Sumatran rhino in Sepilok

A summary of data collected by the Wildlife Department and SOS rhino between 1993 and 2007

Prepared by Dr. P. Kretzschmar, April 2008

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1. INTRODUCTION:

In 1985, the Rhino and Wildlife Conservation Committee (SRWCC) of Sabah established a local capture and breeding program which was activated in 1987. Several forest reserves were surveyed and rhinos that were exposed to poachers due to the loss of their habitat; were captured. A total of 10 rhinos were caught between 1987 and 1995 in Sabah (8 males, 2 females). Two of the captured animals, both males, died during the capturing in 1987 and 1988. One animal was released back into the wild, the Tabin Wildlife reserve, after being equipped with a radio transmitter. Eventually, a total of seven rhinos were moved to the rhino breeding center in Sepilok, Sabah (Bosi 1996, Foose 2005). The rhinos were taken care of by the the Wildlife Department Sabah (J.H.L.), which was formed in 1988, when the game branch and the SRWCC merged together. This Department is guided by the Wildlife Conservation Enactment 1997. The conservation of this species was boosted between 1995 to 1998 with funding for about US 411 000 received from the Global Environment Facility (G.E.F.) through the United Nations Development Program (UNDP) with the support of the United Nations Environment Program (UNEP) and the facilitation and coordination of the AsRSG Malaysia (Anon. 1995b). SOS rhino, a US-based conservation organization that focuses its resources and expertise on the critically endangered Sumatran rhinoceroses in Sabah, got involved in Sepilok in 1998. Dr. Nan Schaffer, a renowned veterinarian specializing in rhino reproduction, is the founder and President of SOS Rhino. She advised the former staff in Sepilok in the reproduction of the rhinos and the use of ultrasound equipment and she examined the rhinos. From November 2000 onwards SOS rhino got more involved and assisted the Sabah Wildlife Department with manpower and foreign expertise in Sepilok. Dr. Annelisa Kilbourn, Dr. Edwin Bosi, Dr. Rosa Sipangkui, Dr. Cheong Choong and Dr. Petra Kretzschmar were employed by SOS Rhino to assist the Wildlife Department with the breeding in Sepilok. They were assisted by local veterinarians and keepers which were employed by SOS rhino and the Wildlife Department. The present report gives is an overview of data collected by rangers and scientist on the health, nutrition and breeding status of the Sumatran rhinos in Sepilok between 1993 and 2007. The report does not make a claim to be complete it just summarize the information which were available to the author.

2. RHINO FACILITIES AND MANAGEMENT:

2.1 Data source:

The report contains data collected between January 1993 and December 2006. The main sources of information were monthly reports written by the head rangers of the Wildlife Department. They collected basic information on food offered and eaten, weight and health of the rhinos. These reports were complimented by reports written by veterinarian and scientist who incorporated information hormone concentration, breeding attempts, behaviour and blood chemistry and rectal temperature in their reports. The following scientific reports were used for the report:

Jan 1993 – Dec 2006	monthly reports written by head rangers of the Wildlife Department	
Nov 2000 – Feb 2001	quartely report	Dr. Annelisa Kilbourne
July 2001 – January 2002	monthly reports	Dr. Cheong Chee Choong
September 2002 – November 2002	monthly reports	Dr.Symphorosa Sipangkui
March 2004 – October 2005	data collected by the author	Dr. Petra Kretzschmar
September 2006 – December 2006	monthly reports	Dr. Cecilia Boklin

Missing data:

1987 – 1991
Dec 93
Nov 94
Sep 2000 – Nov 2000
Dec 01 Choong report exists but food data missing
Jan 03 – March 2004

2.2 Animals:

In July 1987 the first Sumatran rhino was introduced to Sepilok. It was an adult male of approximately 27 years of age. He was named after the area where he was captured, called Hutan Simpan Tenegang, in the Kinabatangan area. One and a half year later "Tenegang" got a companion, a young female called "Lun Parai". She was captured in April 1989 as an orphaned of approximately 5 years of age living under a stilt house in Bukit Belancon, in the area of Lahad Datu. Two years later, another male, "Takala", with an estimated date of birth of 1981, was captured in Sungai Pin, in the Kinabatangan area. In 1992 and 1993 two additional males were captured, "Sidom", with an estimated birth date in the wild of 1982,

and a young male of approximately 4 years named "Tanjung". The second female, called "Gelugob", was captured in 1994 in Sungai Gelugob in the Kinabatangen area. Her estimated date of birth was 1979 (needs to be discussed, this date is in the data file from Sepilok but her resulting age appears too old to me). Finally, in 1995 the last rhino was introduced to Sepilok, a young male named "Malbumi" with an estimated date of birth in the year 1990. A summary of this historical data is given in Table 1.

Table 1: Historical information of the rhinos captured and introduced to Sepilok between 1987 and 1995.

name	Sex	estimated year of birth	place of origin	date of capture	introduced to Sepilok
Teneggang	Male	1960	Hutan Simpan Teneggang, Kinabatangan, Sandakan	no information	14.07.1987
Lun Parai	Female	1984	Bukit Belacon, Lahad Datu	22.04.1989	no data
Takala	Male	1981	Sungai Pin, Kinabatangan	05.05.1991	no data
Sidom	Male	1982	Sapa Sidom, Sukau	27.08.1992	28.08.1992
Tanjung	Male	1988 - 1989	Bulud Napa, Sukau, Kinabatangan (Tanjung Panjang)	20.07.1993	23.07.1993
Gelugob	Female	1989	Sugai Gelugob, Sukau Kinabatangan	17.06.1994	20.6.94
Malbumi	Male	1990	Hutan Simpan/Rizab Hidupan Liar (Gelugob/Sandakan)	no data	21.11.1995

Picture 1: The male Tanjung in the large outdoor enclosure Picture taken in February 2005.

Picture 2: The female Gelugob in a mud wallow in the small outdoor enclosure. Picture taken in April 2004.

2.2 Rhino enclosures in Sepilok:

The rhino were housed at the Sumatran Rhinoceros Breeding Center (SRBC) in Sabah, Malaysia, within the northern strip of the Sepilok Forest Reserve (N 05° 51.841', E 117° 57.003'). The enclosures consisted of five night stalls and two outdoor enclosures. Each night stall had an indoor area with a cemented floor and a water basin and an outside area with a sandy ground and a cement wallow. The indoor areas were covered with a corrugated iron roof; the outside areas were not covered and were exposed to sunlight. A small viewing platform was attached to one night enclosure. The platform was used for VIP guests only. The outdoor enclosures consisted of natural rainforest which was fenced with walls made from tropical hardwood ("belian"). The areas differed in size. The so called "breeding enclosure" was 3.1 hectare or 0.031 square kilometers in size. The building of the breeding enclosure started in November 1990 and finished in January 1993. It was built in order to facilitate the natural breeding of the rhinos. The vegetation in this large enclosure can be characterized as a secondary rainforest consisting of a few tall trees and lots of bushes with a relatively dense canopy. Part of this enclosure was a visitor platform and a walkway for visitors which were situated at the opposite end of the night stalls. The second outdoor enclosure was much smaller, 0.4 hectare in size. The vegetation in this small outdoor enclosure can be characterized as grass land, with a few bushes and trees and with little cover against sunlight. This enclosure was used as a breeding enclosure as well. It was much easier to monitor and separate the rhinos in this small outdoor enclosure. It had in some areas a noticeable slope which was sometimes used by the male in order to mount the female. Both outdoor enclosures consisted of a mud pool which the rhinos used for a mud bath. The night enclosures and the outdoor were built next to each other and the rhinos could see and hear each other through the wooden planks.

For easier handling of the rhinos, a chute was built in September 1992. It enabled the ranger to treat the animals in case of an injury and to take measurements and collect samples without any risk for the rangers. The front and back part of the chute consist of iron poles that could be fully removed. The side parts consist of a movable iron grid which could be adjusted to the width of the animals (Picture 4).

In April 2004 the outside area was covered by an opaque net to prevent that the animals were exposed to direct sunlight, especially when they were wallowing. The floor of two outside enclosures; used for Gelugob and Tanjung during that time; were cemented in order to enable the people to clean and to disinfect the enclosure properly (Picture 3).

Picture 3: Outside area of the night enclosure after renovation.

Picture 4: Front of the chute with Gelugob inside.

