
The Javan Rhinos, *Rhinoceros sondaicus annamiticus*, of Cat Tien National Park, Vietnam: Current Status and Management Implications

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ABSTRACT

Recent studies into the plight of the Javan rhinoceros in Vietnam (*Rhinoceros sondaicus annamiticus*) are presented in this report. The January 1999 rhino survey in Cat Tien National Park estimates the number of rhinos surviving to be seven or eight. Over recent years their range has severely diminished and is now a mere 6,500 ha. The preliminary findings of an on-going camera-trapping exercise are presented here, including the first-ever pictures made of *Rhinoceros sondaicus annamiticus*. A literature review discusses the past status of the Javan rhino in Vietnam. Management implications include a discussion on improved protection and zoning of the protected area in which the rhinos occur.

RESUMEE

Ce rapport présente des études récentes sur la situation critique du rhinocéros de Java au Vietnam (*Rhinoceros sondaicus annamiticus*). Le recensement des rhinocéros dans le Parc National de Cat Tien en janvier 1999 estime le nombre de survivants à sept ou huit. Leur territoire a été sévèrement diminué au cours des dernières années et ne s'étend plus actuellement que sur 6,500 ha. Nous présentons ici les résultats préliminaires d'une expérience en cours de piégeage par caméra, incluant les premières photographies jamais réalisées du *Rhinoceros sondaicus annamiticus*. La position du rhinocéros de Java au Vietnam dans le passé est discutée dans une recherche bibliographique. Les conséquences pour la gestion comportent une discussion sur l'amélioration de la protection et le zonage des espaces protégés dans lesquels le rhinocéros est présent.

INTRODUCTION

Cat Tien National Park is famous for its Javan rhino population, the only one known on mainland Asia. Apart from this population, one other Javan rhino population is known to exist in Ujong Kulon National Park, Java, Indonesia. The two populations are recognised as being two different subspecies of Javan rhino; *Rhinoceros sondaicus annamiticus* (Desmarest, 1822) in Cat Tien National Park and *Rhinoceros sondaicus sondaicus* in Ujong Kulon National Park. Just seven or eight individuals are believed to survive in the Cat Loc area of Cat Tien National Park

and between 50 and 60 in Ujong Kulon National Park. The Javan rhino is therefore probably the most endangered large mammal in the world.

This paper aims to provide an overview of the past and current status of Javan rhino in Cat Tien National Park, Vietnam. It does so by providing a literature review and by presenting the results of a rhino survey held in January 1999 and an on-going camera trapping exercise. Finally the paper highlights several management implications which seek to ensure the continued survival of *R. s. annamiticus* in Vietnam.

STUDY AREA

Cat Tien National Park is located about 150 km north of Ho Chi Minh City, situated in the plains of the Dong Nai river and just south of Vietnam's central highlands. The Park consists of two sections, each of about 35,000 ha, in the provinces of Dong Nai, Binh Phuoc and Lam Dong (Figure 1). These sections are separated by a zone which is inhabited by people of different ethnicity, who are rapidly opening up large areas of wild lands for farming.

The Park has a variety of habitats: primary and re-growth evergreen tropical lowland rain-forests dominated by Dipterocarpaceae; primary and re-growth semi-evergreen tropical lowland rainforests dominated by *Lagerstroemia* spp.; tropical freshwater wetlands with open lakes and seasonal floodplains containing *Saccharum spontaneum*, *S. arundinaceum* and *Neyraudia arundinacea*; flood forests dominated by *Hydnocarpus anthelmintica* mixed with *Ficus benjamina* and areas severely denuded by warfare but dominated by bamboo and open grasslands. Table 1 provides an overview of the most recent vegetation cover information available for the Park.

Apart from Javan rhinos, the Park hosts a variety of rare and endangered animal species. Orange-necked partridge *Arborophila davidi* is endemic to the Park. Other rare avian species include white-winged wood duck *Cairina scutulata* and black ibis *Pseudibis davisoni*. The Park is known to host large mammals such as Asian elephant *Elephas maximus*, tiger *Panthera tigris* and gaur *Bos gaurus*, albeit in rather low numbers (Polet, in press; Polet and Khanh, 1999). A population of Siamese crocodile *Crocodylus siamensis* is probably extinct (Bembrick and Cannon, 1999).

