COMPANION REFERENCE DOCUMENT TO OPTIONS DOCUMENT TO GUIDE STRATEGY DEVELOPMENT FOR THE NORTHERN WHITE RHINOCEROS

(*Ceratotherium simum cottoni*)

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On Behalf of
The IUCN/SSC African Rhino Specialist Group

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1. HISTORY AND STATUS OF WILD POPULATION

Population dynamics

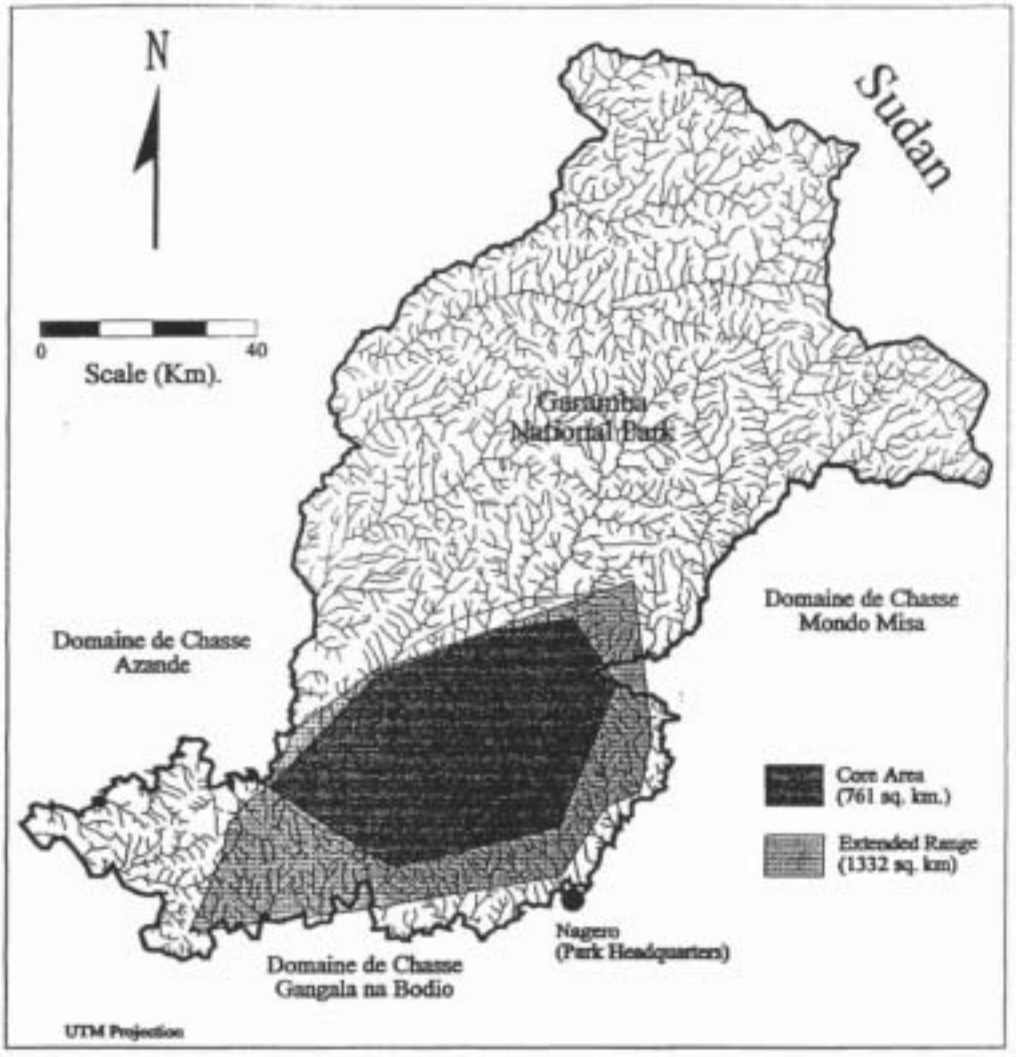
At the start of the 20th century, the northern white rhinoceros (*Ceratotherium simum cottoni*) occurred in 5 countries in central Africa: Sudan, Uganda, Zaïre, Central African Republic, and Chad. The last confirmed wild population of 28 individuals of this subspecies inhabits Garamba National Park in Zaïre. (Figure 1)

The total area of Garamba is 4,900 km². Garamba is surrounded by 3 Reserves in which human settlement, subsistence hunting, and commercial poaching occur.

Figure 1: Map of Garamba National Park, Zaïre

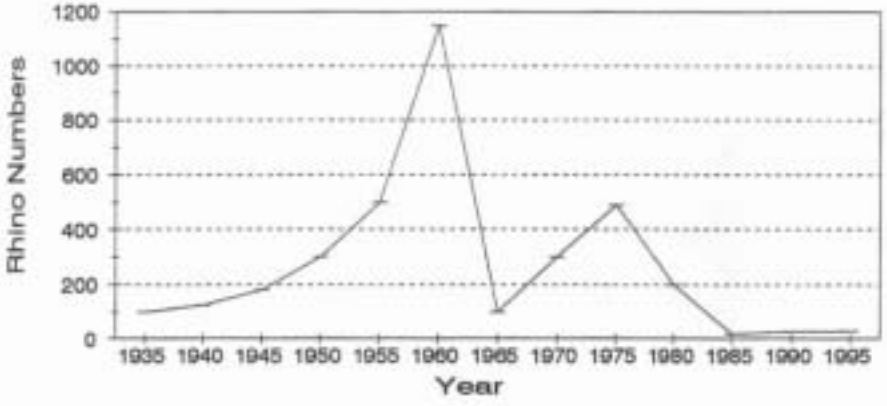
The range of the surviving white rhino is in the south central area of the Park. The core area is 761 km^2. The outer convex polygon delimiting the extended area of observations of rhinos or their tracks since 1983 encompasses 1332 km^2. (Figure 2).

Figure 2: Range of White Rhino in Garamba National Park.



The white rhino population in Garamba has suffered considerable fluctuations over the last 60 years (1935-1995). (Figure 3). The population has demonstrated high rates of increase when afforded protection, though initial apparent increase was probably augmented by immigration and early under-estimation. There were estimated to be approximately 100 rhino in the Park when it was established in 1938. The highest population estimate recorded was of 1,000-1,300 in 1961. This would have given a density overall in the park of 0.20-0.27 rhinos/km^2. The population was decimated in the early 1960s by heavy poaching related to the civil war, reducing the rhino to an estimated 100 in 1965 (Curry Lindhal 1968). With assistance from the presence of a UNDP/FAO project, numbers increased again. In 1976, the results of a systematic aerial sample count gave a rhino population estimate of 490 ± 270 (Savidge et al 1976). After cessation of this project, commercial poaching commenced. At least half of this poaching was believed perpetrated by Park staff. By 1983, rhino numbers had fallen to 13-20 (Hillman et al 1983), and in 1984, calculating retrospectively from subsequent work the number was probably 15, effectively the founders of the current population.

Figure 3: Population Numbers of Northern White Rhino in Garamba National Park 1935-1995



On the basis of monitoring through individual recognition since 1984, 32 different individuals are now known, but one has recently died and three have not been observed during the last year hence there are doubts about their continued existence. The population increased to a high of 31 in 1992 and is currently confirmed at 28, an average population growth rate of 6% per annum (Figure 4).

Figure 4: Population Growth of Garamba White Rhino 1983-1995

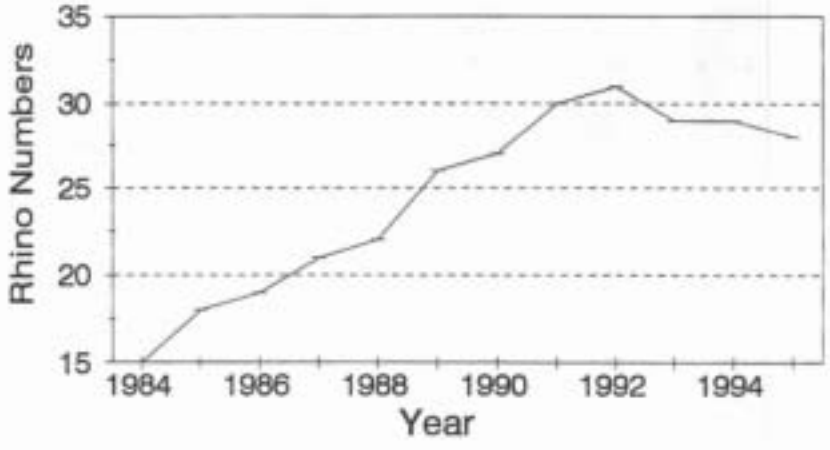
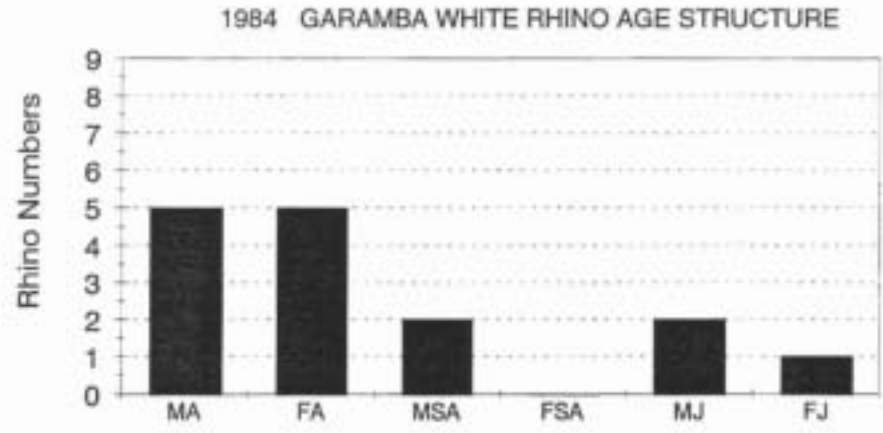
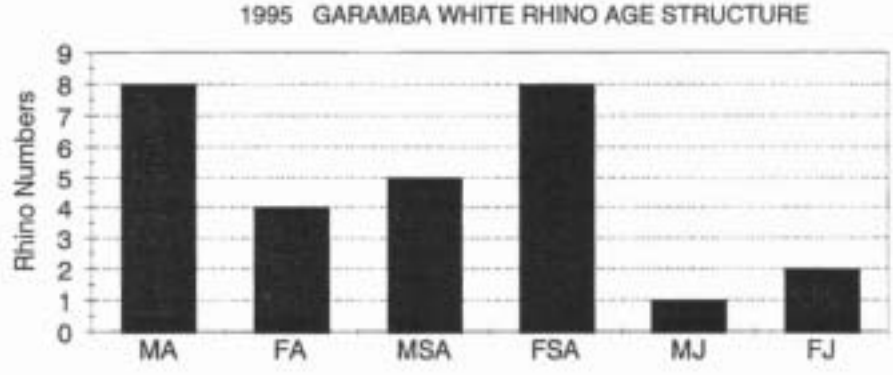


Figure 5 presents the age and sex structure of the Garamba northern white rhino population in 1984 and 1995. More detailed information on the population structure by individual is provided in Section 3 of this Document.

Figure 5: Age and Sex Structure of Garamba White Rhino Population 1984 Versus 1995





During the period 1983-1995, there have been 23, possibly 24 births. During the same period, 3 rhinos are known to have died of natural causes. Two of these were new born calves and the 24th suspected birth would have been of a calf that then died. The reproductive record and inter-calf intervals of known Garamba females is presented in Table 1.

Table 1: Reproductive Record and Intercalf-Interval for Female Rhino in Garamba National Park

CALVING RECORD BY YEAR FOR GARAMBA FEMALES > 7 YEARS OF AGE														
FEMALE	**1983**	**1984**	**1985**	**1986**	**1987**	**1988**	**1989**	**1990**	**1991**	**1992**	**1993**	**1994**	**1995**	Total
Adults in 1983 = Founders														
Still Alive in 1995														
F1 Mama Mokn	Jun						Mar-Apr		Feb		Jun			4
F3 Kunalina	Sep-Oct		Jul				Dec		Sep		Jul			5
F4 Boletina	Aug-Sep		May		Sep-Oct		Aug-Sep			Jan		Jan		6
F6 Pacque				Mar		Jun								2
Not Alive in 1995														
F5 Mama Gisingamba			Feb		Oct		Aug		Jul				**Died**	4
Born 1983 or Later														
3aF Kuni	-	-	-	-	-	-	-	Dec						1
4bF Mai	-	-	-	-	-	-	-	-	-					0
3bF Juillet	-	-	-	-	-	-	-	-	-					0
6aF Oeuf De Pacque	-	-	-	-	-	-	-	-	-	-				0
4cF Noel	-	-	-	-	-	-	-	-	-	-	-	-		0
5bF Grizmek	-	-	-	-	-	-	-	-	-	-	-	-		0

- Signifies that females were < 7 years of age in this year.

Security

Protection of the rhinos was afforded, initially by the gazetting of the National Park in 1938. During the Simba rebellion following Independence it was estimated that 90% of the rhino population, some 900-1000 rhinos, were killed. After 1964 protection was afforded by the re-development of the national wildlife organization, now the Institut Zaïrois pour la Conservation de la Nature (IZCN) and from 1972 to 1976 it was further supported by a UNDP/FAO project, which was based at the Park. Poaching, stimulated by commercial demands recommenced when the project left and there was a change of Conservateurs. It reduced rhino numbers from 490 to 15 in 8 years.

In 1983/4 a proposal was put forward that the rhinos be captured and translocated to captive security, with the potential for possible later re-introduction. This was unacceptable to Zaïre and the rhinos remained in the Park. Since 1984 an international aid project funded initially by the World Wide Fund for Nature (WWF), Frankfurt Zoological Society (FZS), UNESCO and coordinated by the World Conservation Union (IUCN) has been working on rehabilitating the Park and developing the conservation of the whole ecosystem, with the rhinos as a priority.

The support of this Garamba National Park Project (GNPP), in conjunction with the IZCN succeeded in stopping the majority of the poaching which had such a massive effect on the rhino and elephant populations between 1978 and 1984. The rhino population increased again, and has more than doubled. As an indicator of the reduction in poaching, the elephant population, after an initial lag, has increased from between 4,000 and 4,500 to 8,836 ± 1,586 in 1993 (Smith et al 1993) and the dead to live ratio of elephants seen on counts changed from 1 dead : 8 live in 1983, to 1 dead : 576 live in 1991. No fresh carcasses were counted in March 1993. However, in 1994 and 1995 poaching of elephants increased again.

It must however be recognized that historically, adequate conservation of the rhinos in Garamba in the face of poaching pressure, has only been possible with international support.

The poaching prior to 1983 was at least partly internal, or condoned from within and therefore could more easily be controlled from within, when the means and motivation were present. During the period 1985 through 1991, some minor poaching largely for meat and mainly of buffalo *(Synceros caffer brachyceros)* continued in the north of the Park. The rhinos, however, confine themselves to the relatively secure south (Map 1.), and there has been no evidence of poaching of rhinos.

In April 1991, several thousand refugees, many of them armed, fled across the border from the Sudan war. Most of these weapons were confiscated, but inevitably some remained. The continued availability of arms and ammunition from Sudan since that time, together with the increased demand for meat and the reduced standard of living caused by the state of the national economy has led to a serious increase in poaching pressure. To our knowledge this has not yet affected the rhinos, since poaching is still largely confined to the north of the Park and still largely focused on meat. But it is getting closer south, is including elephants for ivory, and as the rhino population increases, the overall area of their activity is expanding.

At the same time, the FZS has ceased to be a major donor partner, apart from continued contribution of the aircraft, existing donors are restrained by the general economic recession and many new donors are precluded because of sanctions on Zaïre until the political situation is resolved.

Over the last seven years, the average monthly wage received by IZCN field staff in Garamba from the Government of Zaïre has been (in US$):

1987	$ 1.3
1988	$ 2.4
1989	$ 3.5
1990	$ 4.6
1991	$ 13.0
1992	$ 1.8
1993	$ 0.8

Recently IZCN has had major problems in being able to supply regular salary payments to their field staff, and to keep apace with devaluation. It has fallen to the lot of the international donors to find compensatory support for guards. The International Rhino Foundation (IRF) was able to secure a donation of $10,000 from the Columbus Zoo, which supported the guards on the same level as in 1990 for a year, but the cost of living is now far higher than it was (de Merode et al 1994). In order to survive the guards must rely on growing their own food crops and protecting them at night from animals. This often interferes with effective conservation work and reduces motivation for the dangerous task of poaching control.

The continuation of the project by WWF even when there have been political problems in Zaïre is a major positive move, that has not only ensured the continued effective operation of Garamba National Park and the loyalty of the guards throughout, but has also raised the national status of IZCN, when so many other donors have left.

However, in order to ensure adequate *in situ* protection of the rhinos in view of increased threat, the anti-poaching and monitoring strategy needs development to increase detection rate, fire and man-power needs to be balanced against that of the poachers, and the standard of living of the guards needs to be improved. These require increased support.

2. HISTORY AND STATUS OF CAPTIVE POPULATION.

Population dynamics

In 1995, there are 9 (4 males and 5 females) pure bred northern white rhinos in captivity. They are maintained in 2 institutions (San Diego Wild Animal Park, California USA, with 2.2 and Vychodeceska Zoo, Dvur Kralove, Czech Republic with 2.3). There is also 1 intergrade female (Studbook Number 476, Nasi) of mixed parentage (*C.s.simum/C.s.cottoni*). The captive population has been decreasing. In late 1983, there were 12 (6 males and 6 females) pure bred northern white rhinos in captivity in 5 institutions, plus the 1 intergrade female (Hillman & Smith 1983).

Consolidation into two institutions was in keeping with a recommendation from the IUCN Captive Breeding Group and the Union of Zoo Directors in order to stimulate breeding and spread risk. All but one of the rhinos currently alive are the property of the Vychodoceska Zoo at Dvur Kralove, but three of these and one from Khartoum Zoo are held at San Diego.

Since 1983 there have been a total of four deaths, three of which were animals over 40 years old. There have been two births in that period, but a total of four births in captivity, all at Dvur Kralove over a 25 year period. All births were from the same female (Nasima, Studbook Number 351) who had been pregnant on arrival at Dvur Kralove from Prescott Zoo in England with her first offspring which is the intergrade, Nasi Studbook Number 476) Nasima unfortunately died in June 1992 of shock during some management manipulation. Her death occurred 11 months after she aborted a fetus due to a vaginal and cervical prolapse that may have been caused by phytoestrogens in alfalfa (lucerne) hay. The last birth occurred in 1989, but the last reproductive event was the abortion in 1992. None of the other females have reproduced. All full-term births are still alive. (Table 1.)

All the living wild born northern white rhinos are from the Shambe area of Southern Sudan. However, Nasima, the mother of all the captive born offspring was from Uganda. Two different northern white males have fathered calves, so the gene pool within the captive population should be reasonably varied. All except the youngest female (Najin, Studbook Number 943) are of breeding age and she should be just about sexually mature. (Table 1.)

Facilities and Management

Dvur Kralove:

There are 5 northern white rhino in this facility: 1.2 which were received direct from the wild in Sudan in 1975; 1.1 which have been born here. There is also a female intergrade that was born to a northern white rhino female (now dead) that arrived pregnant by a southern white rhino male from Prescott Zoo in England.

Currently, the northern white rhino are maintained in a complex of 5 adjacent enclosures of .5 to 1 hectare (1 to 2.5 acres) which are arrayed in a line connecting with the indoor enclosures. These enclosures represent greatly improved facilities. There is desire to further improve the facilities by installing more gates between these four enclosures and adding more structural and vegetational complexity. With such facilities, the plan would be attempt to stimulate some territorial behavior in the rhino by placing the two males in non-adjacent enclosures with females in intervening yards. The female and one male enclosures could be connected when females appear to be in estrus.

Information on the management of northern white rhino at Dvur Kralove has been provided by Dr. Dana Holeckova (Curator of Rhinos at Dvur Kralove)) and Dr. Kristina Tomasova (European Species Coordinator for White Rhino and Zoological Curator at Dvur Kralove). Dvur Kralove has been continually placing females with males, in various combinations:

- Mating has occurred at least 5 times since 1992 between male Suni (Studbook Number 630) and female Nesari (Studbook Number 377): November 1992; April, June, August 1993; and January 1994. However, through June 1995, there is no evidence of pregnancy as indicated by hormonal analysis of feces and urine at the Institut of Biochemistry at the University of Vienna, Austria. Nesari remained with Suni for a while and has been treated with TPGS to stimulate reproductive activity.
- Females Nabire (Studbook Number 789) and Nasi (the intergrade, Studbook Number 476) have been treated with hormones TPGS to stimulate reproductive activity. They had been with Suni, but in July 1994 were placed with male Sudan (Studbook Number 372; the only proven sire at Dvur Kralove). Sudan copulated with Nabire (Studbook Number 789) in September 1994 but she is apparently not pregnant. Sudan manifested no sexual interest in Nasi).
- As of April 1995, the plan was to place all 4 females with Suni.

This institution has demonstrated its commitment to conservation of northern white rhino and has declared it will cooperate with an AfRSG/Global Captive Action Plan recommendation to move their rhinos. However, their cooperation would probably be conditional on significant support being provided for their other rhino programmes as this institution is in dire financial straits.

San Diego Wild Animal Park:

There are 4 northern white rhino in this facility: 1 male and 2 females were moved here from Dvur Kralove in 1989. A male was moved here from the Khartoum Zoo in 1990.

For most of their residency, the females and one male northern white have been maintained in the East Africa enclosure, an area of 120 acres. The other male has been kept separate, previously in a distant exhibit, more recently in a 30 acre enclosure an average of 50 feet from the East Africa enclosure but separated by a ridge and a monorail track. During 1993, two holding bomas of about 1,000 sq m. each (10,000 sq. ft. each) were constructed with an observation deck and a restraint shute to permit hormonal manipulation and reproductive examination of the females and now breeding management of the rhinos. These bomas are adjacent to the 120 acre East Africa Exhibit.

There has been no breeding or reproductive activity yet. Until an intensive program of reproductive examination and manipulation commenced in 1993, the females appeared to constitute a close alliance against advances by the males. Currently, only 1 male has been placed with the females at any one time and the other male has been out of sensory range. Both males have been tried with the females. During this period, neither female exhibited estrous behavior and fecal steroid analysis did not reveal fluctuations of estrogens or progestins indicative of cyclicity. These analyses were conducted in the laboratory at the Center for Reproduction of Endangered Species (CRES) at the San Diego Zoo.

Since late 1993, this institution has intensified its program by conducting more intensive reproductive exams and attempting hormonal enhancement (prostaglandin) of the females in an effort to render them more amenable to the males. As reported by Dr. Barbara Durrant (Reproductive Physiologist at CRES) to Dr. Tom Foose, notable developments in this program are:

- Ultrasound examination of Nola (Studbook Number 374) in December 1993 revealed an inactive left ovary (the right ovary could not be visualized).
- Both females Nola (Studbook Number 374) and Nadi (Studbook Number 376) were treated with prostaglandin and exposed to the male Angalifu (Studbook Number 348), but no breeding or estrous behavior was observed.
- In 1994, a 15 day regimen of synthetic progestin was then administered to both females. Nasi responded to the withdrawal of hormone treatment by exhibiting behavioral estrus within 23 days. Aggressive interactions occurred between Nola and Angalifu and may have prevented Nadi from breeding. Nola exhibited ambiguous behavioral signs of estrus 65 days after the end of progesterone therapy, but she was not bred.
- Another ultrasound evaluation of Nola was performed 15 days (October 1994) after presumptive estrus. The presence of a corpus luteum confirmed that ovulation had recently occurred and the appearance of a follicle on the other ovary indicated continuing cyclicity.
- Nola was treated with prostaglandin again in October 1994 and exhibited some behavioral signs of estrus 2 days later. She was not bred by Angalifu at that time or again 30 days later when Nola once more exhibited possible estrous behavior.
- Nola was immobilized 23 days (in December) later for another ultrasound examination. The vaginal exam revealed evidence of estrogen influence, indicating approaching estrus. The ovaries and uterine horns could not be visualized by ultrasound as a large, firm mass just beyond the pelvis obstructed access past the cervix. This 6 inch (15 centimeter) diameter mass was not present at Nola's last ultrasound exam two months earlier. The mass at that time was thought to be a feces-filled loop of the intestine.
- On May 24, 1995 Nola was again immobilized for ultrasound evaluation. The mass observed in December 1994 was still present but was now larger and firmer. Hence at last report (June 1995) Nola was being managed as a medical case. A team of veterinarians was being assembled to devise the best strategy for biopsy of the mass which appeared to be encapsulating the reproductive tract. It was decided that results of the biopsy will determine the course of medical treatment.
- In July, Nola was immobilized in an effort to collect a biopsy. However, it was not possible to penetrate far enough to collect a tissue sample. However, at this time the mass appeared smaller than in May. There was also evidence that Nola was cycling. No further information is available at this time.
- Nadi (Studbook Number 376) was examined by ultrasound in late November 1994. Two 30 mm follicles were visualized on her left ovary indicating impending estrous. Based on follicle growth rates in Nola, it was estimated that Nadi's next estrus would be in early December. Indeed, Nadi did exhibit signs of estrus on 1 December 1994, but Angalifu failed to breed her. Nadi may once more have been in estrus on 10 March 1995.
- From November 1994 to May 1995, each female was rotated from their boma into the 120 acre exhibit with the male Angalifu in anticipation of estrus.
- Because Angalifu has not bred either female, it has been decided to move Saut (Studbook Number 373, the only proven breeder male at San Diego Wild Animal Park) from a distant exhibit area for introduction to the females.
- Saut is being laced in the East Africa exhibit where further breeding attempts will occur. The other male Angalifu will now be maintained in one of the holding bomas so he is in proximity to Saut.
- Nadi will be introduced to Saut after she has been examined. The pair will be observed for signs of estrus and/or breeding.
- Until Nola's medical condition is diagnosed and treated, she will not be placed with Saut.

At the time of preparation of this document, the authors are awaiting further reports of Nola's diagnosis and the results of the pairing of Nadi and Saut.

San Diego Wild Animal Park has indicated that it would cooperate with whatever recommendations the AfRSG and global captive community recommend. The possibilities include:

- Relocating their animals to a consolidated captive population elsewhere. They would comply, however, with the caveat that they believe relocation of animals of this age would incur significant risks. The longer the move (i.e. to African versus the U.S.), the greater the risk. They would have no funds to support this relocation.
- They would consider being the site for consolidation of the captive population and perhaps the addition of a few additional founders from Garamba. It is not clear what resources they would have to contribute to movement of rhinos to their institution.

3. POPULATION STRUCTURE WORLD POPULATION: BY INDIVIDUAL & SUMMARY

GARAMBA POPULATION JUNE 1995

ADULT MALES		**SIRE / DAM**	**STATUS/BIRTHDATE**	**AGE**	**LAST SEEN**
M2	'Eleti'		dominant	Age >25	6.95
M3	'Kondo akatani'		dominant since 09.88	Age ±17	6.95
M4	'Bac'		probably dominant	Age >20	5.95
M5	'Bawesi'		dominant	Age >20	6.95
M6	*'Longuecorne'*		*dominant*	Age >30	92
M7	*''Moitier'*		*young male*	Age ±15	92
M9	'Notch'		dominant	Age >19	6.95
1aM	'Moke'	? / F1	S2, male, born mid 1983	12-13	6.95
4aM	'Bolete moke'	? / F4	S2, male, born c.08-09.1983	11-12	5.95
5aM	'Giningamba'	? / F5	S2, male, born 02.85	10-11	5.95
ADULT FEMALES					
F1	'Mama Moke'		with JM	Age >20	5.95
F3	'Kunalina'		with J	Age >19	5.95
F4	'Boletina'		with I	Age >19	5.95
F5	*'Mama Giningamba'*		*with JF*	Age >18	Died nat. cause1.95
F6	'Pacque'		with JM and SM	Age >19	5.95
3aF	*'Kuni*	*? / F3*	*born c.9-10/83, with JM*		92
SUB-ADULTS					
4bF	'Mai'	? / F4	S2, female, born 05.85	10-11	5.95
3bF	'Juillet'	? / F3	S2, female, born 07.85,	10-11	6.95
6aF	'Oeuf de Pacque'	? / F6	S2, female, born 03.86	9-10	4.95
4cF	'Noel'	?M2/ F4	S2, female, born 10-11.87	7-8	4.95
5bF	'Grizmek'	?M4/ F5	S2, female, born 10.87	7-8	4.95
6bM	'Elikya'	? / F6	S1, male, born 06.88	7-8	4.95
1bM	'Mpiko'	? / F1	S1, male, born 03-04.89	6-7	5.95
4dF	'Minzoto'	? / F4	S1, female, born 08-09.89	5-6	5.95
5cM	*'Molende'*	*?M3/ F5*	*S1, male, born 08.89*		Died 3.93
3cM	'Solo'	? / F3	S1, male, born 12.89,	5-6	4.95
3aaM	'Bonne Annee'	?M6/ F3a	S1, male, born 12.90	4-5	5.95
1cF	'Nawango'	? / F1	S1, female, born 02.91	4-5	5.95
3dM	'Mamu'	? / F3	J2?, male, born 09.91	3-4	5.95
5dF	'Jengatu'	?M3/ F5	J2?, female, born 07.91	4-5	4.95
JUVENILES					
4eF	'Sifa'	? / F4	J3, female, born 01.92	3-4	5.95
1dM	'Almeje'	? / F1	J1, male, born 6.93	2-3	5.95
3eF	'Etumba'	? / F3	J1, female, born 7.93	2-3	5.95
INFANTS					
?M	*'Kenge moke'*	*? / ?*	*I1, male, born c.12.2.93*		Died 15.2.93
4f	*'Nauloko' (sex ?)*	*? / F4*	*I1, born 01.94*		Presume died 2-3.94

TOTAL KNOWN INDIVIDUALS

Male adults (MA)	8 + 2 poss	
Female adults (FA)	4 + 1 poss	
Male sub-adults (SM)	5	
Female sub-adults(SF)	8	
Male juveniles (JM)	1	
Female juveniles (JF)	2	
TOTAL	28 + 3 possible	(Sex Ratio 14M : 14F, Adult:subad.+ Juv.ratio 1 : 1.3)

Individuals born since 1983 are given the same identity number as their mother, with a post-fix denoting order of birth.

