FIELD NOTE

Past population dynamics and individual information on possible surviving northern white rhinos in Garamba National Park and surrounding reserves

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Since 1983, the Garamba National Park Project (GNPP) in partnership with the Institut Congolais pour la Conservation de la Nature (ICCN) have been monitoring the northern white rhinos (*Ceratotherium simum cottoni)* of Garamba National Park, Democratic Republic of Congo (DRC) as part of the conservation of the park and ecosystem (fig.1). Individual recognition has been one of the key tools. The current crisis facing this population has been and is being reported elsewhere.

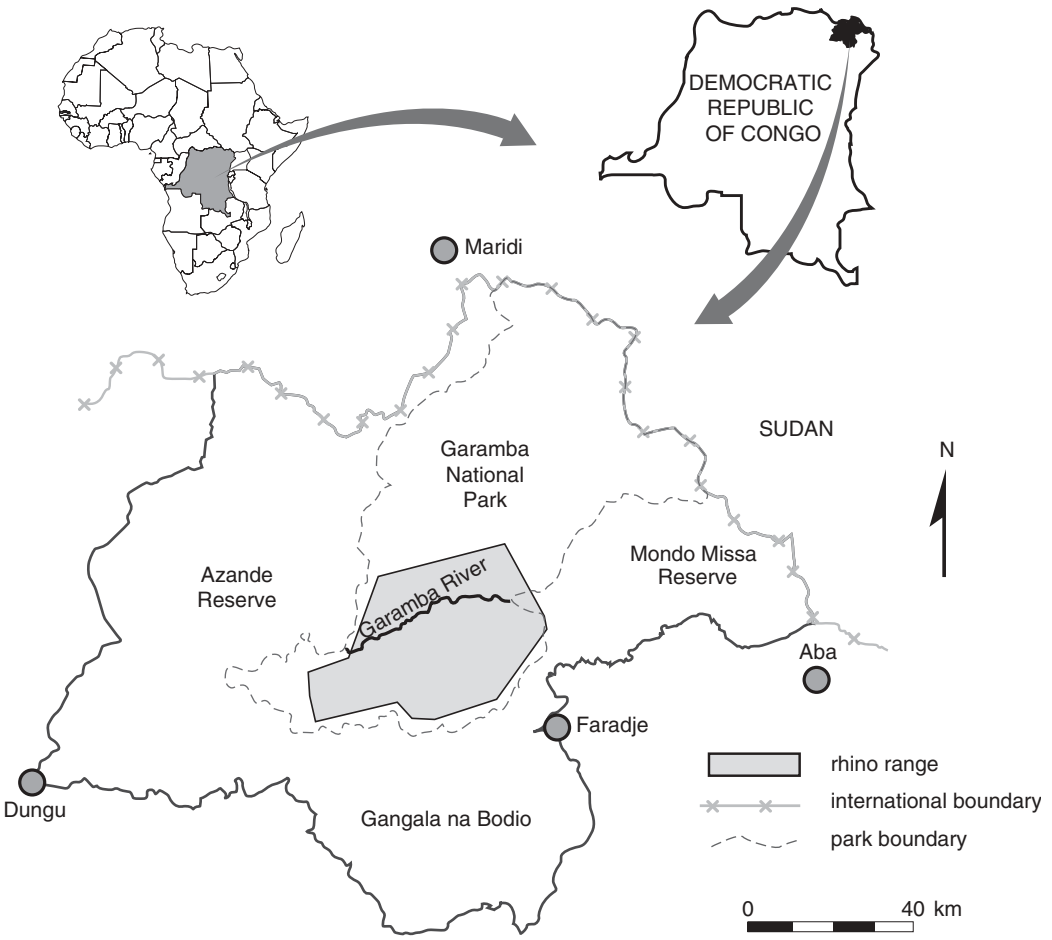
The objective of this note is to summarize rhino population dynamics based on the individuals and their families, to demonstrate the past capacity of the natural population to increase, to outline what is known of individual components of the decline of the population since mid-2003 with the likelihood of individual rhinos that could potentially still exist, and to provide background material for individual identification, population management and conservation at all levels of this now severely reduced population.