The section of the Park situated in Dong Nai Province received protected status in 1978 and became known as Nam Cat Tien National Park in 1992. The section of the Park situated in Lam Dong Province became a rhino sanctuary in 1992, known as Cat Loc. Tay Cat Tien in Binh Phuoc Province has been part of a logging concession. In December 1998, these three areas have been integrated administratively and are now known as Cat Tien National Park.

The Javan rhino habitat in Cat Tien National Park

The topography of the area in which the rhinos occur is characterised by many small steep hills ranging between 300 and 600 m above sea level. Soils are alluvial and consist of heavy clay. Numerous streams criss-cross the area and drain into the Dong Nai river.

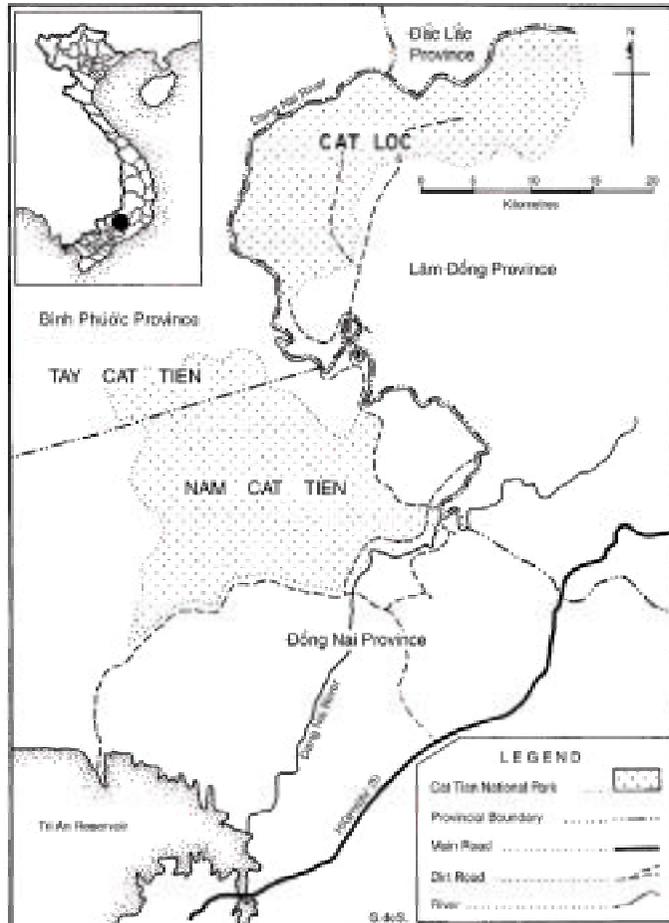
Originally the area in which the rhinos currently occur was tropical lowland semi-deciduous forest, dominated by Dipterocarpaceae and *Lagerstroemia* spp. During the American war, the area was severely sprayed with defoliants (on average of 84 l/ha). Most of the large trees have thus been killed. Although the forest is recovering, the area is mainly covered with bamboo and rattan.

People, park and economy

Cat Tien National Park is situated on the territory of two indigenous ethnic minorities, known as S'Tieng and Chau Ma. In Nam Cat Tien, these shifting cultivators have been sedentarised in a village called Ta Lai on the southern border of the Park. A large number of S'Tieng and Chau Ma still live within the Park in the Cat Loc area. That people live within the National Park is against Vietnam's National Park laws. It is however understandable because in the case of the S'Tieng and Chau Ma, the National Park was declared on their ancestral land. But also a large number of Kinh Vietnamese (the dominant ethnic group in Vietnam) and minority people from the north live in Cat Loc. Most of them came under the New Economic Zone Programme (the Vietnam government's re-settlement programme of the 1980s aiming at reducing population pressure in the Red River delta), before the area was designated a protected area. Polet (in press) estimates a total of about 9,800 people living within the Park, of whom about 5,000 belong to indigenous groups.

