	Mataili	<i>Lepidobotrys staudtii</i>	Lepidobotriaceae	Arb
32	Mbuni-Mbongo	<i>Staedti stipitata gabonensis</i>	Myristiaceae	A
33	Mtotomototo	<i>Hugonia platysepala</i>	Linaceae	L
34	Mupini	<i>Trichilla rubenscens</i>	Meliaceae	A
35	Mutondo	<i>Alstonia bonei</i>	Apocynaceae	A
36	Mwenge	<i>Heisteria parviflora</i>	Olacaceae	Arb
37	Okenge	<i>Trema guineensis</i>	Ulmaceae	Arb
38	Oro	<i>Syphonia globulifera</i>	Clusiaceae	Arb
39	Pado	<i>Ficus mucuso</i>	Moraceae	A
40	Peke	<i>Ricinodendron heudelotii</i>	Euphorbiaceae	A
41	Pepepe	<i>Diospyros bipindensis</i>	Ebenaceae	Arb
42	Sobiane	<i>Porterandia nalaensis</i>	Rubiaceae	Arb
43	Sossa	<i>Cleistanthus michelsonii</i>	Euphorbiaceae	A
44	Teba	<i>Aidia micrantha</i>	Rubiaceae	Arb
45	Teka	<i>Urera cameroonensis</i>	Ulmaceae	L

Legend :

A = Tree

Arb = Small shrub

H = Grass

L = Creeper

Okapi nutrition questionnaire

In 1997 your zoo collaborated with an okapi diet questionnaire (Stoppels and Nijboer, 1997) which contributed to the establishment of nutritional guidelines in 1998. The intention of this questionnaire is to review the assembled information from 1997 and possibly adapt the information in the nutrition guideline for the advanced nutrition knowledge on okapi's. In the revised guideline we intend to include information of data on health problems, such as: hoof problems, rumen acidosis, obstruction of gastrointestinal tract, bezoars and obesity.

As final thesis students from the Van Hall Institute, Leeuwarden, the Netherlands, we intend to finish the reviewing of the guideline before 31st of January 2007. Therefore we would be pleased if you want to fill in this questionnaire and send it back **before December 8th 2006.** After two weeks you will receive a reminder by email. If we do not receive the entire questionnaire before the deadline mentioned above, we will contact you to remind you to fill in and return the questionnaire.

Send your questionnaire back, preferably by email to the following email address:

kimengelhart@gmail.com

If this is not possible, you can send it by regular mail to:

**Van Hall/Larenstein
c/o T.R. Huisman
Postbus 1528
8901 BV Leeuwarden
The Netherlands**

The project is supervised by dr. Joeke Nijboer, nutrition advisor to the okapi EEP, in cooperation with dr. Kirstin Leus, international studbook keeper for okapi's and European experts in okapi nutrition.

Dr. Joeke Nijboer, Rotterdam Zoo
Dafna Azulai and Kim Engelhart, final thesis students, Van Hall Institute, Leeuwarden, the Netherlands

For your information:

- This questionnaire appears long; however it also contains your information from the questionnaire held in 1997.
- The questionnaire offers an extra line in every table, in case your zoo has received another okapi, which is not yet processed in our studbook information.
- We would also like to analyze your Lucerne and concentrates (pellets) for comparison with okapis held in other collections, therefore we would be pleased if you could send us 3 samples Lucerne (250 grams each) and 150 grams concentrates of the total amount offered per day per okapi, in an air-sealed package and send it to the van Hall/Larenstein Institute (Mr. T.R. Huisman) in Leeuwarden.

Questionnaire okapis

**Royal Zoological Society of Antwerp,
Belgium**

Filled in by:

Job description:

Email address:

Part 1 - Animals in your collection

Table A: European Okapi Studbook 01/08/2006, Royal Zoological Society of Antwerp

Stud #	Sex	Birth Date	Location	Date	Local ID	Name
T7	F	2 June 2006	Antwerp	2 June 2006	M10735	Hakima
400	F	14 July 1991	Antwerp	14 July 1991	M9222	Sofie
487	F	28 October 1997	Antwerp	28 October 1997	M9950	Yenthe
531	M	13 Augustus 2000	Antwerp	13 Augustus 2000	M10257	Bondo
588	F	1 November 2004	Antwerp	1 November 2004	M10635	Faraa

1.1) Is the data above in table A, still correct?

Yes

☐

No, note any changes in the table B below:

Table B: Changes in Studbook[illegible]

Part 2 - Feeding

According to the nutrition questionnaire of 1997, on average, you fed the following (see table C below):

Table C: Data nutrition questionnaire 1997 of your zoo

	Item per week per okapi
Vegetables (grams/item/week)	- <u>Carrot</u> 5726 - <u>Cabbage</u> 406 - <u>Chicory</u> 452 - <u>Celery</u> 263 - <u>Beans</u> 546 - <u>Endive</u> 441 - <u>Onion</u> 578 + Total 8412
Fruits (grams/item/week)	- <u>Apple</u> 6388 - <u>Orange</u> 322 - <u>Banana</u> 5327 + Total 12037
Browse (grams/item/week)	- <u>American Oak</u> 1376
Hay (kilograms/item/week)	- <u>Lucerne</u> 22,4
Concentrates (pellets) (grams/item/week)	- <u>Herbivore pellet</u> 6136 - <u>Oat</u> 522 - <u>Mineral pellet</u> 791 - <u>Lucerne pellet</u> 1610 - <u>Bread</u> 305 + Total 9364
Mineral and vitamin supplements (grams/item/week)	<u>No data</u>

2.1) The nutrition guideline of 1998 recommended the following diet:

- 50% prime quality alfalfa hay (minimum)
- 25% nutritionally complete pellets (minimum)
- 0-25% produce/browse (maximum)

Intake as % body mass: 1.8% dry matter diet (so the offered diet must be 2-2.4% of body weight)

(Feeding guidelines for the okapi, 2000, Crissey et al.)

Are you satisfied with these nutrition guidelines?

☐ Yes

☐ No

Mention what additional aspects should be discussed in the new nutrition guidelines to your opinion:

2.2) Fill in the current feeding (strategy) of your okapis in table D below.

Table D: Feeding (strategy)

	ID nr. okapi: Name okapi:	ID nr. okapi: Name okapi:	ID nr. okapi: Name okapi:	ID nr. okapi: Name okapi:	ID nr. okapi: Name okapi:	ID nr. okapi: Name okapi:
Okapi fed inside	☐ separately ☐ together with ☐ all together	☐ separately ☐ together with ☐ all together	☐ separately ☐ together with ☐ all together	☐ separately ☐ together with ☐ all together	☐ separately ☐ together with ☐ all together	☐ separately ☐ together with ☐ all together
Okapi fed outside	☐ separately ☐ together with ☐ all together	☐ separately ☐ together with ☐ all together	☐ separately ☐ together with ☐ all together	☐ separately ☐ together with ☐ all together	☐ separately ☐ together with ☐ all together	☐ separately ☐ together with ☐ all together
Vegetables (grams/ item/week)						
Fruits (grams/ item/week)						

Continue table D: Feeding (strategy)

	ID nr. okapi: Name okapi:	ID nr. okapi: Name okapi:	ID nr. okapi: Name okapi:	ID nr. okapi: Name okapi:	ID nr. okapi: Name okapi:	ID nr. okapi: Name okapi:
Browse (bundle/ item/week)						
Hay (kg/ item/week)						
Concentrates (pellets) (grams/ item/week)						

Continue table D: Feeding (strategy)

	ID nr. okapi: Name okapi:	ID nr. okapi: Name okapi:	ID nr. okapi: Name okapi:	ID nr. okapi: Name okapi:	ID nr. okapi: Name okapi:	ID nr. okapi: Name okapi:
Mineral and Vitamin supplements (grams/item/week)						
Seasonal changes in offered diet <u>Other season than longest season mentioned above</u> From (month): To (month):						

2.3) Note the differences from the maintenance diet for specific “life stages” of your okapis in table E below:

Table E: Diet adjustments for different “life stages”

“Life stage”	How does the diet differ	Remarks
Juvenile		
Aged		
Gestating		
Lactating		
Obese		
Emaciated		
Sick		

2.4) The information you mentioned in the previous tables (tables D and E above) is obtained by:

- ☐ Weighing all the feedstuffs offered
- ☐ Weighing all the feedstuffs offered and weighing back most of the feedstuffs left.
- ☐ Using the feeding guidelines that your zoo (nutrition advisor) established herself
- ☐ Estimating weights and amounts fed
- ☐ Other way:

Part 3 - Health

3.1) Fill in, which health problems occurred with every individual okapi in your zoo, in table F below:

Table F: Health problems

Okapi	Hoof problems	Rumen acidosis	Obstruction of gastrointestinal tract	Bezoars	Obesity
ID nr: Name:	Diagnosed by: ☐ Veterinarian ☐ Other:	Diagnosed by: ☐ Veterinarian ☐ Other:	Diagnosed by: ☐ Veterinarian ☐ Other:	Diagnosed by: ☐ Veterinarian ☐ Other:	Diagnosed by: ☐ Veterinarian ☐ Other:
ID nr: Name:	Diagnosed by: ☐ Veterinarian ☐ Other:	Diagnosed by: ☐ Veterinarian ☐ Other:	Diagnosed by: ☐ Veterinarian ☐ Other:	Diagnosed by: ☐ Veterinarian ☐ Other:	Diagnosed by: ☐ Veterinarian ☐ Other:
ID nr: Name:	Diagnosed by: ☐ Veterinarian ☐ Other:	Diagnosed by: ☐ Veterinarian ☐ Other:	Diagnosed by: ☐ Veterinarian ☐ Other:	Diagnosed by: ☐ Veterinarian ☐ Other:	Diagnosed by: ☐ Veterinarian ☐ Other:
ID nr: Name:	Diagnosed by: ☐ Veterinarian ☐ Other:	Diagnosed by: ☐ Veterinarian ☐ Other:	Diagnosed by: ☐ Veterinarian ☐ Other:	Diagnosed by: ☐ Veterinarian ☐ Other:	Diagnosed by: ☐ Veterinarian ☐ Other:
ID nr: Name:	Diagnosed by: ☐ Veterinarian ☐ Other:	Diagnosed by: ☐ Veterinarian ☐ Other:	Diagnosed by: ☐ Veterinarian ☐ Other:	Diagnosed by: ☐ Veterinarian ☐ Other:	Diagnosed by: ☐ Veterinarian ☐ Other:
Remarks					

Part 4 - Body Condition Score

4.1) By Disney's Animal kingdom, a body condition score has been developed for okapis (see the next page). Do you agree with this body score system?