CAPTIVE POPULATION
JUNE 1995

ADULT MALES		**SIRE / DAM**	**STATUS/BIRTHDATE**	**AGE**	**LAST LOCATION**
348	'Angalifu'	WILD / WILD	Estimated born 1972	23	SD-WAP
372	'Sudan'	WILD / WILD	Estimated born 1972	23	Dvur Kralove
373	'Saut'	WILD / WILD	Estimated born 1972	23	SD-WAP
630	'Suni'	373 / 351 (Dead)	Born 8 June 1980	15-16	Dvur Kralove
ADULT FEMALES					
374	'Nola'	WILD / WILD	Estimated born 1974 Large, firm mass encapsulating reproductive tract	19	SD-WAP
376	'Nadi'	WILD / WILD	Estimated born 1972	23	SD-WAP
377	'Nesari'	WILD / WILD	Estimated born 1972	23	Dvur Kralove
789	'Nabire'	372 / 351 (Dead)	Born 15 November 1983	11-12	Dvur Kralove
SUB-ADULTS					
943 ♀	'Najin'	372 / 351 (Dead)	Born 11 July 1989	6-7	Dvur Kralove
INFANTS					

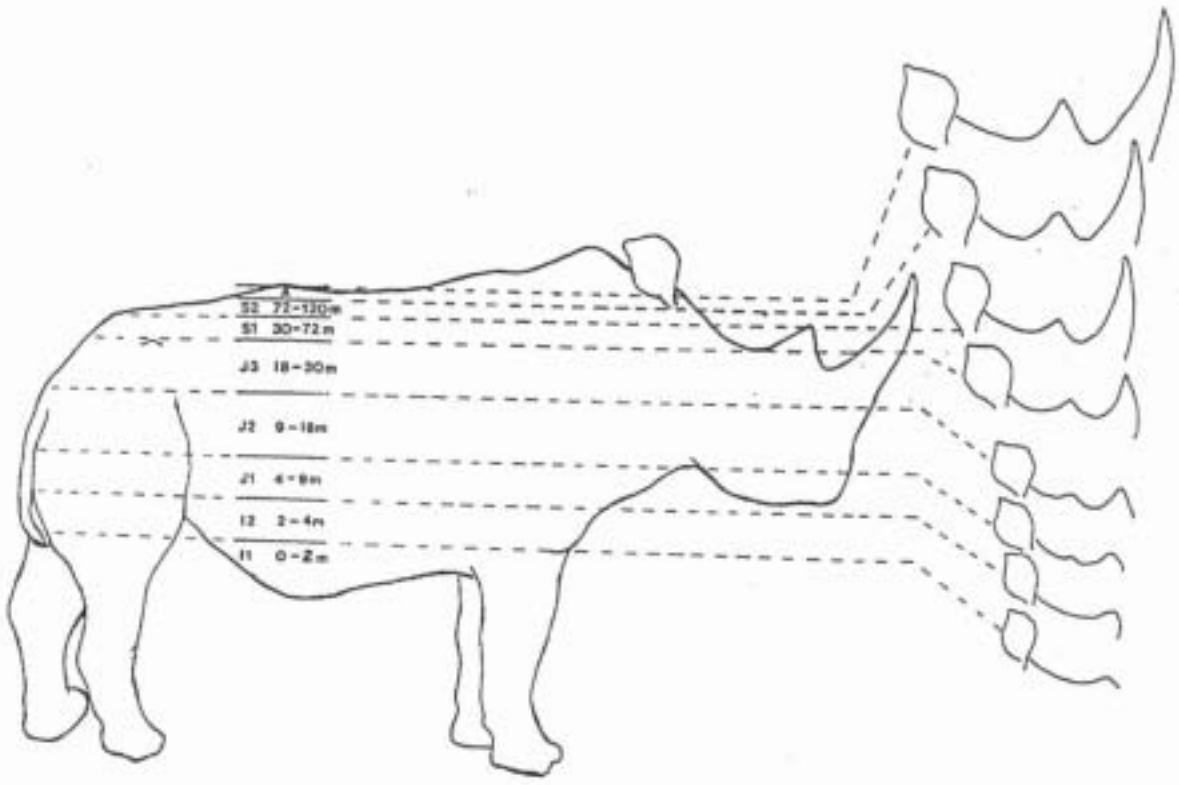
TOTAL KNOWN INDIVIDUALS

Male adults (MA)	4	
Female adults (FA)	4	
Male sub-adults (SM)	0	
Female sub-adults(SF)	1	
Male juveniles (JM)	0	
Female juveniles (JF)	0	
TOTAL	9	(Sex Ratio 4M : 5F, Adult:subad.+ Juv.ratio 1 : 0)

There is also 1 intergrade female:

476	'Nasi'	? / 351 (Dead)	Born 11 November 1977	17-18	Dvur Kralove

Figure 6: Chart for Field Determination of Ages of Garamba White Rhino



Height of Juvenile White Rhino Relative to Mother

Length of Horns Relative to Ears

(Based on Hillman-Smith, A.K.K., N. Owen-Smith, J.L. Anderson, A.J. Hall-Martin, & J.P. Selaladi. 1986. Age Estimation of the White Rhinoceros (Ceratotherium simum). J. Zool. Lond. (A) 210: 355-379.)

Table 2 - Summary Population Structure and Performance - Garamba and Captive Population

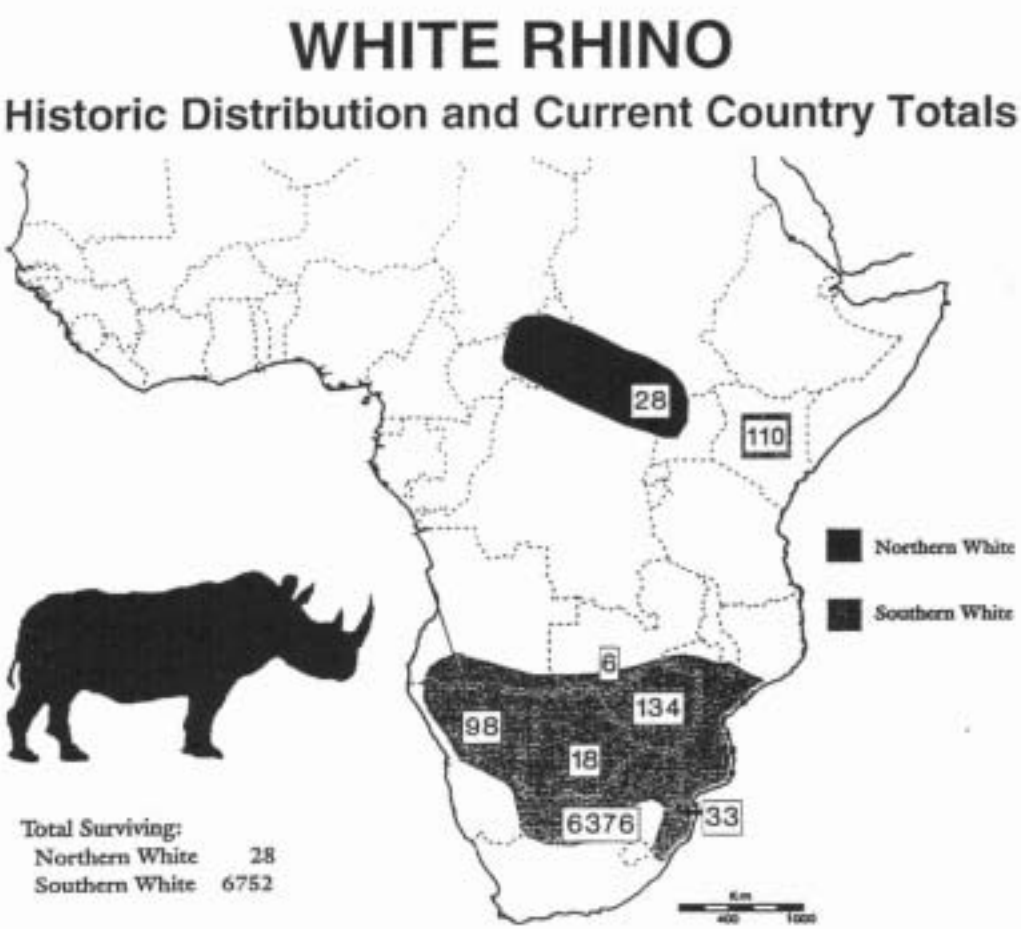
POPULATION STRUCTURE AND PERFORMANCE SUMMARY NORTHERN WHITE RHINOCEROS								
CATEGORY	GARAMBA POPULATION				CAPTIVE POPULATION			
	Total		Proven Breeders		Total		Proven Breeders	
	♂♂	♀♀	♂♂	♀♀	♂♂	♀♀	♂♂	♀♀
ADULTS Age > 7 Yrs ♀♀ Age >10 Yrs ♂♂	8	9	3?	4	4	4	2	0
SUBADULT 4 Yrs < Age < 7 Yrs ♀♀ 4 Yrs < Age < 10 Yrs ♂♂	4	3	-	-	0	1	-	-
JUVENILES Age < 4 Yrs	2	2	-	-	0	0	-	-
ADVANCED AGED ADULTS Age > 25 Yrs	1	0?	-	-	1	1	-	-
NEW BREEDERS SINCE 1985	1?	1	1?	1	0	0	0	0
BIRTHS 1984-1995	11	11	-	-	1	1	-	-
DEATHS 1984-1995	4	3	1	2	2	2	0	1
RATE AND EXTENT OF CHANGE	Rate of **increase** equivalent to 6%/year 1984-1995 Numbers increased from 15 to at least 28.				Crude rate of **decrease** equivalent to 4%/year 1984-1995 Numbers decreased from 13 to 9			

4. GENETICS AND SYSTEMATICS OF NORTHERN WHITE RHINO

Systematics:

Data on historic distribution and from fossilized remains suggests that the northern and southern subspecies of white rhinoceros have been separated geographically for at least 12,000 years and perhaps longer.

Figure 7: Historic Distribution of Northern and Southern White Rhino



Studies of biochemical genetics also supports the distinctness of the northern and southern white rhinos. In work by M. George, Jr., L.G. Chemnick, D. Cisova, E. Gabrisova, A. Stratil, and O.A. Ryder, mitochondrial DNA and serum proteins of white rhinos (*Ceratotherium simum*) have been analyzed for evidence of subspecies differences. Samples were examined from captive specimens of 6 unrelated northern white rhino, 6 southern white rhino and 6 black rhino of two described subspecies. It is estimated that the sample for northern white rhino may represent at least one-third of the total subspecies mtDNA haplotype diversity.

The northern white rhinoceros (*C.s. cottoni*) and the southern white rhinoceros (*C. s. simum*) can be distinguished by recognition sites for ten different restriction endonucleases and by the presence or absence of a serum esterase ES3. Based on comparison of 129 restriction fragments in the northern white rhino and 128 restriction fragments in the southern white rhino, 108 fragments were held in common by the two groups, corresponding to a F-value of 0.840 (Nei and Li, 1979) and an estimated mtDNA nucleotide sequence divergence of 1.4%. Results derived from the larger sample set utilized in these studies reinforce the phylogenetic distinctiveness of the two geographic forms of white rhinoceros, although estimates of their divergence based on mtDNA analyses have decreased from 4% to 1.4%. For comparison, the white rhinos were discovered in this study to differ from the black rhinos by an estimated 4.5% mtDNA nucleotide sequence divergence.

Variation in serum proteins appears to be relatively low in the white rhino. Only 6 variable loci have been elucidated with certainty. Both southern and northern white rhinos have experienced severe population bottlenecks requiring recovery from single populations in their natural habitat. The intrasubspecific variability of mtDNA is low for both the northern and southern white rhino (0.0-0.07% and 0.0-0.04% respectively). The dynamics of their population decline over the last several centuries may differ significantly from that of the greater one-horned rhinoceros, a species that retains high levels of genetic variability (Dinerstein and McCracken, 1990).

This study corroborates the evidence for phylogenetic separation of northern and southern white rhinos obtained previously, although the extent of nucleotide sequence divergence is smaller than the previous estimate.

Other material, collected by the study described in the next section from the Garamba population, has been examined by Professor Eric Harley, University of Capetown. Using mitochondrial DNA restriction enzyme digestion, their studies demonstrate that the northern and southern sub-species of white rhinoceros are more widely separated than the different sub-species of black rhinoceros (*Diceros bicornis*) and warrant special consideration. (E. Harley, pers.comm.)

The IUCN SSC African Rhino Specialist Group certainly recognizes the northern white rhino as a distinct taxon that should continue to be conserved as a separate and valuable unit.

Genetic and Demographic Considerations for Management of Northern White Rhino

From the perspective of both the source and possible new population(s), demographic considerations are probably more important than genetic concerns in formulating a management strategy for northern white rhino. Over the short term, the northern white rhino is in a demographic crisis which if not solved will render genetic concerns which are would be expected to be longer term in their effect academic. From the perspective of the new population, demographic considerations are definitely more important than genetic ones.

However, over the longer term and even over the shorter term if the population of northern white rhino does not expand rapidly to much larger size, genetic concerns are justified.

Small populations are at risk for loss of genetic variability. The northern white rhino has passed through several bottlenecks of small size, one of them, the most recent one, very severe. However, populations reduced to very low numbers do not necessarily suffer major reductions in heterozygosity, especially if the recovery from a bottleneck is rapid. The results of genetic analysis by Dinerstein and McCracken indicate such is the case for the Indian Rhino. It should be noted that reduction to small size is in itself not cause for loss of diversity. A population of 20 unrelated animals from a rapidly reduced much larger population would still on the average be expected to retain 97.5% of the original gene diversity. The Southern White Rhino is another good example. Some reports put their numbers as low as 20 in the first quarter of this century.

In general, many positive correlations have been demonstrated between genetic heterozygosity and parameters of fitness, and "in-breeding" depression could be a potential threat. However, there are considerable inter-specific, inter-generic and inter-order differences in inherent heterozygosity and polymorphism and mammals have manifested the lowest variability of all. A low heterozygosity in itself, therefore is not necessarily a major limiting factor in the wild. The case of the cheetah (*Acinonyx jubatus*), which has a heterozygosity of virtually 0, yet is represented in the wild by numerous, apparently healthy, reproducing populations is a classic example. Further, even when the genetic composition is unknown, there are many examples of good demographic performance following major numeric reductions. They now number over 6,700. Therefore, genetic considerations are not in themselves a valid reason for **not** investing in the conservation of a taxon. On the other hand, it must also be acknowledged that it is not just fitness in the current or recent environments that may depend on genetic variation. Adaptation to changed environments over the longer-term is also critical.

Hence, genetic factors should be considered in management strategies wherever possible. Trying to manage for genetic diversity when it does not conflict with more immediate problems is well advised. Such consideration is especially important when especially when manipulative management is being contemplated for a very small world population like the northern white rhino.

To this end remote biopsy sampling of the wild northern white rhino was begun in 1992 using the methods of Karesh et al. In 1992 and 1993, material was collected in both 1992 and 1993 for genetic analysis, both by remote biopsy darting and during immobilization for radio telemetry.

The aims of the genetic analyses are to assess the genetic variability of the population, the male contribution to breeding and to link behavioral observations with known relationships. This information can contribute to decisions on whether and how genetic management might need to be carried out for long term conservation of the wild population.

More technically, the objectives of this study have been:

- To assess the level of genetic variation present in this only remaining *in situ* population of this subspecies.
- To develop molecular markers that will assist in individual identification, determination of paternity and establishment of breeding structure in this population.

Genetic data generated in this study would be an important input into the strategic management and conservation of this subspecies in the wild by ensuring the maintenance of a maximum gene pool and avoidance of inbreeding and genetic erosion characteristic of small populations that have experienced genetic bottlenecks. As far as possible genetic considerations should be applied: (a) to the choice of any individuals translocated, in order to have the widest representation from matriarchal and as far as known, patriarchal contributions, in both the remaining source population and in founders, and (b) in measuring the state of variability within and between existing separate groups to assess the degree of need for any interchange to potentially improve genetic fitness. It is proposed that a genetic ID of all northern white rhino be established to guide future metapopulation management.

To date samples from 23 different individuals from Garamba are being analyzed, although 3 are from individuals no longer part of the population, compared with samples from captive individuals from San Diego. Samples are being analyzed at the National Museums of Kenya under a group led by Dr. Rashid Aman and at the University of Cape Town by Dr. Eric Harley and Dr. Coleen O'Ryan.

Full or extensive results of the analyses being conducted by Dr. Aman have not been fully received. Although there are insufficient data to arrive at conclusions, partial sequences obtained from several individuals indicate that the extent of variation between individuals is minimal suggesting an overall low genetic variation within this population. A low variability within the Garamba population could imply a low ability to adapt to environmental change. Interchange of genetic material with other populations if available may be beneficial.

This study aims to completely sequence the entire 1.6kb region from twelve individuals in order to obtain accurate data on the extent of genetic variation present in this population. Among these we have included a few samples from northern white individuals held in captivity at zoos in Europe and N. America. This will provide an indication of any differences between wild and captive individuals.

Microsatellite markers have proved extremely useful in parentage testing and construction of detailed linkage maps. The particular attributes of these simple repeat loci (di-, tri- and tetranucleotide blocks) that have made them so useful are their high polymorphism and abundance in nuclear genomes. We have been working on developing rhino microsatellite markers to enable us to realize objective 2 of this project. A genomic library is now available and we are in the process of screening it. We have also synthesized flanking primers for a few of the earlier clones and are in the process of testing the informativeness of these loci in the population by PCR and denaturing gel electrophoresis. We hope that this process will identify several polymorphic microsatellite loci that will be useful singly or in combination in establishing individual identities and paternity in this population. Allele diversity will be examined by PCR followed by denaturing gel electrophoresis of labeled PCR products.

Hopefully, more conclusive results of this study will be available soon.

5. A. ESTIMATES OF COSTS OF *in situ* PROTECTION AND MANAGEMENT IN GARAMBA

Continued conservation of rhinos in Garamba is an accepted part of the strategy. To date, the Park has proved itself: (1) with the results of protection since the start of the project and (2) with the continuation of conservation activity after the problems in 1991, when many aid projects departed. But in 1993, the Garamba Project lost almost half its funding with the loss of one of the major donors. This shortfall has been temporarily filled by other donors, but the question remains: Is the current state of protection sufficient to counteract the increased threat from Sudan, the pressure of the poor economic state of the country and the unlikely but possible potential for a break-down of law and order in the event of civil unrest in the country?

The Project Management Unit (PMU) of the joint IZCN/WWF Garamba Project believes that potentially it is, and has proved that it can counteract the threat by cooperative action with military. However further improvements in efficiency, capability, motivation and training and equipment are required to increase detection rate, to develop a strong and effective force, flexible enough to deal with any situation, and motivated enough to continue the conservation ethic in the event of serious unrest. To maintain and improve the current level of anti-poaching activity and to assure protection of the rhinos and ecosystem *in situ*, more support is needed

Current Anti-poaching

Anti-poaching is carried out mainly on foot with initial placement by a vehicle and periodic aerial support and radio contact. On the basis of rhino distribution and poaching pressure, anti-poaching activities are divided as follows:

North, - northern two thirds of the Park, the heavy poaching area. Mobile teams, working from high game concentrations in the center outwards, and having numerous contacts with poachers armed with automatic weapons.
South, - southern third, the rhino sector. Currently more of a monitoring and deterrent presence than active anti-poaching.
Domaine de chasse - Specific sorties accompanied by Conservateur or local authorities to recover automatic weapons and ammunition from people in the Reserves that surround the Park.

Problems:

Border-related
- Arms and ammunition from civil war in Sudan brought into surrounding area
- Poachers based in Sudan entering the Park
- Sudanese refugees (50,000) living east and west of Park
- Numerically large, heavily armed poaching gangs

Economic situation
- Salaries irregular and inadequate
- Local demand for meat and negative attitudes
- Reduced budgets

Personnel

- Insufficient motivation, training and supervision
- Large number of unproductive guards
- Demoralization due to standard of living and lack of promotion
- Recruitment and pensioning needed
- On-going need for equipment and uniforms

Proposed strategy

Goal and Objectives

The primary goal is to stop commercial poaching, to protect the rhinos and elephants and to conserve the ecosystem as a whole, with the flexibility to respond to contingencies.

This is being achieved through the following objectives:

- Increase the detection rate of poaching by greater mobility in the north and the use of observation posts and aerial reconnaissance
- Have more effective anti-poaching action through training, motivation, leadership re-structuring of the guard force and support
- Reinforce the current rhino surveillance to counteract threats from the north or direct incursions to the south through increasing coverage, monitoring, aerial and ground work, development of new observation posts and in field training
- Increase weapon recovery and use of the informer network in the Reserves
- Cooperative action with local military and other authorities

Anti-poaching

- Combined operations between local military and park guards to knock back the upsurge in poaching.
- Combined operations between local authorities and park staff to recover automatic weapons from the population in the surrounding Reserves.
- *in situ* training of the guards in para-military tactics during the phase of local military support to anti-poaching activities.
- Development of observation posts on strategic high points, each one manned by two guards with a radio to report on gun shots, vulture aggregations and smoke. Ideally each observation post will have access by road and air.
- Employ mobile units of select guards working from a 4x4 vehicle who will patrol the northern areas of the Park, responding to information supplied by the observation posts.
- Expand the system of observation posts, lookouts and mobile units into the southern reaches of the Park to prevent poaching spreading to areas of rhino range.
- Develop the radio network so that all foot patrols, observation posts and mobile units will be equipped with mobile hand held radios.
- Improve control of the peripheral zone in the north by installing a radio network between Park HQ and key patrol posts along the Sudan/Zaïre boundary. As these patrol posts are in contact with the local population the radios will operate on a different frequency from the internal anti-poaching units, so as to avoid information leaks.
- Training guards in para-military techniques will be repeated at regular intervals.

- Increase aerial monitoring of the Park. Aerial surveillance is the most efficient deterrent to poachers if sightings are followed up by mobile units.
- Develop a formal arrangement with military HQ in Kinshasa concerning a contingency plan for dealing with a possible upsurge in poaching. The plan will be based on transferring well equipped elite troops specifically to help combat poaching and to train park guards.
- Liaise with local authorities regarding the refugee problem. The aim is firstly to disarm the refugees and secondly to move all refugees out of the Reserves.

Personnel

The key to conservation is the man-power. But the present system is one that has a high number of unproductive poorly paid staff. A new system is being designed as part of the management plan, based on less people, who are better paid and well motivated.

For the overall running of the Park, the following is needed:

- Identification of the Park's long term minimum staffing needs
- Develop and implement a strategy for the recruitment of staff
- Until such time as IZCN is able to provide regular and adequate salaries, external funds are needed to support the Park staff
- Motivation in the form of bonuses paid according to results achieved
- An adequate system of promotion of personnel with the concomitant material and professional advantages
- Adequate provision for retirement
- *In* and *ex situ* training in scientific, technical and para-military subjects at all levels, as relevant, and refreshing that training regularly
- International experience and training for higher levels

For the Project there is need for continued support for a:

- Workshop/Construction Supervisor/Trainer, to maintain the on-going work of vehicle maintenance, stores supervision, basic infrastructure development and mechanics training.

Infrastructure development in the Park is based on anti-poaching and surveillance needs

- Develop guard observation posts on strategic high points as per the anti-poaching workplan
- Construct concrete causeways on strategic minor river crossings
- Replace causeways over the Dungu, Garamba and Mabwamu rivers with bridges
- Open airstrips in the Park as per the anti-poaching workplan
- Develop the radio network by expanding the VHF relay system, developing the VHF peripheral link, and improving the VHF link with Kinshasa
- Develop the solar power system to back up all requirements
- Develop and maintain roads in the northern section as per anti-poaching activities
- Develop and maintain the road network in the southern section as per rhino movements and tourist needs

Road Unit

Long term plan for maintenance and construction of roads and airstrips requires a road unit.

Vehicles

- Mercedes 911 4x4 Truck for mobile anti-poaching unit.
- Two Landrover Defenders in 1997 and there after every two years.

Vehicle and equipment spares
- Bulk orders from Europe
- Monthly purchases from Kenya

Fuel
- Shipped in from Kenya
- Avgas 150 drums pa
- Diesel 200 drums pa
- Lubricants 20 drums pa

Bridges
- These require Bailey Bridge sections. It is only feasible if these can be obtained locally.

- *Infrastructure development at Headquarters* is needed to support field activities
  - Renovate staff housing
  - Aircraft hangar
  - Water supply
  - Renovations to workshop facilities
  - Construct office block
  - Replace all asbestos roofing
  - Develop the solar power systems
  - Renovate and develop storage facilities in the Grand Magasin
  - Construct fuel storage facilities
  - Renovate tourist accommodation

Guards' Equipment

Replacements required every two years
- Uniforms, boots, caps, belts, ponchos
- Tents, sleeping bags, backpacks, binoculars

Guards' Rations

Purchased and transported within Zaïre
- Rice 10 tons per annum
- Bean 6 tons per annum
- Salt 500 kgs per annum
- Palm oil 2,000 litres per annum
- Soap

Radio Equipment
- Purchase of more Motorola walkie talkie units
- Maintenance to present radio and relay system

Construction Equipment
- Cement, wood, steel, hardware, roofing, water pipe

Infrastructure Equipment
- Rice dehusking machine
- Water pumps
- Workshop equipment

Monitoring and Research

Monitoring and research needs to be continued and expanded to detect any problems with the rhinos early and to back up and guide management action.

- Increase of rhino recce series to once every 6 weeks
- High intensity rhino surveys with two aircraft and full observer crews twice a year
- Maximize guard participation and all forms of on the ground monitoring
- General all species aerial sample counts of Park and Reserves every two years
- Continuation and development of monitoring of poaching and anti-poaching activities by standardized guard reports and monthly summaries, and feed-back into the direction of patrol activities.

Financial requirements

Further details of actions and funds required are provided in the tables (Table 3 A & B; Table 4 A, B, C) on the ensuing pages. Figures are presented as both very Minimum Budgets and as Desirable Budget.

The present budget representing more or less the minimum is between $ 200,000 and $300,000 per annum: $ 200,000 for management; $ 70,000 for monitoring and research. For really adequate support of the full conservation needs approximately an average of $ 1,000,000/year over the next 3-5 years: ~ $ 500,000 per year for management with a one-time cost of $ 500,000 for road work; $ 140,000 for research and monitoring; ~ $ 230,000 for the Reserves and Elephant Domestication Center.

The Desirable Budgets are to support:

- Management activities in terms of anti-poaching with all the necessary back-up entailed
- Infrastructure Development including patrol posts, roads, airstrips, and their maintenance, as well as an office block for both management and research/monitoring
- Conservation oriented monitoring and research to provide rhino surveillance and feed-back on management and the ecosystem
- Securement of long-term future through integration of surrounding Reserves and local communities in the conservation process
- Funding mechanisms for long-term sustainability through ecotourism based largely on the elephant domestication center, which was established in 1950 and still has 3 domesticated elephants from the 1950s as well as the basic infrastructure to resume fuller operations.

Additional detail on financial costs and needs are presented in the proposal entitled *Conservation and Development of Garamba National Park and Surrounding Reserves* prepared by WWF and IZCN for the World Bank in partial fulfillment of requirements of the Japanese Grant Agreement No. KZ4564, which is available from WWF-International in Gland, Switzerland.

Table 3 A & B: Minimum Budgets for Conservation & Development of Garamba National Park

CONSERVATION & DEVELOPMENT OF GARAMBA NATIONAL PARK

MINIMUM BUDGET - USD $
PARK MANAGEMENT

Budget Line	Year 1995	Year 1996	Year 1997
102 - Equipment	7,700	8,500	9,350
103 - Infrastructure/Construction	3,100	5,100	5,600
201 - Chief Technical Advisor	53,000	55,600	58,400
204 - Park Staff	50,000	50,000	50,000
206 - Vehicle Operation	64,000	81,000	89,200
210 - Office Operation	3,850	4,250	4,700
211 - Field Costs	9,900	10,850	11,900
212 - Travel	2,350	3,100	3,400
Totals	**193,900**	**218,400**	**232,550**

CONSERVATION & DEVELOPMENT OF GARAMBA NATIONAL PARK

MINIMUM BUDGET - USD $
MONITORING & RESEARCH

Budget Line	Year 1995	Year 1996	Year 1997
102 - Equipment	1,550	1,550	1,550
201 - Chief	43,000	43,000	43,000
203 - Non WWF Staff	2,350	2,350	2,350
204 - Park Staff	3,100	3,100	3,100
205 - Professional Fees	800	800	800
206 - Vehicle Operation	10,800	10,800	10,800
207 - Equipment Operation	400	400	400
210 - Office Operation	3,100	3,100	3,100
212 - Travel	900	900	900
217 - Training	2,350	2,350	2,350
Totals	**68,350**	**68,350**	**68,350**

Table 4. A. - Desirable Budgets - Conservation & Development of Garamba & Reserves

CONSERVATION & DEVELOPMENT OF GARAMBA AND RESERVES DESIRABLE BUDGET - US$ PARK MANAGEMENT			
Budget Line	**Year 1**	**Year 2**	**Year 3**
101 - Vehicles	80,000	50,000	
101 - Road Unit			500,000
102 - Radio System	20,500	13,500	1,700
102 - Tents & Packs	16,500		17,000
102 - Shipping & Clearing	15,000		15,000
201 - Chief Technical Adviser	53,000	53,000	53,000
201 - Facilities Manager/Trainer	25,000	25,000	25,000
201 - Assistant	25,000	25,000	225,000
204 - Park Staff	66,000	66,000	66,000
206 - Aircraft	34,000	36,000	38,000
206 - Fuel	86,000	86,000	100,000
206 - Spares	35,000	35,000	35,000
208 - Construction	20,000	20,000	10,000
208 - Bridges		30,000	26,000
208 - Headquarters Renovation	17,000	45,000	34,000
210 - Office	5,000	5,000	5,000
211 - Uniforms	25,000		25,000
211 - Rations	8,000	8,000	8,000
212 - Travel	6,000	6,000	6,000
Totals	**537,000**	**503,500**	**989,700**

Table 4 B - Desirable Budgets - Conservation & Development of Garamba & Reserves

CONSERVATION & DEVELOPMENT OF GARAMBA AND RESERVES DESIRABLE BUDGET - USD $ MONITORING & RESEARCH			
Budget Line	**Year 1**	**Year 2**	**Year 3**
101 - Vehicles		25,000	
102 - Equipment	20,000	5,000	12,000
201 - Technical Assistant Ecology	43,000	43,000	43,000
201 - Research Assistants	20,000	20,000	20,000
204 - Park Staff	5,000	5,000	5,000
206 - Vehicle/Aircraft	18,000	18,000	18,000
208 - Infrastructure Development	10,000	10,000	10,000
210 - Office	3,000	3,000	4,000
211 - Field Costs	1,500	1,000	5,000
212 - Travel	2,500	2,500	2,500
214 - Publications	10,000	2,000	3,000
217 - Training	10,000	3,000	5,000
400 - Contingencies	5,000	5,000	5,000
Totals	148,000	142,500	132,500

Table 4. C. - Desirable Budgets - Conservation & Development of Garamba & Reserves

CONSERVATION & DEVELOPMENT OF GARAMBA AND RESERVES DESIRABLE BUDGET - US$ RESERVES & OTHER PROJECTS			
Budget Line	**Year 1**	**Year 2**	**Year 3**
RESERVES			
101 - Vehicles	25,000	25,000	
201 - Project Coordinator	35,000	35,000	35,000
201 - Assistants	20,000	20,000	20,000
211 - Field Costs	15,000	20,000	25,000
Total	**95,000**	**100,000**	**80,000**
MANAGEMENT PLAN DEVELOPMENT	**15,000**		
TRUST FUND DEVELOPMENT	**11,000**	**11,000**	
ELEPHANT DOMESTICATION CENTER	**135,000**	**135,000**	**135,000**

5. B. ANALYSIS OF SOURCES FUNDS FOR *in situ* ACTIVITIES: LEVELS AND LIKELIHOODS

SOURCES OF FUNDS TO DATE

The accompanying table outlines funding sources from 1984 to 1994 for the Garamba Project as a whole, comprising the sub-projects: **Conservation and Development** (WWF ZR 0009.01, FZS 967/83) and **Monitoring and Research** (WWF ZR 0009.02).

The main funding sources to date have been:

World Wide Fund for Nature (WWF)	11 yr average $141,851 p.a.
Frankfurt Zoological Society (FZS)	11 yr average $ 78,080 p.a. + aircraft
UNESCO (World Heritage Fund)	11 yr average $17,364 p.a.