It is estimated that 6,100 people live within the Cat Loc sector of the Park, the sector which holds the rhinos (Polet, in press). These are all indigenous ethnic minority people. Two hundred people live within the current rhino range (which consists of about 6,500 ha within the Cat Loc sector).

Figure 1. Location of Cat Tien National Park, Vietnam.



Large areas of forestland have been transformed into cashew nut plantations. Most of the cashew nuts are traded in kind by the ethnic minority people with traders from cities in the vicinity. On several occasions this has led to dependency relations whereby the ethnic minority people remain living under very poor conditions despite the favourable market prices for cashew nuts.

Along Dong Nai, most of the flat land has been converted into rice fields by Kinh Vietnamese and ethnic minority people from the north and middle of Vietnam. These people have also converted the area of one of the most important rhino saltlicks into rice fields.

With the arrival of a cash economy and an increasing pressure on the land due to a large and

rapidly growing human population, the traditional slash-and-burn farming system has been modified whereby instead of leaving the forest to re-generate, cashew nut is being planted. Kinh Vietnamese converted a lot of flat land into paddy fields. This process took place especially within the Cat Loc sector as this area received a protected status relatively late, while parts of it had been designated New Economic Zones and thus the area has more people living within its boundaries.

The combination of having a number of very rare animals within the Park and at the same time a large and growing pressure from, human populations provides potential for a classic human -wildlife conflict. The Cat Tien National Park authorities see themselves faced with a very complex and demand-

Vegetation Types	Total Cat Tien National Park		Sector		
	Area	% of area	Nam Cat Tien	Tay Cat Tien	Cat Loc
Total Natural Area	74,219	100.0	38,202	5,382	30,635
1. Evergreen forest	17,819	24.0	7,844	147	9,828
1.1 Primary evergreen forest	687	0.9	662	25	-
1.2 Logged evergreen forest	17,132	23.1	7,182	122	9,828
2. Semi-evergreen forest	5,097	7.0		5,097	-
3. Bamboo forest	29,805	40.1	10,519	2,692	16,594
4. Mixed forest	14,361	19.3	11,760	529	2,072
5. Plantation	62	0.1	-	62	-
6. Bush/shrub	487	0.6	487	-	-
7. Grasslands	2,388	3.2	1,109	577	702
8. Cultivation/settlement	2,509	3.4	69	1,001	1,439
9. Wetlands/lakes	1,603	2.2	1,287	343	-
10. Other	61	0.1	30	31	-

Source: MOF/WWF, 1994.

ing task. The Park's ecosystem and its many rare and sometimes critically endangered species is designated to be conserved as an example of a relatively intact ecosystem, typical for lowland southern Vietnam. At the same time human populations within and around the Park are trying to improve their poor standards of living, illegally utilising the Park's natural resources in the process.

In order to improve the protection of the Park and to assist the people living around the Park to develop alternative livelihoods, Cat Tien National Park receives substantial technical and financial assistance from the Netherlands government "WWF-Cat Tien National Park Conservation Project", as well as from other donors such as WWF-US and the US Fish and Wildlife Service.

MATERIALS AND METHODS

For this study, a comprehensive review of literature has been carried-out. The result of a rhino survey, carried out by the WWF - Cat Tien National

Park Conservation Project in January 1999, is reported here as well. Lastly, the initial results of an on-going photo-trapping exercise, carried out by the WWF-Cat Tien National Park Conservation Project, are presented here.

Rhino survey

For the rhino survey, standard tracking analysis methods were used consisting of three components:

- establishment of the current range by surveying a wide area for any signs of rhinos,
- track analysis by measuring footprints encountered and making plaster casts in order to identify individual rhinos based on foot measurements and front hoof measurements to estimate the minimum number of rhinos in the area, and
- extrapolation for areas not covered in the track analysis but within the rhino range in order to estimate a maximum number of rhinos in the area.