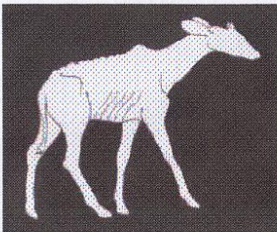
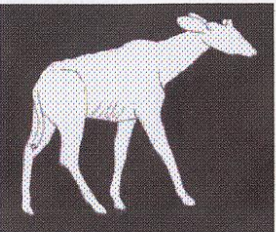
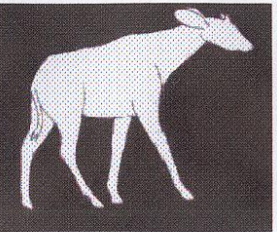
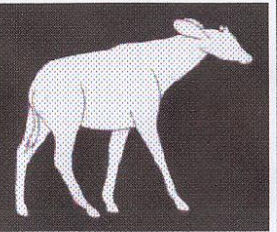
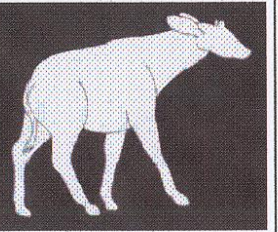
- ☐ Yes
- ☐ No, it has to be adjusted, because:

4.2) Score the condition of each okapi in your zoo in table G below and give remarks for the way you have scored the animals. (please score according to the scoring system of Disney's Animal Kingdom, that is given on the next page)

Table G: Body Condition Score[illegible]

Body Condition Score Okapis

Developed by Disney's Animal Kingdom - 2005

Score	1: Emaciated	2: Thin	3: Good	4: Fat	5: Obese
Outline Depiction					
Neck & Shoulders	- Emaciated - Bone structure is easily identifiable - No fat	Ventral portion of neck is thicker than dorsal portion	- Neck is thick - Blends into shoulder	- Fat deposits are present - Fat wrinkles are present at bend of neck	- Fat is evident along neck - Bulging fat - Neck is thick
Withers	- Emaciated - Bone structure is easily identifiable - No fat	Withers are less emphasized, but still identifiable	Withers appears flatter	Fat deposits are present	- Fat deposits make withers unidentifiable - Withers are flat
Loin & Back	- Emaciated - Spinous processes are easily identifiable	- Spinous processes are not individually identifiable, but the spine is still prominent - Transverse processes are faintly discernible	Back is flat	Fat deposits are present and back appears flat	- Wide Back - Patchy fat
Tailhead & Hips	Pelvic bones are very prominent	- Pelvic bones at point of hip are rounded, but still evident - Pelvic bones at rump may be slightly discernible	- Fat is around tailhead - Hips are flat	Hips are rounded	Hips/thighs are very round
Ribs	- Emaciated - Ribs appear wide and depressed	Ribs are discernible, but fat is evident by touch	Ribs are not visible, easily discernible by touch	Fat deposits over ribs are wide and unevenly spaced	Fat deposits may be present, easily evident

5) If you have any additional information or remarks you want to share with us and that could be useful for this questionnaire, you can note these down below:

Appendix 3: Summary answers okapi questionnaire 2006

Table A: Satisfaction nutrition guidelines 1998

Zoos	Satisfied (Y/N)	Remarks
Antwerp	N	If possible, the diet should contain as much browse you can get. As okapis only eat browse in nature. If you have enough browse you need less alfalfa hay. What is prime quality alfalfa hay for okapis? In my view, not only the composition but also the structure is of importance. The stems should be thin and soft (third cut).
Basel	Y	Enrichment issues. Prevention of oral stereotypes.
Beauval	Y	ND
Chester	Y	The guidelines are useful for a nutritionist, but I think for more general usage, the recommendations should also be converted from proportions to actual (fresh) weights of food by using an example. E.g. if your animal is 250 kg then intake is xx, so the diet should have x gram hay and x gram pellet etc. I think the allocation for produce is too generous (should be <10%) and there should be no maximum for browse, since my feeling is that most EAZA (mostly temperate) climates will struggle to over-supply browse.
Frankfurt	Y	During winter time: Dried raspberry leaves, dried acacia, frozen browse sugar free molasses during the whole year.
Köln	N	ND
Lisboa	Y	- List of plants suitable for browse - List of plants toxic for okapis
London	Y	ND
Marwell	Y	ND
Rotterdam	N	To our opinion the best diet for an okapi should be: 1/3 pellets, 1/3 lucerne and 1/3 browse
Stuttgart	Y	Basically, we think that the guidelines are quite useful and are very helpful in many respects. Nevertheless, we feel that the value of 25% nutritionally complete pellets given as a minimum is too high and should be reduced to 15%.
Wuppertal	N	Every detail of feeding stuff should be mentioned!

Y= Yes

ND= No Data

N= No

Table B: Feeding strategy concerning inside and outside enclosures

Zoos	Inside	Outside
Antwerp	All okapis are fed separately	- Hakima together with Yenthe - Sofie, Bondo and Faraa are fed separately
Basel	All okapis are fed separately	All okapis are fed separately
Beauval	All okapis are fed separately	All okapis are fed separately
Chester	All okapis are fed separately	All okapis are fed separately
Frankfurt	All okapis are fed separately	- Lomela together with Padolo and Antonia - Libembe together with Padolo (?)
Köln	All okapis are fed separately	Depending
Lisboa	Both okapis are fed separately	Both okapis are fed together
London	Both okapis are fed separately (pm) and together (am)	Both okapis are fed together
Marwell	- Mieke together with Zukisa - Shomari, Isiro, Kiburi and Dumela are fed separately	ND
Rotterdam	- Dayo together with Demba - Lisala, Tom, Kamina and Kimdu are fed separately	- Dayo together with Demba and Kimdu - Lisala together with Kamina - Tom is fed separately
Stuttgart	All okapis are fed separately	- Xano together with Epena - Vitu together Ibina and Kabinda - Stanley is fed separately
Wuppertal	All okapis are fed separately	ND

ND= No Data

Table C: Adjusted diet for life stage ‘Juvenile’ :

Zoos	Adjusted diet, life stage: Juvenile
Antwerp	Amount of food offered according to age. Gradually increased
Basel	ND
Beauval	ND
Chester	ND
Frankfurt	Less fresh food and pellets, good hay (2 nd cut), plenty of browse and dried acacia. Slow adaptation to the mothers diet
Koln	Less
Lisboa	Both animals resident at Lisboa zoo have arrived and still are at juvenile stage
London	Increased as the animal grows ad lib depending on the individuals appetite. Unfortunately we don’t have any specific weights for this.
Marwell	Concentrates and chopped fruit and veg. are introduced at about 4 months of age (a couple of handfuls). This is then monitored and gradually increased until the animal is old enough to consume the same as the adults
Rotterdam	When okapi is 3 months old, he gets a little bit from his mothers food offered in his own food bowl. When okapi is 6 months old, he gets a little bit of food of his own. When okapi is 1 year, he will be separated from his mother and gets his own food offered
Stuttgart	All juveniles are fed together with their dam, composition is as usual, but amount is increased accordingly (up to 180% for mother and one-year old calf). Once the calf is weaned and fed separately (between 12-15 months), the juvenile gets about 75-80% of the amounts fed to adult individuals
Wuppertal	ND

ND = No Data

Table D: Adjusted diet for life stage ‘Aged’:

Zoos	Adjusted diet, life stage: Aged
Antwerp	ND
Basel	ND
Beauval	We follow the diet given by the zoo where Gunther came from. It is not an adaptation of the diet used for Jamar
Chester	ND
Frankfurt	Adapted to the animal
Koln	Full amount
Lisboa	ND
London	ND
Marwell	This is the same as the adult maintenance diet. No changes are made unless there is a change in body condition and health of the animal
Rotterdam	ND
Stuttgart	ND
Wuppertal	ND

ND = No Data

Table E: Adjusted diet for life stage ‘Gestating’:

Zoos	Adjusted diet, life stage: Gestating
Antwerp	ND
Basel	ND
Beauval	ND
Chester	I would not consider changing the diet during this period unless there the female was losing condition/coat quality. If absolutely necessary, might increase pellets towards end of last trimester
Frankfurt	More pellets according to demand of the animal
Koln	Increasing diet (beet pulp and concentrates)
Lisboa	ND
London	All food items are increased as her appetite increases ad lib depending on the individual. Unfortunately we don’t have any specific weights for this.
Marwell	This is usually the same as the adult maintenance diet
Rotterdam	Maximum 2100 grams extra concentrates/week. Extra Lucerne and browse
Stuttgart	ND
Wuppertal	ND

ND = No Data

Table F: Adjusted diet for life stage ‘Lactating’:

Zoos	Adjusted diet, life stage: Lactating
Antwerp	Amount of food offered is increased to 133% of a normal diet
Basel	ND
Beauval	ND
Chester	Likely increase in pellets to accommodate extra nutrient/energy requirements of lactation, but would examine on case by case basis
Frankfurt	Little more fresh food, pellets according to demand of the animal. More browse according to season
Koln	Increasing diet (beet pulp and concentrates)
Lisboa	ND
London	The amount remains at the amount increased during gestation and is increased as the youngster starts to wean. Unfortunately we don’t have any specific weights for this.
Marwell	Concentrate, fruit and veg. quantities offered are increased slightly if the animal appears to have lost condition
Rotterdam	Maximum 2100 grams extra concentrates/week. Extra Lucerne and browse
Stuttgart	Composition of diet is not changed, but amounts of all components is increased (between 25% for females with newborn calves up to 80% for females with calves ready to be weaned, (see juvenile)
Wuppertal	ND

ND = No Data

Table G: Adjusted diet for body condition ‘Obese’:

Zoos	Adjusted diet, body condition: Obese
Antwerp	Less alfalfa hay and/or concen-trate
Basel	ND
Beauval	ND
Chester	Our animals are not obese, but on arrival all have been overweight which was addressed/corrected by rationing the amount of fruit/vegetables provided (usually reducing what had been recommended by sending institution)
Frankfurt	Diet
Koln	Reducing diet (concentrates)
Lisboa	ND
London	ND
Marwell	This has never been a problem here. However, if it did occur, food rations would be introduced
Rotterdam	ND
Stuttgart	ND
Wuppertal	ND