All figures are inclusive of the management fees

In addition, the following non governmental organizations (NGOs) have contributed:

- **Fauna and Flora Preservation Society** and **Kenya Rhino Action Group** contributed $3,000 and $2,000 respectively to the initial rhino survey.
- **Wildlife Conservation Trust** contributed $5,000 in 1985 to Monitoring and Research, and $6,000 in 1989, which comprised purchase of half the Monitoring and Research aircraft.
- **Save the Rhino International (SRI)** since 1991 has given a 4 yr average of $8,925 p.a., which included a vehicle for Monitoring and Research.
- **International Rhino Foundation (IRF)** since 1993 has contributed a vehicle at a cost of $29,714.53 and a 2 yr average of $7,500 to guards salaries, making an overall 2 year average of $22,357.27 The guards' salaries are an expenditure which is theoretically the responsibility of *the Institut Zaïrois pour la Conservation de la Nature (IZCN)* and is therefore extra to a normally foreseen project budget. During this period, however, the economic situation of the country has made it difficult for this commitment to be met by the IZCN.
- **Elephant and Rhino Foundation** and **Wildlife Veterinary Services** in 1993 supported the expenses of the veterinarian and the collars for radio telemetry to improve rhino surveillance.
- **World Bank** in 1993/1994 contributed $90,000 under the Japanese Grant No. KZ4564

The **IZCN** contribution to the running of the park was foreseen in the original project document as comprising:

> Salaries and medical and administrative expenses for the IZCN staff of 250-232 people,
> Rations for patrolling and a contribution towards vehicle fuel and uniforms.

Since 1987, the 8 yr average of support from IZCN has been $10,497 p.a. for salaries and administrative costs. Other expenses have been supported from NGO contributions. During 1994, no financial contribution for salaries was possible, but uniforms were provided, with transport paid by the project. In May 1995, IZCN authorized the use of tourist returns to pay salaries. This involved approximately $2000 on hand at the time.

In summary, as indicated in Figures 8 and 9, support for *in situ* conservation in Garamba since 1984 has been almost entirely provided by international donors. It is also clear that funding has decreased in the last year and over the entire period has not kept pace with inflationary trends.

Figure 8: Sources of Financial Support for Garamba 1984-1995

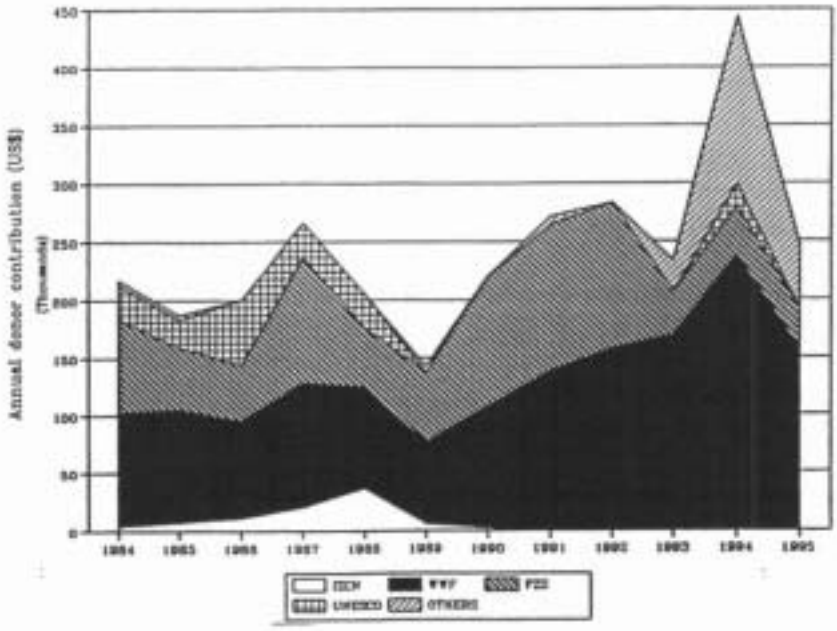


Figure 9: Total Financial Support for Garamba in Relation to An Annual Increase of 10%.

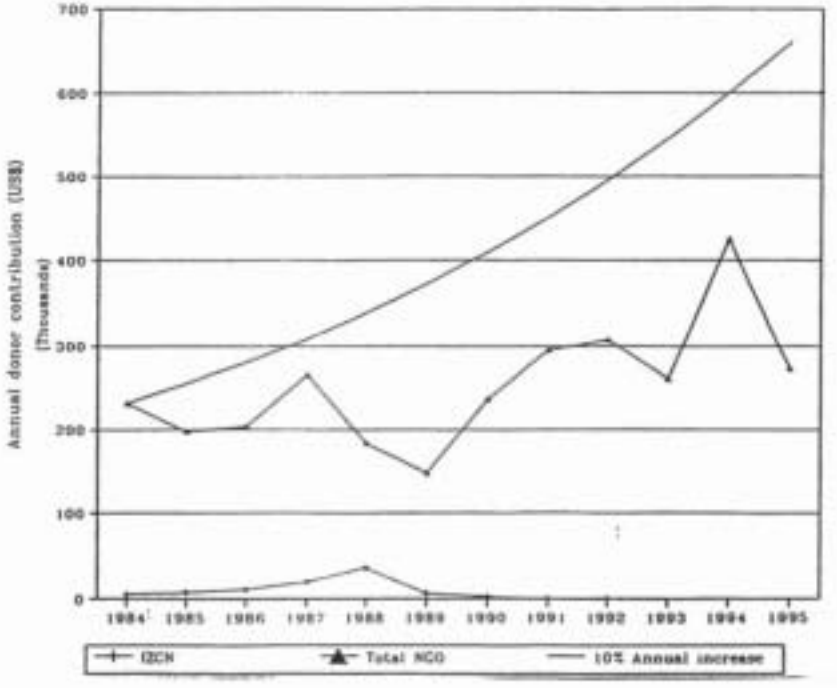


Table 5: Contributions of Donors to Garamba National Park 1984-1995

GARAMBA NATIONAL PARK PROJECT													
ANNUAL BUDGETS (US $) BROKEN DOWN BY BROAD BUDGET LINES													
WWF (Projects 1954 & 1954.01 and ZR0009.01 & ZR0009.02)													
Budget Lines	**1984**	**1985**	**1986**	**1987**	**1988**	**1989**	**1990**	**1991**	**1992**	**1993**	**1994**	**1995**	**Totals**
Personnel	38,780	46,200	40,920	72,667	58,733	24,267	44,433	36,000	46,533	58,533	94,630	52,121	562,617
Travel	2,761	2,700	3,700	5,200	3,333	2,000	6,667	8,000	8,000	4,726	3,000	2,273	50,087
Vehicles	24,724			0	0	0	0	0	0	0	38,462	0	63,186
Equipment & Field costs	2,693	23,000	11,000	17,800	7,333	30,333	13,333	22,000	16,667	14,000	7,692	17,254	163,942
Infrastructure	9,069	8,000		0	0	0	0	0	0	0	2,308	3,030	19,377
Running costs	13,693	12,000	19,000	6,000	11,667	6,667	39,067	47,600	60,933	54,634	47,692	62,879	318,952
Local Development				5,333	5,333	5,333	1,667	8,333	10,000	0	0	0	36,000
Paid workers	542		1,000	0	0	0	0	2,000	0	9,911	6,538	0	19,991
Contingency	5,954	8,000	9,000	1,667	1,667	1,667	0	0	0	10,066	0	0	38,020
Research & Monitoring				0	0	0	0	15,200	15,400	16,667	33,398	18,939	84,665
Totals	99,136	97,900	84,620	108,667	88,067	70,267	105,167	139,133	157,533	168,627	237,720	156,496	1,513,332
+ 15% Management fee	114,006	112,585	97,313	124,967	101,277	80,807	120,942	160,003	181,163	193,921	273,378	180,018	1,742,180
Source: WWF(I), WWFEARO, Garamba NP Project accounts					Expenses & part-time salary for Monitoring and Research in 1991 from US Fish & Wil. Service								

Table 5: Contributions of Donors to Garamba National Park 1984-1995

FRANKFURT ZOOLOGICAL SOCIETY

Budget Lines	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	Totals
Personnel				1,000	539	10,512	29,975	39,104	30,159	0	0	0	111,270
Travel				3,333	0	0	0	582	0	0	0	0	3,915
Vehicles	30,000			33,333	0	0	17,024	0	0	0	0	0	80,357
Equipment & Field costs	30,000	15,000		24,000	3,419	66	28,291	17,451	23,613	4,707	7,000	0	153,547
Infrastructure				5,333	2,414	0	306	3,333	10,000	0	0	0	21,386
Running costs		10,000		7,067	21,767	19,452	995	833	20,000	0	0	0	80,114
Aircraft expenses	15,000	25,000	25,000	25,333	18,913	30,965	25,627	42,631	33,433	31,875	35,406	35,714	309,185
IUCN Expenses(10%?)	7,500	5,000	25,000	9,940	5,441	0	1,161	260	2,333	170	0	0	56,805
Contingency				0	0	0	11,395	23,003	6,667	1,233	0	0	42,297
Totals	82,500	55,000	50,000	109,340	52,474	60,995	114,774	127,198	126,206	37,985	42,406	35,714	894,591
Source: IUCN Regional Office, GNPP Accounts and proposed budgets													

UNESCO

Budget Lines	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	Totals
Vehicles	30,000		38,000	25,000	25,000						10,000		128,000
Equipment&spares		25,000	18,000	5,000	5,000								53,000
Field costs											10,000		10,000
Totals	30,000	25,000	56,000	30,000	30,000						20,000		191,000
Source: GNPP records													

Table 5: Contributions of Donors to Garamba National Park 1984-1995

OTHER DONORS

Organization/Budget Line	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	Totals
KRAG/Rhino Research	2,000												2,000
FFPS/Rhino Research	3,000												3,000
WIL Conserv. Trust/Rhino monitoring		5,000				6,000							11,000
SRI/Monitoring, Resrch, Eqpt.								7,200		7,500	21000		35,700
IRF/Guard Support, Eqpt.										10,000	34715	50,000	94,715
IWVS&REF										10,000			10,000
World Bank											90,000		90,000
Zool. Soc. London												4,500	4,500
Totals	5,000	5,000	0	0	0	6,000	0	7,200	0	27,500	145,715	54,500	250,915
Source: GNPP Records													

OVERALL TOTALS

	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	11yrTOTAL
	231,506	197,585	203,313	264,307	183,758	147,801	235,716	294,401	307,369	259,406	481,499	272,032	3,078,686

IZCN Budgets Received from Headquarters for Garamba

	1987	1988	1989	1990	1991	1992	1993	1994	1995	Totals	Anl Avrg		
Average Exchange Rate (Z/US$)	1,000	2,000	2,500	4,000	33,000	131,936	2.5NZ						
Salaries (Zaires)	3,653,216	13,444	24,069,962	93,381,601	1,209,481,088	6,676,864,955	5811NZ			75,950			
Salary equivalents in US$	3,653	6,722	9,628	12,595	35,996	5,062	2,324				10,854		
Operating expenses(Zaires)	400,000	650,000	1,650,000	264,520	0	0	0						
Operating expense equiv.in US$	400	325	660	6,613	0	0	0	uniforms		7,998	1,143		
Total US$	4,053	7,047	10,288	19,208	35,996	5,062	2,324	0	0	83,948	11,997		
Source: PNG/IZCN accounts, provided by Comptable Sengi Aaleno													

The development of project goals and financial requirements and constraints may be summarized as:

The initial goal of the project was rehabilitation of the National Park. Survey of the status of the rhinos and whole ecosystem and establishment of a long term monitoring project was required, but funding was to be sought separately. WWF and FZS were equal partners in the rehabilitation project, with a major annual contribution from UNESCO possible through the World Heritage Fund. Based on the success of the rehabilitation of the Park in the first phase, the subsequent phases of the project were renamed Conservation and Development, with goals changing accordingly. Not only did this involve conservation and development of the Park, but it was recognized that for the long term future of conservation of the ecosystem, integration of the surrounding human-occupied buffer zone Reserves was necessary, with consideration also of tourist development, based on the domestic elephants. To this end, a project was under development and negotiation for funding by **GTZ** (German Technical Aid). When riots broke out in Kinshasa in 1991, and in the process of subsequent political developments, all government linked aid to Zaïre was sanctioned. Initiation of this or any other supplementary development project was therefore held in abeyance, but is still a requirement.

From 1991 through 1994, WWF funded the Research and Monitoring component of the project, initially with funds from US Fish & Wildlife Service through WWF(US), then from WWF(International).

Since 1991, when the civil war in Sudan moved south, refugees entered Zaïre in the vicinity of the Park and arms and ammunition became more readily available, poaching for meat has increased, requiring an expansion of activity to combat it. Involvement of the army in anti-poaching activities during 1994 required greater funds for rations and financial bonuses.

Simultaneously the economic situation of Zaïre led to lower and more irregular salaries for IZCN staff, which had to be supplemented by international NGO funds in order to maintain motivation of guards.

In 1993, for internal reasons, **FZS** reduced its contribution to providing and maintaining the aircraft, while the world economic situation has led to budget cuts in the **WWF** support. In the 1994/5 financial year, the **World Bank** grant and **WWF** and **UNESCO** emergency funds filled the gap left by the removal of the **FZS** contribution and new vehicles greatly helped the Park management. Such funds are not so far available for 1995/6, and further **WWF** budget reductions required closure of the Research component of the Project. The **IRF** has recruited funds, principally from the **Columbus Zoo** and others, to fill the salary, bonuses and medical support gap left by **IZCN**, and in 1995/6 to allow better personnel support, though the buying power of local money has fallen even more than its exchange rate.

Overall therefore, the financial and personnel requirements for adequate long term conservation of the ecosystem have increased, while, despite an emergency response in 1994, funds and personnel are decreasing.

CURRENT FINANCIAL STATUS

In July 1995 the financial support for the 1995/6 year is foreseen as :

WWF	$ 181,818
FZS	$ 35,714 + aircraft
IRF	$ 50,000
Zoological Society of London (ZSL)	$ 4,500
TOTAL	**$ 272,032**

This total includes the $50,000 towards salaries, which is above normal project running costs. The total expenses for financial year 1994/5 were $465,819. The budget cuts, which have been necessitated by the world economic situation have led to closure of the monitoring and research project. A limited amount of flying expenses for rhino monitoring is now included within the main project.

The balance considered necessary for minimum surveillance of the rhinos is being sought from **Wildlife Conservation Society,** and **SRI,** the **Michael Werikhe Foundation** and **WWF** organizations. It was stated by WCS that if they agreed to a contribution, it was likely to be limited to the short term as a stop gap measure.

SOURCES OF FUNDS FOR FUTURE *in situ* ACTIVITIES

The following existing donors have expressed long term commitment to *in situ* conservation: **WWF, FZS, IRF,** and **SRI** but the level or term of commitment is not defined, and is unlikely to be greater than the present degree of support.

Major, longer term support to the full range of *in situ* conservation as defined by the management plan is currently being sought through an application for **Global Environment Facility (GEF)** funds of World Bank, administered by UNDP. A GEF concept document was proposed by the Président Délégué Géneral of IZCN in the form of a tri-partite project comprising support to Garamba National Park, Reserve Forestier à Okapi and institutional support for IZCN. The draft proposal "Conservation and Development of Garamba National Park and Surrounding Reserves, Zaïre" prepared by WWF and IZCN and submitted to World Bank in partial fulfillment of the Japanese Grant Agreement No. KZ4564, forms the basis of the action proposed for Garamba. It was proposed that a two level Trust Fund be established, with part as an investment fund from which the interest would cover annual running costs and part as a capital fund, which would form a basis for fund-raising from other organizations. The two would be overseen by a steering committee, of involved and interested parties, who would be implicated both in the management of the funds and in active attraction of support. It has been stated, however (John Hough pers. comm.) that until a review is complete the GEF will not be putting money into investment trusts. The possibility has also arisen of separating the proposal for Garamba from the original GOZ submission as part of a metapopulation management plan for the northern white rhinos. The two options are open, and depend largely on the results of the meeting.

It is proposed that a small, active steering committee be established, whatever the sources of funds. A stronger link, particularly on the scientific and practical aspects, with the steering committee of the projects at Epulu, is also proposed, in line with the decentralization ethic of IZCN.

Possibilities for Funding the reserve development component of the activities exist in the form of the **CARPE** (Central African Regional Program for the Environment) proposal for **USAID** support to environmental development in the Congo Basin, linked with a GIS database of the environment. The projects proposed for Garamba are relevant to this initiative and are therefore being pursued for the development project.

If any funds are possible from **WWF national organizations**, the possibility of a long term involvement would be investigated.

Conservation of a Second Population in Africa

It has been assumed in the above discussions that the basic costs of existing or increased security at a new population site, would be borne by the host organization in return for the advantage of having the northern white rhino attraction and in the cause of conservation. Current security would need to be increased in all areas identified in East Africa, except possibly Ol Pejeta. Guarantee of adequate security and support for the costs of it would therefore be a major criterion in selection of a site in Africa. There is insufficient funding available for any competition for security funds with those available for Garamba.

Relocation

Foose notes that major, perhaps complete support, would be available from the global captive community for the costs of translocation to a new population if that site were in North America. Partial support would be possible if the second population were in Africa.

Reciprocal Support

The question of reciprocal support towards *in situ* conservation in Garamba from any reception sites could be considered. It has been stated by the Président Délégué Géneral of IZCN that reciprocal support would be expected if rhinos from Garamba are provided for improving the breeding potential of a second population *ex situ*.

The only indication of reciprocal support from establishment of a second population elsewhere in Africa come from Lonrho Ltd who offered to solicit funds from visitors to Ol Pejeta. They would not, however be able to provide sufficient money to cover costs of translocation. (R. Clark, Managing Director, pers.comm.)

6. A. CONSIDERATIONS FOR RHINO RELOCATION SCENARIOS

General Considerations

It is a necessary condition that any and all translocations would only be made in the context of high level political agreement. Following this, agreement on the number and identity of animals to be moved and the source populations of each rhino selected for translocation is an requisite starting point. Once these fundamental agreements have been forged, it is reasonable to expect that any intervention on behalf of the northern white rhino will strictly adhere to a strategy of: low risk, least regret, most reversible and most fundable in the short and long term.

If the metapopulation management strategy which is eventually adopted involves the consolidation of any animals, wild or captive, into a new site (in Africa or outside) it is imperative that the basic aims and objectives of such a re-introduction be agreed upon, followed by the identification of short- and long-term success indicators. Re-introductions should follow the tenets of adaptive management and allow for change and modification if established indicators are signalling failure or less than acceptable performance anywhere along the line. It would be counterproductive to carry out re-introductions in the absence of objective feedback on success or failure relative to the agreed goals and objectives.

The IUCN/SSC Guidelines for Re-introduction provide an excellent set of basic principles to be followed. The most important among these include: removal of individuals must not endanger the wild source population; re-introduction must take place with the full permission and involvement of all relevant government agencies of the recipient or host country; and the monitoring of post-release movements and physical condition must be undertaken for each and every animal.

If rhinos are moved, either from captivity or Garamba, the IUCN/SSC guidelines governing re-introductions should be strictly adhered to. The establishment of any new sites and new breeding nuclei should always be considered in the context of the constraints imposed by the biological and social requirements of the animals from the start. The successful re-introduction of rhinos either to free-ranging conditions in Africa or back into Garamba will be measured through the reproductive success of the re-introduced animals and to a greater extent by the successful reproductive efforts of the next and future generations.

The strict definitions of "re-introduction", "translocation" and "re-enforcement" can be found within the IUCN Guidelines. However, for the purpose of this overview, we will be considering different scenarios which require the movement of wild or captive rhinos to a new setting, in combination or alone. Such movements will include: (i) the transfer or translocation of northern white rhino from Garamba to a new site; (ii) the re-introduction of captive bred or held animals into wild or semi-wild range in Africa or, further down the line; (iii) the re-introduction and integration of rhinos successfully bred outside Garamba back into Garamba.

Careful consideration must be given prior to any decision to move individuals of this rare sub-species. These considerations must include: ecological, behavioral, veterinary, socio-political and financial considerations.

Ecological Considerations

If options adopted involve the movement of any individuals, captive or wild, to new sites, certain criteria are more vital than others. For example, in choosing potential sites for the establishment of any new populations, dietary considerations should be of extreme importance. With white rhinos, particular attention should be paid to limitations on grazing - whether they are seasonal or due to competition from other grazers - wild or domestic. There should be tangible benefits to selecting a site which provides a basic diet as well as a seasonality of diet most similar to the species' natural habitat. Water availability can also present a limiting factor and any potential release site must have good, year-round groundwater guaranteed.

Food and water availability are, of course, components of the overall carrying capacity of a potential site for rhinos. The characteristics of any translocation site selected should mimic the natural range of the northern white rhino as closely as possible if there is to be any potential for eventual return to the wild. A detailed analysis must be conducted on any translocation site to determine, as accurately as possible, site limitations and the true carrying capacity of an area. The sites must also be evaluated for any features which could affect social behavior and, in turn, influence the actual number of rhinos which could be successfully introduced.

Captive bred or reared rhinos will present novel challenges for re-introductions. The primary incentive for bringing captive northern white rhino back to natural conditions is the fact that they have not bred successfully in captivity. It is not clear what the root cause of this non-performance has been and it could very well involve physiological and behavioral components or both. However, the successful experience to date with confined populations of southern white rhinos under free-ranging conditions (Solio Ranch in Kenya, private ranches in South Africa) suggests this option for the northern white rhino currently in captivity be seriously considered. In addition, southern white rhinos have manifested impressive plasticity in their reproductive behavior.

It must be kept in mind that while there are certainly potential benefits of re-introducing captive rhinos to the wild, it would not be a straightforward process. For animals born in captivity, maintenance of adaptability back to the wild can be lost very rapidly. Experience has shown that captive bred animals, like rhinos, are unlikely to survive translocation to free-ranging conditions. Figures vary but recent analyses reported by Mark Stanley Price, Chairman of the IUCN SSC Re-Introduction Specialist Group, suggest that only 11% of captive-bred re-introductions are successful. The outcome of re-introduction of wild-caught animals held in captivity many years is less certain.

For most large mammals, the issues of greatest concern during re-introduction involve both dietary and social or behavioral problems. While for some species, these problems may be overcome through the provision of sufficient space and forage, in large, social mammals these factors can greatly influence the likelihood of survivorship.

The prospect of moving any or all of the northern white rhino currently held in San Diego and Dvur Kralove presents many challenges and will depend on whether they are moved to Africa or to a free-ranging situation in North America or Europe. The move to Africa would obviously present the biggest challenge. If wild-caught originally, the transition to independence and self-sufficiency should be easier than for a truly captive born individual. However, it is unknown to what extent long-lived species can retain wild-learnt behaviors once they have been captive for many years. Animals which have been on highly processed zoo rations may have difficulty coping with wild foods, particularly with the seasonal variability in quality and palatability.

In the early stages of re-introduction, the animals' diets should be adapted slowly and they should be weaned from a purely processed diet of cubes and lucerne and/or teff to one of large quantities of natural, cut grass. The same may be true regarding water for drinking and wallowing. A predictable watering trough and man-made wallow may require far different learned behavioral patterns than the use of a seasonal waterhole which comes and goes. To aid the process of adapting, supplemental water should be supplied at the time of release and eventually withdrawn, if natural supplies allow. In order to succeed, re-introduced animals would have to innately have or develop the capacity to deal with changes in their environments.

Animals born, raised or having adapted to a free-ranging situation under natural conditions but outside the native range will presumably be likely to successfully adapt to re-introduction to Garamba. That having been said, it is unlikely that any sanctuary, even one in Africa, will exactly mimic the conditions in Garamba and the rhinos will need to adjust to various factors, including the presence of resident rhinos. Presuming the habitat in Garamba remains suitable, successful re-introduction of rhinos will almost certainly be helped if returnees have been born and raised in conditions as natural and close to Garamba as possible. The re-introduction will not be deemed truly "successful" until the returnees are breeding and rearing their own young. Assuming the Garamba population persists, the most favorable outcome would be the inter-breeding of indigenous Garamba rhinos with re-introduced animals bred in another site.

Behavioral Considerations

The social aspects of re-introduction present an even greater challenge. The social context of any newly-constituted, semi-wild population may be particularly important in the context of the northern white rhino. If the southern white can be used as a model, in other managed populations the balance of males to females, as well as the age structure may have significant effects on breeding performance. For example, it seems that multi-male situations (at least in adjacent paddocks if not actual in the same large enclosures) are catalytic and may stimulate breeding activity. Similar limitations on reproduction have not been worked out for the northern white rhino. It could well be that release of captive-held animals into a more natural setting, with more space would stimulate reproduction in the same way as it has for southern whites.

Other behavioral improvements may also occur when animals are moved to new areas. For example, a southern white female (> 25 years old) which had been barren while living on Solio Ranch was released into Lake Nakuru National Park where it was bred and produced a calf. Young females or males which are translocated to new areas in the absence of older, dominant animals may be released from social inhibition and reproduce at an earlier age.

However, there are also dangers associated with releasing multiple animals, from perhaps different sources, into a single, new area. This may be particularly problematic if the re-introduced individuals have been accustomed to living in individual enclosures but can also be a problem if the new area has other founders who may have already established their territories. The actual release site may need to be changed depending on whether the new rhinos are the first group of founders or a later batch brought in to reinforce the pioneers. Proper choice of the release site can help to minimize intra-specific aggression after their release into the new area. Intense, sometimes fatal, intra-specific aggression has been shown among southern white rhinos in sanctuaries. The dehorning of rhinos prior to release in the new site may reduce injury from fights but it cannot eliminate the risk entirely.

Exposure to novel predators should also be considered prior to release and possibly controlled as naive females may not know how to defend their calves against large, mammalian predators. Risk of predators may argue for not de-horning rhinos.

Habituation to the area by maintaining the rhinos in a boma for a period of time may be useful in reducing risk. Such a period of adjustment can produce calmer releases and less post release movement thereby reducing chances of aggressive encounters or accidental injury. Time in the boma can also be used to facilitate controlled introduction to new food plants.

Veterinary Considerations

Any procedure involving immobilization or translocation procedure involves risk to the animals and this must be accepted from the start. Historically, losses on the order of 25 - 30% were not uncommon during such operations or in the three to six months following translocation. In recent years, there have been great improvements in capture and translocation techniques and today a risk of 10 - 15% mortality should be considered the norm according to Dr. Pete Morkel of the National Parks Board in South Africa and Dr. Richard Kock, Senior Veterinarian for the Kenya Wildlife Service. This indicates the need to anticipate that, as a result of capture-related mortality alone, 11 rhinos may have to be captured for every 10 which reach the final destination.

Long transportation times can lead to traumatic injuries and myopathy but the method of transport may determine the degree of injury. For example, southern white rhinos being moved from South Africa to Kenya experienced transport times of over 24 hours with no ill effect. While there do appear to be greater anaesthetic risks with white rhinos than black, these risks are not unreasonable and research is currently being done to understand and further reduce these risks. Ten immobilizations of northern white rhino in Garamba have already been performed with full veterinary monitoring. The results can provide guidelines for future immobilizations.

The issue of whether or not animals should be held in bomas on the capture and/or release is not universally agreed. However, experience in South Africa demonstrates that there are advantages to maintaining white rhinos in bomas at both the capture and release-sites. Generally, it is agreed that boma training on one end or the other eases the translocation process and the transitioning of rhinos from one area to another. Boma maintenance can reduce social conflict, accidental injury, as well as facilitate dietary adaptation to new foods in the relocation area.

Historically, in the case of southern white rhinos, at least 25 - 50% of recently captured rhinos never settled into bomas and often refused to feed. With good boma design and management, this rate has recently been dropped to 15 - 20% in South Africa. Rhinos which do not settle into the routine of boma confinement must be released within seven days or they will die. This rate of "non-settlers" will require that 20% more animals would need to be captured in Garamba to provide the number desired for relocation to a new site, if boma confinement is planned on the capture end. If animals are to be transported immediately to the new site, without a holding period, "non-settlers" would have to be free-released into the new area. There could be risks associated with such a free-release. (see Companion Reference Document Section 6. C.).

Kenya, on the other hand, has met with success in the capture and translocation of white rhinos without boma confinement on the capture end and a combination of boma and free-release on the receiving end. Free-release at the new translocation site has been used for black rhinos but would

be considered too risky for northern white rhino unless the area was small, contained no resident rhinos and presented no novel and possibly dangerous geographical features (like cliffs, lakes, deep gorges, etc.). Often times upon release, rhinos will take off in all directions, sometimes travelling long distances, traversing the entire area and this can present a problem. This would be problematic and dangerous, especially for naive rhinos coming from captivity or those which have been in boma confinement for some time prior to translocation.

With or without boma confinement, there is always the possibility of complications during capture and translocation. Following release into new areas, rhinos continue to face risks. These can be of both a physiological and behavioral nature. This is of particular concern regarding northern white rhino introductions into areas which harbor biting flies, such as tsetse, which may transmit *trypanosomiasis*. Although there were serious problems with such transfers of southern whites to Matusadona National Park (a tsetse-infested area in Zimbabwe's Zambezi Valley) some years ago, the recent movement of southern whites to an area (Masai Mara) with high trypanosome challenge in Kenya has proven to be non-lethal. All the translocated rhinos have been challenged by *trypanosomiasis*, but only 2 of 10 animals have manifested clinical signs and these have been treated with positive effect. For precautionary reasons, it would be advisable to undertake some type of environmental fly control to reduce exposure during the early stages of release. A more conservative approach might be to wait for 2-3 years to evaluate the overall performance of the southern whites in the Mara area.

Most importantly, post-release monitoring of each and every individual will be essential. This monitoring capability should include qualified veterinarians and staff with basic knowledge of the ecological requirements and performance potential of the rhinos. Early detection of health or behavioral problems will increase the chance of finding a remedy.

Socio-Political Considerations

If there is a decision to move Garamba rhinos to a new site, there will be political considerations and some of these will be of a local nature. Potential neighboring communities at both source and relocation sites must be carefully informed and their support for the initiative must be cultivated. The introduction of northern white rhino to a new area could be presented in a very positive light and any benefits which may accrue from tourist viewing should be shared with local communities to help ensure continued good relations. Rhinos moved into areas where work is not done with the community incur the risk that local communities will view the move with suspicion, concern or disapproval.

There will also be higher level, diplomatic considerations. With the current emphasis placed on the benefits of south-south transfer of ideas, skills and resources, a transfer of this nature could bode very well for cooperation within Africa and, in particular, between the range states of Africa's rhinos.

Relocation of any captive rhino will also require consensus and cooperation of all the stewards and stakeholders involved. The captive holders have signed agreements in the past to manage their rhino as a global population. However, communication and cooperation could be improved. It may also be necessary to consider what benefits may be available to any captive holders who relinquish their rhino for relocation to another site.

Cost Considerations

(a) Translocation from Garamba to a New Site in Africa

The translocation of any rhinos from Garamba will be both logistically difficult and expensive. The true costs involve investment in the pre-capture setup, the capture operation, the transportation and the creation of holding bomas on both the capture and release sides, if necessary. Whether they involve actual capital outlay or they can be provided in kind, these costs must be accounted for as accurately as possible. In addition to capital costs, there is also the cost of personnel, at all levels, the expense of materials for boma construction (where necessary), the maintenance of the rhinos under confinement and the operating costs for helicopters, aircraft and vehicles.