Some of this work was done to update the rhino recognition file and to identify possible surviving individuals, provide guidance for a survey carried out in March 2006 through the auspices of the IUCN African Rhino Specialist Group and the African Parks Foundation, and for ongoing monitoring.

Methods

Full rhino monitoring methods are written up in the Garamba National Park Rhino Monitoring Manual (Hillman Smith et al. 1996).

M2 Eleti, an adult male northern white rhino in Garamba National Park, showing nose wrinkles and ear characteristics.



Figur 1. Garamba National Park and sorrounding reserves.

Identification is based on age, sex, horn shapes, ear notches cut on immobilized rhinos, or natural ear marks, tail lengths and hairs, nose wrinkles, associations (such as infant or juvenile with mother). Home ranges and distribution were plotted and observed and once known were additional guidance.

Age and sex: Basic ageing (infant, juvenile, subadult, adult) and sexing formats were provided at a series of training courses for ICCN park staff and researchers over the years. All members of the Monitoring and Research Unit, patrol leaders and secretaries of anti-poaching patrol teams, and guards selected for Equipe Rhino followed the training course. Therefore there were some guards in every patrol who could do basic reporting of rhino observations, as well as the specific rhino-monitoring teams. The guidelines and rhino report forms and maps are carried as part of the patrol data sheets. The diagram of how to determine age for northern white rhinos is given in figure 2. Based initially on age determination of southern white rhinos (Hillman Smith et al. 1986), classification details have been refined over 22 years with long-term observations of known-age animals, body and tooth measurements taken from casts on immobilized animals.

Physical features: Horn shape, earmarks (natural or with cut notches), tail length, hair variations, nose wrinkles, and scars were maintained on individual identification cards and later in an Access database, with drawings and photographs. All rhino observers, from the air or on the ground, use a quick reference guide to all extant rhinos, and a further updated guide was drawn up that new observers used on thhhhhe recent surveys.