ND = No Data

Table H: Adjusted diet for body condition ‘Emaciated’:

Zoos	Adjusted diet, body condition: Emaciated
Antwerp	The food/hay is chopped in smaller pieces. More food is offered as long as the faeces are OK
Basel	ND
Beauval	ND
Chester	ND
Frankfurt	High quality hay, more browse, additions
Koln	Increasing diet (beet pulp and concentrates)
Lisboa	ND
London	ND
Marwell	Again this has never happened here
Rotterdam	ND
Stuttgart	ND
Wuppertal	ND

ND = No Data

Table I: Adjusted diet for body condition ‘Sick’:

Zoos	Adjusted diet, body condition: Sick
Antwerp	Less concentrates if there is a digestion problem
Basel	ND
Beauval	ND
Chester	ND
Frankfurt	Temporarily no additions/supplements, depending on the disease
Koln	Depending
Lisboa	ND
London	Animals suffering from diarrhoea are given more browse and less pellets. Animals feeling out of sorts are given extra browse as this is one of their favourite food items.
Marwell	Depending on the problem, food intake would either be increased or decreased
Rotterdam	When an okapi is sick, no or less pellets will be offered for a certain period. Especially when an okapi has diarrhoea
Stuttgart	Diet is changed following recommendations by the vet
Wuppertal	ND

ND = No Data

Table J: Health problems in captive okapis

Zoo	Hoof problems	Rumen acidosis	Obstruction of the G.I. tract*	Bezoars	Obesity	Other (Diarrhoea)
Antwerp	Sofie – V&K					
Basel						
Beauval						
Chester						
Frankfurt	Padolo – V Libembe - V		Padolo - V			
Koln						
Lisboa						
London	Dicky – K Elila - K					
Marwell	Mieke – K					
Rotterdam	Lisala – V Demba - V					Lisala – K Demba - K
Stuttgart	Vitu – K Ibina – K Kabinda - K					
Wuppertal	Tunda – V&K		Tunda - V		Tunda – K Sudi – K Henry - K	

V = diagnosed by Veterinarian

K = diagnosed by Keeper

V&K = diagnosed by Veterinarian and Keeper

* = Gastrointestinal tract

Table K: Satisfaction body condition score system Disney's Animal Kingdom

Zoos	Satisfied? (Y/N)	Remarks
Antwerp	Y	ND
Basel	Y	ND
Beauval	Y	ND
Chester	Y	ND
Frankfurt	Y	ND
Koln	Y	ND
Lisboa	Y	ND
London	Y	ND
Marwell	N	All okapi are individual in shape and size, e.g. We have 2 contrasting females. By using this body condition score, one would be thin and the other fat, but on weighing them, they both weigh the same.
Rotterdam	N	Some okapis have a fat neck, but a good back, while others have fat hips, but a good neck. This means that you can never place every okapi in one particular box. I think it's always a combination of two or more boxes. It might be more useful to give a score for every part of the body separately. For example: Neck & shoulders: 3, Withers & back: 4 etc. Eventually you can calculate the average of these scores per okapi.
Stuttgart	Y	ND
Wuppertal	Y	ND

Y = Yes

N = No

ND = No Data

Table L: Body condition score

Zoo	Name okapi	Weight (kg)	Body Condition Score
Antwerp	Hakima	116	3
	Sofie	276	3
	Yenthe	264	2
	Bondo	238	3
	Faraa	242	3
Basel	Xina	ND	3
	Zidan		3
Beauval	Günther	218	3
	Jamar	275	3
Chester	Mbuti	220	4
	Stuma	205	3
Frankfurt	Padolo	250	4
	Libembe	110	3
	Antonia	230*	3
	Lomela2	220*	3
Köln	Tiemen	243	4
	Kisanga	371	3
Lisboa	Basongo	260	3
	Djugu	226	3
London	Dicky	313	3
	Elila	296	3
Marwell	Shomari	ND	3
	Mieke		3
	Zukisa		3
	Isiro		3
	Kiburi		3
	Dumela		3
Rotterdam	Dayo	210*	3
	Lisala	300	2
	Tom	225*	3
	Demba	250*	3
	Kamina	250*	3
	Kimdu	215*	3
Stuttgart	Xano	260*	3
	Vitu	290*	3
	Epena	260*	2
	Ibina	340*	3
	Kabinda	330*	3
	Stanley	190*	3
Wuppertal	Tunda	328	4
	Sudi	260	4
	Henry	237	3

ND= No Data

Table M: Additional information and remarks of different zoos

Zoos	Remarks
Antwerp	ND
Basel	- Detailed necropsy reports available - Detailed knowledge in production of browse silage available - Diet is from 2003: vegetables and fruits have been reduced since then. We use some of them to perform behavioural enrichment (e.g. special boxes, hang them up on ropes)
Beauval	Jamar seems to react to the alfalfa hay's quality: he often has some digestive problems, with faeces not much structured. But we noticed an improvement after we used another hay. Furthermore Jamar is a nervous animal with some tendency to stereotypic behaviours. He eats very quickly and we can often see him licking/sucking the bamboos in his enclosure.
Chester	I have attached a copy of our diet sheet. Samples of current Lucerne hay and pelleted feeds (Mazuri Browser Breeder & I'ansons Linseed Lozenges) follow by post. We will shortly (January 2007) replace both of these products with the Nutrazu ruminant cube. I can also provide more details of our browse species & some limited analytical data upon request.
Frankfurt	ND
Koln	ND
Lisboa	ND
London	ND
Marwell	We feel it may be useful in table E to just identify what you mean by the various life stages (e.g. until what age do you class a juvenile). Also, by saying a sick animal, this could account for a whole number of things so dietary changes will obviously depend on the problem.
Rotterdam	Currently, we are changing the diet for our okapis. Eventually, we want to remove the browse pellet from the diet and replace it with the horse pellet and additional browse (willow) etc. This means that the diet that is mentioned in the tables above will differ from the eventual diet we want to offer in the near future.
Stuttgart	ND
Wuppertal	ND

ND = No Data

Table N: relation fruits, vegetables and concentrates with the appearance of hoof problems

Zoos	Age	Sex	Fruits & vegetables offered per okapi per day as fed (given in grams)	Concentrates offered per okapi per day as fed (given in grams)
Antwerp (1 hp, 4 nhp)	15y, 7m	Female	800	1400
Frankfurt (2 hp, 2 nhp)	18y, 2m 1y, 11m	Male Male	550	800
London (2 hp, 0 nhp)	10y, 2m 9y, 11m	Male Female	3000	8100
Marwell (1 hp, 5 nhp)	21y, 6m	Female	4900	3800
Rotterdam (2 hp, 4 nhp)	15y, 7m 10y, 5m	Female Female	1800	1400
Stuttgart (3 hp, 3 nhp)	8y, 10m 5y, 5m 4y, 5m	Male Female Female	4300	2000
Wuppertal (1 hp, 2 nhp)	10y, 8m	Female	6300	2600
7 zoos (12 okapis with hp, 20 okapis with nhp)	Average: 11 y, 6m (12 okapis with hp) Average: 6 y, 6m (20 okapis with nhp)	8 Females, 4 Males (okapis with hp) 10 Females, 10 Males (okapis with nhp)	Average: 3093 grams (offered/okapi in zoos with hp)	Average: 2871 grams (offered/okapi in zoos with hp)
Basel (0 hp, 2 nhp)			1800	1000
Beauval (0 hp, 2 nhp)			4000	2000
Chester (0 hp, 2 nhp)			2200	2000
Koln (0 hp, 2 nhp)			720	1200
Lisboa (0 hp, 2 nhp)			1100	2400
5 zoos (0 okapis with hp, 10 okapis with nhp)	Average: 7y, 5m (10 okapis with nhp)	3 Females, 7 Males (okapis with nhp)	Average: 1964 grams (offered/okapi in zoos with nhp)	Average: 1720 grams (offered/okapi in zoos with nhp)

Antwerp Zoo, November 2006

Table O: Average offered diet per okapi per day

Item	Kilogram	DM (g)	As h (g)	CP (g)	NDF (g)	ADF (g)	CF (g)	CFat (g)	Ca (g)	P (g)	Fe (mg)	Zn (mg)	Mg (g)
Fruits :													
Total:	0	0	0	0	0	0	0	0	0	0	0	0	0
Vegetables :													
<i>Carrot</i>	0,2	27,8	2,0	2,3	0,0	0,0	0,0	0,5	0,1	0,1	3,0	1,0	0,0
<i>Celery</i>	0,1	3,1	0,5	0,5	0,0	0,0	0,0	0,1	0,0	0,0	0,2	0,1	0,0
<i>Onion</i>	0,2	23,3	0,9	1,9	0,0	0,0	0,5	0,3	0,0	0,1	0,8	2,1	0,0
<i>Endive</i>	0,2	8,4	1,6	2,0	0,0	0,0	0,6	0,3	0,1	0,1	1,4	0,8	0,0
<i>Chicory</i>	0,2	8,3	0,7	1,4	0,0	0,0	0,0	0,2	0,0	0,0	0,4	0,2	0,0
<i>Cabbage (red&white)</i>	0,1	9,0	0,6	1,3	0,7	0,0	0,9	0,2	0,0	0,0	0,4	0,2	0,0
Total:	0,8	79,8	6,3	9,3	0,7	0,0	2,0	1,5	0,3	0,3	6,2	4,4	0,1
Total Fruits & Veg.:	0,8	79,8	6,3	9,3	0,7	0,0	2,0	1,5	0,3	0,3	6,2	4,4	0,1
Item	Kilogram	DM (g)	As h (g)	CP (g)	NDF (g)	ADF (g)	CF (g)	CFat (g)	Ca (g)	P (g)	Fe (mg)	Zn (mg)	Mg (g)
Browses													
<i>Willow, black twigs & leaves</i>	0,5	205	14,5	24,5	105	81,5	0	0	3	0,45	62,5	47,5	0,4
Total:	0,5	205,0	14,5	24,5	105,0	81,5	0,0	0,0	3,0	0,5	62,5	47,5	0,4
Hay													
<i>Alfalfa/luceme</i>	2,6	2210,0	215,8	413,4	962,0	624,0	754,0	88,4	27,6	6,2	530,4	65,0	5,7
Total:	2,6	2210,0	215,8	413,4	962,0	624,0	754,0	88,4	27,6	6,2	530,4	65,0	5,7
Item	Kilogram	DM (g)	As h (g)	CP (g)	NDF (g)	ADF (g)	CF (g)	CFat (g)	Ca (g)	P (g)	Fe (mg)	Zn (mg)	Mg (g)
Concentrates													
<i>Beet pulp*</i>	0,4	140,4	9,3	15,1	0,0	0,0	26,3	0,0	0,0	0,0	0,0	0,0	0,0
<i>Alfalfa pellet(CAVO)</i>	0,2	191,1	27,9	35,9	0,0	0,0	42,6	7,4	0,0	0,0	0,0	0,0	0,0
<i>Horse pellet (Agrifirm 7715506)</i>	0,8	704,0	71,2	117,6	164,0	74,4	55,2	24,0	8,8	6,4	149,6	112,0	1,9
Total concentrates :	1,4	1035,5	108,4	168,6	164,0	74,4	124,1	31,4	8,8	6,4	149,6	112,0	1,9
Total whole diet:	5,3	3.530,3	345,0	615,9	1.231,7	779,9	880,2	121,2	39,7	13,4	748,7	228,9	8,1