The survey was carried out over a period of one month by two teams, consisting of six people each. Each team had one person dedicated to take

all measurements in order to avoid errors, which could occur if more than one person was involved in taking the measurements. Geographical coordinates were taken for every measurement. Data were recorded on a standard sheet and included length and width of footprint and length and width of front hoof for every good quality footprint encountered and observations on other signs such as droppings, grazing signs, saltlicks, etc. The total length of investigation lines was around 218 km, with some lines repeated several times. The survey team collected data on wallows (12), dung (6), salt licks (2), footprints (241 of which 137 plaster casts were made) and other signs such as traces of body-rubbing on tree trunks and traces of eaten and broken plants and trees.

The total number of plaster casts used for the analysis was 144 of which 137 casts were made during the survey in January 1999 and 7 casts just prior to the survey in December 1998. Of the 144 casts, 33 could not be analysed because of poor quality; the other 111 were carefully analysed in the laboratory. Also the dimensions of 241 measurements taken in the field were included in the analysis. The width and length of all the footprints and front hooves were recorded.

Based on dimensions of the casts, the dimensions of the field measurements and differences in forms, the plaster casts were divided into groups, each group with the same characteristics in form and size. In this manner individual rhinos were recognised (Dang and Khanh, 1999). The plaster casts and other raw data are kept at the headquarters of Cat Tien National Park.

The field and analysis methods used for this survey were similar to the ones used during the April 1998 census carried out under the auspices of the International Rhino Foundation and the IUCN/SSC/Asian Rhino Specialist Group (Sung et al., 1998). Methodologies used during both these surveys follow the procedures developed by van Strien (1986) in Gunung Leuser National Park, Sumatra, Indonesia during his work on the Sumatran rhino. The April 1998 survey was carried out during the dry season while the January 1999 survey was conducted just after the rainy season.

Automatic camera trapping

The two rhino surveys provided a detailed understanding of the locations within their range where the rhinos come frequently. This information combined with suggestions from local people was used to install ten automatic photo camera sets in the area. The sets are made by Trail Master, a company based in the US.

One set consists of an infrared transmitter, an infrared receiver and a modified compact camera. Whenever the infrared beam is interrupted, the receiver gives a signal to the camera, which is then triggered. Sensitivity of the receiver and the interval time between pictures can be adjusted. Sensitivity is measured in pulses of 0.05 seconds each. The receiver records every event in which the infrared beam is interrupted, even if the interruption is of less duration than the set sensitivity. Therefore, the number of pictures taken is usually lower than the number of events recorded. As falling

Table 2. Basic settings of infrared cameras in Cat Tien National Park.

Item	Setting
Height above ground of transmitter / receiver	approximately 75 cm
Sensitivity of receiver	5 - 7 pulse (= 0.25 - 0.35 seconds)
Interval time between pictures	6 seconds
Film	Fuji Color 200 ASA 24 exposures
Time between change of films	12-15 days
Time between change of batteries	1 month

leaves, extremely big raindrops and insects attracted by the infrared transmitter can also trigger the camera, not all pictures taken have the targeted species on them. Table 2 provides some of the basic settings of the cameras used in Cat Tien National Park.

For every camera the following information is kept on record: geographical location, dates in the field for every location, dates of change of film and batteries, dates and times of pictures taken, dates and times of events and contents of pictures.

RESULTS OF THE JANUARY 1999 RHINO SURVEY

Number of rhinos

The results of the analysis of dimensions and forms of plaster casts and field measurements are summarised in Table 3. Here it is noted that in general that the widths of the feet measured from casts and in the field are comparable, but the lengths of

the feet measured in the field are generally one cm larger than those measured from casts.

The analysis of differences and dimensions and the form of plaster casts made of full prints and front hooves, suggests that there are six individual rhinos.