Basically, four different scenarios for a translocation operation of this order have been proposed (see Companion Reference Document 10). The first involves the construction of bomas on both the capture and release sites; the second involves boma holding only on the capture end; the third involves capture and transport as a single action followed by release into bomas at the new site and the fourth requires no boma construction on either end.

In all four scenarios, the planning is for the removal of probably 3 to 6, up to 10, white rhinos from Garamba to the new site, assuming it is either in Kenya or Uganda. Costings have also been compiled for sites further afield and for the relocation of captive rhinos.

In all four scenarios, budgetary implications could be significantly different if we account for the possibility of certain costs being met in kind or through the loan of equipment or personnel. The full budgets are presented below for each scenario. An "*" is placed next to items where there is a good chance that the cost could be covered through a loan (e.g. on capital equipment) or as a donation in kind from KWS (e.g. technical and logistical support), relief organizations operating in the area or foreign governments with such equipment deployed in the region (e.g. Hercules, C-130 transport plane).

To provide a general idea of costs they are broken down below.

Estimated Cost - Removal of Rhino from Garamba for Relocation to New Site

	US $$
I. Capital Equipment	
1 Mercedes Benz 1113 (4x4 lorry)	86,000*
1 Fassi 10-ton crane	23,000*
8 1400-20 tires	3,500
6 Rims for 1400-20 tires	5,700
1 10-ton winch	2,800
2 Runners (for loading crate)	500
1 Portable generator	1,200*
1 Portable pump	1,000
II. Operating Costs	
a. Fuel & Rental	
5000l Diesel fuel	5,000
1000l Avgas	1,200
2000l Jet A-1	2,400
Oil, hydraulic fluid, etc.	500
Hercules C-130 hire (wet)	120,000*
(4 flights Nairobi - Garamba)	
Jet Ranger (dry rate - 40 hrs)	35,000
b. Expendables	
Drugs for capture and treatment	2,000
Darts	180
5 rhino transport crates	8,600*
Wire (8-gauge + binding)	200
16 mm threaded rod	300
Cement	450
Heavy duty drill (13 mm chuck)	300
Steel bar, drill bits, pliers, spanners, hammers, etc.	500*
c. Feed	
Teff Hay	2,100
Lucerne Hay	420
Horse cubes	400
III. Labor	
Casual labor	800*
Pilot - fixed wing (6 days)	1,200*
Pilot - helicopter	1,400*
Veterinary services	15,000*
Other personnel services	10,000
IV. Contingency Costs	30,000
Total (All Costs Included)	**361,650**
Total (with Donations in Kind)	**103,950**
Total (with 50% Donations in Kind)	**222,300**

It is assumed that budgets for the capture and translocation of 3 to 6, up to 10, rhinos from Garamba to a site within Eastern Africa will not be significantly different for the four different scenarios described above for most budget lines. Of course, the second scenario will have slightly lower costs because there will be lower costs on the capture side. These would be the costs of boma construction, feeding of the rhinos, and the cost of labor both on the capture operations and the maintenance of the rhinos. The biggest costs will involve the transportation of the rhinos from Garamba to any new site but this would be a likely line item to have donated or provided "in kind". The costs will obviously be lower if suitable bomas exist at the new site. Likewise, if no boma construction is required, these costs will be eliminated.

(b) Cost Consideration for Relocation of Captive Rhino to New Site Inside or Outside Africa:

Estimated Costs for Relocation/consolidation at Site Outside Africa:

Consolidating/Relocating Current Captive Rhino To Site Outside Africa:

Dvur Kralove to White Oak ($ 15,000/rhino Dvur-Atlanta; $ 5,000 for group Atlanta-White Oak)	$ 80,000
San Diego Wild Animal Park to White Oak ($ 5,000/rhino San Diego to White Oak)	$ 20,000
Subtotal of All Captive Rhino to White Oak	*$ 100,000*
San Diego Wild Animal Park to Dvur Kralove ($20,000/rhino)	$ 80,000
Subtotal All Captive Rhino to Dvur Kralove	*$ 80,000*
Dvur Kralove to San Diego Wild Animal Park ($20,000/rhino)	$ 100,000
Subtotal All Captive Rhino to San Diego Wild Animal Park	*$ 100,000*

Consolidating/Relocating Current Captive Rhino To Site In Africa:

San Diego Wild Animal Park to Site in East or South Africa ($ 25,000/rhino)	$ 100,000
Dvur Kralove to Site in East or South Africa ($ 20,000/rhino)	$ 100,000
All Captive Rhino To Site in East or South Africa	*$ 200,000*

Relocating Current Garamba Rhino To Site Outside Africa:

Garamba Rhino from East Africa to White Oak ($ 25,000/rhino; estimate for 6 rhino)	$ 150,000
Garamba Rhino from East Africa to Dvur Kralove ($ 20,000/rhino)	$ 120,000
Garamba Rhino from East Africa to San Diego Wild Animal Park. ($25,000/rhino)	$ 150,000

Estimated Costs for Preparation of Site Outside Africa:

White Oak:

Construction of Cable Fence Around Female Pastures and Male Pens	$ 100,000
All site preparation cost at White Oak	*$ 100,000*

Dvur Kralove:

Modifications to Current Facilities (Gates between enclosures, moat improvements, construction of palisades and addition of vegetation to add configurational complexity to enclosures)	$ 25,000
Expansion of current yards to include larger area	$ 75,000
All site preparation costs at Dvur Kralove	*$ 100,000*

San Diego Wild Animal Park:

Construction of additional complex of enclosures for males	* ? $ 100,000
Construction of new enclosures for more females	* ?
All site preparation costs at San Diego Wild Animal Park	** ? > $ 100,000*

* Very rough guesstimate from the editors. San Diego WAP will provide better estimates in near future.

6. B. LOGISTICS FOR CAPTURE AND RELOCATION OF GARAMBA RHINO

The relocation of any rhinos from Garamba involves risks at all stages. In Garamba, the greatest risk during capture is related to the extensive systems of rivers and luggas, where darted rhinos run a risk of collapsing into water and drowning. On the receiving end, unfamiliar, unsafe and novel geography could be deadly to newly-released rhinos. It would be very safe to assume a 10% mortality rate on any translocations.

Four different scenarios are described below for the capture and translocation of 3 to 10 northern white rhino from Garamba to a new site in Eastern Africa. The first scenario involves the confinement of rhinos in bomas on both the capture and release end; the second scenario involves the holding of rhinos in bomas only on the capture end; the third involves the holding of rhinos in bomas only on the release end and the fourth involves no boma holding on either end.

If captive rhino were to be moved to a site in Africa, it is assumed that confinement in a boma at the release site would be essential. If captive rhino are to be relocated among facilities in captivity, relatively standard procedures that prevail for such movements would be used, as has occurred successfully in the past. In any case, the importance of coordinating and controlling any introductions of captive rhino to one another or to Garamba rhinos cannot be overemphasized.

If Garamba rhino were to be moved to a new site outside Africa, again procedures that have been used successfully in the past for relocation of wild rhino to captive facilities would be employed. Such movement would require boma maintenance at the capture site.

The best time for relocation of rhino from Garamba is the early wet season (April-May), with preparation of equipment and facilities during the preceding dry season (December through March). The presence of long old grass in the early dry season and frequent dense haze throughout this period would render capture and transport of rhino difficult. Additionally, rhino could be under nutritional stress during the dry season and there would be very little fresh grass available for collection for the boma maintenance. The start of the rains clears the atmosphere and stimulates new growth of grass for the necessary nutritional support. Since the soil is so well drained there are no major limitations to movement of equipment in the early wet season.

A 2-km long landing strip for the C-130 Hercules transport plane will need to be cleared and levelled in a flat area, with good drainage, between the Dungu and Garamba Rivers. Likewise, an appropriate landing strip would be prepared on the receiving end, if no suitable were already available nearby.

Therefore the best plan would be to prepare the facilities and equipment during the dry season and to capture rhino in the early wet season (April), actually moving them out of Garamba around May.

Scenario I: Boma Holding at Both the Capture and Release Sites

A possible time line is described below:

Preparations

The procedures described below have been developed over years of capture and translocation of southern white rhinos in South Africa.

January/February/March

A 4 x 4 Mercedes lorry would be driven from Nairobi to Garamba carrying fuel and spares, building supplies for the bomas and clearing of C-130 landing strip.

Five or six holding bomas would be constructed in the watershed within 2 kms of the C-130 landing strip. These bomas would be constructed using local timber (intended to last only one season). Each boma would be approximately 30 x 30m. The bomas would each require a small, covered area for shade and a concrete water trough.

The area will need to be secured with 24-hour armed guards. These guards will need to be heavily-armed and well-trained to deal with any eventuality. The consolidation of northern white rhino in the bomas may be one of their most vulnerable periods in the entire process. The guards will need to be housed in temporary quarters or, preferably, tents for the duration of the capture and translocation operation.

Capture

Early April

The helicopter would be brought over from Nairobi (very likely on loan from the Kenya Wildlife Service). The C-130 will then transport goods to Garamba, including: a water bowser, fuel for the helicopter, lorry and aircraft as well as food for rhinos during their boma confinement and the transport crates to carry them to the new site.

During the month, the rhinos will be captured and transported to the holding bomas. The "target" rhinos would be located by Garamba PMU staff from a fixed wing aircraft. The ground team would then move to the site carrying the necessary transport crate(s). The veterinarian and relevant PMU staff would then be flown in with the chopper to immobilize the rhino(s). The crate(s) would be loaded onto the lorry and carried to the holding bomas. The capture of all rhinos should be completed in one to two weeks.

Boma Holding

April/May

Over the next six weeks, the rhinos would be boma trained. The captured rhinos will be "weaned" from fresh cut grass to lucerne/teff hay and pellets over a period of time. The eventual goal being an 80% teff/20% lucerne diet during boma confinement.

While in the bomas, the rhinos will be trained to eat in their transport crates to facilitate their eventual movement. During this period, the rhinos will be habituated to the sight, smells and sounds of people. Baseline data on body condition, parasite loads, etc. will be able to be collected and monitored by the vet during this time.

Animals which do not settle would have to be free-released from the boma site. It is not anticipated that this would cause any social problems as the bomas will be within the core area of the rhinos and they will be familiar enough with their surroundings to find their way "home".

Transport

May

The animals will be crated (probably three at a time, but possibly as many as five), loaded onto the C-130 using a tractor or vehicle and winch and carried to the receiving site.

Settling In

May/June

The rhinos will be held in bomas on the release end and eventually "weaned" off their lucerne/teff diet through the gradual introduction of cut, green grass. This stage should require a month to six weeks. The timing would coincide with the onset of the long rains and should provide ideal conditions for feeding.

However, tsetse flies also proliferate during the rainy season and it could be a time of high *trypanosomiasis* challenge. Therefore, the rhinos would need to be monitored constantly so that treatment could be administered rapidly in the event of a clinical case.

Scenario II: Boma on Capture End Only

This scenario would be similar for all intents and purposes to Scenario I on the capture end. Bomas would be constructed from local materials using local labor and rhinos would be held there for four to six weeks.

Under this scenario, rhinos would be free-released on the receiving end. Such an approach has been successfully used on southern white rhinos but could only be considered given ideal conditions at the new site. Preferably, the new site would be small (ca. 50 km^2), topographically safe (i.e. no cliffs, gorges, deep rivers), well-fenced, have high security, resident veterinary care, and no resident rhinos already present unless they were also recently introduced and had not had time to establish territories and, therefore, did not present a social threat to the new rhinos. The rhinos would have to be closely monitored as they settle into their new environs.

Scenario III: Boma Holding on Release End Only

Using two or three teams in Garamba, three or four rhinos would be captured, loaded, transported and delivered to bomas at the new site all on the same day. An optimistic estimate is that the entire operation could be completed in a period of 12 hours from capture to delivery. However, it should be noted that capture conditions may be more difficult in Garamba than for example in Umfolozi (South Africa) or Solio (Kenya) and hence estimates of time required may need to be adjusted. There will also be need to locate specific individuals that may be identified for the relocation. However, it may be possible to accomplish this step in advance of initiation of capture operations by placing guards with radios near located rhinos.

The construction of bomas on the receiving end would depend on where the new site was and what facilities were already available. The KWS has temporary bomas which can hold up to 10 rhinos and could be provided "on loan" if the translocation site is within Kenya. If the site were elsewhere, it would require the construction of bomas and the cost of material and labor would have to be budgeted for, accordingly. Boma training would then proceed as described in Scenario I, above.

Scenario IV: No Boma Holding on Either End

Accepting as a general premise that boma training, on one end or the other or both, facilitates the transitioning of rhinos from one area to another, there may be circumstances in which this approach is preferred. While this scenario may in some ways appear risky, it would be an acceptable way to carry out the translocations under the right conditions.

This scenario has elements of both Scenario II and III. It would involve the capture, transport and free-release of rhinos, three or four at a time, in a single-day operation from Garamba to the new site. Of course, this would require that the new site meet the criteria described in Scenario II, above.

The translocation of rhinos without the use of bomas on either end involves the least commitment of time and expense for purchase of materials and subsequent construction.

6. C. CRITERIA FOR IDENTIFICATION OF RHINO TO BE RELOCATED FROM GARAMBA OR CAPTIVITY

Possible Relocations From Garamba:

Criteria for selection of individuals for relocation from Garamba to a new site include:

- Minimizing the risk of genetic variability in Garamba
- Minimizing the risk of reducing reproductive potential in Garamba
- Minimizing social disruption in Garamba and during release
- Minimizing danger to the relocated animals or their offspring, born or unborn
- Maximizing reproductive potential for a new population
- Maximizing genetic foundation of new population

From the perspective of both the source and the new population, demographic considerations are probably more important than genetic concerns. Over the short term, the northern white rhino is in a demographic crisis which if not solved will render genetic concerns which are would be expected to be longer term in their effect academic. From the perspective of the new population, demographic considerations are definitely more important than genetic ones.

There are currently only 4 breeding females in the Garamba population, and at any one time each either has a young calf or is pregnant. It may not be advisable to relocate any of these animals for both demographic and genetic reasons: demographic is to retain the productivity of the Garamba population until younger females reproduce; genetically there is always more genetic diversity in parental versus descendant generations because of genetic drift.

Two sub-adult females (in the 10-11 year cohort), 3b and 4b are nine years old and should have produced calves by now, but have not. They have, however been observed in long term consort with dominant males and have been seen mating. It is hoped that they are pregnant. It could therefore be a risk to relocate both or perhaps either of these two. However, it will be essential that any new population have the potential to produce as soon as possible. Demographically, it is advisable not to decimate any cohort of females. Thus one, but probably only one, of these two females might be seriously considered as candidates for relocation.

Based on the principle of not decimating cohorts, it might not be advisable to consider the only female in the 9-10 year age class. (However, with presumed subadult and adult mortality low, it may be irrelevant precision to distinguish between age classes that differ by only a year). Nevertheless, it may be argued that 6aF (Oeuf de Pacque) should not be a candidate.

In the more or next younger cohort (the 7-8 year olds), one, but again only one, of the females 4cF Noel and 5bF Grizmek might be considered. By similar logic: the only female 4dF Minzoto in the 5-6 year age class might be exempt; while one of the females in the 4-5 year age class might be a candidate for relocation.

Genetically, it will be advisable not to remove all of the offspring from any of the "founder" females. There should also be caution in removing offspring of any dead founders (i.e. F5) since the potential to replace these "genes" is lost.

Applying this logic, it may be argued that the female from the 4-5 age class might better be 1cF Nawango, whose mother is still alive, and not 5dF Jengatu whose mother is dead. Similarly, it might be argued that the candidate from the 7-8 year age class should be 4cF Noel not 5bF Grizmek. Continuing to apply all of the above logic, the candidate from the 10-11 year age class would be 3bF Juillet not 4bF Mai since a daughter of 4F has already been selected.

Finally, if fewer rather than more females are to be removed, preference might be extended to older rather than younger females to provide a new population with a "kick start" on reproduction.

Other logic and arguments are possible and need to be considered as the interactive process of discussing the strategy and possible relocation continues.

In terms of selecting males, the trade-offs between demographic and genetic considerations may be even more acute. Genetically, it might again be argued that removal of any adults, i.e. the "founders" would be inadvisable. However, sexually mature males will be essential to the success of any new population. Because demographically males may be more expendable than females, it could be argued that adults should be the candidates for relocation. Unfortunately, the limited data available on male parentage in the Garamba population impairs the ability for sound genetic judgements in this matter.

In order to reduce in-breeding risks in the new population, it would be optimal for any mix of males and females to include only one offspring from each original founder females. However, this optimum may be difficult to realize if greater priority is accorded to demographic considerations for the new population.

Possible Relocations From Captivity:

If fewer than all the captive rhino were to be recruited as founders for a new population, demographic considerations should probably have priority over genetic ones. Hence, the preference would be for younger females and proven breeder males. In this regard, it will be noted that:

- There are no proven breeder females in the captive population.
- The only "younger" male in the captive population is already of an age when he should be sexually mature.

There is also one possible medical complication to be considered, i.e. the "large, firm" and apparently growing mass that appears to be "encapsulating" the reproductive tract of female Nola (Studbook Number 374) at San Diego Wild Animal Park.

7. POTENTIAL RELOCATION/CONSOLIDATION SITES FOR A NEW FREE-RANGING POPULATION

In considering potential sites for the establishment of a second population of northern white rhinos under wild or semi-wild, free-ranging conditions, a number of basic ecological and non-ecological criteria for site selection were formulated. These are not presented in order of importance. They include but are not limited to:

1. **Ecological criteria**
- Suitable and sufficient habitat and water
- Estimated carrying capacity greater than 20 northern white rhino
- Physical separation from southern white rhinos
- Location within the historical range of the sub-species
- Limited or controllable disease considerations

2. **Non-ecological criteria**
- Continuity of commitment
- Security adequate for both immediate and long term
- Positive attitude of local communities
- Facilities for control of movements (i.e. fencing) in place
- Finance availability for establishment and operating costs
- Proximity to Garamba
- Amenability to ownership arrangements of present and future generations of rhinos agreeable to current owners/holders
- Readily available, qualified veterinary care
- Good post-release monitoring in place and properly financed
- Ease of removing animals in future

This two-tiered, listing does not, however, specify necessary and sufficient conditions for site selection, nor does it prioritize which of these criteria should take precedence over others. This prioritization process must take place before any final decision regarding sites could be taken. Both the process of prioritization of requisite criteria and the final selection of translocation site(s) will involve both technical and subjective or political judgements to be made from the outset.

Until such a process has been conducted or such judgements have occurred, it has only been possible to provide a first rough cut of potential sites. These sites are not prioritized but are merely presented as possible options which have been discussed and which may be worthy of further consideration. The following site descriptions are provided for information and to facilitate discussion on the topic.

To compile information on potential sites, visits were conducted to Ol Pejeta Ranch, Shimba Hills National Reserve, Murchison Falls National Park and Ajai White Rhino Sanctuary by Kes and Fraser Smith of the Garamba National Park Project. Other information on other areas was obtained from knowledgeable individuals, publications and personal past experience of the areas: Dr. R. Kock, Dr. T. Foose, Dr. H. Dublin, Dr. E. Edroma, Dr. J. Else, Mr. T. Oloo, Mr. P. Jenkins, Mr. M. Infield and Dr. R. Brett.

The two countries with the closest proximity to Garamba are Kenya and Uganda. However, only one site in Uganda is truly within the historical range of the northern white rhino; this is Ajai Game Reserve. At present, no single site is without limitations and, therefore, each must be viewed in the context of its advantages and disadvantages.

POTENTIAL RELOCATION/CONSOLIDATION SITES

KENYA

- **Ruma National Park (formerly Lambwe Valley Reserve)**
- **Sweetwaters Rhino Sanctuary (Ol Pejeta Ranch)**
- **Shimba Hills**

UGANDA

- **Queen Elizabeth National Park**
- **Murchison Falls National Park**
- **Ajai Game Reserve (formerly Ajai White Rhino Sanctuary)**

SOUTH AFRICA

- **Site not identified as yet**

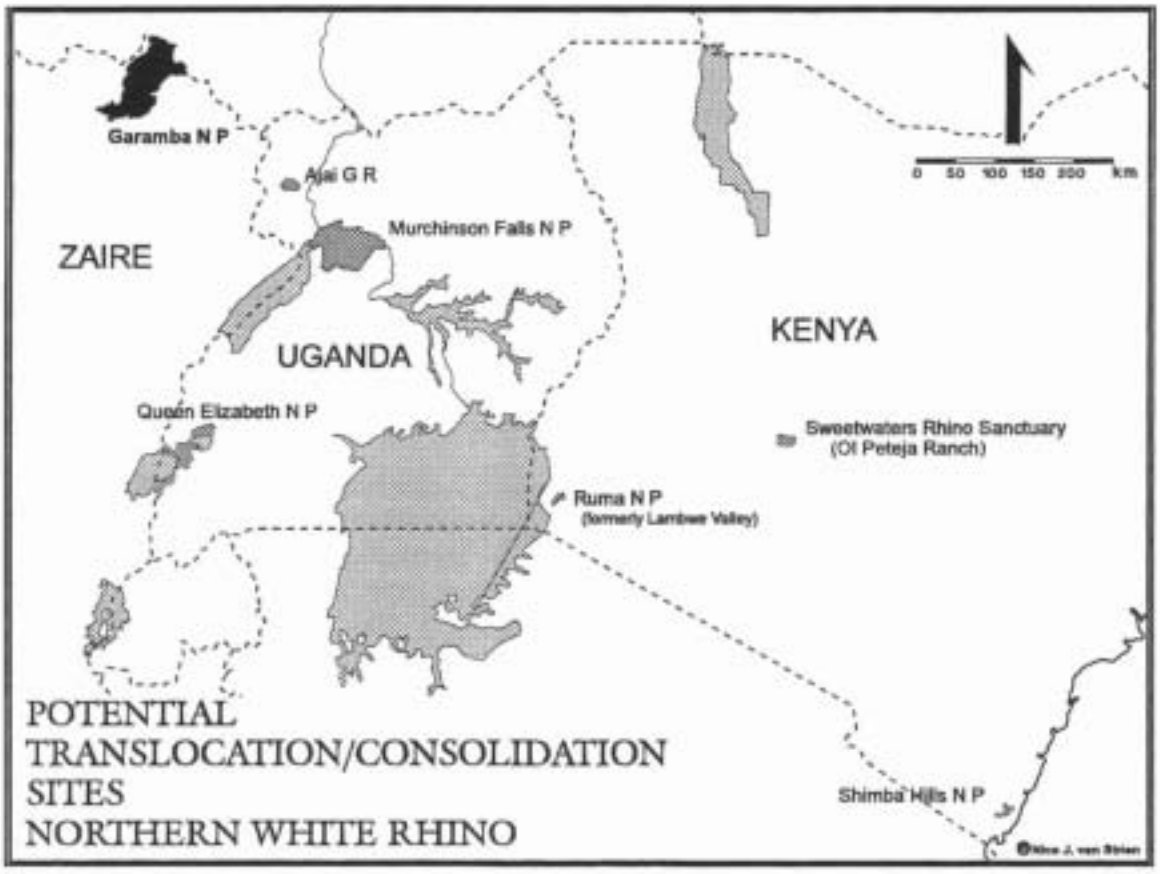
UNITED STATES OF AMERICA

- **San Diego Wild Animal Park**
- **White Oak Conservation Center**

CZECH REPUBLIC

- **Dvur Kralove Zoo**

Figure 10: Possible Sites In Africa for Second Free-Ranging Population of Northern White Rhino



KENYA

Kenya is indisputably one of the leading lights in the conservation of Africa's rhinos. The country's innovative programme to capture and consolidate rhinos into small, well-defended sanctuaries for the purpose of breeding has paid off. Today, Kenya is one of only three African rhino range states which can report an increasing population trend.

It goes without saying that Kenya's primary expertise, experience and priority centers around the conservation of the black rhino. This is Kenya's only native species of rhino and has been the focus of their conservation efforts since the mid-1980s. However, Kenya also has experience in the conservation and management of southern white rhinos; there are currently about 110 in the country. With the exception of 18 which now live in Lake Nakuru National Park, the remainder are held in private land sanctuaries. Their upkeep and protection is primarily the responsibility of those private individuals with veterinary and technical backup from the Kenya Wildlife Service (KWS).

KWS has a strong veterinary department with extensive experience in capture, translocation and wildlife diseases. KWS has repeatedly expressed a willingness to assist this in the implementation of an northern white rhino management strategy by providing technical expertise and by loaning necessary equipment and manpower, as and when possible.

RUMA NATIONAL PARK (formerly Lambwe Valley Game Reserve)

Information from Dr. R. Kock, Dr. R. Brett, Dr. J. Else
Further investigation required.

Ruma National Park, in western Kenya, is home to Kenya's last breeding herd of roan antelope. In view of the endangered status of roan in Kenya, Ruma has attracted much attention from the KWS recently.

Ecological Factors

Habitat
70-80% of that area is suitable grassland habitat.

Size and Carrying Capacity of Area:
The park is approximately 126 km^2 in total area.

Northern white rhinos have never been reported at a density greater than 0.3/km^2. At these densities Ruma's carrying capacity would be approximately 38 animals if the entire area of the Park were included; 11, if the estimated area of suitable grassland is used. Based on the densities of southern white rhino at Solio Wildlife Sanctuary where densities of 1.1 rhino/km^2 have occurred, the carrying capacity could be approximately 50. The habitat is different, however, and a detailed assessment would be needed. Applying the principle that founder number should not be more than 50% of carrying capacity, the maximum founder number should be 5-19. (Emslie, Property Evaluation Workshop, 1993).

The densities of other grazing species in the Park are relatively low and there are unlikely to be any problems over resource competition. Any illegal cattle grazing would have to be brought under control by KWS. The predator situation is not well known.

Health
Tsetse fly, while still present, are of much-reduced significance. Any necessary veterinary care would fall to the Veterinary Services department of the KWS where extensive experience with black and white rhinos is available. Thorough veterinary examination would be required.

Historic Range
Although Ruma is not within the historical range of the sub-species, seventy to eighty percent of the Park comprises grassland suitable to northern white rhino and is more similar to Garamba than any other sites in Kenya.

Non-ecological Factors

Legal Status/Continuity Arrangements

Ruma is a national park and is, as such, under the legal jurisdiction of the Kenya Wildlife Service (KWS), a self-financing, para-statal branch of the Kenya government in the Ministry of Tourism and Wildlife. All negotiations for the use of Ruma as a translocation site would be held with the KWS, directly.

Security
KWS is intending to fully ring-fence Ruma, the financing is already secured and this should be completed in the near future. KWS also intends to mount a recovery plan for the species which will include the additional establishment of a ring-fenced internal sanctuary of 5 - 10 km^2. This could have important implications for any possible translocation of northern white rhino. The cost of both the short-term and long-term fencing projects will be borne by the KWS under their Planning and Wildlife Services (PAWS) project.

Security at present is insufficient with roan antelope still being poached. Ruma is closely surrounded by a dense human population. However, security could be rapidly improved with the establishment of the inner sanctuary for roan. Over time, the KWS intends to fence the entire area. Roan are still wandering in and out of the Park and their numbers have continued to decline through the poaching which is for both ritual purposes and meat.

Following years of activity to eliminate *trypanosomiasis*, the area has now become heavily settled by agricultural people. The KWS has devoted much effort to community liaison work and a number of joint KWS-community projects are underway. As a result, local attitudes in the vicinity have shown serious improvement. As benefits continue to accrue to the local communities from Park revenues, these attitudes are expected to continue to improve over time.

Proximity
Ruma is closer to Zaïre and the habitat is more similar than that of other areas in Kenya,

Cost Effectiveness and Feasibility
The costs of fencing and increased protection would be borne by KWS under their own planning for roan antelope. There is no linked funding for translocation.

Ownership of Rhino/Progeny
Ownership agreements would be with KWS, a para-statal organization.

SWEETWATERS BLACK RHINO SANCTUARY (OL PEJETA RANCH)

Visited in April 1994 by F.& K Smith, T.& E. McShane, July 1993 by N. Leader-Williams and T. Foose. Sources of information: Russell Clark, Managing Director; Simon Barkus, Sanctuary Manager

Sweetwaters Black Rhino Sanctuary is a private, tourist facility owned and run by Lonrho (Kenya), Ltd. on the Laikipia Plateau. Although the long-term commitment of Lonrho to the health and well-bring of black rhinos has been a question in the past, the situation has improved significantly with the appointment of a new wildlife manager for the Sanctuary in the recent past.

Ecological Factors

Habitat
Habitat is bushed grassland, with lower rainfall and different floral composition from Garamba. Sweetwaters is clearly not within the recent historic range of the sub-species but southern white rhinos have bred very well on a nearby ranch (Solio) which has very similar habitat conditions. The grasslands on Sweetwaters are dominated by *Themeda triandra*, a very palatable and highly nutritious grass, though not one that occurs in their native range.

Size and Carrying Capacity of Area
The sanctuary is 92 km^2.

At Garamba densities, Sweetwaters would provide space for 28 rhinos; at Solio densities 90-100. Maximum founder densities should be no higher than 14. Preliminary assessment suggests that on the basis of other species, habitat and rainfall, maximum carrying capacity would conservatively be towards the lower end of the spectrum between 28 and 100.

There are currently 20 black rhinos (*Diceros bicornis*) at Sweetwaters (including one male which is semi-tame). The rhinos have been introduced in two installments. Originally, Sweetwaters was to receive a founder population of 20 black rhinos but some difficulties were experienced in getting to this target as a result of intra-specific aggression. There have been two deaths from aggression and several incidences of fighting, including 3 recorded incidences after the second introduction. However, with the removal a particular troublesome individual, the resident population seems to have now stabilized and no further introductions are contemplated.

The sanctuary has from time-to-time been home to well over 100 elephants. It is the desire of management to maintain elephants in the Sanctuary at much lower densities (to reduce to 30 elephants maximum). For some time, elephants have been driven out of the Sanctuary from time-to-time to lower their numbers. However, Lonrho is now considering a request to have KWS remove 60 - 70 elephants by live translocation. Because Sweetwaters is well-endowed with shrubs and trees, elephants are unlikely to compete with white rhinos for grazing resources. In fact, as they increasingly open the bushland, more white rhino habitat is subsequently being created.

Spotted hyenas are present in the Sanctuary. Three black rhino calves have been born in the last year and there have been no problems with predation. Predator impact on the white rhinos would have to be carefully monitored.

Historical Range
Sweetwaters is not within the recent historical range of northern white rhinos.

Health
Thorough veterinary examination would be required. It is presumed that veterinary care for white as well as black rhinos would be handled by the KWS Veterinary Services.

Non-ecological Factors

Legal Status/Continuity Arrangements
Sweetwaters Black Rhino Sanctuary is a private, tourist facility owned and run by Lonrho (Kenya), Ltd. on the Laikipia Plateau. Although the long-term commitment of Lonrho to the health and well-bring of black rhinos has been a question in the past, the situation has improved significantly with the appointment of a new wildlife manager for the Sanctuary in the recent past.

According to a formal agreement of the Lonrho Board, the long-term maintenance of the land as a rhino sanctuary has been accepted. However, economic principles might be expected to play a major role in both policy decisions and the level of recurrent investment in the sanctuary. The Managing Director of Lonrho (Kenya) believes that the company will stay involved if for no other reason than the public relations value, or the damage which could ensue if they pulled their support out.