* = this amount is not soaked in water

Zoologischer Garten Basel, November 2006

Table P: Average offered diet per okapi per day

Item	Kilo gram	DM (g)	As h (g)	CP (g)	NDF (g)	ADF (g)	CF (g)	CFat (g)	Ca (g)	P (g)	Fe (mg)	Zn (mg)	Mg (g)
Fruits :													
<i>Apple</i>	0,3	43,8	0,9	0,75	0	0	1,32	1,17	0,024	0,03	0,93	0,24	0,009
<i>Banana</i>	0,4	102,8	3,2	4,08	0	0	0	1,96	0,04	0,08	1,24	0,64	0,36
Total:	0,7	146,6	4,1	4,83	0	0	1,32	3,13	0,064	0,11	2,17	0,88	0,369
Vegetables :													
<i>Carrot</i>	0,2	24,2	1,76	1,98	0	0	0	0,4	0,08	0,08	2,6	0,84	0,028
<i>Onion</i>	0,3	46,5	1,8	3,84	0	0	1,02	0,69	0,09	0,12	1,5	4,2	0,03
<i>Fennel</i>	0,6	102	9,84	13,98	0	0	4,02	1,74	0,6	0,3	15,6	1,44	0,288
Total:	1,1	172,7	13,4	19,8	0	0	5,04	2,83	0,77	0,5	19,7	6,48	0,346
Total Fruits &Veg.:	1,8	319,3	17,5	24,63	0	0	6,36	5,96	0,834	0,61	21,87	7,36	0,715
Item	Kilo gram	DM (g)	As h (g)	CP (g)	NDF (g)	ADF (g)	CF (g)	CFat (g)	Ca (g)	P (g)	Fe (mg)	Zn (mg)	Mg (g)
Browes													
<i>Willow, black twigs & leaves</i>	3	1230	87	147	630	489	0	0	18	2,7	375	285	2,4
Total:	3	1230	87	147	630	489	0	0	18	2,7	375	285	2,4
Hay													
<i>Alfalfa/lucerne</i>	3	2550	249	477	1110	720	870	102	31,8	7,2	612	75	6,6
Total:	3	2550	249	477	1110	720	870	102	31,8	7,2	612	75	6,6
Item	Kilo gram	DM (g)	As h (g)	CP (g)	NDF (g)	ADF (g)	CF (g)	CFat (g)	Ca (g)	P (g)	Fe (mg)	Zn (mg)	Mg (g)
Concentrates													
<i>Horse pellet (Agrifirm 7715506)</i>	1	880	89	147	205	93	69	30	11	8	187	140	2,4
Total concentrates :	1	880	89	147	205	93	69	30	11	8	187	140	2,4
Total whole diet:	9	4.979	443	796	1.945	1.302	945	138	62	19	1.196	507	12

Zoo Parc De Beauval, November 2006

Table Q: Average offered diet per okapi per day

Item	Kilogram	DM (g)	Ash (g)	CP (g)	NDF (g)	ADF (g)	CF (g)	CFat (g)	Ca (g)	P (g)	Fe (mg)	Zn (mg)	Mg (g)
Fruits :													
<i>Apple</i>	0,6	87,6	1,8	1,5	0	0	2,64	2,34	0,048	0,06	1,86	0,48	0,018
<i>Banana</i>	1,2	308,4	9,6	12,24	0	0	0	5,88	0,12	0,24	3,72	1,92	1,08
Total:	1,8	396	11,4	13,74	0	0	2,64	8,22	0,168	0,3	5,58	2,4	1,098
Vegetables :													
<i>Carrot</i>	1,5	181,5	13,2	14,85	0	0	0	3	0,6	0,6	19,5	6,3	0,21
<i>Onion</i>	0,75	116,25	4,5	9,6	0	0	2,55	1,725	0,225	0,3	3,75	10,5	0,075
Total:	2,25	297,75	17,7	24,45	0	0	2,55	4,725	0,825	0,9	23,25	16,8	0,285
Total Fruits & Veg.:	4,05	693,75	29,1	38,19	0	0	5,19	12,945	0,993	1,2	28,83	19,2	1,383
Item	Kilogram	DM (g)	Ash (g)	CP (g)	NDF (g)	ADF (g)	CF (g)	CFat (g)	Ca (g)	P (g)	Fe (mg)	Zn (mg)	Mg (g)
Browses													
Total:	0	0	0	0	0	0	0	0	0	0	0	0	0
Hay													
<i>Alfalfa/lucerne</i>	5	4250	415	795	1850	1200	1450	170	53	12	1020	125	11
Total:	5	4250	415	795	1850	1200	1450	170	53	12	1020	125	11
Item	Kilogram	DM (g)	Ash (g)	CP (g)	NDF (g)	ADF (g)	CF (g)	CFat (g)	Ca (g)	P (g)	Fe (mg)	Zn (mg)	Mg (g)
Concentrates													
<i>Barley-groats</i>	0,25	217,5	3	19,73	0	0	0	3,75	0,043	0,48	5	3,2	0,175
<i>Horse pellet (Agrifirm 7715506)</i>	0,75	660	66,75	110,3	153,75	69,75	51,75	22,5	8,25	6	140,25	105	1,8
Total concentrates :	1	877,5	69,75	130	153,75	69,75	51,75	26,25	8,293	6,48	145,25	108,2	1,975
Total whole diet:	10	5.821	514	963	2.004	1.270	1.507	209	62	20	1.194	252	14

Zoological Society Chester, November 2006

Table R: Average offered diet per okapi per day

Item	Kilo gram	DM (g)	As h (g)	CP (g)	NDF (g)	ADF (g)	CF (g)	CFat (g)	Ca (g)	P (g)	Fe (mg)	Zn (mg)	Mg (g)
Fruits :													
<i>Apple</i>	0,13	18,98	0,39	0,325	0	0	0,572	0,507	0,0104	0,013	0,403	0,104	0,0039
<i>Watermelon</i>	1,4	616	5,6	8,4	0	0	0,126	2,8	0,126	0,182	5,6	1,4	0,056
Total:	1,53	634,98	5,99	8,725	0	0	0,698	3,307	0,1364	0,195	6,003	1,504	0,0599
Vegetables :													
<i>Carrot</i>	0,1	12,1	0,88	0,99	0	0	0	0,2	0,04	0,04	1,3	0,42	0,014
<i>Cabbage (red&white)</i>	0,5	45	3	6,55	3,3	0	4,6	0,9	0,2	0,15	2,2	0,95	0,1
Total:	0,6	57,1	3,88	7,54	3,3	0	4,6	1,1	0,24	0,19	3,5	1,37	0,114
Total Fruits & Veg.:	2,13	692,08	9,87	16,265	3,3	0	5,298	4,407	0,3764	0,385	9,503	2,874	0,1739
Item	Kilo gram	DM (g)	As h (g)	CP (g)	NDF (g)	ADF (g)	CF (g)	CFat (g)	Ca (g)	P (g)	Fe (mg)	Zn (mg)	Mg (g)
Brow ses													
<i>Willow, black twigs & leaves</i>	1,5	615	43,5	73,5	315	244,5	0	0	9	1,35	187,5	142,5	1,2
Total:	1,5	615	43,5	73,5	315	244,5	0	0	9	1,35	187,5	142,5	1,2
Hay													
<i>Alfalfa/luceme</i>	2	1700	166	318	740	480	580	68	21,2	4,8	408	50	4,4
Total:	2	1700	166	318	740	480	580	68	21,2	4,8	408	50	4,4
Item	Kilo gram	DM (g)	As h (g)	CP (g)	NDF (g)	ADF (g)	CF (g)	CFat (g)	Ca (g)	P (g)	Fe (mg)	Zn (mg)	Mg (g)
Concentrates													
<i>Linseed</i>	0,5	455	23,5	109	0	0	47	175,5	1,75	2,8	153,5	25	1,75
<i>Browser maintenance (Mazuri 5654)</i>	1,5	1350	120	186	649,5	454,5	363	43,5	14,7	8,25	510	150	5,4
Total concentrates :	2	1805	143,5	295	649,5	454,5	410	219	16,45	11,05	663,5	175	7,15
Total whole diet:	8	4.812	363	703	1.708	1.179	995	291	47	18	1.269	370	13