However, the analysis and comparison of the dimensions of 241 footprint sizes measured in the field shows that the range of variation is rather large. From 157 mm to 240 mm wide, and 187 mm to 258 mm long. The smallest footprint is 157 mm wide and 197 mm long, and the largest footprint is 240 mm wide and 248 mm long. It is concluded that these are the footprints of many different individuals. 90% (217 measurements) of the footprints' widths are within the range from 176 mm to 215 mm. There are 19 footprints shorter than 176 mm and five wider than 215 mm.

Among the footprints which are wider than 216 mm, there are three particularly large, of which measurements were taken at three different

Characteristics	Foot plaster casts N = 111		Footprints N = 241		Front hoof plaster casts	
	Width	Length [mm]	Width	Length [mm]	Width	Length [mm]
Rhino 1 (n=21) Front hoof regularly round, wide, high	191.2	217.9	191.1	228.3	106.0	46.9
Rhino 2 (n=19) Front hoof regularly round, wide	202.1	222.9	195.8	234.7	111.9	33.7
Rhino 3 (n=10) Front hoof slanting, wide, high	196.6	219.7	194.6	232.0	107.6	47.4
Rhino 4 (n=29) Front hoof regularly round, low, narrow	185.8	220.8	190.0	228.9	101.1	33.4
Rhino 5 (n=17) Front hoof slanting on the right, high, narrow, hoof rim sharp	187.0	207.4	190.0	218.6	93.4	47.1
Rhino 6 (n=15) Front hoof slanting on the left, high, narrow, hoof rim sharp	191.1	210.1	187.5	218.5	96.4	44.4

locations. There is also a very large plaster cast of 135 mm wide and 246 mm long. All the other casts are less than 120 mm wide. Obviously, this is the footprint of a rhino different from the six rhinos that were recognised above. Based on the above analysis, the minimum number of rhinos in Cat Tien National Park is estimated to be seven.

Besides these seven individuals, there are a number of footprints of which the widths are beyond the above seven rhinos' range of dimensions. In addition, in the process of investigation there were many footprints recognised at different locations, but their plaster casts could not be made because they were not clear. There were also a number of locations in which there might be rhinos' footprints but the survey team could not reach them despite the fact that this survey has been the most intensive one ever. It is possible that several rhinos were not counted in this survey. Therefore, the maximum number of rhinos in Cat Tien National Park is estimated to be at least eight.

Population structure

Of special interest was the discovery of a tree with many cuts on the bark, which might be inflicted either by a rhino's horn or by a rhino's incisors. If it could be established that these marks were caused by the horn of a rhino, then that would be strong evidence that an adult male is present in the population.

Based on survey results, the rhino population of Cat Tien National Park is believed to include young individuals (footprints less than 170 mm), adult individuals (footprints over 170 mm), probably male individuals (very large footprint of 230 mm and the goring traces against tree-trunks), and female individuals (because there are young individuals). It should be stressed that these conclusions are based on deductions from a comprehensive set of plaster casts and field measurements of rhino footprints only and need to be confirmed by more direct observations. Also obtaining important information such as the exact number of male, female and young individuals and whether there are individuals at the reproductive stage of their lifecycle (i.e. age structure and sex structure of the population) can only be achieved by direct or indirect observation of individuals.

Based on the 1999 rhino survey the following conclusions can be drawn:

- The rhino population in Cat Tien National Park is estimated to include minimally seven and maximally eight individuals.
- The rhino population in Cat Tien National Park is confined to an area of 6,500 ha in the Cat Loc sector of the Park.
- The rhino population in Cat Tien National Park is believed to include sub-adult, adult male and adult female individuals.
- Important information on sex and age structure of the population can only be obtained through more direct observations of the rhinos.

Preliminary results of the on-going camera trapping exercise

It is with the last observation in mind that the WWF-Cat Tien National Park Conservation Project decided to execute a camera trapping exercise in the Park. It is hoped that enough pictures of rhinos can be taken so that individuals can be recognised and related to footprint sizes and shapes. Thus critically important information on the population's sex and age structure might be obtained.