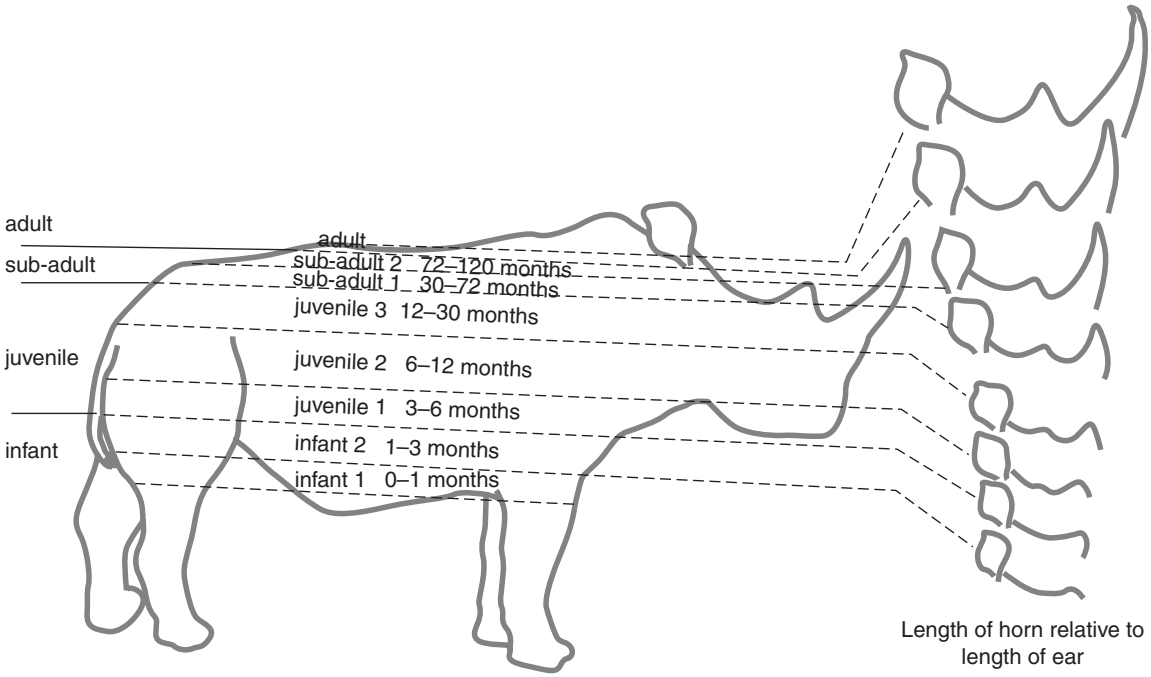


Figure 2. Age determination classification for the northern white rhino.

Association and nomenclature: Each rhino has a name and ID number. The ID number–letter combination is an indicator of family. At the start of the project all males were given the code M plus a number and all females F plus a number. The offspring of any female then take her number plus a successive letter plus F or M depending on sex—for example, F6, Pacque (Easter)'s first known offspring was a daughter, 6aF Œuf de Pacque (Easter Egg). Her most recent one was 6g, which had not yet been sexed. 6aF's first calf was 6aaM, Pascal, and the second 6abF, Chocolat. A theme, in this case Easter, often also runs through the naming. When rhinos are very young they clamp their tails down when disturbed and are difficult to sex from the air or from the ground if the grass is long, and the postfix may come later. The infants and juveniles are identified by association with the mother at first until other features are recognizable. The family trees are available for use in conjunction with DNA analyses in future identification and management of the current reduced and disrupted population.

Observations: All rhino observations by anyone—researcher, guard or visitor—have been recorded in a standard format since 1983. They included date, time, location name, and location coordinates on a Universal Transverse Mercator-compatible kilometre-based grid system that was standard for all monitoring, anti-poaching and aerial surveys at Garamba. It therefore also formed an easy means of communicating between aerial and ground patrols and with the central radio unit and mapping their positions. The total number in the group are given, with age and sex breakdown, habitat and condition based on standardized classifications, activity, associated species, individual identification as far as possible, measurements of tracks and notes. Observations are also classified as original or follow up, by air or ground, and the observer's initials are recorded. On the back of the data sheet are blank outlines of rhino heads for drawing horn shapes, ear marks and nose wrinkles and room to complete other identifying features observed. All observations are all entered into a computer in a spreadsheet format for analysis.

Survey: Focused monitoring and study of the rhinos has been done from ground and air. Aerial work has included regular surveys of the whole southern

sector comprising the rhino range and adjacent areas, done as total block counts using individual recognition and other general reconnaissance and radio tracking when radios were active. All observations of rhinos, signs of illegal activity and areas of long-grass habitat are plotted The intensive block counts, used to guide anti-poaching efforts and to maintain field monitoring, were carried out roughly every two months before war started in 1997 but had to be reduced to one to three times a year during the wars.

Radio telemetry: Between 1993 and 1996, initially with collars and then by pioneering horn transmitters with embedded antennae, radio telemetry was used to treble the rate of observations per time unit over the intensive aerial survey and therefore to make monitoring and protecting the rhinos more efficient. While rhinos were immobilized for radio telemetry, their ears were also notched, providing easy and certain identification of a selection of animals, particularly subadults.

DNA analysis: Material from the notched ears and from an earlier programme of biopsy darting and from rhinos found dead, was analysed to evaluate genetic variability and subspecific differences and to try to assess paternity to further guide conservation and management of this small, vulnerable population. Analysis was and is being carried out by the molecular genetics laboratories at the National Museums of Kenya and Cape Town University.