Daily work schedule:

Between 7 and 9 rangers were working in the rhino unit. Two people were busy collecting the food of the rhinos (see below) and another two people were cleaning the enclosures (see below). The rest was involved with other accumulating work, such as constructions in the enclosure, blood collection, treatment of the animals etc. A Veterinarian, employed by the Wildlife Department, was always overlooking the health of the rhinos. Between 1991 and 2007, the following veterinarians were working in Sepilok: Dr. Haiwan, Dr. Edwin Bosi, Dr. Sen Nathan and Dr. Rosa Sipangkui and finally Dr. Cecilia Boklin. SOS rhino assisted the Sabah Wildlife Department with manpower and foreign expertise in Sepilok. They employed the following veterinarian and scientist: Dr. Annelisa Kilbourn, Dr. Edwin Bosi, Dr. Rosa Sipangkui, Dr. Cheong Choong and Dr. Petra Kretzschmar.

Cleaning of the enclosure and the surroundings:

a) The rhino enclosure, the water tank and the cement floor of the wallow were cleaned daily with a brush and they were disinfected with the disinfectant Dettol.

b) The wallow was cleaned and filled with water. The water level was filled to the top so that the rhino could totally submerge in the water.

c) The facility within and outside of the rhino enclosure were cleaned daily.

d) A food bath containing water and Dettol was placed at the entrance of the rhino enclosure to prevent that any infections were carried into the rhino enclosure, such as any infections from sick Orang Utans or other animals.

Feeding:

a) Two rangers went twice daily, in the morning and in the afternoon, with a car to farms and fallow land in the vicinity of Sepilok in order to chop down branches as food for the rhinos.

b) The leaves fed to the rhinos were always cleaned with fresh water before given to the rhinos. This helped to prevent any poisoning of the animals with toxin which might have been sprayed in the area were the food was harvested.

2.2.1 Frequency of releasing the rhinos into the outsight enclosure:

After completion of the outdoor enclosure, in 1993, the rhinos were released in the outside enclosure according to a rotation principle. The new captured animals were tamed first before being released in these enclosures.

In 2004
The male was usually released in the large outdoor enclosure and the female into the small. The rhinos were only released when they were healthy, and if there were enough people to monitor them. Tanjung spend 191 days of 232 days of observation in the outside enclosure (173 days in the large enclosure and 18 days in the small enclosure), and Gelugob spend 68 days of 233 days of observation in the outside enclosure (43 days in the small enclosure, 25 days in the large enclosure).

Food:

The diet of the rhinos consisted of locally-grown wild browse and locally-obtained fruits such as unpeeled bananes and jackfruits. The food was collected either by contractors (from 1993 until ?? ask Silvia) or by the staff of the Wildlife Department (from ?? – 2006). The ranger collected the food twice daily in the surrounding of Sepilok; the contractors collected the food

further away from Sepilok and delivered it once daily (need confirmation for this). The browse and fruits were washed after collection with water to avoid possible contamination with pesticides. The weight of the food species offered to each rhino was established to the nearest 1 kg and, starting from the year 2001, the leftovers collected the next morning in the enclosures were measured. These values were used to calculate the amount of food eaten by the rhinos.

The rhinos were fed 2- 4 times daily. The food was placed on the floor in the indoor enclosure of the night stall. Trace mineralized salt blocks were provided daily without restriction during the whole study period (1993 – 2006). The information on the mineral concentration of the salt blocks provided to the rhinos is limited. In 1995 a salt block by Rookies, Tithebarn, England was offered but the mineral concentration was not named. In 1998, a trace mineral block by KNZ brand containing a very high iron concentration: 3000 mg/kg (see Table ??) was provided. Iron overload associated morbidity and mortality has been identified in multiple species including rhinoceros (Paglia & Dennis 1999, Dierenfeld 2006). In the year 2004, a new mineral block by AKZO NOBEL SALT, which did not contain any iron (see Table ??), was chosen as the new trace mineral source for the rhinos.

Table ??: Trace mineral concentration of the salt block offered in 1998

Minerals	Concentration
Na	38 %
Mg	0,2 %
Fe	3000 mg/kg
Mn	830 mg/kg
Zn	810 mg/kg
Cu	220 mg/kg
I	100 mg/kg
Co	18 mg/kg

Table 2: Trace mineral composition of the salt lick provided daily in 2004 and following years

Minerals	Concentration
NaCL	> 97 %
Na	38.5 %
Mg	2000 mg/kg
Mn	830 mg/kg

Zn	810 mg/kg
Co	220 mg/kg
I	100 mg/kg
Cu	18 mg/kg
Se	10 mg/kg

Food intake:

The records of food data were not consistent. From January 1993 until August 2000, the monthly amount of food species offered to each rhino was noted, while from January 2001 until March 2004 the daily amount of food given and the amount of leftovers collected the next morning in the enclosures was recorded but not the amount of food species. From March 2004 until April 2006 both information were recorded, the daily amount of food species offered to each rhino and the amount of leftovers.

The analysis of the average amount of food offered each month to each rhino allowed the combination of all data available (from January 1993 until December 2006). The monthly amount of all food species (including fruits and browse) fed to a single rhino between 1993 and 2000 and the daily amount of food (including fruits and browse) fed between 2001 and 2006 were summed up and divided by the numbers of days within a month. The calculation of the median would be more adequate for data which are not evenly distributed such as the food data, but with the recorded data available it was not possible to conduct this analysis.

The food intake was established by subtracting the amount of leftover collected the next morning from the amount of food offered the day before. For this analysis the data from January 2001 until December 2006 were used only (excluding data from January 2003 until March 2004 that were not available see Table ??) The median amount of food eaten each day by each rhino was calculated out of the median daily amount of food eaten established for each month from each rhino. The frequency of food eaten was calculated, dividing the median daily amount of food eaten established for each month by the monthly median amount of food offered per day.

The median monthly body weight was calculated and compared with the median monthly amount of food eaten, giving the monthly consumption in relation to body mass. The median consumption level was calculated out of the monthly values.

3.4. Behavior observations:

Annelisa:

Data recorded was ultimately limited to 8AM until 5PM. Behavior prior to or after these times, collected during the first month and a half, appeared more to result from human presence than undisturbed observed behavior. When human presence was not obvious animals were noted to be sleeping before 8 AM. After 5 PM, behavior appeared related to human disturbance and feeding times again.

Figure x. Malaysian translation of key behaviors to record on daily sheet.

Behavior	Behavior
Urine Spray/ Sembur Kancing	Urine Spray/ Sembur Kancing
Vocalization/ Berbungi	Vocs/ Berbungi
Winking/ Kemaluan bekengit	Erection/ ketiragan
Discharge/ Kemaluan keluar (cairan cecal)Hingus	Flehmen/ mencari kesan betina
Swelling/ Kemaluan Bengkak	Urogenital exam/ memeriksa kemaluan betina
Color/ Kemaluan tukar warna	Penis unsheathed/ keluar sarong
Standing for male/ sedia mangawan	Follow female w/in 1 1/2 BL/ mengekori betina
Tail erection/ ekor tegak	Head resting/ kepala atas badan betina
Pacing/ jalan-jalan	Mounting/ mengawan
Joustling/ Berlaga	Jousting/ berlaga
Rubbing/ Bergesev	Pacing/ Jalan-jalan
Other/ Lain-lain	Foot Scrapping/ Gesok kaki

Observer bias, lack of experienced staff during the first months and clinical disease is believed to have influence the male's activity and interest in the female or food. Flooding prevented animals from in close proximity or introduced to one another on several occasions.

Breeding:

Annelisa:

The two animals have been placed together on multiple occasions to allow for copulation. The first introduction, on the 15th of February 2000 was based on preliminary results from the hormone analysis. The female stood for the male on two occasions. The male had an erection on both occasions but only an ejaculate on the second. No intromission occurred. Aggression developed after this and disinterest resulted in the separation of the animals for the nights after over two hours of monitoring. The second attempt to pair the animals was hindered by severe flooding of all the enclosures on the 16th of February. The 17th of February provided some relief from the torrential rains and she stood for the male once before aggression escalated and they were separated. The third and fourth introduction on the following days resulted in only aggressive behavior and for the well being of the animals, they were separated. After receiving the next blood results indicating no progesterone peak during her standing heat or the following days, pairing was attempted again. There was no interest on either side and animals were separated after they had been keeping their distance for over an hour and were

just eating. Samples sent to UPM every 2 weeks will continue to guide the pairing of the animals.