Security
Sanctuary ring fenced. Protection currently excellent. Scouts go out on foot daily to monitor rhinos and records centralized. 1500 visitors per month also contribute to security by presence and by economic support.

Long term commitment of Lonhro to conservation has been a question in the past. According to Clark a formal agreement of the board to long term maintenance of the sanctuary has been passed. Economic principles will inevitably be a factor in policy decisions and could outweigh conservation issues at some time in the future.

Sweetwaters is located in the middle of the Laikipia Plateau, an area of primarily large-scale, private landholdings devoted to cattle ranching and wildlife. The Ranch staff report very good neighbor relations with the small-scale landholders on one of their boundaries.

Cost Effectiveness/Feasibility
Costs for security of a new population would be borne by the company.

The cost of securing the area for rhinos has already been covered by Lonrho. The 92 km^2 area is totally ring-fenced and Lonrho would consider increasing the size of the Sanctuary if that were deemed necessary in future. Protection is considered excellent. Armed game scouts conduct daily foot patrols, there is an extensive communications network, rhinos are monitored and a central database is maintained. The regular presence of 700 - 1,000 visitors per month also contributes, indirectly, to the security of the sanctuary for rhinos.

No contribution towards translocation could be provided by the company, but The offer has been fund raising for *in situ* conservation in Garamba from tourist visitors to the sanctuary.

Proximity
Although further from Garamba than Ruma N.P., Sweetwaters is well within the range of a C-130 transport plane which could be landed on their own strip (3-km long) or, if necessary, at the nearby Nanyuki Air Base.

Ownership of Rhino/Progeny

The Sanctuary's 20 black rhinos are under the management control of the KWS. It is presumed, but would have to be negotiated, that decisions regarding the security and management of any translocated northern white rhino would also become the responsibility of the KWS.

There was verbal agreement that ownership of any introduced rhinos would remain with Zaïre. Ownership of progeny is a question that would have to be decided with any new population, prior to any movements.

SHIMBA HILLS NATIONAL RESERVE

Visited June 1994

Sources of information: Ms. Melly Reuling, Research; Mr Macharia, Park Warden; Dr. Holly Dublin

Shimba Hills has been disqualified by recent information received from KWS. A study to determine the cause(s) of sable antelope decline and poor performance suggests that they are limited by forage quality and availability. Biologically, Shimba Hills is therefore not an appropriate situation in which to introduce another large grazing herbivore which not only will compete with the beleaguered sable but may very likely suffer from food shortage itself.

UGANDA

Part of Uganda was within the historic range of northern white rhinos and the habitat and climate are similar. It is close to Zaïre for reducing transport time and facilitating metapopulation management.

Uganda has accomplished great strides in the field of wildlife conservation since the settlement of civil disturbance. The country is, at present, considered a "favoured country" by many of the conservation and development donors and is experiencing a period of enormous growth in the wildlife sector. However, the security situation in these areas has not totally stabilized. As a result, key potential sites, such as Ajai Game Reserve, have not been developed to the extent of those in the more southerly parts of the country.

Nevertheless, Uganda's obvious strong political will in support of conservation and their busy development agenda place make them a key player in conservation efforts within the eastern African region. The close proximity of the three potential sites in western Uganda to Garamba make each worthy of consideration. The strengths and constraints on each are detailed below.

AJAI GAME RESERVE (FORMERLY AJAI WHITE RHINO SANCTUARY)

Area visited August 1994
Sources of information: Dr. E.L.Edroma, Director UNP; Game Warden, Ajai Sanctuary

The Ajai Game Reserve is located in the northwestern corner of Uganda, in the West Nile area, bordering the Nile River. The Reserve is the only potential site analyzed which falls within the former range of the northern white rhino. The area was established as the Ajai White Rhino Sanctuary in 1958, in an area previously with reserve status, to protect the northern white rhino that were indigenous there. The hills surrounding the sanctuary have forest reserve status. The area is extremely attractive. Ajai contained northern white rhino until very recent times (in the late 1970s or early 1980s). They are believed exterminated during Uganda's civil war. Its isolation and relatively low priority, historically, to the government of Uganda has resulted in total neglect over the past 20 years. There are, however, recent signs of interest in reviving the Reserve within the Ministry and the wildlife sector, overall.

Ecological Factors

Habitat
The habitat is a mixture of wooded savanna, grasslands, and swamps including *Loudetia-Eragrostis*, *Hyparrhenia*, and *Imperata* communities. The area is considered to be very similar to Garamba and Shambe, in southern Sudan. The habitat is considered excellent for northern white rhino.
Habitat is similar to that of Garamba and Shambe in Sudan, with a sparsely bushed long grassland, swamps and patches of forest. Grassland composition is similar to that of Garamba. The forest patches are occupied by colobus monkeys. Waterbuck, bushbuck, duiker, kob, warthogs and a variety of smaller mammals occur. The status of other wildlife in the Reserve is not well known. Presumably Ajai will be surveyed in an upcoming aerial survey of the country's game reserves and this will provide more information on the status of wildlife in the Reserve.

Size and Carrying Capacity of Area
The area is 155 km^2.

Carrying capacity or maximum stocking rate would depend on the area which could be enclosed and protected. The previous population was previously ecologically viable. Poaching and translocation caused its extinction. If the entire area were to be ring-fenced and secured, at densities similar to

Garamba, carrying capacity would be 47 animals. The founder population size of should not exceed 23 or 24 rhinos.

Historical Range
Ajai is within the true indigenous range.

Health
Veterinary examination would be required, but with a history of previous northern white rhino habitation challenge would probably be minimal. Neither the Uganda National Parks nor the Game Department currently have an active veterinary arm. However, there is talk of one being established in future. At the present time, veterinary care would have to come either through private veterinarians or through an agreement which might be made between the Uganda and Kenya governments for assistance from the KWS Veterinary Services.

Non-ecological Factors

Legal Status/Continuity Arrangements
The legal ownership of the area lies with the central government of Uganda. Any and all negotiations would, however, have to involve the National Parks and the Game Department until such time as the merger of the two has been completed.

Security
Current security is almost non existent. The sanctuary is not fenced and people live right to the borders and roads pass through it, freely used. The only criterion for considering it on this aspect would be if it was designated a National park, as has been suggested by Dr. Edroma and security was adequately improved. This is unlikely in the immediate future.

In the merger process between Uganda National Parks and the Uganda Game Department, there has been talk of upgrading Ajai to National Park status. The Reserve is presently 158 km^2. It is entirely unfenced and there is human settlement up to its borders. There is a public access road which runs through the Reserve and is used to transport people and goods. The Reserve is very beautiful and is believed to have a high tourism potential.

There is no security in force in the Reserve and this situation would only improve with an upgrading to National Park status. If this were to take place, it is unlikely to take anything short of five years. At present, there is also indication of possible Uganda rebel activity building up on the Zaïre side of the border.

Cost Effectiveness and Feasibility
It is currently not cost effective, nor a national top priority, unless the value of re-introducing northern white rhino to a former range was recognized by a funding source as sufficiently valuable for investment.

Proximity
Ajai is the closest site to Garamba (200 - 250 km) and is within the indigenous range. Any translocations from Garamba would very likely have to take place by road. Translocations from the captive population would be logistically very difficult.

Ownership
Ownership agreements would be with a para-statal organization.

MURCHISON FALLS NATIONAL PARK

Area visited several times, most recent August 1994
Sources of information: Dr E.L.Edroma, Director UNP Assistant Park Warden, MFNP; Peter Jenkins, Consultant; R.van Geyseghem (1979) Zur Okologie des nordlichen Breitmulnashorns C.s.cottoni, Lydekker 1908; Tesis, Universitat Kaiserslautern

Over the past two to three years, Murchison Falls National Park (MFNP) has been undergoing a major rehabilitation programme with funding from German GTZ. The Park's infrastructure is being restored, staff have been trained and deployed and security has improved.

Ecological Factors

Habitat
Though not within the true indigenous range of the northern white rhino, there have been a history of previous, successful introductions from Ajai. The habitat in MFNP is varied but the Buligi Triangle provides ample food. On the peninsula, grasslands are dominated by *Hypparhenia filipendula* on which the rhinos introduced long ago did very well. The area, in general, is drier than Garamba, but water availability presents no problem. The habitat has been proven as suitable by the northern white rhino that were introduced in the 1960s.

Size and Carrying Capacity of Area
The MFNP covers an area of over 3,800 km^2.

Under the current Park management programme, there are plans afoot to establish eventually a white rhino sanctuary. The proposed sanctuary would be approximately 90 - 100 km^2 in an area of the Park known as the Buligi Peninsula, with a 10 - 12 km fence securing the peninsula from Paraa, on the Nile, to Pakuba, on Lake Albert. The security of such a large area with so much access from the water on three sides could be very difficult. In 1978 there were 15 northern white rhino ranging over 74 km^2 (van Geyseghem 1979). Hence, an area of 90-100 km^2, could support 25-30 rhinos, possibly 50 or more, but the *Hypparrhenia* grassland could be limiting. However, the introduced rhino which one occurred in MFNP were apparently at very high densities (almost 5.0/km^2) as late as 1978. The maximum founder population should be no larger than 13 - 15 rhinos.

The current status of other large grazing mammals or large predators has not been recently established. However, following severe depletion in the 1970s and 1980s, there would unlikely be any significant competition or threat from either.

Current plans are to stock the proposed sanctuary with southern white rhinos. Clearly, if this plan is implemented, the area would be unsuitable for the translocation of any northern white rhino.

White rhinos of either sub-species are exotic to MFNP. However, if the Uganda government were interested in establishing a rhino sanctuary for the non-native northern white rhino instead of the southern whites, the area could be a desirable one.

Health
Veterinary examination would be required, but with a history of previous introductions the challenge would probably be minimal. Neither the Uganda National Parks nor the Game Department currently have an active veterinary arm. However, there is talk of one being established in future. At the present time, veterinary care would have to come either through private veterinarians or through an agreement which might be made between the Uganda and Kenya governments for assistance from the KWS Veterinary Services.

Non-ecological Factors

Legal Status/Continuity Arrangements
The Ministry of Wildlife, Tourism and Antiquities which oversees both the Uganda National Parks and the Game Department is the relevant branch of government for negotiations.

Security
Current security is not good. Most animals have been poached out of the area in the past, but a GTZ project operational until at least 1999 is rehabilitating the park and re-building security. Scouts are based at the Paraa South head-quarters and a few patrol posts and do foot patrols if called out. A road runs through the park, and on our recent visit a lorry heavily laden with fish was stuck on the road in the park and its occupants lobbied considerable abuse at us as suspected park personnel. There is still civil unrest in the area with occasional bomb explosions directed at people in the surrounding areas.

Future security may be considerably better. Jenkins recommended to the project that a 10-12 km fence be placed across the top of the Buligi Peninsula, site of the previous northern white rhino introductions, and introduce rhinos.

While security has certainly improved within the MFNP it is not considered stable as there is still some civil unrest in the surrounding area.

Cost Effectiveness/Feasibility
Selection of this site would depend upon fencing and effective build up of the ranger force, supported by the GTZ project. There is no source of funds for translocation.

Proximity
MFNP is close to Garamba which would facilitate ease of movement of rhinos between the two. If MFNP were selected as a priority site for the translocation of northern white rhinos, there would have to be further investigation into the logistics of the transfer by road or air.

Historical Range
Though not within the true indigenous range, it is within the previously introduced range.

Ownership of Rhino/Progeny
Ownership agreements would be with a para-statal organization.

QUEEN ELIZABETH NATIONAL PARK

Visited in the past briefly.
Information from Dr. E.L.Edroma, Dr. R. Olivier, Mr. M.Infield
Further investigation needed.

Queen Elizabeth National Park (QENP) is situated in the western part of the Rift Valley between Lake Edward and Lake George. The Park was also designated as a Biosphere Reserve in 1979 and is also the site of the Uganda Institute of Ecology. Despite suffering the depreciation of all wildlife areas of Uganda during the war, QENP has received considerable attention under the current Uganda National Parks administration. The QENP is an important tourism area in Uganda and this bodes well for its continuing rehabilitation.

Ecological Factors

Habitat
QENP has areas of extensive grassland, though these are not similar in kind to the grasses of their indigenous range in Garamba, Ajai or southern Sudan. The area has adequate rainfall and presumably sufficient forage, though this would be an important selection consideration for any eventual sanctuary location. The grasslands would probably be adequate. Southern white rhinos have proven to be very adaptable to different grassland habitats under translocation. However, the adjacent Virunga National Park in Zaïre never contained white rhinos in the past. Unlike MFNP, there has been no history of introductions in the past. This leaves a good deal of uncertainty about the suitability of the area.

Size and Carrying Capacity of Area:
The area is almost 2,000 km^2.

The carrying capacity would depend on the area selected. It has been suggested that a very small area (20 km^2) on the Mweya Peninsula could be fenced. At Garamba densities, this proposed Mweya Peninsula site would certainly not be able to hold more than six animals maximum, rendering this an unlikely sanctuary site. The second proposed location has not been identified. Without having any idea of the eventual size of such a proposed sanctuary, there is no way to establish either a maximum founder population size or an eventual carrying capacity.

Historical Range
The QENP is not within the native range of the northern white rhino but is within a country that was a range state. The species' introduction to the area would be as an exotic and would therefore need approval of the highest authorities in Uganda.

Health
Thorough veterinary examination would be required. Information on the Garamba rhinos is given below.

Non-ecological Factors

Legal Status/Continuity Arrangements
The Ministry of Tourism, Wildlife and Antiquities which oversees both the Uganda National Parks and the Game Department is the ultimate authority for QENP. Along the Park's boundaries a number of private concessions have been leased out and these areas have already requested that there be consideration of introduction of southern white rhinos. In early discussions, they have said that they could finance fencing and security but these negotiations have never gone very far and there are no moves at present to do so. Of course, consideration of establishing a northern white rhino sanctuary on privately-leased land in Uganda would be an unprecedented and, possibly, complicated move. The ramifications regarding responsibility for the care and well-bring of the rhinos would be much more difficult in negotiations with private companies than between the governments of Zaïre and Uganda.

Security
There is agreement within Uganda National Parks, that the security situation is best there and Edroma proposes QEP as the most suitable for rhino introduction at present. However, security is not high. Olivier suggests that an area that could be secured is the Mweya Peninsula, which would require only a 200 m. fence and patrolling. However, it would give a region of only about 20 km^2, with park habitation in it. There are suitable grassland areas towards Kasese and at Ishasha, but the latter is close to the Zaïre border and there is poaching.

Around the southern border of the Park are reserves where private companies have long term concessions and are investing in protection. The introduction of southern white rhinos has been proposed. The question again falls upon the relative merits of relying on a private company or a national organization.

Among the potential sites within Uganda, QENP is probably the most secure. However, security cannot be considered adequate. Again, it has been proposed that a small area (20 km) on the Mweya Peninsula could be fenced and patrolled, but the area has human settlement within it. There is a more suitable area, to the west, at Ishasha. But this area would be close to the border with Zaïre, more difficult to secure and more vulnerable to poaching incursions.

Cost Effectiveness/Feasibility
There is no immediate source of funds for fencing or increased security, although the private concessionaires mentioned above could be a possibility.

Proximity
The area is relatively close to Garamba, certainly within flying range but probably too far to move rhinos safely by road. If QENP was chosen as a priority site for translocation, the feasibility of landing a Hercules C-130 transport plane would have to be investigated further.

Ownership of Rhino and Progeny
Ownership agreements would be with a para-statal organization.

SOUTH AFRICA

South Africa, and specifically, the Natal Parks Board, are indisputably the world's leading experts in the conservation and management of the southern white rhino. Today the country is home to the vast majority 95% of the world population of approximately 6,700 southern white rhinos, a number that is greater than the combined total of all other species and subspecies of rhinoceros combined.

The Natal Parks Board, through their Director of Research, (who is the current Chair of the IUCN African Rhino Specialist Group) have played already played an integral role in the planning process towards a northern white rhino management strategy.

Although no specific translocation sites have been identified in South Africa, there is a clear will to be involved and to help identify one or more sites, either on private or state land, that may be appropriate. Security on state lands in South Africa is the best in Africa. However, negotiations on the possibility of a site on state land would probably have to be taken up at high levels of government. Private land ranches and sanctuaries in South Africa would carry a higher security risk. Also, the question of ownership would be more complicated in dealing with private individuals than with the government of South Africa. Most private land rhino programmes in South Africa have been costed on the basis of private ownership, giving individuals full rights over rhinos which they purchase. The northern white rhino situation would clearly require a unique custodianship type arrangement but it is possible and should not be discarded as an option.

While appropriate habitat and space could be located, South Africa is a long way from Garamba for the movement of rhinos. However, it should be kept in mind that South Africa successfully captured, translocated and donated 20 white rhinos to Kenya in 1994; a trip of almost the same distance albeit not as remote.

CZECH REPUBLIC

DVUR KRALOVE

Dvur Kralove is a state operated facility for captive management, propagation, and research in the northeastern part of the Czech Republic. Currently, there are 23 rhino of 3 species at Dvur Kralove.

Ecological Factors

Habitat
It would not be possible at Dvur Kralove to provide a situation where the rhino would obtain most of their nutrition from natural graze. The most limiting condition at Dvur Kralove is the climate with an appreciable number of days and nights with the temperature below freezing.

The breeding programs for both black and southern white rhino have been very successful at Dvur Kralove. A total of 14 black rhino have been produced and there are 4 breeding males and 5 breeding females at the facility. A total of 21 rhinos have been successfully produced at Dvur Kralove. Dvur Kralove is the only captive facility that has succeeded in reproducing northern white rhino. Unfortunately, only one female was involved and this animal died during research manipulation. A total of 3 northern white rhino have been born there; 3 have died there.

Size and Carrying Capacity of Area
Currently, Dvur Kralove has 5 enclosures of .5 to 1 hectare each in size devoted to northern white rhino. These enclosures are or can be interconnected to permit various grouping combinations of the rhino. Further modifications proposed would enhance the flexibility of these facilities. There is another 5+ hectare enclosure adjacent that could conceivably be incorporated into the rhino complex.

Historic Range
Dvur Kralove is not within the historic range of the northern white rhino.

Health
Dvur Kralove has a fully qualified veterinary staff with much experience with 3 species of rhino, including northern white rhino.

Non-Ecological Factors

Legal Status/Continuity Arrangements
Dvur Kralove is currently a state zoo. There have been discussions that the zoo might privatize but there is much sentiment against such a move by the current administration.

Security
Security is good. Little threat of poaching would be expected.

Cost Effectiveness/Feasibility
Dvur Kralove could accommodate a few more female northern white rhino in its current complex of enclosures. However, extensive modifications have been proposed for improved management of the existing collection. Even more modifications would be in order if additional rhino were to be relocated here. Dvur Kralove would not be prepared to provide funds for additional construction or to pay for relocation costs of rhino.

Proximity
Dvur Kralove is not located close to Garamba.

Ownership of Rhino and Progeny

Dvur Kralove owns 8 (3.5) of the 9 northern white rhino in captivity; 3 of their rhino are on breeding loan to the San Diego Wild Animal Park. The breeding loan agreement commits both institutions to global management of the rhino. Presumably, ownership arrangements in the future would be with a state agency in the Czech Republic.

UNITED STATES OF AMERICA

SAN DIEGO WILD ANIMAL PARK

The San Diego Wild Animal Park is a large facility owned by the City of San Diego and operated by the Zoological Society of San Diego for captive management, propagation, research on southwestern California in the United States, about 20 miles inland from the Pacific coast.

Ecological Factors

Habitat
The climate is mediterranean, somewhat seasonal with temperatures normally moderate to hot with a range of 7° to 48° C (20° F to 120° F) with temperatures rarely below freezing during the day but for a total of 21 nights which are dispersed randomly during a 3 month period. Rainfall is about 30 cm (12 inches) per year; extensive irrigation does occur. The vegetation is arid grassland or savannah.

Breeding programs for southern white, black, and Indian rhino have been very successful at the San Diego Wild Animal Park. The numbers of rhino produced here are: 75 southern white rhino; 6 black rhino; and 22 Indian rhino. However, no northern white rhino have reproduced there; 4 northern white rhino have died there.

Size and Carrying Capacity of Area
The facilities used for northern white rhino consist of: the 120 acre East/Central Africa Exhibit which also accommodates many other East/Central African ungulate species; two holding bomas of about 1,000 sq m. each (10,000 sq. ft. each) with an observation deck and a restraint chute to permit hormonal manipulation and reproductive examination of the females and now breeding management of the rhinos. The 2 female rhino are being maintained in one of the holding bomas except when one of them is introduced into the 120 acre exhibit when estrus is suspected. One of the males is kept in the 120 acre exhibit. Until recently, the other male has been accommodated some distance from the other northern white rhino in a 30 acre (10 hectare) enclosure that is separated by a mono-rail track and an average of 50 feet from the 120 acre enclosure. However, the second male will now be maintained in the other of the holding bomas to permit sensory contact and hopefully stimulation of the other rhino. San Diego could accommodate many more female northern white rhino in its current 120 acre enclosure. A large enclosure or a complex of additional enclosures would be required to accommodate multiple males. It would not be possible at San Diego to provide a situation where the rhino would obtain most of their nutrition from natural graze.

Historic Range
San Diego Wild Animal Park is not within the historic range of the northern white rhino.

Health
San Diego has an extensively qualified veterinary staff and facilities with much experience with 3 species of rhino including northern white rhino.

Non-Ecological Factors

Legal Status and Continuity Arrangements

Security
Security is high. There is little to no threat of poaching or other vandalism.

Cost Effectiveness/Feasibility
San Diego has stated it would not be prepared to provide funds for additional construction or to pay for relocation costs of rhino.

Proximity
San Diego is not located close to Garamba.

Ownership of Rhino and Progeny
Dvur Kralove owns 3 (1.2) at the San Diego Wild Animal Park; Khartoum zoo, the other male. The breeding loan agreements commit all 3 institutions to global management of the rhino. Presumably, ownership arrangements in the future would be with the Zoological Society of San Diego.

WHITE OAK CONSERVATION CENTER

White Oak Conservation Center is a highly successful facility owned by the Gilman Paper Company for propagation of and research on large mammals, particularly African, located in northeastern Florida in the United States.

Ecological Factors

Habitat
The environment is sub-topical: normal temperature ranges are 20-35° C (70-95° C) daytime and 10-27° (50-80° F) nighttime with an average of only 16-17 days with temperatures below 0° Centigrade (32° F). Existing southern white and black rhino are provided with infrared heaters, windbreaks, and heavy bedding when temperatures are below 20° C (50° F). No symptoms of cold stress have been observed. Average rainfall is 54 inches (137 centimeters) per year. The vegetation consist of moist forest, both conifer and broadleaf, interspersed with lush pastures dominated by coastal bermuda (*Cynodon maritimus*), fescue (*Festuca arundinacea*), winter rye (*Secale cereale*) and bahia (*Paspalum notatum* var. *Saurae*) grasses that provide excellent grazing for a wide variety of ungulates including pure-bred horses, Grevy's zebra, and white rhinoceros.

White Oak has been highly successful with their programs for southern white rhinoceros with 4 births from a breeding group many of whom were long-term non-breeders at previous locations.

Size and Carrying Capacity of Area
The herd of females currently occupies a pasture of approximately 17 acres. The rhino are grazing extensively. Immediately adjacent are 1 acre enclosures for male rhinos. A facility such as White Oak would not be able to provide the amount of space necessary for successful consolidation of multiple males in a free-ranging situation, for behavioral reasons. Instead, the facility could provide the situation that has proven successful with southern white rhinos, i.e. a free-ranging situation for groups or units of 6-12 females (30-40) acres for each female group/unit, with males in sizable (1-5 acre) adjacent enclosures that would permit much sensory, interaction (including some tactile contact, i.e. fighting through fences) among the males and between them and the females but which would not expose males to significant risk of injurious combat. Depending on the number of rhinos that might be proposed for consolidation at White Oak, the Center would be prepared to provide space and facilities for 2 such units. It is believed enclosures of this size would permit rhino to obtain most of their nutrition from natural graze.

Health
White Oak has a highly qualified veterinary staff and facilities with much experience with 3 species of rhino including southern white rhino.

Historic Range
White Oak is not within the historic range of the northern white rhino.

Non-Ecological Factors

Legal Status and Continuity Arrangements
White Oak Conservation Center is privately owned by the Gilman Paper Company. However, a private Foundation has been established and provisions are in place for the Center to be continued in perpetuity.

Security
Security is extremely high. There is virtually no threat of poaching or other vandalism.

Cost Effectiveness/Feasibility

White Oak would be prepared to pay for construction of all facilities to accommodate any northern white rhino recommended for relocation there. White Oak would also pay for all relocation costs.

Proximity
White Oak is not located close to Garamba.

Ownership of Rhino and Progeny
Ownership arrangements would be with the Gilman Paper Company (private corporation) and its Howard Gilman Foundation (non-profit organization).

SUMMARY

In summary, if any rhino are to be moved from Garamba or from the captive collections to a new site, there must be agreement on and prioritization of criteria for evaluation of suitability of the site. It is suggested that a tabulation of the criteria with some system of priority be used to then evaluate potential sites. The table below is presented as a possible tool for such tabulation and evaluation.

Table 6: An Evaluation Chart for Candidate Sites for New Population of Northern White Rhino

NORTHERN WHITE RHINO RELOCATION SITE CRITERIA & ASSESSMENTS											
SITES	KENYA			UGANDA			RSA	CZECH.	U.S.A.		Zaire
CRITERIA	Ruma	Ol Pejeta	Shimba Hills	Queen Elizabeth	Murchison Falls	Ajai		Dvur Kralove	SDWAP	White Oak	Garamba
Habitat Suitability											
Carrying Capacity											
Historical Range											
Veterinary											
Legal Status/ Continuity											
Security, Current											
Security, Potential											
Cost Effectiveness											
Cost Feasibility											
Proximity											
Rhino Ownership											
Total Score											

8. SURVEY FOR RHINO IN SUDAN.

According to recent reports, there may still be northern white rhinos remaining in Southern Sudan. If this is true, they may represent a significant proportion of so small a world wide population. A survey is proposed to investigate this further and to assess conservation potentials, within the context of a metapopulation strategy. To this end, a proposal has been prepared for a survey.

PROJECT PROPOSAL

TITLE: **SURVEY FOR NORTHERN WHITE RHINOS IN SOUTHERN SUDAN**

PROPOSERS: Dr A.K.Kes Smith
Technical Advisor (Ecology), WWF
Garamba National Park, Zaïre
c/o WWF EARO
PO Box 62440, Nairobi

Mr Philip Winter
Save the Children Fund
PO Box 48700, Nairobi

EXECUTANTS: Aaron Nicholas, Emmanuel de Merode, Philip Winter, Kes Smith, Fraser Smith

BUDGET: £16,070 (US$ 25,712)

TIME PERIOD: 6 Months

SUMMARY:

The northern white rhino sub-species (*Ceratotherium simum cottoni*) is one of the most endangered large mammals in Africa. Fewer than 50 remain in the world: 28 to 31 are in Garamba National Park in northern Zaïre, where they are increasing; 9 are in captivity; and there have been recent reports of a few remaining in southern Sudan. It has been recommended by the IUCN African Rhino Specialist Group that the sub-groups of the remaining world population be managed as a metapopulation to ensure the survival of the sub-species. It is vital to ascertain whether any still remain in Sudan, and if so what can be done about them. This proposal is to carry out a survey to achieve this goal.

BACKGROUND

The northern sub-species of white rhinoceros (*Ceratotherium simum cottoni*) occurred, at the beginning of this century in western Uganda, north eastern Zaïre, Southern Sudan, Central African Republic and Chad. Even in 1980, several hundred were believed to exist in Sudan (Hillman 1981). By 1983 a survey was able to confirm only two observations of tracks, in the Shambe area of Sudan, and it was impossible to explore far into Southern National Park due to the security situation at the time (Hillman 1983). Following this the civil war broke out and it was decided that nothing could be done at the time for active conservation of the rhinos in Sudan.

Conservation efforts *in situ* were concentrated on Garamba National Park in Zaïre, which borders on to Sudan, where the remaining 15 rhinos were successfully protected in the context of the whole ecosystem of the park. In eight years the population had doubled.

In 1983 there were 12 northern white rhinos in captivity. In 1995, there are 9 pure bred and one which is a cross between northern and southern *(C.s.simum)* . They are in 2 groups: 2 males and 2 females in the San Diego Wild Animal Park, USA: and 2 males and 3 females in the Vychodeceska Zoo in Dvur Kralove, Czech Republic. During the period 1984-1995, only 1 female has bred and she has since died.

Following meetings with the Director of the Institut Zaïrois pour la Conservation de la Nature (IZCN) and representatives of IUCN, WWF and the International Rhino Foundation (IRF), and meetings of the IUCN African Rhino Specialist Group (AfRSG) in May 1994, it has been agreed that a strategy should be developed and implemented to consider the world wide population of this endangered sub-species as a whole metapopulation in conservation and management activities, in order to ensure its continued survival.

Various reports have been received recently of rhinos having been seen in different parts of Southern Sudan. If they are true, any northern white rhinos remaining in Sudan could constitute a significant proportion of a total world population, since the confirmed animals at present number 37.

OBJECTIVES

- To carry out surveys in southern Sudan to confirm or refute the presence of any remaining northern white rhinos.
- To assess possibilities for their conservation and to submit informed recommendations in this regard.

JUSTIFICATION

- There are only 37 confirmed northern white rhinos remaining alive in the world. If any still exist in Sudan they would make a significant contribution to the world population.
- It has been recommended by the African Rhino Specialist Group of IUCN that the sub-species be managed as a metapopulation to ensure its survival. The numerical and genetic contribution of a sub-population in Sudan would be important in this regard.
- In view of the above a project to survey the remaining rhinos in Sudan has been identified as a priority by the IUCN AfRSG.

METHODS

Two regions have been selected for investigation, based on the validity of reports received and knowledge of the areas in question. These are Southern National Park, which is considered first priority, and the Pakkam region.

In each area an aerial and a ground survey is proposed. All investigations will be carried out with full knowledge of and in collaboration with wildlife officials in southern Sudan, local authorities and international aid organizations operating in the region, under the auspices of Operation Lifeline Sudan (OLS). Knowledgeable local observers will be used as guides. Investigation period is limited to the dry and early wet seasons, i.e. the first half of the year.

Ground Surveys

The ground surveys will be carried out by two investigators with a local guide, using mountain bikes. Mountain bikes will allow better coverage in rough terrain within the time available and facilitate carrying enough equipment to be self sufficient for up to a month at a time. The following approaches will be used:

- Following up any reports of sightings or indications of rhinos
- Focus during the dry season on sources of water, following rivers and investigating water holes
- Investigation of areas of suitable habitat identified during the aerial surveys
- Counting any signs of rhinos, and other species per unit distance walked/ridden (Hillman 1983), in order to relate to known densities elsewhere
- Following any signs of rhinos to attempt to obtain direct sightings and to maximize information indicating numbers or densities in a region.

Aerial Surveys

It is proposed that aerial surveys are carried out using the Cessna 206 of the Garamba National Park Project, which belongs to the Frankfurt Zoological Society (FZS).