Ten cameras were installed at ten different locations within the rhino range of 6,500 ha in the week of 26 April to 2 May 1999. Within two weeks the first pictures of rhinos were taken. These are believed to be the first-ever pictures taken from life of *R. s. annamiticus*. Having these pictures assists scientists to make a step ahead in learning more about this secretive animal. The seven pictures taken so far are depicted on pages 42 and 43. They originate from three different locations and the time at which the pictures were taken indicate that the animals are most active during the night.

Photo 1 shows a rhino (rhino 1) where a height-marker is visible behind the animal, just in front of its ears. The height of the marker is one meter (32 mm on the picture, about 40 mm at rhino's shoulder when accounted for perspective). The height at the shoulder of this individual is estimated to be 130 cm (52 mm on the picture/40 mm) which is slightly larger than the estimate presented (110-120 cm) by Sung et al. (1998).

Sung et al. (1998) estimate that the *R. s. annamiticus* is about 75 to 80% of the size of a *R. s. sondaicus*. They base this estimate on the ratio of the width of the hind feet measured in Cat Loc (20–23 cm) versus those recorded in Ujung Kulon (25–28 cm). Using this relation in size and estimating the weight of a *R. s. sondaicus* to be 1,600 kg, it may be estimated that a *R. s. annamiticus* weighs about 650 to 800 kg ($1,600 \text{ kg} \times 0.75^3$ to 0.8^3).

DISCUSSION

The small size of the footprints from Cat Loc is more in accordance with the size of footprints of Sumatran rhinos (*Dicerorhinus sumatraensis*) or with sub-adult *R. s. sondaicus* (Sung et al., 1998). Since all footprints from Cat Loc are between 20 and 23 cm in width, it would be hard to conclude that the Cat Loc population consists only of sub-adults. From the pictures presented in this article it is beyond doubt that the Cat Loc rhinos are Javan and not Sumatran rhinos. Sung et al. (1998) argue that the poor quality of the habitat in Cat Loc may have contributed to the smallness of *R. s. annamiticus* and that the Ujung Kulon and Cat Loc populations belong to clearly distinct gene pools. To stress this point, they also suggest for *R. s. annamiticus* the vernacular name “Vietnamese rhino” instead of using the term “Javan rhino” in Vietnam.

Looking at the locations, dates and times that the pictures were taken, combined with the fact that adult Javan rhinos are generally regarded as solitary animals, an attempt can be made to deduct whether the pictures are all of the same or of different individuals. The rhinos on photos 1 and 2, 3 and 4, 6 and 7 are almost certainly of the same individual (each pair of pictures has been taken at the same place and very shortly after each other). Hence it is deducted that all pictures are of at most four different individuals (including the possibility that all pictures are of the same individual).

Referring to camera trapping of Javan rhinos in Ujung Kulon, Griffiths (1992) describes eight parameters with which individual rhinos could be recognised: size, horn shape, eye-wrinkles, neck folds, skin pores, scars, neck plate profile and cheek profile.

The size of the animals in the pictures where a

height marker is visible, is roughly the same. Although differences in perspective make estimates difficult, the rhino in the wallow also seems to be about the size as the others. It is clear that on the basis of the available pictures one cannot differentiate individuals by their size.

The shape of the horn of rhino 5, 6 and 7 looks rather similar; not sharp but somewhat flattened on the top. The shape of the horn of rhino 1, 2, 3 and 4 is more pointed. Although this characteristic could indicate that the available pictures belong to two individual rhinos, evidence seems to be too crude to build upon.

The eye-wrinkles of rhino 5, 6 and 7 look more oval than the others, which seem to be more round. Using this characteristic, one could again argue there are two different individuals on the picture.

The neck folds, neck plate profiles and cheek profile look in general similar. Using this characteristic seems unworkable because differences in position of the head relative to the body, differences in pose and differences in positioning of the camera result in differences in appearance of details in the folds. Patterns in skin pores cannot be recognised clearly in these pictures. From the limited part of the body visible and the mud on the animals, no obvious marks or wounds are visible.

The sex of the animals in the pictures cannot be seen and there are no calves who usually join their mothers.