Results

Before 1984 and the start of the Garamba project, 97% of the population had been lost in eight years due to heavy commercial poaching. In 1984 the rhino population was only 15 individuals comprising five adult females, six adult and one subadult male, and three juveniles. Over a 22-year period 50 births have been recorded. Four died young, one mired in mud, one orphaned and two from unknown causes, but 44 were recruited to the population prior to the recent wave of poaching. It is possible that one to three undetected post-natal losses occurred, considering some long intercalf intervals in females otherwise regularly reproducing.

Figure 3 shows annual recorded births with the annual minimum number of the population and the number of births per year as a percentage of the population of the preceding year (because the current year's population includes the new births). Apart from normal annual fluctuations, there has been no significant trend in rate of reproduction over the 20-year period, with a mean annual rate of reproduction of 9%. Tables 1a and b show individual population histories.

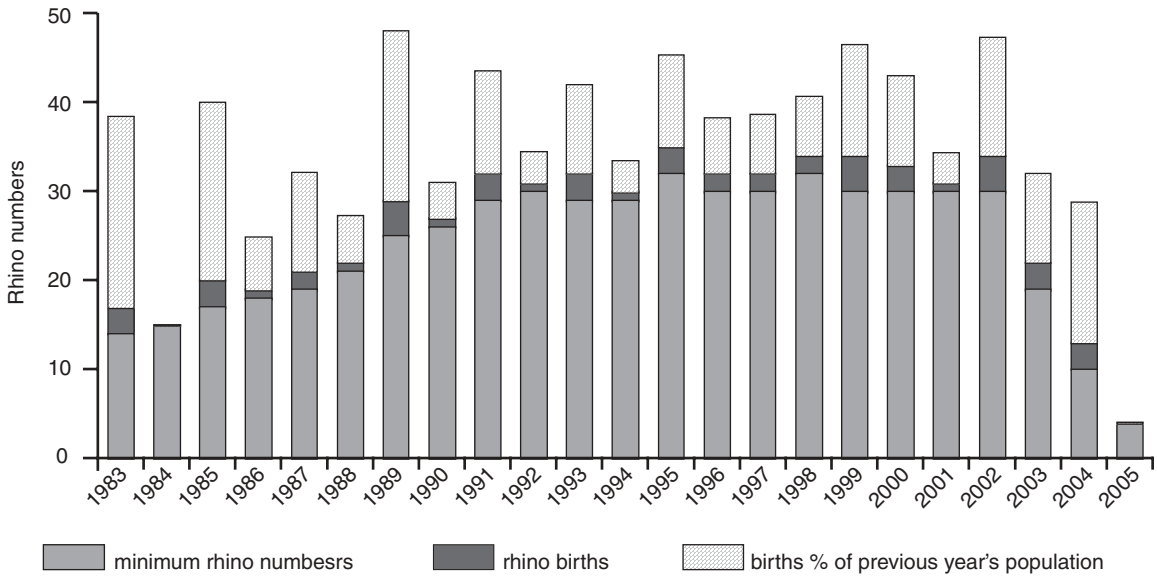


Figure 3. Rhino births between 1983 and 2005 in Garamba National Park.

Table 1a. Garamba National Park: northern white rhino histories (males)

Males	Name	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
M1																									
M2	Eleti																								
M3	Kondo Akatani		9.5.84																						
M4	Bac		27.8.84																						
M5	Bawesi		27.8.84												2.96										
M6	Longuecorne			4.4.86																					
M7	Moitier			3.3.86																					
M9	Notch			23.6.86																			4.04		
1aM	Moke/Ch2? *	b.83														3.97									
4aM	Bolete moke/HE? *	b.83																				Out of territory & disappeared			
5aM	Giningamba			b2.85											?	Not seen again, but could have been Curly Horn who re-appeared									
6bM	Elikya						b6.88																		
1bM	Mpiko **							b3-4.89								Re-named as Curly Horn, but could have been 5aM									
3aaM	Bonne Annee								b12.90																
4e	Sifa										b.01.92														
5cM	Molende							b.8.89																	
3cM	Solo							b.12.89																	
3dM	Mamu									b9.91															
1dM	Almeje											b6.93													
6dM	Willibadi													b.9.95											
4daM	Mbolifue														b.6.96										
6eM	Congo															b8.97									
3gM	Laurent															b12.97									
4baM?	Edi																b2.98								
1fM	Fraise																b3.98								
6fM	Fin de Siecle																	b12.99							
6aaM	Pascal																	b9.99							
6cbM	Sasalia																	b12.99							
5daM	Millenium																		b2-3.00						
	Kenge moke											2.93													