4. RESULTS:

4.1 Blood parameters

Table 3: Median concentration of blood parameters measured for the male and female Sumatran rhino in Sepilok compared with values for Sumatran rhinos given by Radcliffe.

		values	Gelugob			Tanjung		
		Radcliffe	median	IQR	n	median	IQR	n
Full blood picture								
Haemoglobin	g/dl	13-14,1	9.6	2.5	13	9	2.45	11
PCV (hematocrit)	%	34 - 45	43	6	51	40	4	9
Total W.B.C.	/cmm	7800 - 11000	8075	3050	58	5350	1425	16
reticulate count	%		0.2	0	2			
ESR	mm/hr		11.5	20.5	12	20.5	32	10
RBC	%		5.7	0.5	2			
MCV	FL		73	1	3	79	0	1
MCH	PG		25	0.5	3	29	0	1
MCHC	%		34	0	2			
RDW	%		20.1	0	1	19.4	0	1
Platelets	/cmm		192000	53250	10	193000	10500	3
Differential counts:								
Neut.	%		60	8.75	42	57	3	17
Lymph.	%		28	12.75	42	35	8	17
atypical Lymphocyte	%		0	0	2			
Mono.	%		4	4.75	42	4	4	17
Eosin	%		8	5.25	38	3	7	17
BAS	%		0	0	41	0	0	16
Renal profile								
UREA	mmol/l		2	1.45	12	2.3	0.5	10
Creatinine	umol/l	133 ± 44 *	82.5	23.8	14	74.5	11.25	10
Calcium	mg/dl	12,5 ± 1	9	4.21	7	8.9	3.52	5
corrected calcium	mmol/l		3.18	0	1	3.19	0	1
Inorganic phosphate	mmol/l		0.85	0.12	2			
uric acid	mmol/l		0.01	0.01	3	0.04	0	1
sodium	mmol/l		136.5	6.75	8	137	1.5	7

Potassium	mmol/l	4,5 ± 0,5	4.1	0.3	5	4	0.15	7
phosphate	mmol/l		1.01	0	1	0.92	0	1
Chloride	mmol/l	95 ± 5	98	7.5	8	99	3	7
Coronary risk studies								
cholesterol	Mmol/L		1.6	0.15	3	1.3	0	1
HDL cholesterol	Mmol/L		0.15	0.01	2			
LDL cholesterol	Mmol/L		1.2	0.1	2			
Triglycerides	Mmol/L		0.2	0.1	2			
Total/HDL Ratio			9.75	1.65	2			
liver function								
Total Protein	g/l	75 ± 1 *	75.5	9.8	58	68	4	17
Albumin	g/l	30 ± 1 *	38	4	13	37.5	3.5	10
Globulin	g/l	50 ± 1 *	33	3	13	33	2	9
A/G Ratio			1.1	0.2025	4	1.03	0.27	2
Total Bilirubin	umol/l	5 ± 3 *	6.5	4.25	14	9.5	4.5	10
A/K Phosphatase	U/L		73	18.25	4	85.5	20.75	4
SGOT (AST)	U/l		12.5	8	11	16.5	9	10
SGPT (ALT)	U/l		14	5.5	11	19.5	9	9
Alkaline Phosphatase	U/l		0	1	27			
GGT	U/l		10	0.5	3			
CPK	U/l		279	0	1			
LDH	IU/L		803	57	2			
serum iron	Umol/L		35.35	3.45	2			
ASOT	units/ml		135	0	1			
Glucose	mmol/l		2.9	1.5	2	2.8	1	2
Phosphorus	mmol/l					1	0	1

* values from Radcliffe have been converted

Food:

The average amount of food fed daily to the rhinos did not differ between the individuals between 1993 and the year 2006 (Statistischer Test, see Figure ??). Therefore the amount of food fed to the rhinos each month was pooled and the median was used for the following calculations.

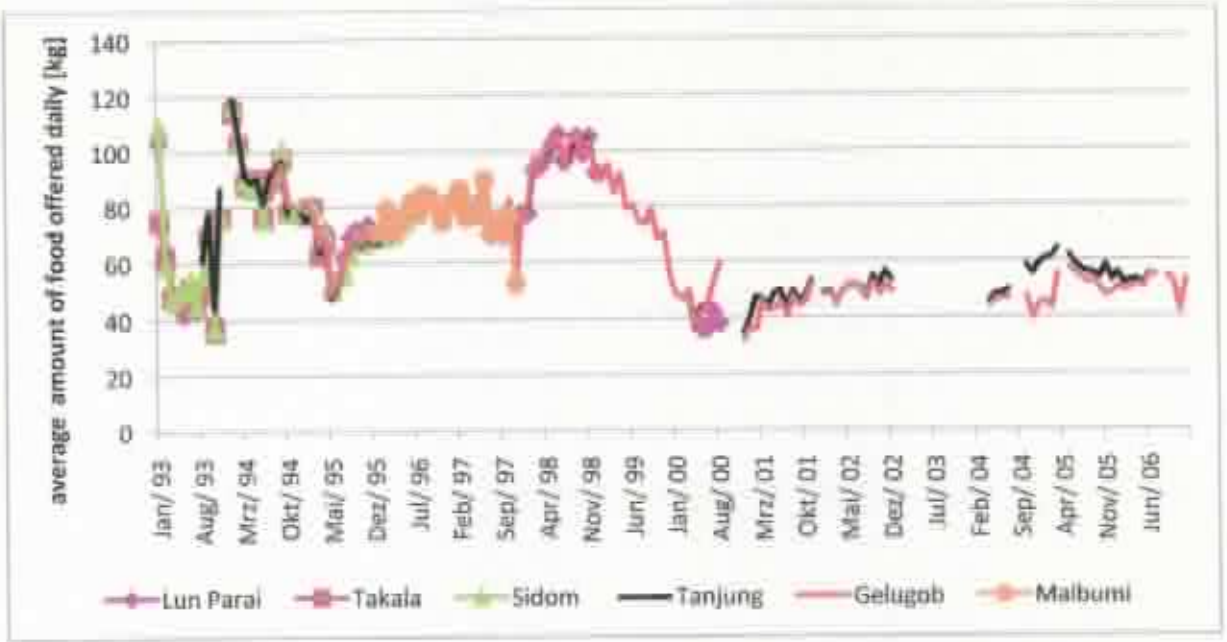


Figure 1: Average amount of food (browse and fruits) fed daily to each of the six Sumatran rhinos in Sepilok, Malaysia between January 1993 and December 2006.

The average amount of food offered daily to all rhinos differed between the months but only slightly between individual animals. In the early years (Jan 1993 until Dec 1999), the amount of food offered to each rhino each day was higher (average established out of average amount for each rhino = 77 kg/day) compared to the years 2001 until 2006 (average of all rhinos 46 kg/day). A possible explanation for the differences in the amount of food offered to the rhinos between the early years and the latter might be that between 1993 and the year 1999 (recheck if this information is correct!!), the food was delivered by a contractor resulting in a constant supply of browse. In the following years, the food was collected in the area around Sepilok which was very labor intensive and therefore more difficult to obtain.

The female rhino "Gelugob" consumed a median amount of 39 kg of food per day (IQR = 9, n = 54 months) or 83 % of the food offered (n = 54) between January 2001 and December 2006 (Figure ??).A comparison of her median monthly body weight with the median monthly amount of food eaten revealed that the female had a median consumption level of 7.5 % of body mass (n = 35). The male rhino "Tanjung" consumed a median of 45 kg of food per day (IQR = 11, n = 49) or 86 % of the food offered (n = 49) between January 2001 and December 2006. He had a median consumption level of 8.8 % of body mass.