Griffiths (1992) recognising 31 individual Javan rhinos in Ujung Kulon, 60% of which the sex was known, notes that all individuals confirmed to be male have a horn, while all individuals confirmed to be female have no horn. Amman (1985) concludes that female Javan rhinos in Ujung Kulon have at most a small “hump” and exceptionally a “small horn”. Schenkel and Schenkel-Hulliger (in Amman, 1985), however, observed that all the rhinos they saw in Ujung Kulon had a distinctive horn and assumed that at least some of them must have been female. Whether or not female Javan rhinos from Ujung Kulon have a small horn or a hump remains unclear. The horn in the pictures of the rhinos from Cat Tien National Park are not large but seem to be too large to be, subjectively, classified as “hump” or “small horn”.

Photo credit: WWF-Canon/Mike Baltzer/CTNPCCP



Photo 1. First-ever known picture of Javan rhino in Cat Tien National Park, Vietnam (location A, May 11, 1999, 22:54).

Photo credit: WWF-Canon/Mike Baltzer/CTNPCCP



Photo 2. Full size Javan rhino in Cat Tien National Park (location A, May 11, 1999, 22:54).

Photo credit: WWF-Canon/Mike Baltzer/CTNPCCP



Photo 3. Javan rhino in wallow in Cat Tien National Park (location B, May 17 1999 04:00).

Photo credit: WWF-Canon/Mike Baltzer/CTNPCCP



Photo 4. Javan rhino in wallow in Cat Tien National Park (location B, May 17, 1999, 04:00).

Photo credit: WWF-Canon/Mike Baltzer/CTNPCCP



Photo 5. Head of Javan rhino in Cat Tien National Park (location C, May 19, 1999, 3:21).

Photo 7. Javan rhino in Cat Tien National Park (location C, May 25, 1999, 19:37).

Photo credit: WWF-Canon/CTNPCCP



Photo 6. Javan rhino in Cat Tien National Park (location C, May 25, 1999, 19:37).

Photo credit: WWF-Canon/CTNPCCP



The rhino on Photo 4 (rhino 4) has its mouth wide open. A large incisor in the lower jaw is clearly visible. Van Strien (pers. comm.) believes that having large incisors is typical for male Javan rhinos.

Based on the above the following tentative conclusions can be drawn:

- the pictures confirm that the Cat Loc rhino population consists of Javan rhinos and not Sumatran,
- the Cat Tien National Park rhinos are most active during the night,
- the pictures are of 1, 2, 3 or 4 different individuals,
- all pictures are of adult rhinos,
- at least rhino 1 and probably rhino 3 and 4 are males,
- it is unlikely that there is a female individual on any of the pictures,
- the pictures confirm that *R.s. annamiticus* is between 75 and 80% of the size of *R.s. sondaicus*, and
- *R.s. annamiticus* is between 110 and 130 cm high at the shoulder and weighs between 650 and 800 kg.

Perhaps, at this stage of the exercise, it is more important to conclude that it requires large numbers of pictures and detailed analysis to be able to recognise individual Javan rhinos using camera traps, if possible at all. Nevertheless, any piece of information is welcome in getting to know this elusive animal better.

Current status of rhinos in Cat Tien National Park

With an estimated population of seven or eight individuals, the future of the *R. s. annamiticus* looks grim. It is probably the most endangered large mammal in the world. Over the years the population has steadily declined and its range has become progressively limited, nowadays to a meagre 6,500 ha of heavily denuded habitat. Apart from these bare facts, hardly anything else is known about this population. The pictures recently taken just confirm its existence, which was known from footprints and other signs and reports of sightings of local people. Sizes of footprints and some of the pictures indicate that the population contains an adult male.

It is, however, too early to conclude that the rhinos of Cat Tien National Park have no future. First of all, not enough is known (e.g. sex and age structure) about this population to justify such a conclu-

sion. Secondly, Santiapillai et al. (1993) discuss the danger of loss of genetic diversity in such a small population through inbreeding depression. They conclude that inbreeding depression may cause a loss in fitness initially but that viability of the population usually returns.