Known life history to last observation or confirmed identification of death

Confirmed death by identification of dead rhino with approximate date

Date at start of line is date of first observation or b.plus date is approximate date of birth

* 1aM and 4aM were readily identified as juveniles by association with mother, until they became independent as subordinate adults. Both were immobilised for radio telemetry and became clearly identified as Channel 2 and Hairy Ears. What was never certain was which was originally 1a and which 4a.

** Mpiko was also identifiable when young, but the male sub-adults disperse and are not seen for periods of time. The young male known as Curly Horn was suspected from his age to possibly be Mpiko, but from horn shape could have been from F5 or F3 familes, i.e potentially Giningamba or Mamu, both of whom were suspected dead due to poaching in their ranges.

Table 1b. Garamba National Park: northern white rhino histories (females)

Females and unsexed		1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
F1	Mama moke	1aM						1bM		1cF		1dM		1eF			1fM								
1cF	Nawango									b 2.91															
1eF	Kasi													b 8.95							1ea				
1ea	Kombolani																				b4-5.02				
F3	Kunalina	3aF		3bF				3cM		3dM		3eF		3fF		3gM			3h		3i				
3aF	Kuni**								3aaM																
3bF	Juillet			b 7.85											3.96Pr										
3eF	Etumba											b 7.93						3eaF		3ebF		3ec			
3eaF	Boboto																	b11.99							
3ebF	Steps																			b11.01					
3ec	November																					b10.04			
3fF	Aligaru													b9.95									3fa		
3fa	Nabema																						b2.04		
3h	Zigba																		b4.00						
3i	Lisungi																				b8.02				
F4	Boletina	4aM		4bF		4cF		4dF		4eM			4f			P11.97									
4bF	Mai			b5.85								Kenge*					4baM								
4cF	Noel					b10.87									4caF			4cbM					4cc		
4caF	Kito														b9.96										
4cc	Espoir																						1.04		
4dF	Minzoto (FlopEar)							b.8.89							4daM				4dbF				4dc		
4dbF	Sanza																		b2.00						
4dc	Etoile																						b1.04		
4f	Nauoloko												b1.94												
F5	Mama Giningamba			5aM		5bF		5cM		5dF				1.95											
5bF	Grizmek					b10.87																			
5dF	Jengatu									b7.91									5daM			5db			
5db	Keba																					b7.03			
F6	Pacque				6aF		6bM			3aaMadopt				6dM		6eM		6fM					6g		
6aF	Oeuf de Pacque				b3.86													6aaM		6abF		6ac		?	
6abF	Chocolat																			b2.02					
6ac	Courage																					b1.04			
6g	Bunny																						b5.04		

Key:

Known life history to last observation or confirmed identification of death

Confirmed dead by identification of dead rhino with approximate date

ID codes within the life line of each female indicates the births of calves. (Male calves e.g 1aM then join the Male Table 3a). Female calves e.g 3bF start their life line below that of mother, with approximate date of birth p.date = confirmed poached with date

* Kenge was a newborn rhino found mired in mud. His mother was not seen for identification, but by elimination could possibly have been 4bF Mai

** 3aF Kuni disappeared and her calf 3aaM appeared to have been adopted by F6

Intercalf intervals of all females throughout the 20-year period averaged 30 months, with means ranging from 24 to 41 months and overall ranges from 21 to 57 months (table 2). The mean intercalf interval of young females with their first few calves was 35 months, with a range of 23 to 49 (table 3). It is not clear whether the longer interval is due to social or physical factors.