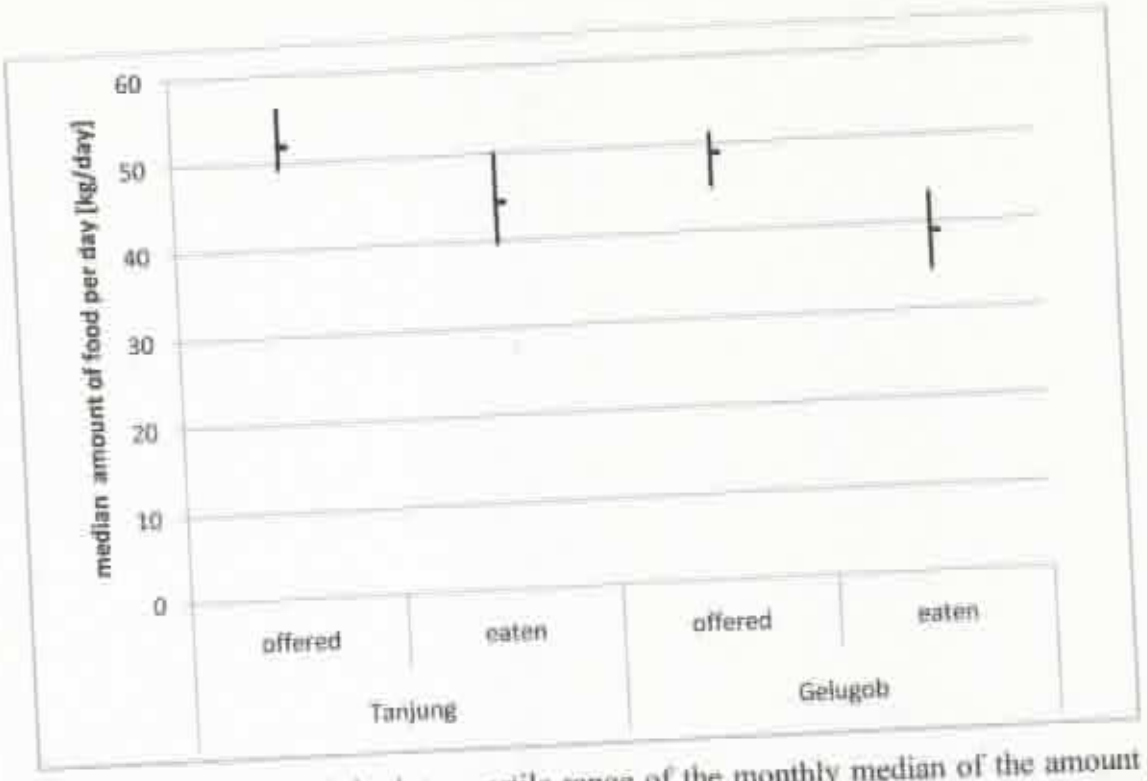


Figure ??: Median and the interquartile range of the monthly median of the amount of food offered per day and the monthly median of the amount of food eaten calculated for the male and female rhino for the time period January 2001 until December 2006.

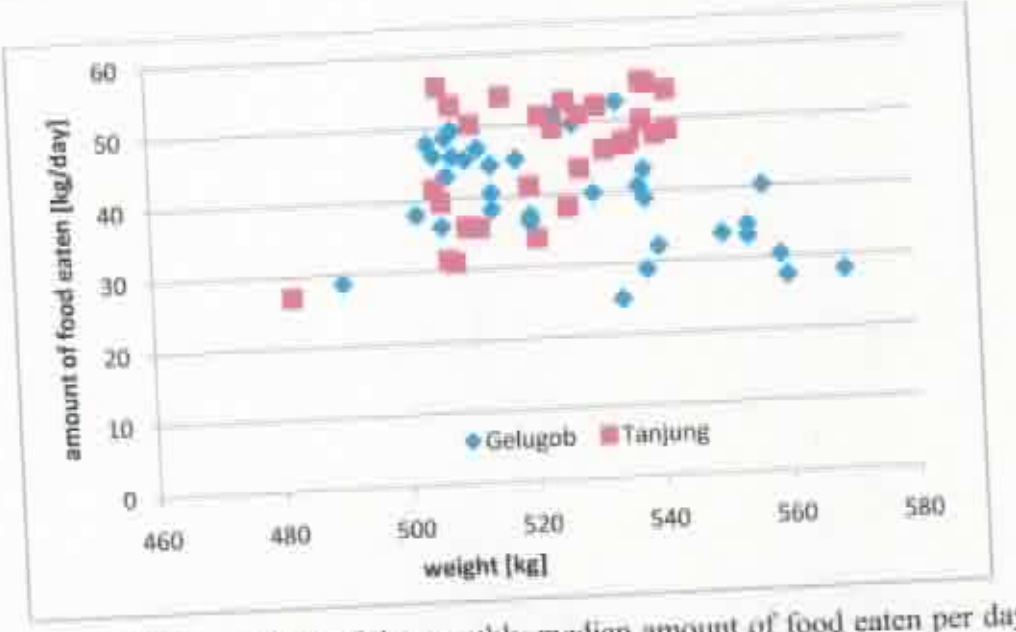


Figure ??: Comparison of the monthly median amount of food eaten per day and the median body weight of Tanjung and Gelugob of the same month.

The body weight of the female rhino was not correlated with the amount of food eaten (statistic test see Figure ??); she had the lowest and the highest body weight when eating an median amount of 20 - 30 kg/day. The male however showed lowest body weight at a median consumption below 30 kg/day and he increased in body weight at a median consumption level of 40 – 60 kg/day.

The average amount of fruits fed daily to each rhino differed between the months but only slightly between the rhinos. It was highest between July 1998 and August 2000 (average established out of average amount for each rhino = 12 kg/day). The amount was threefold compared to the average amount fed daily between January 1993 and June 1998 (4 kg of fruits/day) and sixfold compared to the daily amount fed between March 2004 and December 06 (2 kg of fruits/day, Figure ??). Fruits, especially unpeeled bananas were used to calm down the animal during breeding attemps and during treatment and blood sample collection. The peaks in the graph (Figure ??) coincide with the breeding attempts conducted by Dr. Bosi in 1998 and by Dr. Kilbourne in the year 2000.

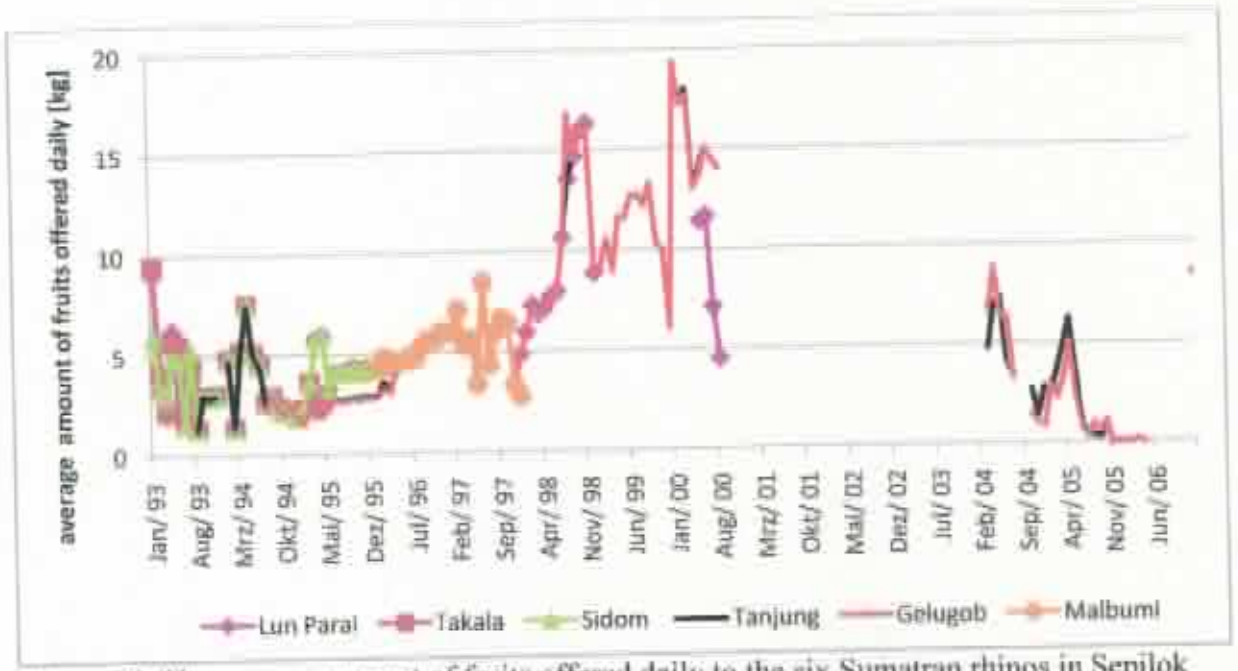
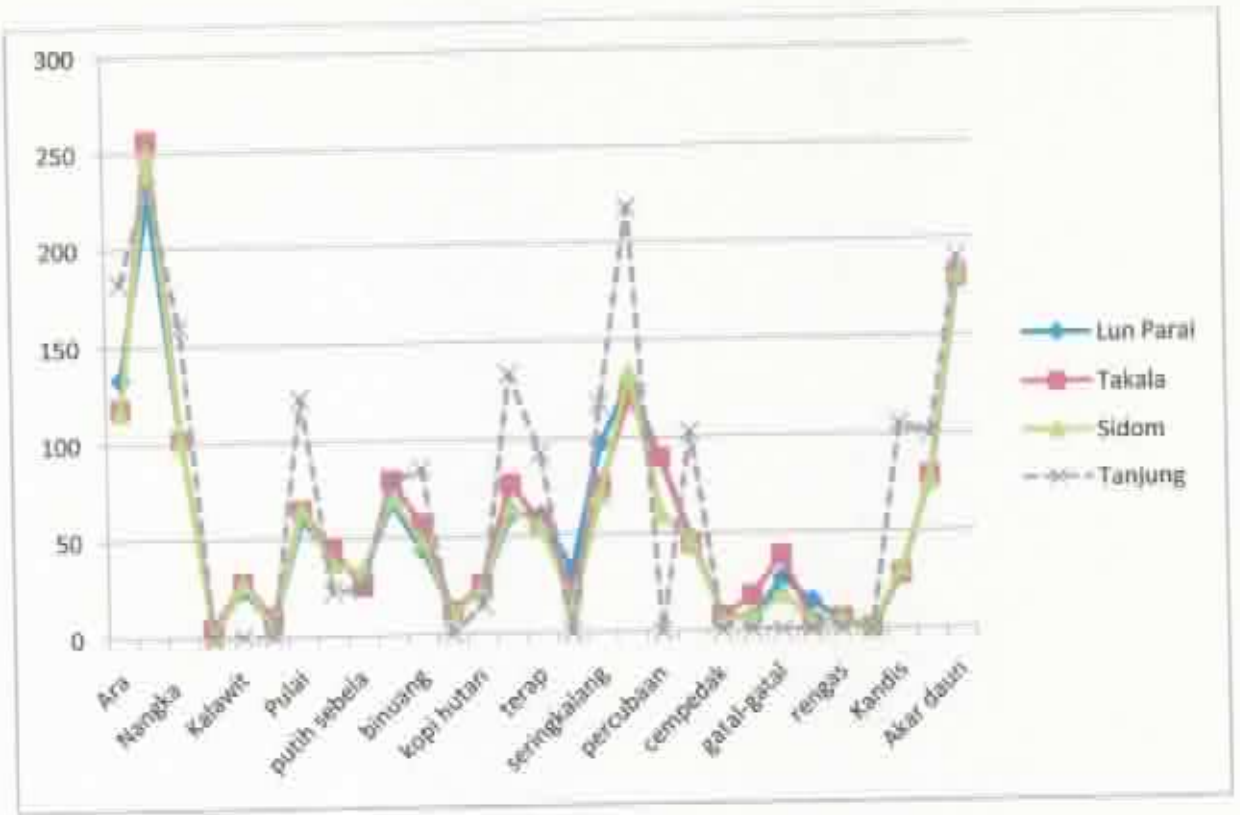