- Crew of six including pilot and the ground investigators
- Low intensity systematic reconnaissance flight (SRF, Norton Griffiths 1978) over the whole region, followed by
- intensive coverage of regions identified as potentially possible for rhinos.

Southern National Park

To survey Southern National Park the aircraft would refuel in the north of Garamba National Park from fuel transported there with the GNP vehicle. Logistical base within Sudan for this region would be Mapel, a relief airstrip north of SNP.

To survey the Pakkam region, fuel would be flown in collaboration with aid aircraft. There are airstrips at Maper and Mariel to the west of Pakkam.

Clearances

Clearances to carry out the surveys have been received verbally from the SPLA authorities, which control the area. OLS and relevant aid organizations are being requested to co-operate. OLS, for example provide security cover for relief workers in South Sudan, and might extend this, through the radio network, to survey members. Clearance is being sought from IZCN and FZS for collaboration of IZCN observers and for use of the aircraft.

Timing		**1996**
Preliminary ground surveys,	Southern National Park	February
	Pakkam	February/March
Aerial Survey,	Southern National Park, Pakkam	March/April
Follow up ground surveys,	Southern National Park	April/May
	Pakkam	May/June
Reports	July	

OUTPUTS

Reports of activities and findings will be produced by end July 1996. This will be followed up by discussions and a feasibility report on conservation possibilities if any signs of rhinos are found.

BUDGET

Capital Equipment	£ Sterling
Mountain bikes x 3 @ £500 ea	1,500
Tools	50
Spare tyres	120
Pannier racks and bags	135
Bottles & cages	40
Inner tubes (x 8)	45
Puncture repair kits	25
Spare brake wire	10
Lights (dynamo)	150
Tents x 3 *	600
Sleeping bags	160
Water filter (Katadyn)	100
Compass *	30
Binoculars *	250
Rucksacks *	75
Cooking equipment	20
Radios *	
Recurrent costs	
Air fares London-Nbi return x 2	1000
Nairobi-Sudan rtn x 2	400
Living expenses x 2	2000
Medical insurance x 2	500
Medical kit	50
Film	100
Visas	200
Contingencies	200
Flying time 40 hrs @ $300	8000
Fuel transport	500
TOTAL	**£ 16,070**
	US$ 25,712

* Denotes items that may be borrowed from the Garamba National Park Project
As far as possible other capital items will be requested on donation

9. OFFICIAL MINUTES/REPORTS OF STRATEGY MEETINGS 1994

IUCN/SSC AFRICAN RHINO SPECIALIST GROUP MEETING ON NORTHERN WHITE RHINO GLAND SWITZERLAND - 8 MARCH 1994

Participants: *Martin Brooks (Chair), Mankoto ma Mbaelele, Nzau Kunkemba, Sivi Dia Yamba, Nsuka Simon, Pete Morkel, Mbanga Manzimi, Tom McShane, Muhindo Mesi, John Newby, Kes Smith, Simon Stuart, Tom Foose (Recorder).*

MINUTES

Introduction

The Chair opened the meeting and welcomed all participants. He described the situation of the northern white rhino as being extremely critical, with fewer than 50 rhinos in the wild and in captivity combined. It has been suggested that to maintain the entire wild population in a single location is risky. It is clear that authority for the wild rhino resides with the government of Zaïre. It is their decision what to do. The purpose of this meeting was to explore options to determine if this group advises continuing on the same course or trying some alternative approaches. The Chair explained that the role of the SSC African Rhino Specialist Group (AfRSP) is to provide information and advice to African nations for management of rhino.

Objective of the Meeting

The Chair proposed the following objective for the meeting:

To examine the situation in Garamba and recommend a plan of action for the long-term survival of the subspecies, also considering the rhino in captivity and perhaps elsewhere in the wild.

This objective was agreed by the meeting.

J. Newby stated that the feasibility of translocation should be evaluated closely. K. Smith thought that translocation should be considered as part of a more holistic plan for the subspecies. The Chair stated that the meeting would consider the different management options. T. Foose thought that the meeting should review risks first, then options.

The Status of the Subspecies in the Wild

K. Smith reviewed the situation in Garamba. The project focuses on *in situ* conservation of rhinos as part of the Garamba ecosystem. Protection and management of the rhino population since 1984 has resulted in an increase of 7% per year. There are now 33 animals as far as known, although three individuals were not observed during 1993. However, not all areas were exhaustively surveyed during 1993. During 1993, three births and two deaths were recorded. There is no doubt that Garamba provides excellent habitat for the northern white rhino.

General wildlife poaching has increased since 1991. In this year, there was a refugee influx from Sudan, and a considerable number of firearms were recovered. In 1993, elephant poaching increased and as a result, anti-poaching efforts have been enhanced. The quality of life for the guards is not good at present. Money from WWF and others has helped, though has not made good the hole resulting from

the withdrawal of most of the support previously given by the Frankfurt Zoological Society. Dr. Smith felt that the pros and cons of translocation had to be considered in relation to other possibilities, and also in relation to the availability of external funds. Although there have been some problems, she was confident that if adequate resources are available, the project can continue to protect and manage the rhinos as well.

S. Stuart pointed out that the AfRSG has identified *in situ* conservation of Garamba rhino as the highest priority in Africa. It was important to realize that translocation options would not diminish the need or priority to continue the Garamba project, and to strengthen the protection of the rhinos.

Dr. Smith also referred to the persistent reports of rhino in Southern National Park in Sudan, but there was still no verification of this.

Dr. Mankoto expressed his thanks and deep appreciation to the Garamba team and to the donors who had assisted over the years: WWF, FZS, UNESCO and IUCN. He reminded the meeting that IUCN had previously proposed translocation of the rhinos in 1985. This was not well received at the time in part because the *in situ* programme had only just commenced. We now know that this programme has been successful. However, since 1985 the political situation in Zaïre and neighboring countries has deteriorated. So there is now a greater willingness to consider translocation as part of a holistic strategy. Any proposal would have to be very cogent, conceptually sound and technically feasible. It would also need to be presented by a high-level delegation visiting Zaïre. He thought that such a high-level mission might cover issues in Virunga as well as Garamba.

Dr. Mankoto referred to a one-time grant of Japanese funding for Garamba that had been channelled through the World Bank. The Chair requested Dr. Mankoto to comment on the security situation around Garamba. He responded that the situation had clearly deteriorated, and was much worse than in 1985. The civil war in Sudan was a constant threat, and the political future in Zaïre remained unclear. He again emphasized the need for an international mission to gain support from the highest political leaders for the Garamba project.

Dr. Mankoto inquired about genetic problems that could result in the Garamba population. The Chair responded that inbreeding would probably not be a major problem if he Garamba population continued to expand rapidly. Dr. Smith stated that until recently there were equal numbers of males and females with at least 6 males participating in reproduction.

The Chair asked the meeting to consider the risks of having all rhino in one place. These were listed as follows:

* natural disasters
* epidemic disease
* civil disorder
* breakdown of the protection system

The Chair reminded participants that it was not the purpose of this meeting to develop a detailed plan, but rather to determine whether or not there is a common direction agreed by all the parties represented at the meeting.

The Status of the Subspecies in Captivity

T. Foose summarized situation in captivity. There were 9 rhino (4 males 5 females) in captivity in 2 facilities: San Diego in U.S.A. and Dvur Kralove in the Czech Republic. There has been no breeding in San Diego, and limited reproduction at Dvur Kralove (last young born in 1989, though one female

is possibly pregnant). He did not agree with suggestions that the two females in San Diego were too old to breed, southern white rhino females having bred at older ages. There were problems with the current captive management, though he thought that some of the current difficulties could be overcome.

When asked if the two zoos would be prepared to give up their animals, Dr. Foose thought that they would be if a coherent strategy for the subspecies could be developed and concerted and unified efforts were directed towards encouraging the two institutions make their animals available for the strategy. He noted that all but one of the animals are the property of Dvur Kralove Zoo.

Dr. Foose also mentioned that rumors persist that there may be 5 subadult rhino for sale in Khartoum @ $120,000 FOB Khartoum. These rhinos are supposedly wild-caught and have the necessary papers for legal export. He was still trying to ascertain more information of the circumstances.

Management Options

The meeting identified the following options that are available for the future conservation of the subspecies. Note that not all the options listed below are mutually exclusive.

(1). Abandon the Garamba project.

(2). Secure the Garamba programme.

- (A) No removal of animals
- (B) Removal of some animals

(3). Relocate rhinos to captivity:

- (A) All animals
- (B) Some animals

(4). Relocate rhino to the wild or free-ranging situation in a natural or quasi-natural situation.

- (A) All animals
- (B) Some animals
  - (a) Africa
  - (b) Elsewhere (North America; Australia).

(5). Contingency plans in case of emergency

The meeting decided that the following options could be ruled out as being undesirable, or likely to be ineffective: 1 (Abandon Garamba project); 3A & B (Relocate animals to captivity); 4A (Relocate all Garamba rhino to the wild or free-ranging situation in a natural or quasi-natural situation).

Concerning option 2, discussion took place on the security of the Garamba population, and the feasibility of translocating animals. As regards the security of the Garamba population, it was asked if it is possible to ensure the complete safety of rhinos. It is obviously not possible to guarantee the safety of the Garamba rhinos (or any other rhino population). However, the project has been very

successful so far. The main concerns for the future include the following risks that are hard to quantify: incursions from abroad; breakdown of civil order; organized commercial poaching. Mr. Muhindo stated that although there has been some elephant poaching, this is not considered to present a risk to the rhino.

Concerning the feasibility of translocating animals, P. Morkel stated that this would be possible, but expensive and extremely difficult logistically. The set-up costs for a translocation programme would be very high. The amount that would need to be spent to move the first animals would be US $500,000 (about 1/3 of the cost is transport as far as Kenya). There are risks, and about 5% of the animals moved would not survive. The operation would have to occur during the dry season. There would need to be a 6-12 month preparation phase. Probably a maximum of 10 rhino could be moved per season. After the first animal, the cost per animal would be mush less.

N. Kunkemba asked if the large amount of money for translocation could be better spent protecting Garamba. T. Foose responded that money that would be available for translocation programmes probably would be earmarked and could not be transferred to protection of rhinos in Garamba. Dr. Mankoto emphasized that it was not desirable to remove all rhino from Garamba, in large part because the rhino are the flagships for Garamba (and moving all the rhino would present problems with Garamba's status as a World Heritage Site). If some translocation takes place, what benefits would there be to the National Park? And what guarantees would there be that rhino would be returned for re-introduction at an appropriate time in the future? And what about ownership? Dr. Mankoto considered it essential that rhinos remain the property of Zaïre. T, Foose stated that there are already three other rhino programmes (black rhino form Zimbabwe and Natal, and Sumatran rhino from Indonesia) which address satisfactorily the questions raised by Dr. Mankoto concerning returning financial benefits to protected areas, providing animals for re-introduction and retaining ownership with the country of origin. Such agreements were more likely to be negotiable if animals are moved to a free-ranging situation outside the African continent (since very few institutions in Africa would be able to provide the necessary financial resources to Garamba).

The meeting concluded that the option of translocating some of the rhino outside Garamba (essentially options 2B and 4B) was a possibility that required further investigation. However, the issue still remained as to whether animals taken out of Garamba should be sent to another site in Africa, or to sites outside Africa altogether. In order to consider this point, the meeting identified the criteria that should be satisfied by any receiving site:

* High Security
* High Habitat Suitability
* Carrying Capacity of 20+
* Cost Effectiveness (infrastructure in place)
* Proximity to Garamba (to facilitate metapopulation management)

K. Smith mentioned that there had been some suggestions to move animals to Uganda; this would be desirable in terms of restoration of rhino to natural range but would be very expensive since infrastructure is not in place. Dr. Mankoto asked if there were other places in Zaïre itself where criteria for a receiving site could be satisfied, for example, the Virunga national Park. Dr. Smith felt that although there would be some advantages in this, it would still be very expensive. Also many of the problems of Garamba relate to the situation in Zaïre itself, and these would apply to Virunga as well. The Chair emphasized the importance of the site being financially self-supporting so that not much money will be needed for maintenance. P. Morkel said that it was desirable that the new site not only entailed low cost but also generated revenue for Garamba. This could be achieved if all rhino currently in captivity could be moved to a free-ranging location in the United States, and supplemented by a few rhino from Garamba, thereby generating money for Garamba. S. Stuart stated Zaïre would

need to decide if it was prepared to allow animals to go outside Africa. Dr. Mankoto responded that such a decision would depend on the pros and cons of the different options. There was no *a priori* reasons to reject out-of-Africa options. If security is the paramount concern, then out-of-Africa options could be important.

Concerning contingency plans, the meeting felt that these should focus on moving extremely tight security rapidly into the area when a pre-determined state is reached. Dr. Mankoto said that it might be possible to call on well-trained paramilitary under an emergency situation.
The meeting felt that an emergency evacuation of animals would probably not be possible. This would probably result in a 40-50% mortality.

Revised Management Options

As a result of these discussions, the management options were reduced to the following:

(1). Garamba *in situ* conservation - no relocation of rhino

(2). Garamba *in situ* conservation - some relocation of animals

(A) Africa

(B) Elsewhere

(3). Integrated-Coordinated Programme

(A) Population in Garamba and another elsewhere in Africa (new population could include some captive animals)

(B) Population in Garamba and one outside of Africa (consisting mostly of existing captive animals supplemented by a few from Garamba)

(4) Contingency

Quick paramilitary response from within Zaïre to secure the Garamba population.

Note that options 2 and 3 are very similar. Drs. Brooks, Morkel, Foose agreed that 3 males and 3 females would be the minimum nucleus for starting a new population. Dr. Morkel stated that translocation of rhino from Garamba would probably require 2-3 years to accomplish.

The meeting agreed that continued conservation efforts would be needed in Garamba whatever happened, and also that a contingency plan should be drawn up. It was agreed that a working group should be established to examine the pros and cons of the remaining options involving translocation of animals.

After some discussion, the meeting agreed on the following approach:

(1) A Working Group should be formed

(2) The Working Group should prepare recommendations in a draft report

(3) Workshop in conjunction with AfRSG Meeting in Mombasa (May)

(4) Workshop in Zaïre

(5) Preparation of final report

(6) High-level mission to Zaïre

(7) Decision by Zaïre

The meeting agreed that K. Smith should act as Convener of the Working Group. Members should include P. Morkel, T. Foose, Dr. Mbayma, Muhindo Mesi, and R. Brett. The meeting also agreed the aspects that should be considered by the Working Group in its report:

- Ownership of animals/legal arrangements
- Candidate sites that satisfy the criteria
- Linkage of sites to support for Garamba
- Population consequences for Garamba and the receiving site
- Involvement of captive animals
- Costs of everything (including *in situ* conservation in Garamba as well as for possible new populations.)

The draft document should describe all options, costs and benefits in order to evaluate their pros and cons. It should conclude with a recommendation for a particular option.

J. Newby asked if the meeting endorsed the idea of establishing a second population. The Chair responded that the meeting did believe there are sound reasons for relocation of some rhino from Garamba to establish one or more free-ranging populations and is therefore mandating a working group to develop the details for such options.

Immediate Actions Needed for Programme in Garamba

K. Smith outlined the urgent need to support Garamba at a higher level than now exists, especially for anti-poaching. There is also a need to ensure that the project provides benefits to local people. There is an immediate need to:

- Improve conditions for the guards (housing, pensions, etc)
- Increase salaries and security
- Recruit additional guards
- Provide for promotions
- New equipment for guards
- Community extension work to develop popular support to help protect rhino

Dr. Mankoto responded that IZCN faces a severe funding crisis, due to the very rapid inflation in Zaïre. He recognized the problems outlined by Dr. Smith and was currently carrying out hard negotiations with the government. He was hopeful of improvements, but could not yet say anything for certain.

J. Newby said that WWF would appreciate greater attempts at fund-raising for Garamba. Over the short-term, WWF will not be able to increase and may have to decrease support for Garamba. K. Smith referred to the possibility of a Trust Fund. S. Stuart drew attention to the major problem of many international donors withdrawing from Zaïre. He suggested UNDP as a possibility, as well as some consumer countries like Taiwan. The GEF would be a long-term possibility, as regards a trust fund endowment for Garamba. K. Smith stated that Garamba needs $300,000 per year now; $400,000 if the community extension work is included. WWF is currently providing about $200,000. J. Newby

said that it was imperative that there be a good funding document as soon as possible. T. Foose mentioned that the adopt-a-park concept being developed by the captive conservation community.

Conclusion

The Chair summarized the achievement of the meeting as follows:

- Identified sound conservation reasons to relocated rhino from Garamba
- Explored the possibility of establishing a second population, possibly in conjunction with rhino from captive community
- A detailed assessment of options will be prepared by the Working Group led by K. Smith
- Agreement that tangible benefits must accrue to Garamba as a result of any relocation project
- Once agreement has been developed on a strategy, then a high-level mission visit Zaïre
- New funding possibilities for Garamba have been identified

He thanked all participants for their contributions to the meeting, which he felt, had made significant headway in developing a holistic strategy for the conservation of the northern white rhino.

REPORT OF NORTHERN WHITE RHINO WORKING GROUP IUCN/SSC AFRICAN RHINO SPECIALIST GROUP (AFRSG) MEETING MOMBASA, KENYA 23-27 MAY 1994

Participants: *Mbayma Atalia, Kes Smith, Nigel Leader Williams, Mark Stanley Price, Pete Morkel, Raoul du Toit, Tom Foose*

GOAL

To ensure the survival of the northern white rhino with emphasis on wild populations.

SUMMARY OF MAJOR ACTIONS PROPOSED BY AfRSG

- Metapopulation management, including consolidation of zoo groups
- Workshop of stake-holders to agree approach, preferably in Garamba
- Provision of adequate support for *in situ* conservation in Garamba
- Formulation of a contingency plan for Garamba

CURRENT STATUS

1. There is one known wild population, currently of 28 confirmed and 4 possible northern white rhinos in its natural habitat, that has bred up successfully at a high rate of increase since 1984 in Garamba National Park, Zaïre.

2. This population is below carrying capacity, but is at potential risk from poaching, trans-border incursions and possible civil unrest.

3. This population is a key element of a World Heritage Site that has been largely dependent on donor support.

4. An unknown number of rhinos may exist in natural habitat in Sudan.

5. Two groups exist in zoos in the Czech Republic and USA, numbering 5 and 4 respectively, which represent 25% of the world population.

6. The zoo population has declined since 1984 from 12 to the present 9, with deaths exceeding births.

7. Despite the small size of the global population, none of the different groups of rhinos are in breeding contact, or part of an inclusive and integrated management programme linking wild to captive animals.

OBJECTIVES

1. To establish an integrated management programme that aims to maximize the rate of increase of the global population as rapidly as possible.

2. To spread risk to the global population by ensuring, in the short term, that a second group breeds successfully in a second country.

3. To ensure that the Garamba population is not put at risk from any actions arising from the integrated management programme.

4. To ensure an effective level of support for the maintenance of the *in situ* population at Garamba.

5. To draw up a multi-faceted contingency plan to be implemented in the event of an emergency at Garamba.

6. To confirm or otherwise the existence and location of any rhinos in Sudan and to ensure their integration into the metapopulation.

FUNDAMENTAL TECHNICAL REQUIREMENTS

1. It is necessary to manage all rhinos in an integrated plan according to metapopulation principles. This will require optimizing social structure, and ensuring the reproductive activity in a manner that brings the global population out of a bottleneck as rapidly as possible and in a way that minimizes loss in genetic diversity.
2. It is necessary that all rhinos presently kept ex situ be in ecological and social conditions that are free range and most closely resemble those in their present natural habitat.
3. It is necessary to ensure that all management decisions are made against a set of a priori performance criteria agreed by all stake-holders.
4. It is necessary to ensure that all movement to a new site does not reduce the viability of the source population to an unacceptable extent unless i. that population is already inviable for other reasons or ii. it has been decided to reduce the source population for other reasons.
5. It is essential that when any new population is established, certain minimum standards must be met including suitability of the area, adequacy of security, numbers and composition of founders, extent to which they can be managed under metapopulation principles, and their genetic representation.
6. It is necessary to recognize the biological value of the rhino in Garamba and other natural ecosystems and the importance of the species as a flagship.
7. Ultimately it is necessary that further wild populations are established.
8. It is essential that one aim of metapopulation management is to provide rhinos for release into former natural range, giving preference to donor areas.
9. Translocations will be undertaken according to the highest technical standards

POLITICAL AND ECONOMIC CONSIDERATIONS

The following are important issues that AfRSG is not fully in a position to answer, but that AfRSG wishes to flag as fundamental issues to be addressed by stakeholders.

1. Ownership animals and progeny
2. Selection of ex situ countries and sites
3. Management control of the metapopulation
4. Assistance for implementing the contingency plan
5. Funding of *in situ* conservation in Garamba
6. Funding of consolidation of the ex situ population
7. Funding of contingency plan
8. Funding of capture, translocation and release
9. Funding of any re-introduction
10. Interactions and conditionalities relating to funding, due to donor interests and priorities.

An important component to secure the future management of the northern white rhino is the identification of key stake-holders. Certain stakeholders can be identified with ease, but others will depend upon an approach and an expression of interest for their future involvement, for example particular donors, or possible areas for releasing rhinos.

RECOMMENDATIONS FROM THE AFRICAN RHINO SPECIALIST GROUP
May 1994

It is imperative for the survival of the taxon that as many rhinos as possible, currently living either in the small wild population or genetically isolated or non breeding groups, or as scattered individuals, are managed as members of a metapopulation. Accordingly, AfRSG recommends that IUCN, the Government of Zaïre, and the global captive conservation community, takes immediate steps to implement the following actions:

1. AfRSG recommends that the report entitled "The strategies for the conservation of the northern white rhino" arising from the WWF/SSC meeting in Switzerland in March 1994 is completed by August 1994.

2. It is recommended that a proposal for a major meeting of stakeholders in the survival of the taxon be developed and agreed as soon possible. This would have the purpose of designing, planning and financing a detailed and pragmatic action plan for the taxon as a metapopulation, for the immediate and medium term. This meeting should preferably take place in Garamba, but not if this is to the detriment of full attendance by stakeholders. Planning for the workshop should aim to achieve its organization in January 1995.

3. AfRSG sees consolidation of the present captive population into conditions and management regimes conducive to successful breeding, as a likely outcome of the workshop, and as a probably essential first step in achieving the goal of metapopulation management. This would also be an indicator of the will of relevant parties to conservation of the taxon.

4. Recognizing that Garamba holds most of the world population in natural habitat, as well as the intrinsic biological value of the park, an immediate priority is to ensure that adequate support is provided to Garamba to protect the population against poaching and other threats. This priority should be noted as one of immediate importance given that other actions will not occur immediately.

5. In view of the risks from a possible increase in poaching pressure and the potential for civil unrest, it is recommended that a contingency plan for the enhanced protection and/or evacuation of the rhinos be formulated, and all aspects of its implementation be guaranteed. A draft of this plan should be developed alongside the report from the workshop in Switzerland, and be completed by August 1994.

TECHNICAL DECISIONS TO BE CONSIDERED BY STAKEHOLDERS

As per previous.

GARAMBA-NORTHERN WHITE RHINO MEETING

WWF OFFICES
NAIROBI, KENYA 12 OCTOBER 1994

MINUTES

Participants: *Martin Brooks, Fraser Smith, Kes Smith, Holly Dublin, Mark Stanley Price, Tom Foose*

Brooks Reviews history. Early 1980's proposals for translocation considered rejected. Consideration resumed in March 1994 at meeting at IUCN Headquarters in Gland, Switzerland. Objective was to explore improved options for conservation of rhino. At that meeting, Mankoto advised that situation in Zaïre had deteriorated and the country was now ready to consider translocation as part of holistic strategy. Number of management options

(1) No relocation of rhino - concentrate on Garamba.
(2) Concentrate on Garamba but with some relocation in Africa or elsewhere.
(3) Integrated metapopulation management perhaps involving captive population.
(4) Contingency plan for Garamba.

Meeting concluded that were sufficient reasons to consider relocation. That a more detailed plan would be developed. Garamba would remain the highest priority.

Working Group formed with Kes as leader with task of producing report with elaboration and evaluation of all options with recommendation of preferred in time for Mombasa meeting.

Then there would be a meeting in Zaïre to get consensus. Concurrently, should be an approach to Mobutu.

Mombasa meeting in May 1994 re-endorsed metapopulation management option (i.e. 3 from Gland). Reiterated that a draft document needed to be finalized. To a large extent, Mombasa was an extension of the Gland meeting but did not proceed much further because the document was not done.

Kes Thought that assignment from Gland/Mombasa was a background document for a workshop at which strategy would be formulated. Had assigned various persons to prepare components of the report. Most only arrived at Mombasa with them. Now has a further draft, which she presents.

Brooks Purpose of this meeting is to determine what we have and where we are and how do proceed with a workshop. How adequate is content of current draft report. If needs improvement, how to we do and by when. Mentions that now there is a WWF decision that further development of report should be assigned to Holly Dublin and Tom Foose.

Kes — Thought that the document she was preparing was to present options to be discussed at future workshop rather than arriving at preferred courses of action in advance.

Brooks — Could we commence with discussion of what has changed since Mombasa.

Fraser — Surveys indicate a definite 29 rhino. In June poaching attained worst level ever. Used hand grenades but in north, not where rhinos are. Garamba Project used military to contend with poachers. After very active 2 weeks in June, poaching no longer out of control. Situation back to previous situation. Just a few groups a week. Gratifying to observe how rapidly situation could be placed under controlled. Now have support of fairly high general as had been case before.

Price — How long can you play the military card.

Fraser — Have been using the military for 4 months. Incentive has been the premiums paid. No money for it now.

Holly — Have employed same deployment of military in Mara. Worked well at first. But now has deteriorated with military in complicity with the local poachers.

Fraser — Agrees is a risk. Reason don't have military there permanently: in two weeks; out two weeks. Need to get support from uppermost levels. Optimum would be 20 elite military guards, not just locals. Initially used 30 military. Now down to 15-20 military.

Brooks — Can we review report to determine how it needs to be modified to serve as the basis for the workshop. Did Mombasa conclude that a preferred option should be in report?

A lot of discussion of how much recommendation or conclusion should be in the report.

Brooks — In general, the report should provide a flow of logic on all options and subsequently a strong indication of a recommended strategy.

Holly — Is danger that if incorporate too much detail, Zaïrois may think others deciding things without their involvement. Think Mankoto should be advised of what is happening.

Brooks — Would like report submitted to AfRSG (at least Brooks, Brett, etc.)

Does the report submitted by Kes need to be refined further.

The report needs to have a separate section delineating each option with all costs/benefits.

Report should contain:
- Each option in detail;

- Costs; funding sources; technical feasibility; time lines; anticipated contingencies.
- Must be logic flow that directs toward certain option(s) over others.
- When considering option, some have more costs than others. It would be optimal if can identify and select options that will not incur additional costs to global conservation community. So if establish new population in new country must have options that would not require additional costs.

Price — Uganda would be a high cost place Uganda was originally in full range of species.

Brooks — Credibility a problem too. Uganda doesn't have a good record. Must be very careful.

Price — Now must work through the details of these 4 options. Must try to project what contingencies will occur and how management would adapt.

Brooks — Must determine what will be most sustainable. Garamba must be more self-sufficient and long term sustainable.

Foose — Discusses approach from UNDP GEF. Received call from John Hough at UNDP New York. He indicated that Zaïre had submitted proposal for GEF project encompassing Garamba, Ituri and IZCN. He was interested in exploring de-linking the 3 components and pursuing the Garamba on a faster track. Indicated that there could be money for a preparatory Assistance Mission to help develop strategy for Garamba and perhaps support proposed workshop.

Holly — There are two approaches that include funding for Garamba. One is to the World Bank from WWF and is exclusively for Garamba. World Bank proposal includes discussion of a Trust Fund. The other is to UNDP-GEF and incorporates Garamba, Ituri, and support to IZCN.

UNDP and World Bank must have different but complementary roles.

Brooks — Next thing to consider is workshop.

What are objectives.

Will commence with a very detailed report.

Goal Consider management options and adopt one or more at a fairly senior IZCN level.

Price — Goal: Initiate action on integrated activities for northern white rhino

Aims: (1) Assemble the key players in northern white rhino conservation with such experts on southern white rhino.
(2) Adopt a widely accepted conservation strategy.
(3) Define commitment to ensure action and implementation.

	Organizers must have a common vision of who should and should not be at meeting.
Brooks	First develop timetable for report.
Price	Workshop needs facilitators and possibly other experts (e.g., decision analysis).
Brooks	Zaïre are ultimate deciders on wild population; global captive community and holding institutions on the captive population. Want to elicit as much support from captive community for both metapopulation management and support of *in situ*. Development of the ex situ programs should not negatively impact program in Zaïre.
	So what is time line on report.
Kes	Should site visits be included.
Price	Do we have to relocate rhino to area within historic range. If goal is to increase numbers of rhino to get through the demographic bottleneck, then the criteria for selecting site may be different.
	Different options will have different costs and different sources for funds.
Brooks	30 April as deadline for report. Workshop proposed for July-August.
Kes	Is Garamba the site? Advantage is for everyone to see.
Price	Need high powered people. Must minimize time. Simultaneous English and French translation.
Foose	Can do field trips before and/or after. (Mankoto might rendezvous with them there).
Brooks	Assign Foose to investigate venues and consequences of workshop site. Also of pre-workshop visit. Possible venues include: Nairobi, White Oak.
Fraser	Charter aircraft. (Late April through May optimal for Garamba visit).
Brooks	Should Mankoto be consulted to determine if he agrees to workshop not being in Zaïre.
Brooks	Decide AfRSG leader of initiative; hence organizer of workshop; writer of letter.
	Letter to Mankoto to describe what has to be done in preparation of workshop. Should include a contingency plan. Also the letter to all key players.

Brooks Tentative List of Workshop Participants:

IZCN: Director + 3 other from higher levels Govt.
Garamba: Mbayma Atalia, Muhindo Mesi, Fraser and Kes Smith
AsRSG: Brooks, Emslie, Leader-Williams, Morkel
NGOs:
WWF: Holly Dublin, J. P. d'Huart
AWF: Mark Stanley Price
IRF: Tom Foose, John Lukas
SSC: Simon Stuart, George Rabb
Zoos: 2 San Diego, 2 Dvur Kralove, 2 Columbus, Reece
GEF: John Hough (UNDP) and World Bank

Potential Relocation Countries (4 Individuals total):
Kenya:
Uganda:
South Africa:

Facilitators: Possibilities include: Lynn Maguire, Hassan Moinuddin

2 or 3 Translators/Technicians

2 Secretary

Workshop should be 2 Intensive Days with people arriving the night before.

Price Is it possible to identify risks to individual rhino. Need more detailed modelling in terms of demographics, dynamics, genetics. Need to model different relocation sites.

Kes Will get with Foose to discuss more detail on individuals for modelling.

Price/Kes Some discussion of possibility of surveying in Sudan

Foose Have everyone at this meeting read Kes' report and circulate comments to all at this meeting.

Price What about a contingency plan. Need stages and triggers.

Brooks Is contingency for crisis appropriately part of the metapopulation plan. Perhaps need as separate item.

Fraser Need presidential support to deploy elite units (Beret Rogue) if crisis really intensifies.

Brooks Believes it is incumbent upon Conservation Team in Garamba to develop a contingency plan and that it should be considered separate from the longer-term metapopulation plan.