When the second generation began reproduction, ages at birth of first calves recorded averaged 8 years 3 months, with a variation from 6 years 4 months to 13 years 6 months. The rhino population doubled in the first 8.5 years of the project, with a 9.7% rate of recruitment calculated at that time (Smith and Smith 1991).

From 1991, increase in the rhino population levelled off at around 30 animals, despite continued reproduction (Hillman Smith et al. 1994). This coincided with the nearby town of Maridi in Sudan being captured and the war in adjacent Sudan beginning to have a greater effect on Garamba. With a porous border, easy access to arms and ammunition, 80,000 refugees in areas adjoining park's buffer reserves, and later the establishment of the Sudanese People's Liberation Army camps on the border, poaching for meat increased in the north of the park and, despite strong counter-action, moved down towards the rhino and elephant sector in the south. The first rhinos known to have been poached were in 1996. The situation was further exacerbated with the civil wars in Zaire (now DRC) itself, with initial losses of elephants, hippos and buffalos, but continued project support and development of financial and diplomatic support from the UN Foundation and UNESCO held rhino and elephant populations stable from 1998 to 2003. Since the rate of reproduction remained stable there must have been more rhino deaths than the war time reduction in ground and aerial monitoring was able to detect.

The extreme downward trend of the population that started in 2003, shown in figure 3, is reported elsewhere (Hillman Smith et al. 2003; Hillman Smith and Ndey 2005). It coincided with the ceasefire in southern Sudan and with changes in the type, distribution and intensity of poaching. The trend was detected by both rhino and law-enforcement monitoring.

Table 2. Intercalf interval (in months) of northern white rhino females in Garamba National Park, 1984–2004

Individuals	F1	F3	3eF	F4	4cF	4dF	F5	5dF	F6	6aF
	23	22		21			32		27	
	29	53		29			22		32	
	26	21		22			23		57	
	31	22		28					23	
		26		24	39	42		41	28	29
		27			49	46			48	22
		23	24							
		28	23							
Average indiv.	27	28	24	25	44	44	26	41	36	26
Range	23–31	21–53	23–24	21–29	39–9	42–46	22–32	41	23–57	22–29
Overall ICI			(*n* = 35)							30
Overall range			(*n* = 35)							21–57
Young females			(*n* = 10)							35

ICI – intercalf interval

Table 3. Age at first calving, northern white rhinos, Garamba National Park, 1984–2004

Individual no. and name	AFC	Mean ICI (m.)
1eF Kasi	6 y 8 m	
3aF Kuni	7 y 3 m	
3eF Etumba	6 y 4 m	24
3fF Aligaru	8 y 5 m	
4bF Mai	7 y 9 m	
4cF Noel	8 y 11 m	44
4dF Minzoto	6 y 10 m	44
5dF Jengatu	8 y 7 m	41
6aF Oeuf de Pacque	13 y 6 m	26
Average	8 y 3 m	35
Range	6 y 4 m – 13 y 6 m	

AFC – age at first calving; ICI – intercalf interval; y – year and m – month

The alarm was raised, and major collaborative efforts were made to counter it and conserve the ecosystem and rhinos. But as reported elsewhere, the minimum number of rhinos detected in surveys decreased and nine rhino carcasses were found in 2004 and a further two in 2005 (Hillman Smith and Ndey 2005) (table 4). Reduction in numbers was due both to deaths and to rhinos crossing the Dungu River and moving out of the park to the wooded Gangala na Bodio Reserve to the south.

Since late 2004 it is believed that there are fewer than 10 northern white rhinos remaining. Successive surveys have found 4, 4 and 2 plus a possible further 2 later as minimum numbers within the park (pers. data; pers. comm. with E. de Merode, IUCN AfRSG and J Tello), but there are almost certainly an additional few within the reserve.