Figure ??: The average amount of fruits offered daily to the six Sumatran rhinos in Sepilok between January 1993 and December 2006



The food consisted of 27 different tree species (the most frequent fed species are shown in Figure ??) and four different types of fruit (bananas, sugar cane, mango and Jackfruit).

Figure 5: Frequency of tree species fed each month to the rhinos between 1993 and 2000. The median amount was calculated out of the total amount established per month for each individual rhino

Recommendation:

- Offer the female an amount of 40 to 50 kg/day and the male an amount of 55 to 65 kg/day
- Allow the female rhino to consume an amount of 30 – 40 kg/day and the male an amount of 45 – 55 kg/day
- Keep daily amount of bananas low. Just use them for training of the animals, as reward, or to avoid aggression during breeding or to distract them during blood collection.
- Avoid salt licks containing high concentration of iron. Iron overdosis can result in hemosiderosis, morbidity and mortality
- Offer a variety of species in order to avoid overdosis or lack of minerals
- Try to avoid Manganese in salt lick
- Offer phosphorus and sodium
- Conduct a study on mineral concentration of food since mineral concentration can vary depending of the soil and the region
- Possibly give supplement of vitamin E or selenium
- Avoid species of Vitex they may exhibit a phyto-progesterone effect

4.5 Weight of the rhinos:

Figure 6: Weight of the Sumatran rhinos in captivity between February 1991 and January 2007

The median weight of the rhinos ranged from 492 kg to 650 kg. The weight of the rhinos did not correlate with the estimated age of the animals (statistic test)

Table ??:

	Teneggang	Lun Parai	Takala	Gelugob	Sidom	Tanjung	Malbumi
estimated age [years]	31	7	11	16	13	7	6
median weight [kg]	650	575	571	550	540	507	492
Interquartil range	19	49	0	20	32	22	29
n	4	21	1	64	3	90	4

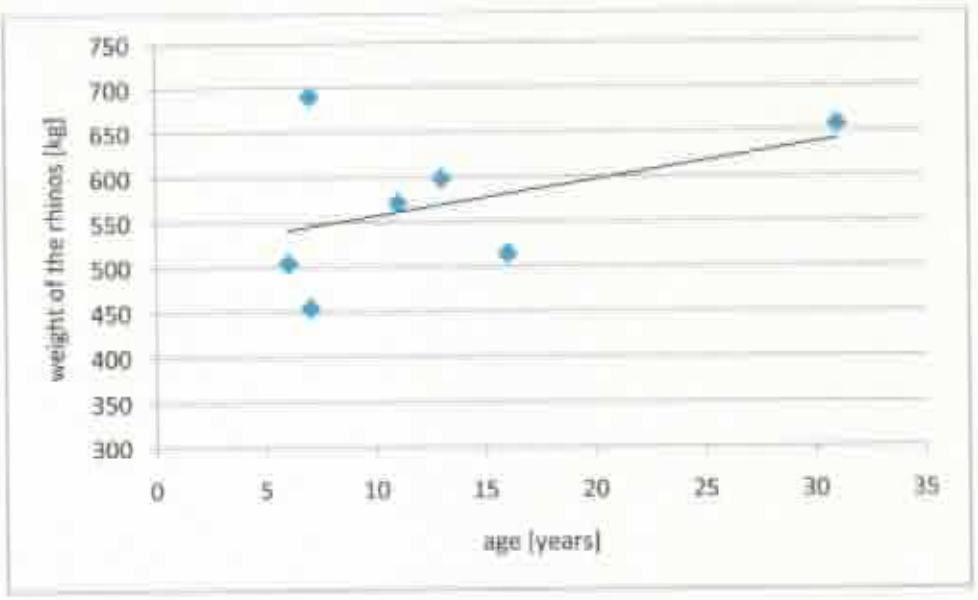


Figure '?': Age and weight of the rhinos in Sepilok.

4.6 Rectal temperature:

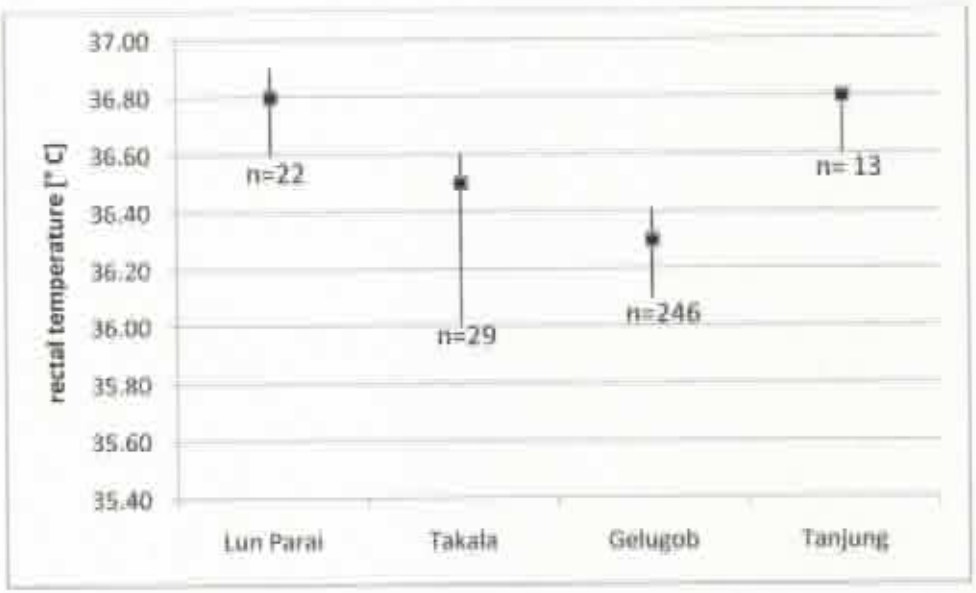


Figure: Median rectal temperature and interquartile range of four Sumatran rhinos kept in Sepilok, Sabah. The number of data (n) is given in the figure.