Frankfurt Zoo, November 2006

Table S: Average offered diet per okapi per day

Item	Kilo gram	DM (g)	As h (g)	CP (g)	NDF (g)	ADF (g)	CF (g)	CFat (g)	Ca (g)	P (g)	Fe (mg)	Zn (mg)	Mg (g)
Fruits :													
Total:	0	0	0	0	0	0	0	0	0	0	0	0	0
Vegetables :													
<i>Carrot</i>	0,2	24,2	1,76	1,98	0	0	0	0,4	0,08	0,08	2,6	0,84	0,028
<i>Celery</i>	0,1	6,2	0,95	0,95	0	0	0	0,15	0,06	0,04	0,45	0,12	0,011
<i>Onion</i>	0,1	15,5	0,6	1,28	0	0	0,34	0,23	0,03	0,04	0,5	1,4	0,01
<i>Endive</i>	0,1	5,6	1,05	1,33	0	0	0,41	0,18	0,05	0,04	0,96	0,53	0,009
Total:	0,5	51,5	4,36	5,54	0	0	0,75	0,96	0,22	0,2	4,51	2,89	0,058
Total Fruits & Veg.:	0,5	51,5	4,36	5,54	0	0	0,75	0,96	0,22	0,2	4,51	2,89	0,058
Item	Kilo gram	DM (g)	As h (g)	CP (g)	NDF (g)	ADF (g)	CF (g)	CFat (g)	Ca (g)	P (g)	Fe (mg)	Zn (mg)	Mg (g)
Browses													
<i>Acacia leaves & twigs</i>	0,84	303,24	18,48	64,68	122,22	76,104	0	0	2,436	0,42	30,324	5,628	0,588
<i>Willow, black twigs & leaves</i>	0,85	348,5	24,65	41,65	178,5	138,55	0	0	5,1	0,77	106,25	80,75	0,68
Total:	1,69	651,74	43,13	106,33	300,72	214,65	0	0	7,536	1,19	136,574	86,378	1,268
Hay													
<i>Alfalfa/luceme</i>	8,5	7225	705,5	1351,5	3145	2040	2465	289	90,1	20,4	1734	212,5	18,7
Total:	8,5	7225	705,5	1351,5	3145	2040	2465	289	90,1	20,4	1734	212,5	18,7
Item	Kilo gram	DM (g)	As h (g)	CP (g)	NDF (g)	ADF (g)	CF (g)	CFat (g)	Ca (g)	P (g)	Fe (mg)	Zn (mg)	Mg (g)
Concentrates													
<i>Horse pellet (Agrifirm 7715506)</i>	0,79	695,2	70,31	116,13	161,95	73,47	54,51	23,7	8,69	6,32	147,73	110,6	1,896
Total concentrates :	0,79	695,2	70,31	116,13	161,95	73,47	54,51	23,7	8,69	6,32	147,73	110,6	1,896
Total whole diet:	11	8.623	823	1.580	3.608	2.328	2.520	314	107	28	2.023	412	22

Köln Zoo, November 2006

Table T: Average offered diet per okapi per day

Item	Kilogram	DM (g)	Ash (g)	CP (g)	NDF (g)	ADF (g)	CF (g)	CFat (g)	Ca (g)	P (g)	Fe (mg)	Zn (mg)	Mg (g)
Fruits :													
<i>Apple</i>	0,18	26,28	0,54	0,45	0	0	0,792	0,702	0,0144	0,018	0,558	0,144	0,0054
<i>Banana</i>	0,075	19,275	0,6	0,765	0	0	0	0,3675	0,0075	0,015	0,2325	0,12	0,0675
Total:	0,255	45,555	1,14	1,215	0	0	0,792	1,0695	0,0219	0,033	0,7905	0,264	0,0729
Vegetables :													
<i>Carrot</i>	0,18	21,78	1,584	1,782	0	0	0	0,36	0,072	0,072	2,34	0,756	0,0252
<i>Celery</i>	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Endive</i>	0,25	14	2,625	3,325	0	0	1,025	0,45	0,125	0,1	2,4	1,325	0,0225
Total:	0,43	35,78	4,209	5,107	0	0	1,025	0,81	0,197	0,172	4,74	2,081	0,0477
Total Fruits & Veg.:	0,685	81,335	5,349	6,322	0	0	1,817	1,8795	0,2189	0,205	5,5305	2,345	0,1206
Item	Kilogram	DM (g)	Ash (g)	CP (g)	NDF (g)	ADF (g)	CF (g)	CFat (g)	Ca (g)	P (g)	Fe (mg)	Zn (mg)	Mg (g)
Browes													
<i>Dried raspberry</i>	0,021	21	1,3356	2,4465	9,1749	5,271	0	0,4767	0,2079	0,0294	9,87	0,42	0,0294
<i>Maple (leaves)</i>	0,105	105	5,985	11,445	10,206	7,581	34,44	2,52	1,8795	0,0735	0	0	0
<i>Willow, black twigs & leaves</i>	0,12	49,2	3,48	5,88	25,2	19,56	0	0	0,72	0,108	15	11,4	0,096
Total:	0,246	175,2	10,801	19,772	44,581	32,412	34,44	2,9967	2,8074	0,2109	24,87	11,82	0,1254
Hay													
<i>Alfalfa/luceme</i>	2	1700	166	318	740	480	580	68	21,2	4,8	408	50	4,4
Total:	2	1700	166	318	740	480	580	68	21,2	4,8	408	50	4,4
Item	Kilogram	DM (g)	Ash (g)	CP (g)	NDF (g)	ADF (g)	CF (g)	CFat (g)	Ca (g)	P (g)	Fe (mg)	Zn (mg)	Mg (g)
Concentrates													
<i>Beet pulp*</i>	0,52	202,8	13,364	21,84	0	0	37,96	0	0	0	0	0	0
<i>Horse pellet (Agrifirm 7715506)</i>	0,72	633,6	64,08	105,84	147,6	66,96	49,68	21,6	7,92	5,76	134,64	100,8	1,728
Total concentrates:	1,24	836,4	77,444	127,68	147,6	66,96	87,64	21,6	7,92	5,76	134,64	100,8	1,728
Total whole diet:	4	2.793	260	472	932	579	704	94	32	11	573	165	6

* = this amount is not soaked in water

Jardim Zoologico De Lisboa, November 2006

Table U: Average offered diet per okapi per day

Item	Kilogram	DM (g)	As h (g)	CP (g)	NDF (g)	ADF (g)	CF (g)	CFat (g)	Ca (g)	P (g)	Fe (mg)	Zn (mg)	Mg (g)
Fruits :													
<i>Apple</i>	0,15	21,9	0,45	0,375	0	0	0,66	0,585	0,012	0,015	0,465	0,12	0,0045
<i>Banana</i>	0,23	59,11	1,84	2,346	0	0	0	1,127	0,023	0,046	0,713	0,368	0,207
<i>Grapes</i>	0,2	36	0,92	1,3	0	0	0,72	0,54	0,04	0,04	0,98	0,16	0,018
Total:	0,58	117,01	3,21	4,021	0	0	1,38	2,252	0,075	0,101	2,158	0,648	0,2295
Vegetables :													
<i>Carrot</i>	0,15	18,15	1,32	1,485	0	0	0	0,3	0,06	0,06	1,95	0,63	0,021
<i>Celery</i>	0,1	6,2	0,95	0,95	0	0	0	0,15	0,06	0,04	0,45	0,12	0,011
<i>Leek</i>	0,1	11	0,88	2,22	0	0	0	0,32	0,09	0,05	1	0,31	0,019
<i>Onion</i>	0,1	15,5	0,6	1,28	0	0	0,34	0,23	0,03	0,04	0,5	1,4	0,01
<i>Cabbage (red&white)</i>	0,1	9	0,6	1,31	0,66	0	0,92	0,18	0,04	0,03	0,44	0,19	0,02
Total:	0,55	59,85	4,35	7,245	0,66	0	1,26	1,18	0,28	0,22	4,34	2,65	0,081
Total Fruits & Veg.:	1,13	176,86	7,56	11,27	0,66	0	2,64	3,432	0,355	0,321	6,498	3,298	0,3105
Item	Kilogram	DM (g)	As h (g)	CP (g)	NDF (g)	ADF (g)	CF (g)	CFat (g)	Ca (g)	P (g)	Fe (mg)	Zn (mg)	Mg (g)
Browse s													
<i>Willow black twigs and leaves</i>	2,1	861	60,9	102,9	441	342,3	0	0	12,6	1,89	262,5	199,5	1,68
Total:	2,1	861	60,9	102,9	441	342,3	0	0	12,6	1,89	262,5	199,5	1,68
Hay													
<i>Alfalfa/luceme</i>	5	4250	415	795	1850	1200	1450	170	53	12	1020	125	11
Total:	5	4250	415	795	1850	1200	1450	170	53	12	1020	125	11
Item	Kilogram	DM (g)	As h (g)	CP (g)	NDF (g)	ADF (g)	CF (g)	CFat (g)	Ca (g)	P (g)	Fe (mg)	Zn (mg)	Mg (g)
Concentrates													
<i>Alfalfa pellet(CAVO)</i>	0,8	728	106,4	136,8	0	0	162,4	28	0	0	0	0	0
<i>Horse pellet (Agrifirm 7715506)</i>	1,6	1408	142,4	235,2	328	148,8	110,4	48	17,6	12,8	299,2	224	3,84
Total concentrates :	2,4	2136	248,8	372	328	148,8	272,8	76	17,6	12,8	299,2	224	3,84
Total whole diet:	11	7.424	732	1.281	2.620	1.691	1.725	249	84	27	1.588	552	17

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Table V: Average offered diet per okapi per day

Item	Kilogram	DM (g)	As h (g)	CP (g)	NDF (g)	ADF (g)	CF (g)	CFat (g)	Ca (g)	P (g)	Fe (mg)	Zn (mg)
Fruits :												
<i>Apple</i>	0,12	17,52	0,36	0,3	0	0	0,528	0,468	0,0096	0,012	0,372	0,096
<i>Banana</i>	0,15	38,55	1,2	1,53	0	0	0	0,735	0,015	0,03	0,465	0,24
Total:	0,27	56,07	1,56	1,83	0	0	0,528	1,203	0,0246	0,042	0,837	0,336
Vegetables :												
<i>Carrot</i>	0,27	32,67	2,376	2,673	0	0	0	0,54	0,108	0,108	3,51	1,134
<i>Spinach</i>	0,12	8,4	1,536	2,568	0	0	0,48	0,312	0,132	0,06	4,2	0,516
<i>Cabbage (red&white)</i>	0,8	72	4,8	10,48	5,28	0	7,36	1,44	0,32	0,24	3,52	1,52
Total:	1,19	113,07	8,712	15,721	5,28	0	7,84	2,292	0,56	0,408	11,23	3,17
Total Fruits & Veg.:	1,46	169,14	10,272	17,551	5,28	0	8,368	3,495	0,5846	0,45	12,067	3,506
Item	Kilogram	DM (g)	As h (g)	CP (g)	NDF (g)	ADF (g)	CF (g)	CFat (g)	Ca (g)	P (g)	Fe (mg)	Zn (mg)
Browes												
<i>Willow, black twigs & leaves</i>	1,5	615	43,5	73,5	315	244,5	0	0	9	1,35	187,5	142,5
Total:	1,5	615	43,5	73,5	315	244,5	0	0	9	1,35	187,5	142,5
Hay												
<i>Alfalfa/luceme</i>	4,3	3655	356,9	683,7	1591	1032	1247	146,2	45,58	10,32	877,2	107,5
Total:	4,3	3655	356,9	683,7	1591	1032	1247	146,2	45,58	10,32	877,2	107,5
Item	Kilogram	DM (g)	As h (g)	CP (g)	NDF (g)	ADF (g)	CF (g)	CFat (g)	Ca (g)	P (g)	Fe (mg)	Zn (mg)
Concentrates												
<i>Linseed</i>	0,1	91	4,67	21,68	0	0	9,35	34,9	0,35	0,56	30,53	4,97
<i>White bread</i>	0,01	6,2	0,16	0,761	0	0	0,167	0,12	0,0056	0,0087	0,095	0,05
<i>ADF #16 Herbivore</i>	3	2700	222	513	870	465	375	96	24,3	20,4	930	450
<i>Oat bran</i>	1	934,5	28,9	173	0	0	0	70,3	0,6	7,3	54,1	31,1
Total concentrates :	4,11	3731,7	255,73	708,441	870	465	384,517	201,32	25,2556	28,2687	1014,725	486,12
Total whole diet:	11,4	8.171	666	1.483	2.781	1.742	1.640	351	80	40	2.091	740