Discussion and conclusions

The initial rate of increase of the population of 9.7% per annum and the overall mean rate of reproduction of 9% over the 22-year period (1983–2004) reported compare favourably with rates of increase of 9.5% found by Owen Smith in a well-protected southern white rhino *(C.s. simum)* population (Owen Smith 1973). The average intercalf interval of 30 months or 2.5 years was also the same. The rate of reproduction was maintained throughout despite disruptions from civil wars and increased poaching. There was no sign of inbreeding depression, and preliminary results of genetic analysis indicated a relatively high variability and a far greater difference between the subspecies of white rhinos than that found between any of the subspecies of black rhinos. (R. Aman pers. comm. 1993; Harley and O'Ryan pers. comm. 1995). Nor was reproduction compromised by low densities, as home ranges were found to be up to 10 times greater than those of southern whites (Smith and Smith 1993). In terms of habitat, behaviour and genetics the northen white rhino population was healthy and reproducing well over the 22-year period and probably has potential to increase again if sufficient animals can be found even on a meta-population scale.

The overriding cause of its recent numerical decline was illegal offtake in a border region of political instability, and easy access to weapons by poachers. Most of the recent illegal exploitation was of elephants, which share the same range, but with lower numbers the proportional loss of the rhinos has been more serious. Protection by all means possible is clearly vital to prevent total extinction.

Table 4. Rhinos found dead in Garamba National Park, 2004–05.

Date found.	Age/sex	Probable ID	Region	Cause and notes	Skull ref.
25 Jan 04	Young adult male 14–20 yr	Elikya 6bM	Willibadi II	Poaching	PNG 22
09 Apr 04	Adult male 25–30 yr	Notch M9; confirmed ID from horns	Willibadi I	Wounded by horsemen poachers and died; horns recovered	PNG 23
13 Apr 04	Adult	Skull not recovered	Willibadi I	Poaching by horsemen; seen from air in water	
07 July 04	Young female adult 7–9 yr	Kito 4caF, Kasi 1eF or Aligaru 3fF	Dinakpio near Willibadi II	Poaching, seen from air and followed up on ground;. lower jaw smashed, horns gone	PNG 24
01 Aug 04	Adult male c. 28 yr	Kondo Akatani M3	Willibadi I	Poaching (bullet in head); marks of head wound seen before death	PNG 25
29 Aug 04	Young adult female 8–9 yr	Kito 4caF, Kasi 1eF or Aligaru 3fF	Willibadi II	Poaching	PNG 26
30 Sep 04	Young adult female 8–11 yr + infant male +- 4 mo	Aligaru 3fF + 3fa	Willibadi II	Poaching	PNG 27 and 28
08 Oct 04	Adult female pregnant	Skull not yet recovered	Source Nakule in the triangle	Poaching	
Feb 05	2 adults	Patrol report skull not recovered	Block 3 near confluence Dungu Willibadi II	Poaching	

Results of the monitoring and previous conservation efforts however, provide positive indications for future increae if protection is sufficient. In addition to physical identification, the use of DNA analysis from dung to help new observers to identify the rhinos is also proposed. Individual relationships and the ongoing analysis of genetic material is therefore of further importance.

Adequate protection and informed management of such a small population should be enhanced by information from previous monitoring. Data presented here and available in more detail can, we hope, contribute to future conservation and management.

Ackowledgements

We of the Garamba Project, are grateful to International Rhino Foundation for having supported the conservation of Garamba National Park and its ecosystem and staff for many years, to the UN Foundation and UNESCO throughout the war, and to WWF, the Frankfurt Zoological Society, and others before that. The support of the Wildlife Conservation Fund by partnering in the monitoring aircraft has been vital. We are very grateful to the Institut Congolais pour la Conservation de la Nature for a long partnership and the opportunity to have lived and worked in Garamba and done our utmost for its conservation. The IUCN African Rhino Specialist Group and the African Parks Foundation have supported conservation efforts and some of the analysis. We thank you all.

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