Foose Disagrees.

Holly	Really need someone who is dedicated to development of contingency plan.
	Need specifics. Need to decide what are options/what aren't. May need some one dedicated for awhile.
Brooks	Need plan of what needs to be done. But also need to identify who will do what if plan needs to be activated.
Holly	Need coordinator for contingency plan. WWF could do but needs mandate.
Brooks	Need to refine contingency plan and arrange who would do what when. Need to proceed to try to contact Mobutu. Also should be placed in a letter to Mankoto. Approach to Mobutu must precede further attempts at arranging details for implementing contingency plan if needed.
Holly	Participants in this workshop should provide input to Kes on the contingency plan part.
Foose	Letter to Mankoto from Martin Brooks to be composed by Holly and Tom.
Kes	d'Huart has already drafted letter but also don't know if it has gone.
Price	What if GEF doesn't fund workshop.
Foose	Then will have to explore alternatives. There are some, e.g. some support from IRF, British Airways, etc.

Brooks: **Recapitulation:**

Holly and Tom will prepare report assessing the various management options for long-term conservation of rhino considering all the pros and cons and searching for programmatic cost-effective options.
Completion date: *30 April 1995. Foose will try to prepare first rough draft for review with Holly at CITES meeting.*

Kes will revise contingency plan with input received from participants in this meeting.
Completion date: *Before Kes returns to Garamba in early November.*

Holly and Tom to prepare draft of letter to Mankoto describing what is occurring for signature by Brooks and translation by d'Huart. It should include reference to development of a contingency plan.

A similar letter will go to key players from Brooks. Again Holly and Tom to prepare. Don't discuss contingency plan in this letter.

Conduct a 2 day workshop of key players at end of July or August-September. A preliminary list of players has been identified. Option of a pre-workshop visit to Garamba in latter half of April of in May to Garamba. Should go in letter to key players. Fraser will obtain estimate of costs.

Foose will explore venues for workshop and return with recommendation to AfRSG Chair and WWF. Suggestions will include statement of aims.
Aims: (1) Assemble the key players in northern white rhino conservation with such experts on southern white rhino.
(2) Adopt a widely accepted conservation strategy.
(3) Define commitment to ensure action and implementation.
A provisional list of participants should also be included.
Completion date: *By end of year.*

Holly and Tom will liaise with John Hough about possible GEF funding of workshop and strategy development process.

10. A. POPULATION SIMULATIONS USING VORTEX*
GARAMBA POPULATION
NORTHERN WHITE RHINO

SCENARIOS INVESTIGATED & INPUT PARAMETERS USED

All simulations have been performed with 500 runs.

BASIC SCENARIOS (6 Scenarios):

Basic parameters used for the simulations are:

- **Initial Population = 28 (14.14, i.e. 14 males and 14 females)**

  This population represents the confirmed individuals as of May 1995.

- **Age at First Reproduction = 7 years for ♀♀; 10 years for ♂♂**

- **Age of Senescence = 37 years**

  (Based on Norman Owen Smith's data for Southern White Rhino for which fecundity declines rapidly after age 35 for females. Since some reproduction does continue until mean age of death at 40-44 years, a figure of 37 years has been used to allow for continued but reduced reproduction after age 35.

- **Reproduction:**
  Three levels of reproduction are considered in the basic scenarios:
  - 40% females producing in any 1 year = intercalf interval of 2.5 years
  - 30% females producing in any 1 year = intercalf interval of 3.3 years
  - 20% females producing in any 1 year = intercalf interval of 5.0 years

- **Natural Mortality Rates (%/year):**

Infant ♀♀ and ♂♂ (Age Class 0-1)	10%
Sub-Adult ♀♀ (Age Classes 1-2 to 6-7)	1% in each age class
Sub-Adult ♂♂ (Age Classes 1-2 to 9-10)	1% in each age class
Adult ♀♀ (Age > 7 years)	3%
Adult ♂♂ (Age > 10 years)	3%

These rates correspond to observed mortalities in the population.
- Infant mortality of 10% = 2-3 deaths out of 23-24 births during 1984-1995.
- Adult mortality of 3% = 1 death every 3-4 years for a population with ~ 12 adults as has been case for Garamba over last 11 years. This mortality rate also corresponds to the number of deaths relative to the average number at risk if the individuals not observed since 1992 are assumed to have died. These rates are slightly higher than reported by Norman Owen-Smith for Southern White Rhino where adult ♀ mortality was about 1.2% and adult male about 3.5%.

The combination of the above mortality rates and 2.5 year intercalf interval produces an mean annual increase rate of 7% (i.e. λ = 1.07, r = .07) the observed value for 1984-1994.

- **Inbreeding:**

  In all simulations, **inbreeding** is considered operative because of the several bottlenecks of small size through which the population has passed in last 50 years and especially last 20 years. In the absence of any specific information on intensity of inbreeding, a level equivalent (3.14 lethal equivalents per diploid locus) to the average for over 50 species of mammals has been used.

- **Carrying Capacity:**

  A carrying capacity **K = 200** Is used.

  Note: For those populations with a positive rate of change, the potential population at end of 25 and 50 years could be higher than ~ 200. A K of 200 was used (1) to expedite simulations (2) to acknowledge that an IPZ or sanctuary with 200 rhino is an objective with modest but perhaps feasible ambition.

CATASTROPHE (POACHING) SCENARIOS (12 Scenarios):

For each of the basic scenarios, the effects of **catastrophes** in the form of poaching are examined. In the model, a catastrophe is defined by a **frequency**, i.e. how often it occurs, and a **severity**, i.e. what its effect (increasing mortality, reducing reproduction) is on the population. All combinations of the basic scenarios with 4 levels of poaching are investigated:

- **Moderate Episodic Poaching** which occurs every **10 years** and **removes 25%** of the population.

- **Severe Episodic Poaching** which occurs every **15 years** and **removes 50%** of the population. The **frequency** of this level approximates what has occurred in Garamba in the last 30 years. However, the **severity** investigated is appreciably less than what has actually occurred.

- **Continuous (i.e. Every Year) Poaching** at two intensities:

  - **3.5% of the population is removed**, i.e. equivalent to the loss of about 1 animal every year at current population size.

  - **7% of the population is removed**, i.e. equivalent to the loss of about 2 animals each year at current population size.

No other catastrophes such as epidemic disease or environmental disaster have been investigated at this time.

* **VORTEX is software developed by Robert C. Lacy, Ph.D. of the Chicago Zoological Society with assistance from Kimberly A. Hughes and Philip S. Miler to permit stochastic simulation of extinction processes operating on populations.**

REMOVALS FOR RELOCATION TO A SECOND POPULATION (45 Scenarios):

A number of scenarios representing all of the above ones but this time involving removal of rhino from Garamba for relocation to another population are examined:

- Removal of Only Males
  - All Adult
- Removal of Males and Females at Two Levels (2.2 and 3.3):
  - Adults and Subadults

For these simulations, it is presumed that all rhino to be relocated are removed in 1 year, the lst year of the simulations. It would be possible to investigate more graduated removals although the costs and logistics may not be feasible for such a strategy.

It is not possible in VORTEX to directly incorporate behavioral or social disruption due to removals. However, by considering the different, especially lower, rates of reproduction, some indication of the effects of any disruption can be obtained.

It is also not possible in VORTEX to remove specific individual animals from population. However, it is possible to designate the age and sex class of animals to be removed.

Applying the logic discussed in Section 6. D. of this document, a number of assumptions have been used for these scenarios:

- If 3 females are moved from Garamba, they might arguably be:
  3bF Juillet (Age 10-11)
  4cF Noel (Age 7-8)
  1cF Nawango (Age 4-5)
- If 2 females are moved from Garamba, they might arguably be:
  3bF Juillet (Age 10-11)
  4cF Noel (Age 7-8)
- If 3 males are moved from Garamba, they might arguably be:
  M4 Bac (Age > 20)
  M9 Notch (Age > 19)
  4aM Bolete moke (Age 11-12) or 1 Am Moke (12-13)
- If 2 males are moved from Garamba, they might arguably be:
  M4 Bac (Age > 20)
  M9 Notch (Age > 19)

10. B. POPULATION SIMULATIONS USING VORTEX GARAMBA POPULATION NORTHERN WHITE RHINO

RESULTS OF GARAMBA POPULATION SIMULATIONS

Expected Outcomes of the population simulations are reported through a number of demographic and genetic conditions of the population at the end of **25 Years** and **50 Years**.

Probability of Extinction — is technically the percentage of the 500 simulations during which the population went extinct. It can be interpreted as the risk that the real population with the parameters used would go extinct.

Mean Time to Extinction — is the average time to extinction for those populations out of the 500 that became extinct.

λ Lambda ($\approx$ r) — is the average annual rate of change in population numbers.
$\lambda > 0$ indicates the population will increase in size.
$\lambda = 0$ means the population will remain constant in size.
$\lambda < 0$ means the population will decrease in size.

These trends strictly apply only once a stable age distribution is attained which is not quite the case yet for the Garamba population but can occur quickly, especially when λ is relatively high; until then there can be some fluctuations in population numbers that may deviate from the general expectations.

Mean Final Population Size — is the average size of the 500 populations simulated in each scenario at the 25 and 50 year points.

Gene Diversity — is the expected heterozygosity in the population, one of the better overall measures of genetic variability.

BASIC SCENARIOS (Table 7)

Using the parameters as described, i.e. no significant poaching or removals for relocation, the future of the Garamba population appears healthy. (Table 7). The degree of health depends on:

- The mortality remaining low, which could change as the adult breeders classes continue to advance in age.
- The reproductive rate remaining high, which again could change as the adult female breeders advance in age and until/unless the subadults commence breeding.

The population numbers such as 198+ and 196+ for Mean Population Size at 50 years signifies that these populations would be larger, i.e. 1041 and 407 respectively, if the carrying capacity had not been artificially established at 200. Again, the carrying capacity was established at this level (1) to expedite the simulations (2) to acknowledge that an IPZ or sanctuary within Garamba with 200 rhino over the next 50 years is an objective with modest but perhaps feasible ambition.

EFFECTS OF CATASTROPHE (POACHING) SCENARIOS (Tables 8-9)

Moderate Episodic Poaching:

An episode of poaching 1 time every 10 years (**frequency** of the catastrophe) during which 25% of the rhino are lost (**severity** of the catastrophe) significantly reduces growth potential of the population so that the carrying capacity of 200 is not attained in the 50 year time period. (Table 8, upper half). If reproductive rates decline to half of their 1984-1995 levels, growth rates are very low and the effect on final population size at the end of 25 and 50 years is spectacular. The population barely increases in size and is at a 6-7% risk of becoming extinct

Severe Episodic Poaching:

An episode of poaching 1 time every 15 years during which 50% of the rhino are lost has appreciable risks (9-32%) of extinction at all levels of reproduction. Again if reproductive rates really decline, the effects are spectacular. (Table 8, lower half). After 50 years, the population is still about the same size but the λ is actually slightly negative which indicates that over the longer term the population numbers would decline. Again the frequency of this level of severe poaching is what has been observed in Garamba over the last 30 years, but the severity of poaching used in the simulation is actually lower than the decimation of the population that has actually occurred on these occasions.

Continuous Poaching:

At a Lower Level:

Continuous poaching that occurs every year and removes 3.5% of the population (at current population size equivalent to about 1 animal/year) significantly reduces population growth at the two higher levels of reproduction but the populations still are not at much risk of extinction and at least more than double their size. (Table 9, upper half). At the lowest level of reproduction investigated, the situation is different and the population actually declines and is on a course for certain extinction with a risk of 5-6% during the next 50 years.

At a Higher Level:

Continuous poaching that occurs every year and removes 7% of the population (at current population size equivalent to about 2 animals/year) has severe effects on the population with the population at zero growth rate even at the highest rate of reproduction. Extinction risks vary from 6 to 65%. (Table 9, lower half).

REMOVALS FOR RELOCATION TO A SECOND POPULATION (Tables 10-21)

Removals Under Basic Scenarios:

Both Sexes Removed:
The removal of rhino of both sexes for relocation does reduce the growth rate and mean population size (about 10-20% lower), but the source population stills grows healthily and there are no risks of extinction reported by the model. (Table 10; Compare Table 10 with Table 7) The effect of removing 6 (3 male/3 female) rhino versus 4 rhino (2 males/2 females) results in final population sizes about 20% lower versus 10% lower than if no removals occur.

Males Only Removed:
The removal of 3 male rhino for relocation appears to have virtually no effect on the prospects for the source population. (Table 11; Compare Table 11 with Table 7).

Removals Under Moderate Episodic Poaching:

Both Sexes Removed:
The removal of rhino of both sexes imposed on scenarios where moderate episodic poaching is occurring does reduce growth rates and mean final population sizes (10-20% lower) and increase extinction risks (about 30% higher) than when no removals occur. (Table 12; Compare Table 12 with upper half of Table 8). There is more impact if 6 (3.3) rather than 4 (2.2) rhino are removed. (Compare upper and lower halves of Table 12).

Males Only Removed:
The removal of 3 male rhino does not changed the results from the case when no removals occur (Table 13; Compare Table 13 with the upper half of Table 8).

Removals Under Severe Episodic Poaching:

Both Sexes Removed:
The removal of rhinos of both sexes imposed on scenarios where severe episodic poaching is occurring does decrease final population sizes (lower by about 10%) and increases risks of extinction (higher by 10-30%). (Table 14; Compare Table 14 with the lower half of Table 8). There are likewise somewhat higher risks of extinction if 6 rather than 4 rhino are removed. (Compare the upper and lower halves of Table 14).

Only Males Removed:
The removal of 3 male rhino has no effect on the results compared to the case when no removals occur. (Table 15; Compare Table 15 with lower half of Table 8).

Removals Under Continuous Poaching:

Lower Level:

Both Sexes Removed:
The removal of rhino of both sexes under continuous poaching at the lower level investigated does decrease growth rate and final population size (about 20% lower) and substantially increases the risk of extinction (50%) over the (Table 16; Compare Table 16 and upper half of Table 9). Removal of 6 rather than 4 rhinos has greater effect.

Males Only Removed:
The removal of 3 male rhino has no effect on the results compared to the case when no removals occur. (Table 17; Compare Table 17 with upper half of Table 9).

Higher Level:

Both Sexes Removed:
The removal of rhino of both sexes under continuous poaching at the higher level has the most significant effect on the prospects for the population, especially at the higher levels of reproduction. (Table 18; Compare Table 18 with the lower half of Table 9). The effect appears somewhat greater if 6 rather than 4 rhino are removed.

Males Only Removed:
The removal of 3 male rhino has no effect on the results compared to the case when no removals occur. (Table 19; Compare Table 13 with lower half of Table 9).

SUMMARY:

Removals of both sexes as high as the level of 3 males and 3 females when no poaching occurs do not appear to incur risks for the Garamba population.

Removal of rhino of both sexes increases risks to the Garamba population if rhino are removed if poaching is not controlled or reproduction is disrupted so it declines.

These results reinforce the importance of linking adequate and indeed improved protection of Garamba with any program of removals for relocation.

Removal of only males does not appear to increase risks for the Garamba population under the scenarios investigated.

It should be noted that the threats that have been investigated are not necessarily worst case scenarios.

In any case, the stakeholders and stewards formulate the strategy for northern white rhino, they must consider what the trade-offs are between the risks of removing rhino and not removing rhino from Garamba.

As the stakeholders and stewards continue the strategy formulation process, they can interactively investigate more scenarios.

10. C. POPULATION SIMULATIONS USING VORTEX NEWLY ESTABLISHED POPULATIONS NORTHERN WHITE RHINO

SCENARIOS INVESTIGATED & INPUT PARAMETERS USED

All simulations have been performed with 500 runs.

FOUNDERS ENTIRELY FROM CAPTIVE POPULATION (Table 20):

The scenarios examine consolidation of the captive population supposing that reproduction can be stimulated to occur at one of the levels considered in the basic scenarios for the Garamba population , i.e.:

- 40% females producing in any 1 year = intercalf interval of 2.5 years
- 30% females producing in any 1 year = intercalf interval of 3.3 years
- 20% females producing in any 1 year = intercalf interval of 5.0 years

The scenarios examine all combinations (**6 scenarios**) of these levels of reproduction with two levels of adult mortality:

- 3%/year, i.e. the Garamba value.
- 5%/year, i.e. a value not quite twice as high as the Garamba value.

FOUNDERS ENTIRELY FROM GARAMBA POPULATION (Table 21):

These scenarios consider the fate a new population established by relocation of 6 (3.3) rhino from Garamba National Park under three levels of reproduction and two levels of adult mortality (**6 scenarios**):

- Two levels of adult mortality:
  - 3%/year, i.e. equivalent to 1 death every 3-4 years.
  - 5%/year, i.e. equivalent to 1 death every other year.
- Three levels of reproduction:
  - 40% females producing in any 1 year = intercalf interval of 2.5 years
  - 30% females producing in any 1 year = intercalf interval of 3.3 years
  - 20% females producing in any 1 year = intercalf interval of 5.0 years

FOUNDERS FROM COMBINATIONS OF CAPTIVE AND GARAMBA POPULATION:

These scenarios examine fates of new populations established with various numbers of rhino from Garamba and the captive population under the three levels of reproduction and two levels of adult mortality considered in previous scenarios (**36 scenarios**).

Combination 1 (Table 22):

- 9 (4.5) rhino from captivity
- 6 (3.3) rhino from Garamba (3 males > 10 yr; 1 ♀ = 4-5 yr, 1 ♀ 7-8 yr, 1 ♀ 10-11 yr)

Combination 2 (Table 23):

- 9 (4.5) rhino from captivity
- 4 (2.2) rhino from Garamba (2 males > 10 yr; 1 ♀ 7-8 yr, 1 ♀ 10-11 yr)

Combination 3 (Table 24):

- 9 (4.5) rhino from captivity
- 3 (3.0) rhino from Garamba (3 males > 10 yr)

Combination 4 (Table 25):

- 4 (2.2) rhino from captivity (1 ♂ 15-16 yr, 1 ♂ 22-23 yr; 2 ♀♀ < 20 yr)
- 6 (3.3) rhino from Garamba (3 ♂♂ > 10 yr; 1 ♀ = 4-5 yr, 1 ♀ 7-8 yr, 1 ♀ 10-11 yr)

Combination 5 (Table 26):
- 4 (2.2) rhino from captivity (1 ♂ 15-16 yr, 1 ♂ 22-23; 2 ♀♀ < 20 yr)
- 4 (2.2) rhino from Garamba (2 ♂♂ > 10 yr; 1 ♀ 7-8 yr, 1 ♀ 10-11 yr)

Combination 6 (Table 27):
- 3 (0.3) rhino from captivity (3 ♀♀ < 22 yr)
- 3 (3.0) rhino from Garamba (3 ♂♂ > 10 yr)

It is also not possible in VORTEX to specify individual animals as founders for a new population. However, it is possible to designate the age and sex class of animals to be removed.

Again applying the logic of Section 6. D. of this Document, it has been assumed:

- If 3 females from Garamba are founders (Combinations 1 & 4), they might arguably be:
  3bF Juillet (Age 10-11)
  4cF Noel (Age 7-8)
  1cF Nawango (Age 4-5)
- If only 2 females from Garamba are founders (Combinations 2 & 5), they might arguably be:
  3bF Juillet (Age 10-11)
  4cF Noel (Age 7-8)
- If 3 males from Garamba are founders (Combinations 1,3,4, & 6) they might arguably be:
  M4 Bac (Age > 20)
  M9 Notch (Age > 19)
  4aM Bolete moke (Age 11-12) or 1 Am Moke (Age 12-13)
- If 2 males from Garamba are founders (Combinations 2 & 5), they might arguably be:
  M4 Bac (Age > 20)
  M9 Notch (Age > 19)
- If only 3 females from captivity are founders (Combination 6), they might arguably be:
  789 Nabire (Age 11-12)
  943 Najin (Age 6-7)
  374 Nola (If her medical condition is resolved satisfactorily) (Age 19)
  or
  376 Nadi (Age 23)
- If only 2 females from captivity are founders (Combination 4 & 5), they might arguably be:
  789 Nabire (Age 11-12)
  943 Najin (Age 6-7)
- If only 2 males from captivity are founders (Combinations 4 & 5), they might arguably be:
  630 Suni (a young male Age 15-16 at Dvur Kralove)
  373 Saut (a proven breeder Age 23 at San Diego)

10. D. POPULATION SIMULATIONS USING VORTEX NEWLY ESTABLISHED POPULATIONS

RESULTS OF NEW POPULATION SIMULATIONS POPULATIONS

Expected Outcomes of the population simulations are reported through a number of demographic and genetic conditions of the population at the end of **25 Years** and **50 Years**.

Probability of Extinction — is technically the percentage of the 500 simulations during which the population went extinct. It can be interpreted as the risk that the real population with the parameters used would go extinct.

Mean Time to Extinction — is the average time to extinction for those populations out of the 500 that became extinct.

λ **Lambda** ($\approx$ **r**) — is the average annual rate of change in population numbers.
$\lambda > 0$ indicates the population will increase in size.
$\lambda = 0$ means the population will remain constant in size.
$\lambda < 0$ means the population will decrease in size.

These trends strictly apply only once a stable age distribution is attained which is not quite the case yet for the Garamba population but can occur quickly, especially when λ is relatively high; until then there can be some fluctuations in population numbers that may deviate from the general expectations.

Mean Final Population Size — is the average size of the 500 populations simulated in each scenario at the 25 and 50 year points.

Gene Diversity — is the expected heterozygosity in the population, one of the better overall measures of genetic variability.

FOUNDERS ENTIRELY FROM CAPTIVE POPULATION (Table 20):
The prospects for new populations established by consolidating and perhaps relocating all 9 (4 male and 5 female) northern white rhino in captivity are good if the rates of mortality and reproduction prevailing in Garamba are attained. The prospects decline as the rates of reproduction decrease and rates of mortality increase. Considering the past performance of this group reproductively only the middle and perhaps lowest reproductive rates are to be expected.

FOUNDERS ENTIRELY FROM GARAMBA (Table 21):
The prospects for a new population established by 6 (3 male and 3 female) appear good if the same rates of reproduction and mortality that prevail in Garamba can be attained. However, the projections are slightly worse than for a population founded by all 9 rhino from captivity for the same input parameters. The reason presumably is simply the smaller number of founding females exposing the population to more risks of random fluctuations. It is also probably more reasonable to assume that the younger rhino that presumably would be moved from Garamba might achieve the higher rates of reproduction and lower rates of mortality than the captive rhino with many individuals advanced in age and perhaps having some medical problems already.

FOUNDERS FROM A COMBINATION OF CAPTIVE AND GARAMBA POPULATIONS (Tables 22-27):

The best prospects prevail when all the captive rhino and 6 of the Garamba rhino are combined to found a new population (Combination 1; Table 22).

More generally, results are best when total number of females is highest and they include the two youngest females from captivity and at least 2 females from Garamba. (Combinations 16, 17, and 19; Tables 22, 23, 24)

All of these results are better than populations founded with only captive (Table 20) or only Garamba rhino (Table 21) found the population.

Adding 3 males from Garamba to all rhino from captivity is marginally better than using just the captives. However, these simulations assume that the captive males will impregnate females as well as Garamba males will. This assumption may not be valid.

The worst results occur when only Garamba rhino and only females from captivity and males from Garamba are used. But again, these simulations presume that Garamba and captive rhino are equally likely to reproduce which may not be valid.

As would be expected, in all cases the higher the reproduction and the lower the mortality the better the results. Reproduction at the intermediate level (i.e. an intercalf interval of 3.3 years) and mortality at the lower (3%) level seems important to keep probability of extinction below 10% and to attain population sizes > 100 over the 50 year period.

TABLE 7

NORTHERN WHITE RHINO POPULATION SIMULATIONS - GARAMBA

BASIC SCENARIOS - NO POACHING - NO REMOVALS

POPULATION PARAMETERS					CATASTROPHES				INBRD	REMOVALS FOR TRANSLOCATION		EXPECTED OUTCOMES 25 (Above) & 50 (Below) YEAR PROJECTION			
					POACHING		?								
Description of Scenario Modelled	Initial Number (5-95) Est.)	Adult Death Rate	% ♀♀ Producing Calves/Yr (Intercalf Interval)	λ % Yr	Freq	Svrty	Freq	Svrity	(Numbr Lethal Equivl. Mammal Mean)	Total Numbr	Years	Probablity (%) of Extinction	T_E Time To Extinctn	Mean Populatn K = 200	H_E Gene Diversity
Basic No Poaching No Moves	28 14.14	3% (1 per 3-4 years)	40 (2.5 Yr)	7.5					3.14			0 0		173 198+	97 96
	28 14.14	3%	30 (3.3 Yr)	5.5					3.14			0 0		113 196+	97 96
	28 14.14	3%	20 (5 Yr)	3					3.14			0 0		65 126	96 97

TABLE 8

NORTHERN WHITE RHINO POPULATION SIMULATIONS - GARAMBA

EFFECTS OF EPISODIC POACHING AT MODERATE AND SEVERE LEVELS

POPULATION PARAMETERS					CATASTROPHES				INBRD	REMOVALS FOR TRANSLOCATION		EXPECTED OUTCOMES 25 (Above) & 50 (Below) YEAR PROJECTION			
					POACHING		?								
Description of Scenario Modelled	Initial Number (5-95) Est.)	Adult Death Rate	% ♀♀ Producing Calves/Yr (Intercalf Interval)	λ % Yr	Freq	Svrty	Freq	Svrity	(Numbr Lethal Equivl. Mammal Mean)	Total Numbr	Years	Probablity (%) of Extinction	T_E Time To Extinctn	Mean Populatn K = 200	H_E Gene Diversity
Episodic Moderate Poaching	28 14.14	3% (1 per 3-4 years)	40 (2.5 Yr)	4.8	.1 = every 10yr	25% Killed			3.14			0 0		95 157	96 94
	28 14.14	3%	30 (3.3 Yr)	2.9	.1 = every 10yr	25% Killed			3.14			0 .6	41	61 103	95 93
	28 14.14	3%	20 (5 Yr)	.4	.1 = every 10yr	25% Killed			3.14			.6 6.6	39	35 37	94 89
Episodic Severe Poaching	28 14.14	3% (1 per 3-4 years)	40 (2.5 Yr)	3.9	.067 every 15 yr	50% Killed			3.14			3 8.6	30	72 108	93 91
	28 14.14	3%	30 (3.3 Yr)	2	.067 every 15 yr	50% Killed			3.14			5.0 15.4	32	48 64	93 89
	28 14.14	3%	20 (5 Yr)	-.5	.067 every 15 yr	50% Killed			3.14			9.2 32.4	33	29 30	91 86

TABLE 9

NORTHERN WHITE RHINO POPULATION SIMULATIONS - GARAMBA

EFFECTS OF CONTINUOUS POACHING AT A LOWER AND A HIGHER LEVEL

POPULATION PARAMETERS					CATASTROPHES				INBRD	REMOVALS FOR TRANSLOCATION		EXPECTED OUTCOMES 25 (Above) & 50 (Below) YEAR PROJECTION			
					POACHING		?								
Description of Scenario Modelled	Initial Number (5-95) Est.)	Adult Death Rate	% ♀♀ Producing Calves/Yr (Intercalf Interval)	λ % Yr	Freq	Svrty	Freq	Svrity	(Numbr Lethal Equivl. Mammal Mean)	Total Numbr	Years	Probablity (%) of Extinction	T_E Time To Extinctn	Mean Populatn K = 200	H_E Gene Diversity
Continuous Poaching At Lower Level	28 14.14	3% (1 per 3-4 years)	40 (2.5 Yr)	3.8	1 i.e., every year	3.5% Killed curntly would be 1/yr.			3.14			0 0		74 152	96 94
	28 14.14	3%	30 (3.3 Yr)	1.8	1	3.5% Killed			3.14			0 .2		47 67	95 92
	28 14.14	3%	20 (5 Yr)	-.6	1	3.5% Killed			3.14			.2 5.6	43	26 21	94 87
Continuous Poaching At Higher Level	28 14.14	3% (1 per 3-4 years)	40 (2.5 Yr)	1	1 i.e., every year	7% Killed curntly would be 2/yr.			3.14			.4 6.4	41	29 26	92 85
	28 14.14	3%	30 (3.3 Yr)	-2	1	7% Killed			3.14			1 24	41	18 11	91 80
	28 14.14	3%	20 (5 Yr)	-4.3	1	7% Killed			3.14			6 65	37	11 6	88 74

TABLE 10

NORTHERN WHITE RHINO POPULATION SIMULATIONS - GARAMBA POPULATION

EFFECT OF REMOVAL OF BOTH SEXES FOR NEW POPULATION - NO POACHING

POPULATION PARAMETERS					CATASTROPHES				INBRD	REMOVALS FOR TRANSLOCATION		EXPECTED OUTCOMES 25 (Above) & 50 (Below) YEAR PROJECTION			
					POACHING		?								
Description of Scenario Modelled	Initial Number (5-95) Est.)	Adult Death Rate	% ♀♀ Producing Calves/Yr (Intercalf Interval)	λ % Yr	Freq	Svrty	Freq	Svrity	(Numbr Lethal Equivl. Mammal Mean)	Total Numbr	Years	Probablity (%) of Extinction	T_E Time To Extinctn	Mean Populatn K = 200	H_E Gene Diversity
No Poaching 6 (3.3) Rhino Moved	28 14.14	3% (1 per 3-4 years)	40 (2.5 Yr)	7.5					3.14	6 (3.3)	1	0 0		145 198+	96 96
	28 14.14	3%	30 (3.3 Yr)	5.5					3.14	6 (3.3)	1	0 0		91 193+	96 95
	28 14.14	3%	20 (5 Yr)	3					3.14	6 (3.3)	1	0 0		53 99	96 94
No Poaching 4 (2.2) Rhino Moved	28 14.14	3% (1 per 3-4 years)	40 (2.5 Yr)	7.5					3.14	4 (2.2)	1	0 0		155 199+	97 96
	28 14.14	3%	30 (3.3 Yr)	5.5					3.14	4 (2.2)	1	0 0		99 194+	96 96
	28 14.14	3%	20 (5 Yr)	3					3.14	4 (2.2)	1	0 0		57 108	96 95

TABLE 11

NORTHERN WHITE RHINO POPULATION SIMULATIONS - GARAMBA POPULATION

EFFECT OF REMOVAL OF MALES ONLY FOR NEW POPULATION - NO POACHING

POPULATION PARAMETERS					CATASTROPHES				INBRD	REMOVALS FOR TRANSLOCATION		EXPECTED OUTCOMES 25 (Above) & 50 (Below) YEAR PROJECTION			
					POACHING		?								
Description of Scenario Modelled	Initial Number (5-95) Est.)	Adult Death Rate	% ♀♀ Producing Calves/Yr (Intercalf Interval)	λ % Yr	Freq	Svrty	Freq	Svrity	(Numbr Lethal Equivl. Mammal Mean)	Total Number	Years	Probablity (%) of Extinction	T_E Time To Extinctn	Mean Populatn K = 200	H_E Gene Diversity
No Poaching 3 (3.0) Rhino Moved	28 14.14	3% (1 per 3-4 years)	40 (2.5 Yr)	7.5					3.14	3 (3.0)	1	0 0		171 197+	97 96
	28 14.14	3%	30 (3.3 Yr)	5.5					3.14	3 (3.0)	1	0 0		113 196+	96 96
	28 14.14	3%	20 (5 Yr)	3					3.14	3 (3.0)	1	0 0		64 123	96 95