Mg (g)
0,0036
0,135
0,1386
0,0378
0,06
0,16
0,2578
0,3964

Mg (g)
1,2
1,2
9,46
9,46

Mg (g)
0,35
0,0025
9
2,4
11,7525
23

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Table W: Average offered diet per okapi per day

Item	Kilo gram	DM (g)	As h (g)	CP (g)	NDF (g)	ADF (g)	CF (g)	CFat (g)	Ca (g)	P (g)	Fe (mg)	Zn (mg)
Fruits :												
<i>Apple</i>	1,46	213,16	4,38	3,65	0	0	6,424	5,694	0,1168	0,146	4,526	1,168
<i>Banana</i>	0,72	185,04	5,76	7,344	0	0	0	3,528	0,072	0,144	2,232	1,152
Total:	2,18	398,2	10,14	10,994	0	0	6,424	9,222	0,1888	0,29	6,758	2,32
Vegetables :												
<i>Carrot</i>	0,45	54,45	3,96	4,455	0	0	0	0,9	0,18	0,18	5,85	1,89
<i>Onion</i>	0,14	21,7	0,84	1,792	0	0	0,476	0,322	0,042	0,056	0,7	1,96
<i>Lettuce</i>	0,54	32,4	3,78	5,832	0	0	2,862	1,242	0,27	0,162	5,832	1,188
<i>Cabbage (red&white)</i>	1,54	138,6	9,24	20,174	10,164	0	14,168	2,772	0,616	0,462	6,776	2,926
Total:	2,67	247,15	17,82	32,253	10,164	0	17,506	5,236	1,108	0,86	19,158	7,964
Total Fruits & Veg.:	4,85	645,35	27,96	43,247	10,164	0	23,93	14,458	1,2968	1,15	25,916	10,284
Item	Kilo gram	DM (g)	As h (g)	CP (g)	NDF (g)	ADF (g)	CF (g)	CFat (g)	Ca (g)	P (g)	Fe (mg)	Zn (mg)
Browses												
<i>Willow, black (leaves&twigs)</i>	0,43	176,3	12,47	21,07	90,3	70,09	0	0	2,58	0,387	53,75	40,85
Total:	0,43	176,3	12,47	21,07	90,3	70,09	0	0	2,58	0,387	53,75	40,85
Hay												
<i>Alfalfa/luceme</i>	5	4250	415	795	1850	1200	1450	170	53	12	1020	125
Total:	5	4250	415	795	1850	1200	1450	170	53	12	1020	125
Item	Kilo gram	DM (g)	As h (g)	CP (g)	NDF (g)	ADF (g)	CF (g)	CFat (g)	Ca (g)	P (g)	Fe (mg)	Zn (mg)
Concentrates												
<i>Oats, hulled</i>	0,68	605,2	12,92	87,72	28,56	12,92	12,92	51	0,476	2,856	40,12	21,08
<i>Nuts, mixed*</i>	1,6	1456	36,8	86,08	0	0	60,48	361,6	0,88	3,2	50,56	41,92
<i>Com</i>	0,68	612	17	87,04	0	0	0	32,64	0	2,448	14,28	12,24
<i>Whole meal bread</i>	0,8	464	12,16	56,08	0	0	24	6,88	0,48	1,6	16	16,8
Total concentrates :	3,76	3137,2	78,88	316,92	28,56	12,92	97,4	452,12	1,836	10,104	120,96	92,04
Total whole diet:	14	8.209	534	1.176	1.979	1.283	1.571	637	59	24	1.221	268

* = Average values from several kinds of nuts (Jansen and Nijboer, 2003)

Mg (g)
0,0438
0,648
0,6918
0,063
0,014
0,0486
0,308
0,4336
1,1254

Mg (g)
0,344
0,344
11
11

Mg (g)
0,816
2,72
1,088
0,72
5,344
18

Appendix 5: Results laboratory analysis

Stuttgart as well as London Zoo has sent samples of hay and concentrates samples to analyze for nutritional contents:

Samples of Stuttgart and London Zoo

Type of sample	Stuttgart	London
Lucerne hay (3 samples)	+/- 700 gr.	-
Concentrates (Pb. horse pellets)	+/- 500 gr.	-
Canadian clover		+/- 250 gr.
Oats and bran	-	+/- 150 gr.
Diary pellets	-	+/- 150 gr.
Linseed cake	-	+/- 150 gr.

Dry matter determination

Dry matter test

Table 1: Results weighing and drying of hay and concentrates

	Weight of holder (in gr.)	Weight of sample (in gr.)	Weight of holder + sample before drying (in gr.)	Weight of holder + sample after drying (in gr.)	Amount of moist evaporated (in gr.)	% DM
Lucerne hay:						
Sample 1	992,54	278,14	1270,68	1233,45	37,23	86,6
Sample 2	1004,59	199,66	1204,25	1177,60	26,65	86,6
Sample 3	1007,35	228,61	1235,96	1204,64	31,32	86,3
Concentrates:						
Sample 1	88,83	100,17	189,00	177,00	12,00	88
Sample 2	90,35	100,02	190,37	179,37	11,00	89
Sample 3	88,61	100,17	188,78	177,87	10,91	89,1
Canadian clover:						
Total	413,55	252,38	665,93	-	-	87,3
Clover rough	413,56	161,78	575,34	553,58	21,76	86,6
Powder residue	82,57	88,26	170,82	160,13	10,69	87,9
Oats & Bran	90,31	100,06	190,37	178,32	12,05	88
Diary pellets 16	88,75	100,44	189,19	177,36	11,83	88,2
Linseed cake	88,57	100,21	188,78	176,01	12,77	87,6

Calculation: $100\% - \frac{100 * \text{amount of moist evaporated}}{\text{Weight of sample}}$

Air dry matter test

Table 2: Results weighing and drying of hay and concentrates

	Weight of holder (in gr.)	Weight of sample (in gr.)	Weight of holder + sample before drying (in gr.)	Weight of holder + sample after drying (in gr.)	Amount of moist evaporated (in gr.)	% Air Dry Matter (ADM)
Lucerne hay:						
Sample 1	15,1180	3,9959	19,1139	18,9286	0,1853	95,4
Sample 2	16,6871	4,8572	21,5443	21,3214	0,2229	95,4
Concentrates:						
Sample 1	15,3813	4,3423	19,7236	19,5337	0,1899	95,6
Sample 2	15,1076	3,2253	18,2429	18,1933	0,0496	98,5
Canadian clover:						
Total						
Sample 1	13,8708	4,8441	18,7149	18,6643	0,0506	99
Sample 2	16,7391	4,5539	21,293	21,2045	0,0885	98,1
Clover rough						
Sample 1	17,7502	3,8420	21,5922	21,5325	0,0597	98,5
Sample 2	12,3246	4,8703	17,1949	17,1224	0,0725	98,5
Powder residue						
Sample 1	13,4018	3,9878	17,3896	17,3700	0,0196	99,5
Sample 2	12,3849	4,7350	17,1199	17,0880	0,0319	99,3
Oats & Bran						
Sample 1	12,7589	3,5356	16,2945	16,2804	0,0141	99,6
Sample 2	13,5718	4,4677	18,0395	18,0214	0,0181	99,6
Diary pellets 16						
Sample 1	17,4806	4,7461	22,2267	22,2087	0,018	99,6
Sample 2	16,8565	3,8006	20,6571	20,6444	0,0127	99,7
Linseed cake						
Sample 1	13,9761	3,7892	17,7653	17,7256	0,0397	99
Sample 2	15,1230	4,5228	19,6458	19,5923	0,0535	98,8

Calculation: $100\% - \frac{100 * \text{amount of moist evaporated}}{\text{Weight of sample}}$

Ash determination

Table 3: Results weighing and ashing of hay and concentrates

	Weight of holder (in gr.)	Weight of sample (in gr.)	Weight of holder + sample before ashing (in gr.)	Weight of holder + sample after ashing (in gr.)	Weight of ash (in gr.)	% Ash
Lucerne hay:						
Sample 1	33,2555	3,1328	36,3883	33,4926	0,2371	7,57
Sample 2	23,4825	3,5883	27,0708	23,7596	0,2771	7,72
Concentrates:						
Sample 1	18,5223	3,2717	21,794	18,7786	0,2563	7,83
Sample 2	23,6469	3,4400	27,0869	23,9163	0,2694	7,83
Canadian clover:						
Total						
Sample 1	14,0044	3,1351	17,1395	14,4020	0,3976	12,68
Sample 2	19,3728	4,0037	23,3765	19,8877	0,5149	12,86
Clover rough						
Sample 1	18,5951	2,7939	21,389	18,8488	0,2537	9,08
Sample 2	23,0195	3,3896	26,4091	23,3249	0,3054	9
Powder residue						
Sample 1	26,9866	3,6795	30,6661	27,4203	0,4337	11,79
Sample 2	21,9710	3,1322	25,1032	22,3306	0,3596	11,48
Oats & Bran						
Sample 1	22,6407	3,1313	25,772	22,7845	0,1438	4,59
Sample 2	19,0758	3,7628	22,8386	19,2491	0,1733	4,61
Diary pellets 16						
Sample 1	22,7202	3,8812	26,6014	23,0413	0,3211	8,27
Sample 2	23,2256	3,2282	26,4538	23,4929	0,2673	8,28
Linseed cake						
Sample 1	33,7616	3,4551	37,2167	34,0399	0,2783	8,05
Sample 2	23,4176	3,9199	27,3375	23,7324	0,3148	8,03