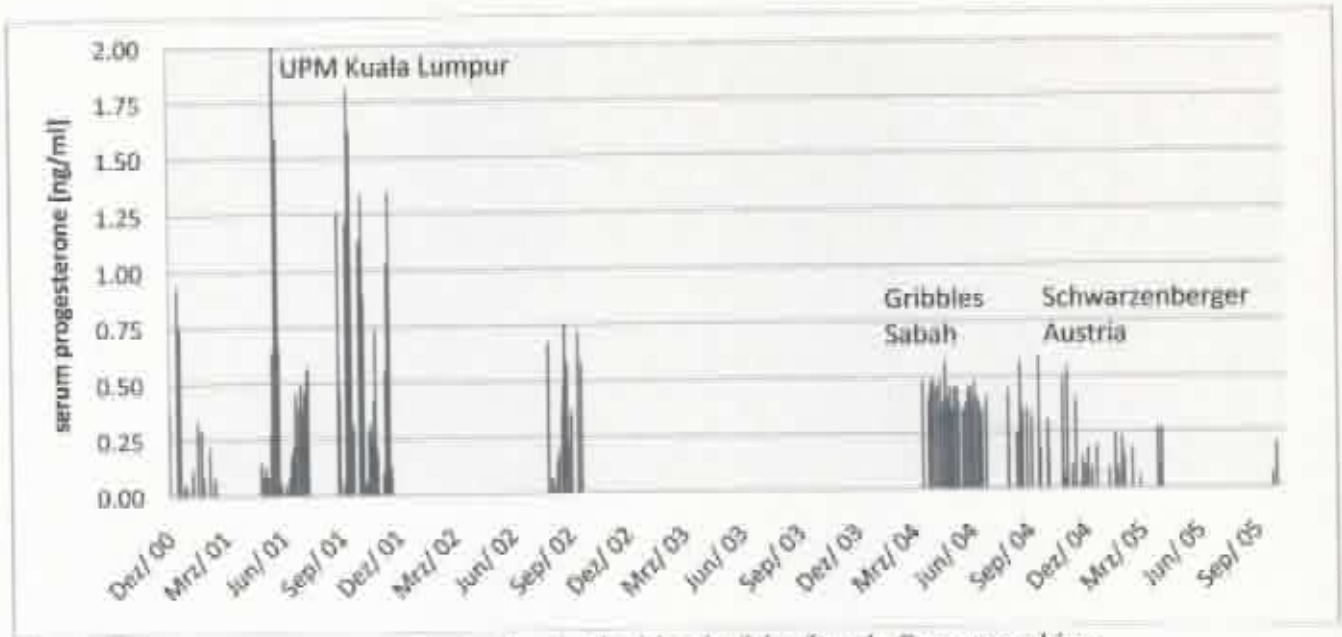


Figure: Serum progesterone concentration in the blood of the female Sumatran rhino established between December 2000 and September 2005. The blood was analyzed in three different laboratories. The names of the laboratories is given in the graph.

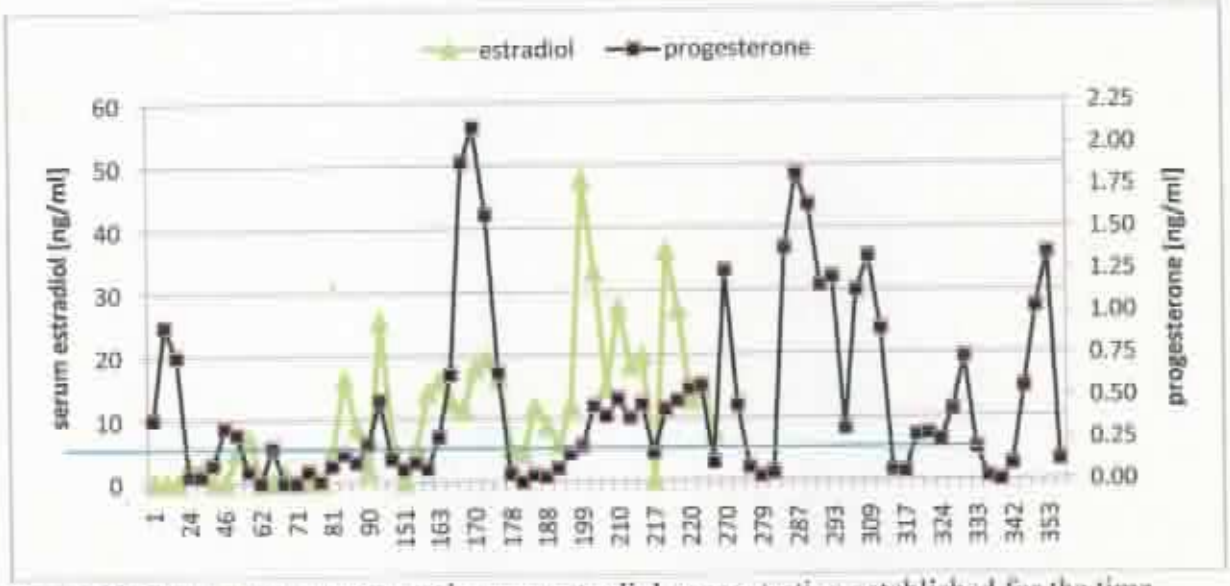


Figure ??: Serum progesterone and serum estradiol concentration established for the time period: 6 of December 2000 until 20 February 2001

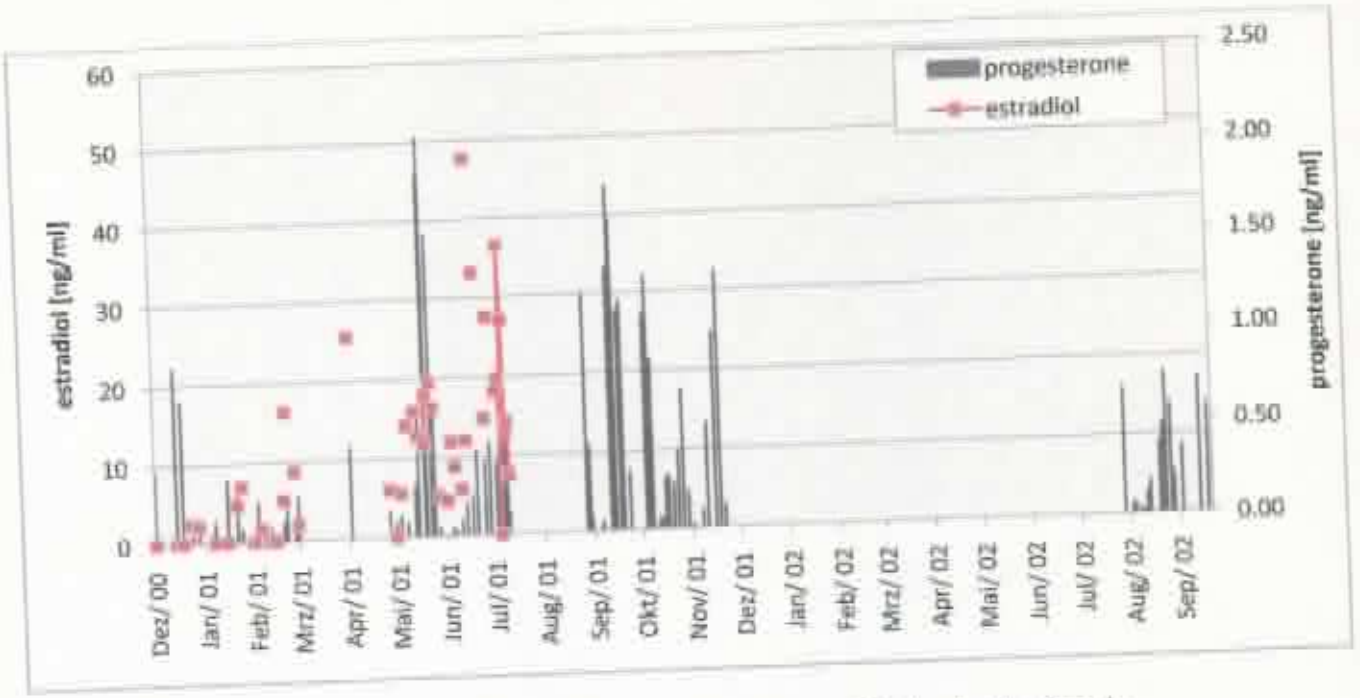


Figure: Serum progesterone and serum estradiol concentration of Gelugob, the female Sumatran rhino measured between December 2000 and September 2002.