TABLE 12

NORTHERN WHITE RHINO POPULATION SIMULATIONS - GARAMBA POPULATION

EFFECT OF REMOVAL OF BOTH SEXES FOR NEW POPULATION - EPISODIC MODERATE POACHING

POPULATION PARAMETERS					CATASTROPHES				INBRD	REMOVALS FOR TRANSLOCATION		EXPECTED OUTCOMES 25 (Above) & 50 (Below) YEAR PROJECTION			
					POACHING		?								
Description of Scenario Modelled	Initial Number (5-95) Est.)	Adult Death Rate	% ♀♀ Producing Calves/Yr (Intercalf Interval)	λ % Yr	Freq	Svrty	Freq	Svrity	(Numbr Lethal Equivl. Mammal Mean)	Total Numbr	Years	Probablity (%) of Extinction	T_E Time To Extinctn	Mean Populatn K = 200	H_E Gene Diversity
Episodic Moderate Poaching 6 (3.3) Rhino Moved	28 14.14	3% (1 per 3-4 years)	40 (2.5 Yr)	4.8	.1 = every 10yr	25% Killed			3.14	6 (3.3)	1	0 .2	44	81 152	95 94
	28 14.14	3%	30 (3.3 Yr)	2.9	.1 = every 10yr	25% Killed			3.14	6 (3.3)	1	0 .8	42	48 81	94 91
	28 14.14	3%	20 (5 Yr)	.4	.1 = every 10yr	25% Killed			3.14	6 (3.3)	1	1 7.4	36	29 29	93 87
Episodic Moderate Poaching 4 (2.2) Rhino Moved	28 14.14	3% (1 per 3-4 years)	40 (2.5 Yr)	4.8	.1 = every 10yr	25% Killed			3.14	4 (2.2)	1	0 .4	37	80 151	95 94
	28 14.14	3%	30 (3.3 Yr)	2.9	.1 = every 10yr	25% Killed			3.14	4 (2.2)		.6 1.2	27	52 88	94 92
	28 14.14	3%	20 (5 Yr)	.4	.1 = every 10yr	25% Killed			3.14	4 (2.2)		1 5.2	37	30 33	93 88

TABLE 13

NORTHERN WHITE RHINO POPULATION SIMULATIONS - GARAMBA POPULATION

EFFECT OF REMOVAL OF MALES ONLY FOR NEW POPULATION - EPISODIC MODERATE POACHING

POPULATION PARAMETERS					CATASTROPHES				INBRD	REMOVALS FOR TRANSLOCATION		EXPECTED OUTCOMES 25 (Above) & 50 (Below) YEAR PROJECTION			
					POACHING		?								
Description of Scenario Modelled	Initial Number (5-95) Est.)	Adult Death Rate	% ♀♀ Producing Calves/Yr (Intercalf Interval)	λ % Yr	Freq	Svrty	Freq	Svrity	(Numbr Lethal Equivl. Mammal Mean)	Total Numbr	Years	Probablity (%) of Extinction	T_E Time To Extinctn	Mean Populatn K = 200	H_E Gene Diversity
Episodic Moderate Poaching 3 (3.0) Rhino Moved	28 14.14	3% (1 per 3-4 years)	40 (2.5 Yr)	4.8	.1 = every 10yr	25% Killed			3.14	3 (3.0)	1	0 .4	30	97 160	95 94
	28 14.14	3%	30 (3.3 Yr)	2.9	.1 = every 10yr	25% Killed			3.14	3 (3.0)	1	.2 .6	34	62 102	95 93
	28 14.14	3%	20 (5 Yr)	.4	.1 = every 10yr	25% Killed			3.14	3 (3.0)	1	.8 5.2	36	34 37	94 89

TABLE 14

NORTHERN WHITE RHINO POPULATION SIMULATIONS - GARAMBA POPULATION

EFFECT OF REMOVAL OF BOTH SEXES FOR NEW POPULATION - EPISODIC SEVERE POACHING

POPULATION PARAMETERS					CATASTROPHES				INBRD	REMOVALS FOR TRANSLOCATION		EXPECTED OUTCOMES 25 (Above) & 50 (Below) YEAR PROJECTION			
					POACHING		?								
Description of Scenario Modelled	Initial Number (5-95) Est.)	Adult Death Rate	% ♀♀ Producing Calves/Yr (Intercalf Interval)	λ % Yr	Freq	Svrty	Freq	Svrity	(Numbr Lethal Equivl. Mammal Mean)	Total Numbr	Years	Probablity (%) of Extinction	T_E Time To Extinctn	Mean Populatn K = 200	H_E Gene Diversity
Episodic Severe Poaching 6 (3.3) Rhino Moved	28 14.14	3% (1 per 3-4 years)	40 (2.5 Yr)	3.9	.067 every 15 yr	50% Killed			3.14	6 (3.3)	1	5.2 9.8	26	65 96	93 90
	28 14.14	3%	30 (3.3 Yr)	2	.067 every 15 yr	50% Killed			3.14	6 (3.3)	1	5.2 15.4	31	43 65	92 88
	28 14.14	3%	20 (5 Yr)	-.5	.067 every 15 yr	50% Killed			3.14	6 (3.3)	1	13.0 34.8	30	25 28	91 85
Episodic Severe Poaching 4 (2.2) Rhino Moved	28 14.14	3% (1 per 3-4 years)	40 (2.5 Yr)	3.9	.067 every 15 yr	50% Killed			3.14	4 (2.2)	1	5.4 11.2	29	66 96	93 90
	28 14.14	3%	30 (3.3 Yr)	2	.067 every 15 yr	50% Killed			3.14	4 (2.2)	1	5.6 17	31	45 62	92 88
	28 14.14	3%	20 (5 Yr)	-.5	.067 every 15 yr	50% Killed			3.14	4 (2.2)	1	9.8 33.0	32	25 26	90 84

TABLE 15

NORTHERN WHITE RHINO POPULATION SIMULATIONS - GARAMBA POPULATION

EFFECT OF REMOVAL OF MALES ONLY FOR NEW POPULATION - EPISODIC SEVERE POACHING

POPULATION PARAMETERS					CATASTROPHES				INBRD	REMOVALS FOR TRANSLOCATION		EXPECTED OUTCOMES 25 (Above) & 50 (Below) YEAR PROJECTION			
					POACHING		?								
Description of Scenario Modelled	Initial Number (5-95) Est.)	Adult Death Rate	% ♀♀ Producing Calves/Yr (Intercalf Interval)	λ % Yr	Freq	Svrty	Freq	Svrity	(Numbr Lethal Equivl. Mammal Mean)	Total Numbr	Years	Probablity (%) of Extinction	T_E Time To Extinctn	Mean Populatn K = 200	H_E Gene Diversity
Episodic Severe Poaching 3 (3.0) Rhino Moved	28 14.14	3% (1 per 3-4 years)	40 (2.5 Yr)	3.9	.067 every 15 yr	50% Killed			3.14	3 (3.0)	1	2.6 8.4	31	75 102	93 90
	28 14.14	3%	30 (3.3 Yr)	2	.067 every 15 yr	50% Killed			3.14	3 (3.0)	1	6.4 14.6	28	51 70	92 89
	28 14.14	3%	20 (5 Yr)	-.5	.067 every 15 yr	50% Killed			3.14	3 (3.0)	1	8.0 27.6	32	30 31	91 85

TABLE 16

NORTHERN WHITE RHINO POPULATION SIMULATIONS - GARAMBA POPULATION

EFFECT OF REMOVAL OF BOTH SEXES FOR NEW POPULATION - CONTINUOUS POACHING LOWER LEVEL

POPULATION PARAMETERS					CATASTROPHES				INBRD	REMOVALS FOR TRANSLOCATION		EXPECTED OUTCOMES 25 (Above) & 50 (Below) YEAR PROJECTION			
					POACHING		?								
Description of Scenario Modelled	Initial Number (5-95) Est.)	Adult Death Rate	% ♀♀ Producing Calves/Yr (Intercalf Interval)	λ % Yr	Freq	Svrty	Freq	Svrity	(Numbr Lethal Equivl. Mammal Mean)	Total Numbr	Years	Probablity (%) of Extinction	T_E Time To Extinctn	Mean Populatn K = 200	H_E Gene Diversity
Continuous Poaching At Lower Level 6 (3.3) Rhino Moved	28 14.14	3% (1 per 3-4 years)	40 (2.5 Yr)	3.8	1 i.e., every year	3.5% Killed curntly would be 1/yr.			3.14	6 (3.3)	1	0 0		58 125	94 93
	28 14.14	3%	30 (3.3 Yr)	1.8	1	3.5% Killed			3.14	6 (3.3)	1	0 0		37 51	93 90
	28 14.14	3%	20 (5 Yr)	-.6	1	3.5% Killed			3.14	6 (3.3)	1	.4 8.6	41	21 17	92 85
Continuous Poaching At Lower Level 4 (2.2) Rhino Moved	28 14.14	3% (1 per 3-4 years)	40 (2.5 Yr)	3.8	1 i.e., every year	3.5% Killed curntly would be 1/yr.			3.14	4 (2.2)	1	0 .2	49	61 129	95 93
	28 14.14	3%	30 (3.3 Yr)	1.8	1	3.5% Killed			3.14	4 (2.2)	1	0 .2	33	40 57	94 91
	28 14.14	3%	20 (5 Yr)	-.6	1	3.5% Killed			3.14	4 (2.2)	1	0 6.4	41	23 19	93 86

TABLE 17

NORTHERN WHITE RHINO POPULATION SIMULATIONS - GARAMBA POPULATION

EFFECT OF REMOVAL OF MALES ONLY FOR NEW POPULATION - CONTINUOUS POACHING AT LOWER LEVEL

POPULATION PARAMETERS					CATASTROPHES				INBRD	REMOVALS FOR TRANSLOCATION		EXPECTED OUTCOMES 25 (Above) & 50 (Below) YEAR PROJECTION			
					POACHING		?								
Description of Scenario Modelled	Initial Number (5-95) Est.)	Adult Death Rate	% ♀♀ Producing Calves/Yr (Intercalf Interval)	λ % Yr	Freq	Svrty	Freq	Svrity	(Numbr Lethal Equivl. Mammal Mean)	Total Numbr	Years	Probablity (%) of Extinction	T_E Time To Extinctn	Mean Populatn K = 200	H_E Gene Diversity
Continuous Poaching At Lower Level 3 (3.0) Rhino Moved	28 14.14	3% (1 per 3-4 years)	40 (2.5 Yr)	3.8	1 i.e., every year	3.5% Killed curntly would be 1/yr.			3.14	3 (3.0)	1	0 0		74 155	95 94
	28 14.14	3%	30 (3.3 Yr)	1.8	1	3.5% Killed			3.14	3 (3.0)	1	0 0		47 67	94 92
	28 14.14	3%	20 (5 Yr)	-.6	1	3.5% Killed			3.14	3 (3.0)	1	.2 2	42	26 22	93 88

TABLE 18

NORTHERN WHITE RHINO POPULATION SIMULATIONS - GARAMBA POPULATION

EFFECT REMOVAL OF BOTH SEXES FOR NEW POPULATION - CONTINUOUS POACHING HIGHER LEVEL

POPULATION PARAMETERS					CATASTROPHES				INBRD	REMOVALS FOR TRANSLOCATION		EXPECTED OUTCOMES 25 (Above) & 50 (Below) YEAR PROJECTION			
					POACHING		?								
Description of Scenario Modelled	Initial Number (5-95) Est.)	Adult Death Rate	% ♀♀ Producing Calves/Yr (Intercalf Interval)	λ % Yr	Freq	Svrty	Freq	Svrity	(Numbr Lethal Equivl. Mammal Mean)	Total Numbr	Years	Probablity (%) of Extinction	T_E Time To Extinctn	Mean Populatn K = 200	H_E Gene Diversity
Continuous Poaching At Higher Level 6 (3.3) Rhino Moved	28 14.14	3% (1 per 3-4 years)	40 (2.5 Yr)	1	1 i.e., every year	7% Killed curntly would be 2/yr.			3.14	6 (3.3)	1	1.2 11.2	38	23 21	90 82
	28 14.14	3%	30 (3.3 Yr)	-1.9	1	7% Killed			3.14	6 (3.3)	1	2.6 37.0	39	15 10	88 76
	28 14.14	3%	20 (5 Yr)	-4.3	1	7% Killed			3.14	6 (3.3)	1	13 74	35	9 5	85 70
Continuous Poaching At Higher Level 4 (2.2) Rhino Moved	28 14.14	3% (1 per 3-4 years)	40 (2.5 Yr)	1	1 i.e., every year	7% Killed curntly would be 2/yr.			3.14	4 (2.2)	1	1.6 10.4	37	24 21	91 83
	28 14.14	3%	30 (3.3 Yr)	-1.9	1	7% Killed			3.14	4 (2.2)	1	2.4 32.4	39	16 10	89 78
	28 14.14	3%	20 (5 Yr)	-4.3	1	7% Killed			3.14	4 (2.2)	1	11.4 71.8	35	9 5	89 70

TABLE 19

NORTHERN WHITE RHINO POPULATION SIMULATIONS - GARAMBA POPULATION

EFFECT OF REMOVAL OF MALES ONLY FOR NEW POPULATION - CONTINUOUS POACHING AT HIGHER LEVEL

POPULATION PARAMETERS					CATASTROPHIES				INBRD	REMOVALS FOR TRANSLOCATION		EXPECTED OUTCOMES 25 (Above) & 50 (Below) YEAR PROJECTION			
					POACHING		?								
Description of Scenario Modelled	Initial Number (5-95) Est.)	Adult Death Rate	% ♀♀ Producing Calves/Yr (Intercalf Interval)	λ % Yr	Freq	Svrty	Freq	Svrity	(Numbr Lethal Equivl. Mammal Mean)	Total Numbr	Years	Probablity (%) of Extinction	T_E Time To Extinctn	Mean Populatn K = 200	H_E Gene Diversity
Continuous Poaching At Higher Level 3 (3.0) Rhino Moved	28 14.14	3% (1 per 3-4 years)	40 (2.5 Yr)	1	1 i.e., every year	7% Killed curntly would be 2/yr.			3.14	3 (3.0)	1	.6 5.8	42	29 26	92 85
	28 14.14	3%	30 (3.3 Yr)	-1.9	1	7% Killed			3.14	3 (3.0)	1	1.2 25.0	40	18 12	90 79
	28 14.14	3%	20 (5 Yr)	-4.3	1	7% Killed			3.14	3 (3.0)	1	5.6 65.8	38	11 6	87 73

TABLE 20

NORTHERN WHITE RHINO POPULATION SIMULATIONS - NEW POPULATION

FOUNDERS ENTIRELY FROM CAPTIVE POPULATION

POPULATION PARAMETERS					CATASTROPHES				INBRD	REMOVALS FOR TRANSLOCATION		EXPECTED OUTCOMES 25 (Above) & 50 (Below) YEAR PROJECTION			
					POACHING		?								
Description of Scenario Modelled	Initial Number (5-95) Est.)	Adult Death Rate	% ♀♀ Producing Calves/Yr (Intercalf Interval)	λ % Yr	Freq	Svrty	Freq	Svrity	(Numbr Lethal Equivl. Mammal Mean)	Total Numbr	Years	Probablity (%) of Extinction	T_E Time To Extinctn	Mean Populatn K = 200	H_E Gene Diversity
9 (4.5) Captivity	9 4.5	3% (1 per 3-4 years)	40 (2.5 Yr)	7.5					3.14			0 0		60 184+	91 90
		3%	30 (3.3 Yr)	5.5					3.14			.2 .4	27	35 110	89 88
		3%	20 (5 Yr)	3.0					3.14			.8 3.6	32	17 36	88 84
		5% (1 per 2 yrs)	40 (2.5 Yr)	6.4					3.14			.4 .6	23	47 149	89 88
		5%	30 (3.3 Yr)	4.3					3.14			1.0 3.4	33	27 61	87 85
		5%	20 (5 Yr)	1.7					3.14			4.6 14.6	31	14 19	85 79

TABLE 21

NORTHERN WHITE RHINO POPULATION SIMULATIONS - NEW POPULATION

FOUNDERS ENTIRELY FROM GARAMBA POPULATION

POPULATION PARAMETERS					CATASTROPHES				INBRD	REMOVALS FOR TRANSLOCATION		EXPECTED OUTCOMES 25 (Above) & 50 (Below) YEAR PROJECTION			
					POACHING		?								
Description of Scenario Modelled	Initial Number (5-95) Est.)	Adult Death Rate	% ♀♀ Producing Calves/Yr (Intercalf Interval)	λ % Yr	Freq	Svrty	Freq	Svrity	(Numbr Lethal Equivl. Mammal Mean)	Total Numbr	Years	Probablity (%) of Extinction	T_E Time To Extinctn	Mean Populatn K = 200	H_E Gene Diversity
6 (3.3) Garamba	6 3.3	3% (1 per 3-4 years)	40 (2.5 Yr)	7.5					3.14			.6 .8	14	35 140	86 85
		3%	30 (3.3 Yr)	5.5					3.14			2.6 4.0	24	23 68	84 82
		3%	20 (5 Yr)	3.0					3.14			3.4 11.2	30	13 23	83 77
		5% (1 per 2 yrs)	40 (2.5 Yr)	6.4					3.14			2.2 3.2	19	27 90	84 81
		5%	30 (3.3 Yr)	4.3					3.14			4.6 9.4	26	17 36	82 77
		5%	20 (5 Yr)	1.7					3.14			15.2 35.4	28	10 14	80 73

TABLE 22

NORTHERN WHITE RHINO POPULATION SIMULATIONS - NEW POPULATION

FOUNDERS FROM COMBINATION OF CAPTIVE AND GARAMBA POPULATIONS - COMBINATION 1

POPULATION PARAMETERS					CATASTROPHES				INBRD	REMOVALS FOR TRANSLOCATION		EXPECTED OUTCOMES 25 (Above) & 50 (Below) YEAR PROJECTION			
					POACHING		?								
Description of Scenario Modelled	Initial Number (5-95) Est.)	Adult Death Rate	% ♀♀ Producing Calves/Yr (Intercalf Interval)	λ % Yr	Freq	Svrty	Freq	Svrity	(Numbr Lethal Equivl. Mammal Mean)	Total Numbr	Years	Probablity (%) of Extinction	T_E Time To Extinctn	Mean Populatn K = 200	H_E Gene Diversity
9 (4.5) Captivity 6 (3.3) Garamba	15 7.8	3% (1 per 3-4 years)	40 (2.5 Yr)	7.5					3.14			0 0		101 198+	94 94
		3%	30 (3.3 Yr)	5.5					3.14			0 0		63 173+	94 93
		3%	20 (5 Yr)	3.0					3.14			0 0		34 64	93 91
		5% (1 per 2 yrs)	40 (2.5 Yr)	6.4					3.14			0 0		78 187+	94 93
		5%	30 (3.3 Yr)	4.3					3.14			0 0		48 115	93 91
		5%	20 (5 Yr)	1.7					3.14			.4 3.2	36	25 35	91 87

TABLE 23

NORTHERN WHITE RHINO POPULATION SIMULATIONS - NEW POPULATION

FOUNDERS FROM COMBINATION OF CAPTIVE AND GARAMBA POPULATIONS - COMBINATION 2

POPULATION PARAMETERS					CATASTROPHES				INBRD	REMOVALS FOR TRANSLOCATION		EXPECTED OUTCOMES 25 (Above) & 50 (Below) YEAR PROJECTION			
					POACHING		?								
Description of Scenario Modelled	Initial Number (5-95) Est.)	Adult Death Rate	% ♀♀ Producing Calves/Yr (Intercalf Interval)	λ % Yr	Freq	Svrty	Freq	Svrity	(Numbr Lethal Equivl. Mammal Mean)	Total Numbr	Years	Probablity (%) of Extinction	T_E Time To Extinctn	Mean Populatn K = 200	H_E Gene Diversity
9 (4.5) Captivity 4 (2.2) Garamba	13 6.7	3% (1 per 3-4 years)	40 (2.5 Yr)	7.5	1 i.e., every year	3.5% Killed curntly would be 1/yr.			3.14			0 0		92 196+	94 93
		3%	30 (3.3 Yr)	5.5	1	3.5% Killed			3.14			0 0		55 159	93 92
		3%	20 (5 Yr)	3.0	1	3.5% Killed			3.14			0 .4	32	29 55	91 89
		5% (1 per 2 yrs)	40 (2.5 Yr)	6.4	1	3.5% Killed			3.14			0 0		69 178+	93 92
		5%	30 (3.3 Yr)	4.3	1	3.5% Killed			3.14			.2 1	31	40 100	91 90
		5%	20 (5 Yr)	1.7	1	3.5% Killed			3.14			1.4 5.4	35	20 29	89 85

TABLE 25

NORTHERN WHITE RHINO POPULATION SIMULATIONS - NEW POPULATION

FOUNDERS FROM COMBINATION OF CAPTIVE AND GARAMBA POPULATIONS - COMBINATION 4

POPULATION PARAMETERS					CATASTROPHES				INBRD	REMOVALS FOR TRANSLOCATION		EXPECTED OUTCOMES 25 (Above) & 50 (Below) YEAR PROJECTION			
					POACHING		?								
Description of Scenario Modelled	Initial Number (5-95) Est.)	Adult Death Rate	% ♀♀ Producing Calves/Yr (Intercalf Interval)	λ % Yr	Freq	Svrty	Freq	Svrity	(Numbr Lethal Equivl. Mammal Mean)	Total Numbr	Years	Probablity (%) of Extinction	T_E Time To Extinctn	Mean Populatn K = 200	H_E Gene Diversity
4 (2.2) Captivity 6 (3.3) Garamba	10 5.5	3% (1 per 3-4 years)	40 (2.5 Yr)	7.5					3.14			0 .2	30	68 190	92 91
		3%	30 (3.3 Yr)	5.5					3.14			0 0		42 127	91 89
		3%	20 (5 Yr)	3.0					3.14			0 1	34	24 43	90 86
		5% (1 per 2 yrs)	40 (2.5 Yr)	6.4					3.14			0 .2	50	48 149	90 88
		5%	30 (3.3 Yr)	4.3					3.14			.2 1.4	32	31 73	89 86
		5%	20 (5 Yr)	1.7					3.14			2.2 9.0	33	17 24	87 82

TABLE 24

NORTHERN WHITE RHINO POPULATION SIMULATIONS - NEW POPULATION

FOUNDERS FROM COMBINATION OF CAPTIVE AND GARAMBA POPULATIONS - COMBINATION 3

POPULATION PARAMETERS					CATASTROPHES				INBRD	REMOVALS FOR TRANSLOCATION		EXPECTED OUTCOMES 25 (Above) & 50 (Below) YEAR PROJECTION			
					POACHING		?								
Description of Scenario Modelled	Initial Number (5-95) Est.)	Adult Death Rate	% ♀♀ Producing Calves/Yr (Intercalf Interval)	λ % Yr	Freq	Svrty	Freq	Svrity	(Numbr Lethal Equivl. Mammal Mean)	Total Numbr	Years	Probablity (%) of Extinction	T_E Time To Extinctn	Mean Populatn K = 200	H_E Gene Diversity
9 (4.5) Captivity 3 (3.0) Garamba	12 7.5	3% (1 per 3-4 years)	40 (2.5 Yr)	7.5					3.14			0 0		62 188+	92 92
		3%	30 (3.3 Yr)	5.5					3.14			0 .2	41	38 122	91 90
		3%	20 (5 Yr)	3.0					3.14			.4 2	33	21 38	90 86
		5% (1 per 2 yrs)	40 (2.5 Yr)	6.4					3.14			.4 .4	17	46 147	91 90
		5%	30 (3.3 Yr)	4.3					3.14			1.2 2.4	27	29 70	90 87
		5%	20 (5 Yr)	1.7					3.14			4.8 12.6	31	15 21	87 81

TABLE 26

NORTHERN WHITE RHINO POPULATION SIMULATIONS - NEW POPULATION

FOUNDERS FROM COMBINATION OF CAPTIVE AND GARAMBA POPULATIONS - COMBINATION 5

POPULATION PARAMETERS					CATASTROPHES				INBRD	REMOVALS FOR TRANSLOCATION		EXPECTED OUTCOMES 25 (Above) & 50 (Below) YEAR PROJECTION			
					POACHING		?								
Description of Scenario Modelled	Initial Number (5-95) Est.)	Adult Death Rate	% ♀♀ Producing Calves/Yr (Intercalf Interval)	λ % Yr	Freq	Svrty	Freq	Svrity	(Numbr Lethal Equivl. Mammal Mean)	Total Numbr	Years	Probablity (%) of Extinction	T_E Time To Extinctn	Mean Populatn K = 200	H_E Gene Diversity
4 (2.2) Captivity 4 (2.2) Garamba	8 (4.4)	3% (1 per 3-4 years)	40 (2.5 Yr)	7.5					3.14			0 0		54 175+	90 89
		3%	30 (3.3 Yr)	5.5					3.14			.2 .2	12	34 102	88 87
		3%	20 (5 Yr)	3.0					3.14			.2 4.8	30	18 33	87 82
		5% (1 per 2 yrs)	40 (2.5 Yr)	6.4					3.14			.4 .8	32	39 129	88 86
		5%	30 (3.3 Yr)	4.3					3.14			1.8 3.2	24	25 56	86 83
		5%	20 (5 Yr)	1.7					3.14			5.2 19.4	33	13 18	83 77

TABLE 27

NORTHERN WHITE RHINO POPULATION SIMULATIONS - NEW POPULATION

FOUNDERS FROM COMBINATION OF CAPTIVE AND GARAMBA POPULATIONS - COMBINATION 6

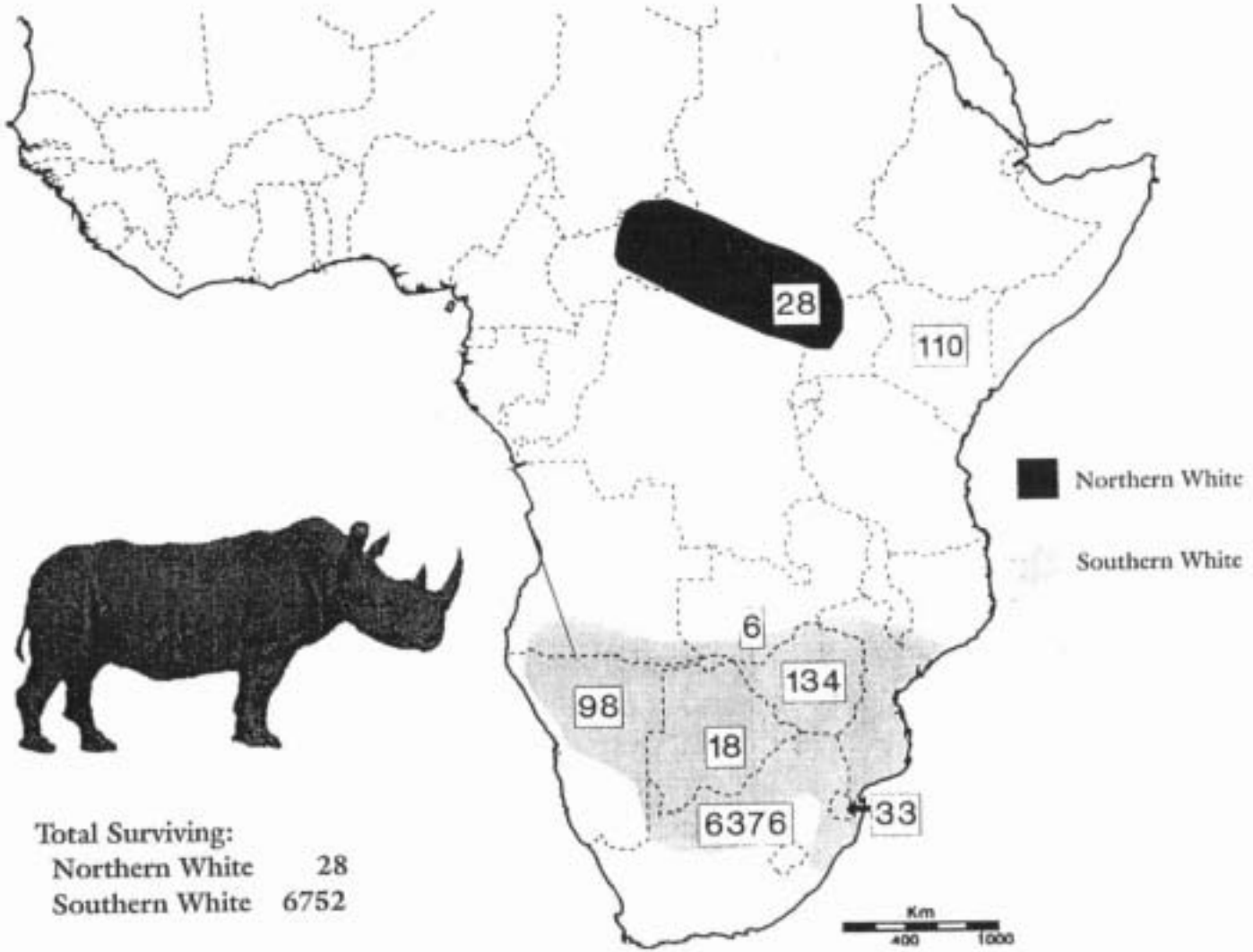
POPULATION PARAMETERS					CATASTROPHES				INBRD	REMOVALS FOR TRANSLOCATION		EXPECTED OUTCOMES 25 (Above) & 50 (Below) YEAR PROJECTION			
					POACHING		?								
Description of Scenario Modelled	Initial Number (5-95) Est.)	Adult Death Rate	% ♀♀ Producing Calves/Yr (Intercalf Interval)	λ % Yr	Freq	Svrty	Freq	Svrity	(Numbr Lethal Equivl. Mammal Mean)	Total Numbr	Years	Probablity (%) of Extinction	T_E Time To Extinctn	Mean Populatn K = 200	H_E Gene Diversity
3 (0.3) Captivity 3 (3.0) Garamba	6 (3.3)	3% (1 per 3-4 years)	40 (2.5 Yr)	7.5					3.14			.8 1	19	36 139	86 85
		3%	30 (3.3 Yr)	5.5					3.14			1.6 2.0	20	23 66	85 82
		3%	20 (5 Yr)	3.0					3.14			5.8 13.6	28	13 22	83 78
		5% (1 per 2 yrs)	40 (2.5 Yr)	6.4					3.14			2.6 3.6	17	27 86	84 81
		5%	30 (3.3 Yr)	4.3					3.14			9.2 14.8	22	17 37	82 78
		5%	20 (5 Yr)	1.7					3.14			15.0 34.2	28	11 15	80 73

10. E. POPULATION SIMULATIONS USING SPARKS/GENES/DEMOG GARAMBA POPULATION OF NORTHERN WHITE RHINO

Since VORTEX does not permit investigation of the effects of removal of specific individuals from Garamba, a "studbook" has been created from the data available on the age-sex structure and the pedigree of this population. It is envisioned that this "studbook" can be used with the captive population management software to better examine the effects of relocation of specific individuals from the Garamba population. These analyses will best be done interactively as the strategy process continues.

WHITE RHINO

Historic Distribution and Current Country Totals



Total Surviving:

Northern White	28
Southern White	6752