Calculation: $\frac{\text{Weight of ash}}{100} * \text{Weight of sample}$

Crude protein determination

Table 4: Results protein determination

	Weight of sample	Breakpoint HCl (in ml)	% Crude protein
Lucerne hay:			
Sample 1	0,8060	12,63	13,4
Sample 2	0,8187	12,7	13,3
Concentrates:			
Sample 1	0,8103	15,35	16,3
Sample 2	0,8253	15,85	16,5
Canadian clover:			
Total			
Sample 1	0,8256	19,60	20,5
Sample 2	0,8005	19,03	20,5
Clover rough			
Sample 1	0,8311	17,87	18,5
Sample 2	0,8422	17,88	18,3
Powder residue			
Sample 1	0,8088	20,94	22,3
Sample 2	0,8036	21,09	22,6
Oats & Bran			
Sample 1	0,8851	15,24	14,8
Sample 2	0,8404	14,53	14,8
Diary pellets 16			
Sample 1	0,8364	16,3	16,7
Sample 2	0,8446	16,2	16,5
Linseed cake			
Sample 1	0,8484	28,27	28,8
Sample 2	0,8592	30,04	30,0
Standard			
Sample 1	-	0,30	

Calculation: $\frac{6,25 * 14 * v * N}{p} * 100\% = \% \text{ Crude protein}$

6,25 = conversion factor 100/16

14 = Atom weight N

v = ml HCl

N = normality HCl

p = Weight of sample

Crude fiber determination

Table 5: Results crude fiber determination

	Weight of filter bag (W1)	Weight of sample (W2)	Weight of bags in desiccant pouch (Step 17)	Weight of holder	Weight of ashed bag and sample (organic matter) (W3)	% Crude Fiber
Lucerne hay:						
Sample 1	0,4978	1,0506	0,8801	21,8712	0,8654	35,46
Sample 2	0,5124	1,0168	0,8803	24,9169	0,8658	35,22
Concentrates:						
Sample 1	0,5147	1,0025	0,6502	23,1284	0,6444	13,46
Sample 2	0,5127	1,0178	0,6561	20,9868	0,6489	13,86
Canadian clover:						
Total						
Sample 1	0,5230	1,0023	0,8564	23,1854	0,8172	29,87
Sample 2	0,5171	1,0032	0,8320	22,8727	0,7934	28,06
Clover rough						
Sample 1	0,5196	1,0109	0,7988	22,3635	0,7826	26,53
Sample 2	0,5186	1,0125	0,7942	22,6863	0,7795	26,28
Powder residue						
Sample 1	0,5122	1,0175	0,6263	22,9821	0,6083	9,95
Sample 2	0,5249	1,0273	0,6303	24,6315	0,6098	8,78
Oats & Bran						
Sample 1	0,5096	1,0295	0,6213	24,6107	0,6182	11,07
Sample 2	0,5126	1,0173	0,6234	23,1988	0,621	11,16
Diary pellets 16						
Sample 1	0,5214	1,0254	0,6144	22,4130	0,6102	9,17
Sample 2	0,5190	1,0025	0,6105	21,8802	0,6064	9,24
Linseed cake						
Sample 1	0,5212	1,0186	0,7283	23,3687	0,6992	17,99
Sample 2	0,5230	1,0274	0,5792	22,2964	0,5702	5,1
Standard	0,5244	-	0,5206	23,5742	0,5185	C1 = 0,9927536

C1 = Blank bag correction

Calculation:

$$\% \text{ Crude Fiber} = 100 * \frac{(W3 - (W1 * C1))}{W2}$$

Acid detergent fiber determination

Table 6: Results ADF determination

	Weight of filter bag (W1)	Weight of sample (W2)	Weight of dried bag (W3)	% ADF (as received basis)
Lucerne hay:				
Sample 1	0,5211	0,4619	0,7042	39,87
Sample 2	0,4972	0,4571	0,6745	39,01
Concentrates:				
Sample 1	0,4990	0,4743	0,5755	16,34
Sample 2	0,5060	0,4558	0,5812	16,72
Canadian clover:				
Total				
Sample 1	0,5263	0,5079	0,6317	20,96
Sample 2	0,5258	0,5253	0,6431	22,53
Clover rough				
Sample 1	0,5223	0,5180	0,6659	27,93
Sample 2	0,5236	0,4893	0,6599	28,07
Powder residue				
Sample 1	0,5188	0,4622	0,6020	18,22
Sample 2	0,5261	0,4733	0,6067	17,25
Oats & Bran				
Sample 1	0,5037	0,5053	0,5793	16,16
Sample 2	0,5046	0,5171	0,5846	15,67
Diary pellets 16				
Sample 1	0,5026	0,5324	0,5807	14,86
Sample 2	0,5028	0,5151	0,5787	14,94
Linseed cake				
Sample 1	0,5114	0,4632	0,6089	21,27
Sample 2	0,5092	0,5241	0,6229	21,89
Standard	0,5183 (C1)	-	0,5175	C1 = 0,9984564 ≈ 0,998

C1 = Blank bag correction

Calculation:

$$\% \text{ ADF} = 100 * \frac{(W3 - (W1 * C1))}{W2}$$

Neutral detergent fiber determination

Table 7: Results NDF determination

	Weight of filter bag (W1)	Weight of sample (W2)	Weight of dried bag (W3)	% NDF (as received basis)
Lucerne hay:				
Sample 1	0,5219	0,4801	0,7664	51,02
Sample 2	0,5201	0,4941	0,7742	51,53
Concentrates:				
Sample 1	0,5245	0,5025	0,7286	40,72
Sample 2	0,5204	0,5325	0,7389	41,13
Canadian clover:				
Total				
Sample 1	0,5383	0,5388	0,7217	34,14
Sample 2	0,5230	0,5437	0,7615	43,96
Clover rough				
Sample 1	0,5236	0,5518	0,7484	40,83
Sample 2	0,5159	0,5136	0,7289	41,57
Powder residue				
Sample 1	0,5232	0,4834	0,6852	33,8
Sample 2	0,5378	0,5062	0,7094	34,01
Oats & Bran				
Sample 1	0,5117	0,4948	0,7185	41,9
Sample 2	0,5209	0,4849	0,7117	39,45
Diary pellets 16				
Sample 1	0,5258	0,4872	0,7114	38,20
Sample 2	0,5229	0,5012	0,7329	42
Linseed cake				
Sample 1	0,5156	0,5578	0,7547	42,96
Sample 2	0,5197	0,4788	0,7012	38,01
Standard	0,5366 (C1)	-	0,5362	C1 = 0,9992545 ≈ 0,999

C1 = Blank bag correction

Calculation:

$$\% \text{ NDF} = 100 * \frac{(W3 - (W1 * C1))}{W2}$$

Appendix 6: Calculations for the revised advice

- According to the nutrition guidelines 2001, 2% DM /Body Weight (BW) should be offered to an okapi per day (1,8% DM intake/BW).
- The average BW of the okapis that were taken in the questionnaire was 268,5 kg.

$268,5 * 0,02 = 5,37 \text{ kg (5370 grams) DM}$ on offered basis per okapi per day.

$268,5 * 0,018 = 4,83 \text{ kg (4830 grams) DM}$ on intake basis per okapi per day.

Now the DM intake per day per okapi is known, one can calculate what the concentration of NDF and CP should be in the 5,37 kg DM in order to meet the okapis' (expected) requirements for NDF and CP.

Minimum requirement NDF on DM basis: 30% $\rightarrow 5370 * 0,30 = 1611 \text{ grams NDF/day/okapi}$

Requirement CP on DM basis: 18,5% $\rightarrow 5370 * 0,185 = 994 \text{ grams CP/day/okapi}$

NDF

Since zoos can not offer a 100% browse diet to okapis, a obtainable percentage should be considered in the advice.

From the questionnaire (2006) it resulted that 0,24 kg – 3,1 kg fresh browse was offered per day per okapi. This is on average 1,67 kg per day per okapi.

In order to increase the average amounts of browse offered, and still keep the amount obtainable for zoos, it was decided that the average offered browse in zoos should increase with 10% $\rightarrow 1,67 * 1,1 = 1,84 \text{ kg. (1840 grams) fresh browse}$

1,84 kg fresh browse = 0,773 kg DM browse (42% DM in average browse offered in zoos)

$100 * (0,773 / 5,37) = 14,4\% \text{ browse in the DM diet should be offered, rounded off to } 15\%$

The average NDF% in fresh browse is: 19,2% (Jansen and Nijboer, 2003)

$1840 * 0,192 = 353 \text{ grams NDF in the offered fresh browse}$

Minimum requirement is 1611 grams NDF(see above) per okapi per day.

$1611 - 353 = 1258 \text{ grams NDF}$ is not yet covered by the amount of browse offered per day per okapi.

Another ingredient high in NDF in the diet of the okapi in captivity is Lucerne hay. The Lucerne hay should therefore cover the amount of NDF that can not be covered by browse (1258 grams left).

NDF% in Lucerne hay is 37% = 370 g NDF/kg fresh Lucerne hay

$1258 / 370 = 3,4 \text{ kg fresh Lucerne hay}$ should be offered per day per okapi in order to meet the okapis' NDF requirement.

DM% of Lucerne hay is: 85%

$3,4 * 0,85 = 2,89 \text{ kg DM Lucerne hay}$

$2,89 / 5,37 = 53,8\% \text{ Lucerne hay in the DM diet, rounded off to } 55\%$

The 14,4% browse will cover for 353 grams NDF

The 53,8% Lucerne hay will cover for 1258 grams NDF

$353 + 1258 = 1611 \text{ grams} = 30\% \text{ NDF in the } 5,37 \text{ kg DM diet}$

CP

The average CP% in fresh browse is: 10,5% (Jansen and Nijboer, 2003)

1,84 kg (see above) fresh browse * 0,105 = **193 grams CP in the offered fresh browse**

CP requirement in offered diet is: 18,5% → $0,185 * 5370 = 994$ grams per day per okapi
(requirement in the intake diet = 18,5% * 4,83 kg = 894 grams CP)

$994 - 193 = 801$ grams CP left

The CP% in fresh Lucerne hay is: 15,9% (Nijboer and Jansen, 2003) = 159 grams CP / kg fresh Lucerne hay.