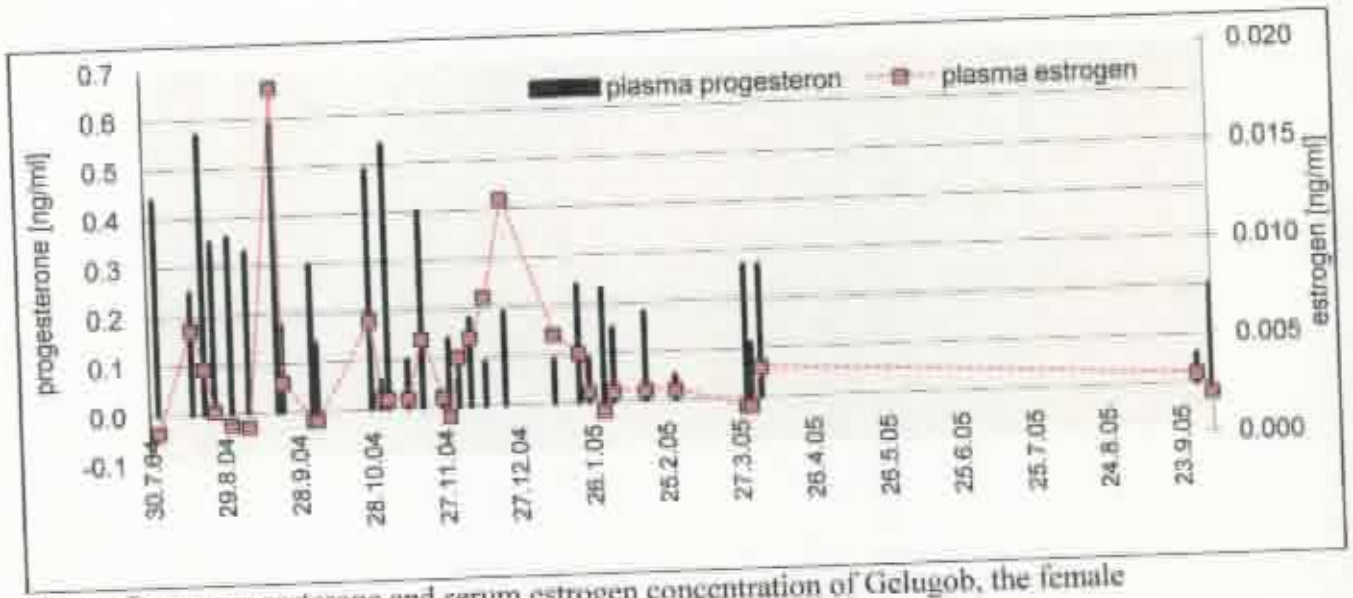
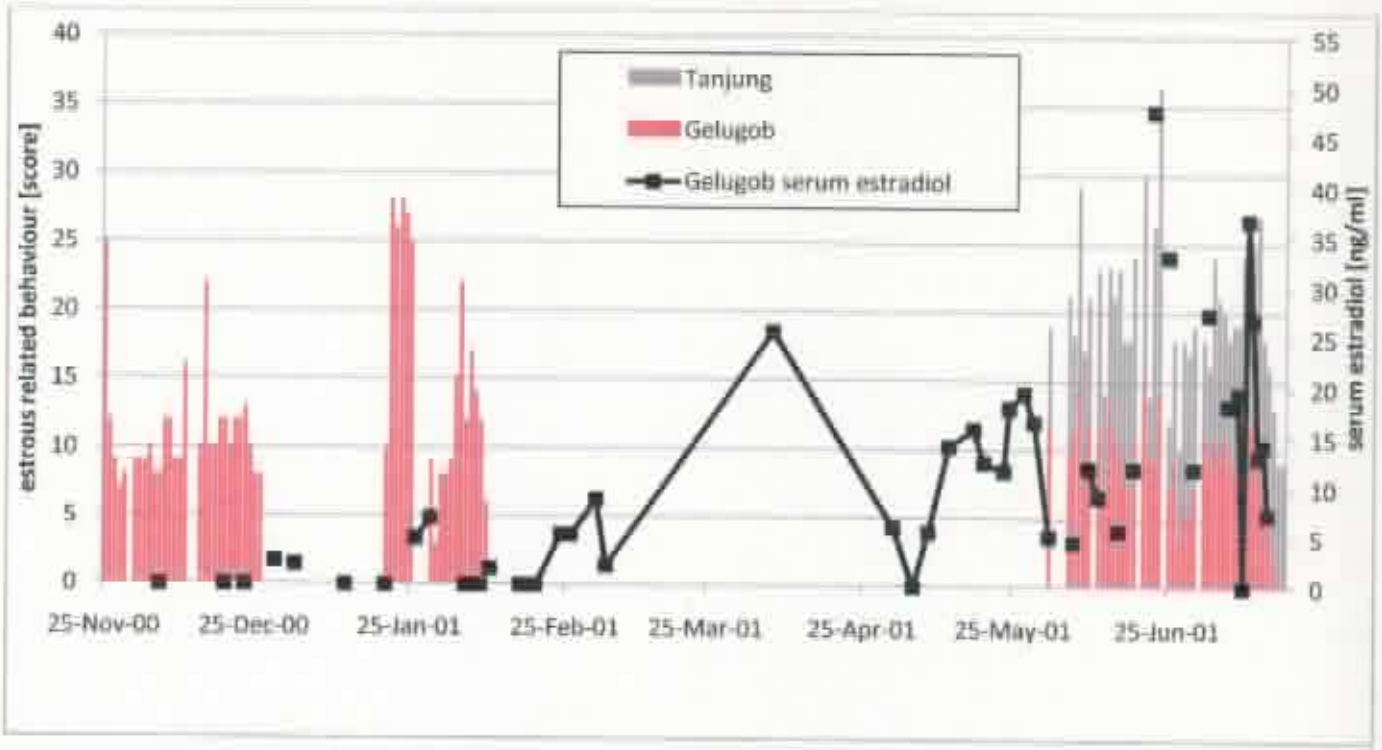


Figure: Serum progesterone and serum estrogen concentration of Gelugob, the female Sumatran rhino measured between July 2004 and October 2005.


Tanjung
Gelugob
Gelugob serum estradiol
estrous related behaviour [score]
serum estradiol [ng/ml]
25-Nov-00
25-Dec-00
25-Jan-01
25-Feb-01
25-Mar-01
25-Apr-01
25-May-01
25-Jun-01