3,4 kg (see above) Lucerne hay * 159 = **540,6 grams CP in the total offered fresh Lucerne hay**

There was 801 grams CP left, which could not be covered by the offered browse.

$801 - 540,6 = 260,4$ grams CP left that can not be covered by the amounts of browse and Lucerne hay offered.

Since it is expected that the amounts of concentrates and unmolassed beetpulp offered will be consumed completely, the actual left amount of CP that needs to be covered is: 233,7 grams.

Calculation:

$193 + 540,6 = 733,6$ grams CP offered already in browse and Lucerne hay

$(733,6/5370) * 100 = 13,66\%$ of the CP requirement is already covered in browse and Lucerne hay on an offered basis.

The left amount of CP should then be calculated on an intake basis, which was 4,83 kg DM.

The CP requirement was 18,5%

$18,5 - 13,66 = 4,84\%$ left

$4,84\% * 4,83 \text{ kg} = 233,7$ grams CP left.

This amount should then finally be covered by the amounts of concentrates and unmolassed beetpulp (UBP) offered to the okapis.

The average CP% in concentrates (resulted from questionnaire 2006; Zootrition V2.6) in zoos is: 15,6% on DM basis. The average CP% in UBP is: 10,3% on DM basis (Hyslop and Cuddeford, 1999).

The proportion between concentrates and UBP should be 1: 1,5, according to the Antwerp advice (December 2006). This means that the average CP% in the mixed concentrates and UBP will be $12,4\% = 124 \text{ g CP/kg}$ mixed concentrates and UBP on a DM basis.

$233,7 / 124 = 1,88$ kg concentrates and UBP on a DM basis should be offered in order to meet the CP requirement (18,5%) of the okapi.

$1,88 / 5,37 = 35\%$ concentrates and UBP in the DM diet of the okapi in order to meet their CP requirement.

The average DM% of the concentrates and UBP is: 87%

$1,88 \text{ kg} / 0,87 = 2,16$ kg fresh concentrates and UBP.

But when the energy is calculated for this 2,16 kg fresh concentrates and UBP, it results in a too high energy intake for the okapi (13.086 kcal /okapi/day → requirement is on average 8127 kcal/okapi/day) which could cause obesity problems.

Therefore, the concentrates and UBP should be reduced.

An amount of **1,5 kg DM (1,72 kg fresh) concentrates and UBP** need to be offered (and consumed), in order to reduce the expected total energy intake to 10.651 kcal per okapi per day (**this amounts to 32% concentrates and UBP in the total DM diet, which can be rounded off to 30% in the total DM diet**). This is still too high, compared with the energy requirement of 8127 kcal per okapi per day, but one has to make compromises concerning CP and energy intake.

Calculations:

1 kg DM UBP =	4144 kcal	103 gr CP
1 kg DM average concentrates =	2698 kcal	156 gr CP
1 kg DM Lucerne hay =	1516 kcal	187 gr CP
1 kg DM browse =	1956 kcal	250 gr CP

Browse should be fed at a minimum of 0,773 kg DM (1,84 kg fresh) per okapi per day (see above). Of this 0,773 kg, it is expected that 90% will be taken in by the okapi (nutrition guidelines 2001).

$0,773 * 0,9 = 0,696$ kg intake.

$0,696 * 1956$ kcal = 1361 kcal in the browse on intake basis.

Lucerne hay should be fed at a minimum of 2,89 kg DM (3,4 kg fresh) per okapi per day (see above). Of this 2,89 kg, it is expected that 90% will be taken in (nutrition guidelines 2001).

$2,89 * 0,9 = 2,6$ kg DM intake.

$2,6 * 1516 = 3942$ kcal in the Lucerne hay on intake basis.

Of the 1,5 kg DM concentrates and UBP, 0,9 kg DM will be covered by UBP and 0,6 kg will be covered by concentrates (proportion of 1:1,5 → Antwerp advice, November 2006).

$0,9 * 4144 = 3730$

$0,6 * 2698 = 1619$ +

Total = 5349 kcal in the concentrates and UBP on offered and intake basis (see above).

The total kcal that is expected to be taken in by an average okapi (BW = 268,5 kg) will be:

1,84 kg fresh browse (offered) =	1361 kcal (intake)	173,7 gr CP (intake)
3,4 kg fresh Lucerne hay (offered) =	3942 kcal (intake)	486,5 gr CP (intake)
<u>1,72 kg fresh concentrates and UBP (offered) =</u>	<u>5349 kcal (intake)</u>	<u>186,3 gr CP (intake)</u>
Total intake:	10.652 kcal	846,5 gr CP

The 14,4% (DM) browse will cover for 173,7 grams CP intake

The 53,8% (DM) Lucerne hay will cover for 486,5 grams CP intake

The 32% (DM) concentrates and UBP will cover for 186,3 grams CP intake

$173,7 + 486,5 + 186,3 = 846,5$ grams CP will be consumed. The CP requirement of the okapi is on average 894 grams per okapi per day (18,5% of 4,83 kg DM intake).

NFE

NFE in concentrates and beetpulp =

34,5%DM $\rightarrow 0,345 * 1,5 \text{ kg DM (see above)} =$ 518 grams NFE

NFE in Lucerne hay = 23,8%DM $\rightarrow 0,238 * 2,89 \text{ kg DM (see above)} =$ 688 grams NFE

NFE in Browse = 9,4%DM $\rightarrow 0,094 * 0,773 \text{ kg DM (see above)} =$ 73 grams NFE

(all NFE percentages are calculated by DM% – (Ash% + NDF% + CP%) values derived from: Jansen and Nijboer, 2003; Hyslop and Cuddeford, 1999)

518 + 688 + 73 = 1279 grams NFE in new recommended 5,37 kg DM diet / okapi / day.

$(1279/5370)*100 = 23,8\%$ **NFE on DM basis on an as offered basis in new recommended diet.**

NFE in natural diet = 30,8% on a DM basis.

Therefore, the range for the new advice will be: **25-35 % NFE on a DM basis.**

Appendix 7: Proceedings meeting at Antwerp Zoo

To do list from okapi nutrition group meeting

Antwerp, 18 December 2006

Participants:

Dafna Azulai

Kim Engelhart

Joeke Nijboer

Jürgen Hummel

Francis Vercammen

Kristin Leus

Patrick Immens

Sander Hofman

By “remote control”: Marcus Claus

TO DO:

I. Samples from Epulu:

Which species

Ask Rosie:

Of the 35 species fed, which species are fed in biggest quantities and does that change over the years.

→ based on that decide on which species to ask to be collected

How to collect/store and how much

All leaves to be collected at about the same time of the day. Write down time of the day and the season and the location

Strip those parts that the okapis at the station eat off the branches and weight the leaves fresh.

Air dry in the sun

Weigh again when dry – we need minimum 400 grams dry matter per species

Transport air dried material in bags that we will send you – find a fast (3-4 days) mode of transport

What analyses

NDF, ADF, CP Ash, macro and microelements, in vitro fermentation, tannins (hydrolysable and condensed) and phenolics (salicylic acid and others), sugars

Kristin to ask Geert Janssens if they can do secondary compound analysis in Gent

Is Gent working on things like: if we go to the same browse fields frequently for browse to be fed in captivity, do we stimulate those trees to produce more secondary plant compounds as protection?

II. Interim recommendations for captive EEP diets

- students Van Hall institute: conclusions of study for the EEP institutions to be sent around to participants of this meeting for approval
- vegetables and fruits to be taken out
- concentrates 30% **BUT !!!!!!!!!!!!!!!!!!!!!** not more 10-12% “real pellets” and 18% from unmolassed beet pulp
- at least 15% of DM intake from leaves (not branch!). Alternatives in winter: frozen (thawed) leaves, silage, dried (rehydrated) leaves. Less willow and more variety in species (to be on safe side re. plant secondary compounds)
- alfalfa 50%: palatable, good quality
- increase number of feeds per day (at least three). Spread the concentrate over several feeds (min 3)
- intake 1.8% DM of body weight

Joeke will contact SSP nutrition advisor to inform them on our plans and try and get some action on their side too.

III. Body condition score

Body condition score is useful tool

- Twice per year, by keeper and curator together
- Photo of each okapi at each scoring event
- Any health or diet related remarks are welcome
- Send to EEP coordinator
- Kristin to check with Zjef re. doing this web based

IV. Foot condition follow up

- Twice per year take a picture of each foot (front, rear, two sides; if possible underside)
- Any health or diet related remarks are welcome
- Send to EEP coordinator
- Kristin to check with Zjef re. doing this web based
- Incorporate hoof stuff in new necropsy protocol (Francis and vets)
- CRC Antwerp to continue with functional morphology studies
- Francis to tell Kris that radiographs need to be taken of the legs to be dissected in January

V. Forage quality

- Joeke to ask okapi SSP nutrition advisor if she can help Jürgen collect forage samples for in vitro fermentation (and for keepers to bring to Dallas Zoo?). We presume nutrition analyses has already been done in US
- Can Patrick bring the samples back when he goes to okapi keepers meeting in April?
- Jürgen wants 1 layer of alfalfa hay from each EEP institution

VI. Kidneys

- get someone to look at all the histological slides of the kidneys; Francis will ask the EEP institutions for slides/kidney samples and will look around for potential researcher

VII. Rumen

- Francis to write small protocol for collection of histological slides/sample of different sites in the rumen (instructions Marcus)
- Francis and okapi vets to incorporate this in new necropsy protocol
- Bezoars: send them to Marcus for analysis

VIII. Necropsy protocol

- Francis and okapi vets to come up with new necropsy protocol that is shorter and explains well why we want people to collect what we ask them to collect
- Ask for liver histology to be done (re. secondary plant compound damage)?

IX. Already collected necropsy reports

- Kristin to send copies to Marcus for evaluation during the EAZWV summer school
- Kristin to give Francis a list of missing reports or missing final reports
- Kristin to ask Ann Petric for missing SSP reports and send her the missing EEP reports

X. What if dead okapi in Epulu

- Cross reference our soon to be produced new necropsy protocol with the White Oak protocol for a death in Epulu
- Take picture of tooth wear
- What can and what should be collected from saliva and salivary glands?