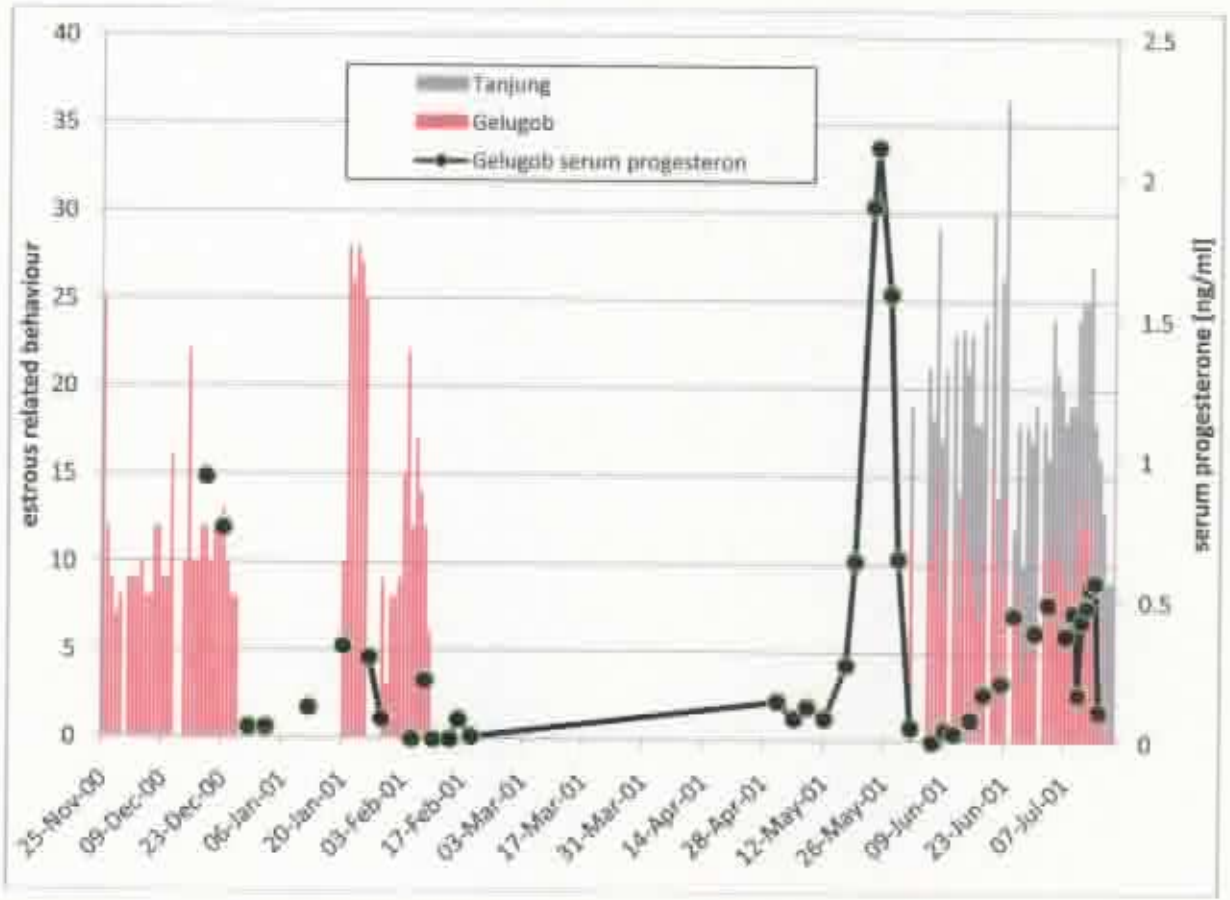

Tanjung
Gelugob
Gelugob serum progesteron
estrous related behaviour
serum progesterone [ng/ml]
25-Nov-00
09-Dec-00
23-Dec-00
06-Jan-01
20-Jan-01
03-Feb-01
17-Feb-01
03-Mar-01
17-Mar-01
31-Mar-01
14-Apr-01
28-Apr-01
12-May-01
26-May-01
09-Jun-01
23-Jun-01
07-Jul-01

Figure 7: The days of erection in relation to the days of observation for the observation period May 04 until December 04.

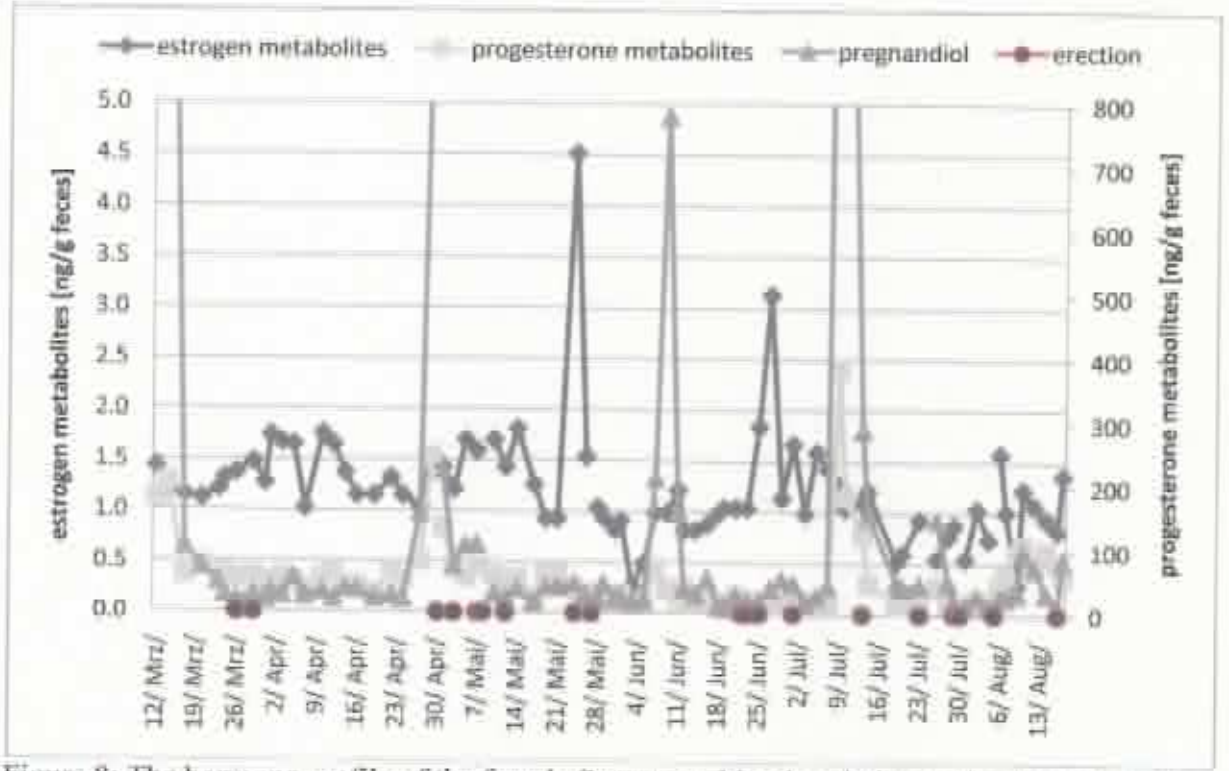


Figure 8: The hormone profile of the female Sumatran rhino in relation to the days of erection of the male rhino.

4.7 Ultrasound analysis:

Annelisa:
Based on previous US images from Dr. Nan Schaffer (see Figure 2) and her re-evaluation of Gelugob on the 30th of January, multiple uterine cysts are visible. The routine US conducted indicate cycling but continue to demonstrate the same pathology. Follicles have been identified on the left ovary. The right remains challenging to evaluate which has lead to difficulties following follicular development. These lesions may reduce conception rate in some species as noted previously in Dr. Nan Schaffer's report but may be potentially tolerated in others. Only through regular breeding and monitoring will this be clarified in these animals.

Figure 2. US evaluation of Gelugob from Dr. Nan Schaffer's 1998 report.

Ultra Sound Images of Gelugob's Reproductive tract

Figure 1 "Gologob"
Uterus

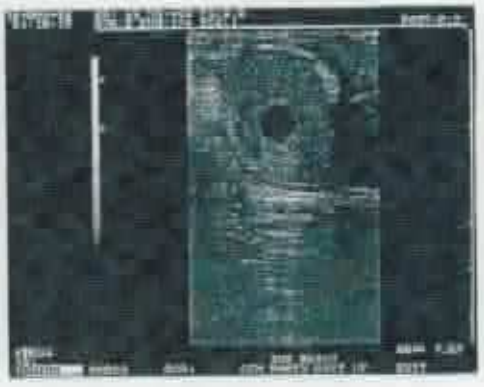


Figure 2 "Gologob"
Uterine Cyst

Figure 3 "Gologob"
Left Ovary
Corpora Hemorrhagica

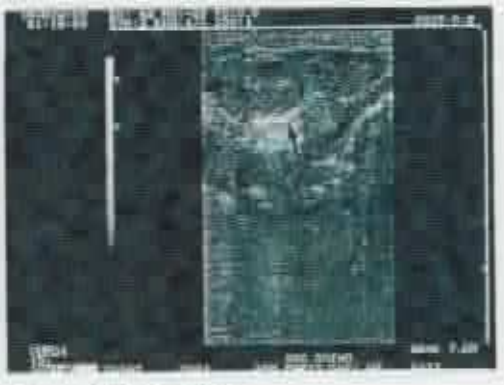


Figure 4 "Gologob"
Left Ovary
Corpus Luteum (arrow)

Post-mortem evaluation of uterus and ovaries from deceased animal, Lunparai indicated 3 medium to large intramural/ endometrial tumors. These are most likely fibromas and were not conducive to a successful pregnancy (short report AMK, NS) (Appendix 1).

4.8 Semen collection:

In the year 2000, semen has been collected successfully from Tanjung during 5 separate occasions. Of these only 3 produced an ejaculate greater than 10 ml (2 > 25ml). In all samples evaluated and spun down, there was no indication of live sperm or any artifacts indicating presence of sperm. Semen was collected once from the ejaculate on the ground after the male mounted the female in the large enclosure. No sperm was seen on this occasion either.
Fluid was collected on almost all semen collection trials but only on the 5th of May 2004 two sperms were found by Dr. Nan Schaffer.

Discussion:

Hemosiderosis is a common pathologic lesion in rhinoceros in captivity (Kock et al. 1989). Hemosiderosis lesions have been identified despite diets of natural browses at SRBC (A.K. meinen sie die Fußwunden im Jahre 2000?).