After the Vietnam government declared the Cat Loc area a protected area after the poaching incident in 1988, no further rhino poaching incidents have been reported. The general awareness about the animal's protected status is well spread amongst local communities. However, the possibility of illegal hunting cannot be discounted whereby the main threat could come from organised outside poaching groups. Of a more immediate threat to the future existence of Javan rhinos in Vietnam is the continued conversion of forestland into farmland, also taking place within the protected area of Cat Loc.

Past and present status of Javan rhinos in Vietnam

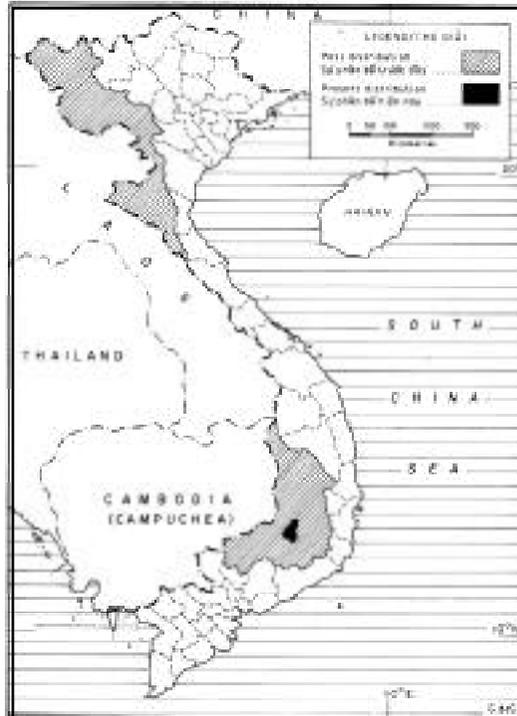
In the past, Javan rhinos were spread over a large area in South East Asia (Figure 2). They were to be found in India, Bhutan, Bangladesh, China, Myanmar, Thailand, Laos, Cambodia, Vietnam, Malaysia and Indonesia (Sumatra and Java). Reports of local people and explorers indicate that the animals were quite numerous during the late 19th and early 20th century. The sub-species *R. s. annamiticus* was found in Vietnam, Laos, Cambodia and the eastern parts of Thailand (Foose and van Strien, 1997).

Old Vietnamese and French reports indicate that the Javan rhino was once common in Vietnam. Early this century the Javan rhino was to be found in the north-western and south-western parts of Vietnam (see Figure 2).

In the 1960s it was feared that the Javan Rhino had become extinct in Vietnam and thus on mainland Asia. In 1969 van Peenen wrote: "*at present there probably are no living members [of Javan rhinos] in South Vietnam, although as recently as the 1920s rhinoceroses were hunted not far from Saigon*" (in Schaller et al., 1990).

In 1988 a hunter shot a female rhino near the Dong Nai River in Cat Tien District. Rhinos were a protected species by Vietnamese law already at

Figure 2. Past and present distribution of the Javan rhino *Rhinoceros sondaicus annamiticus* in Vietnam. (Source: modified after Santiapillai et al., 1993).



that time and thus the hunter was arrested after he tried to sell the horn and skin on the market (Schaller et al., 1990). This incident renewed the attention of the Vietnamese and international scientific and conservation communities for the rhinos of Vietnam. Moreover, the incident proved that rhinos were still surviving in Vietnam.

This incident has also been the last documented poaching incident. Whether more rhinos have been lost due to poaching after 1988 is not certain but unlikely when taking into consideration the effective intelligence network of local police and the Cat Tien National Park. A poaching incident would have been difficult to keep hidden from authorities. However, Haryono et al. (1993) report that one rhino was killed in Song Be province in 1991 and two rhino horns were offered for sale in Ho Chi Minh City in 1992. The data on which this report was made is, however, unclear. Also, authorities cannot confirm these incidents; it seems there are no official documents describing these incidents.

A number of publications in the early 1990s

(Schaller et al., 1990; Haryono et al., 1993; Santiapillai et al., 1993) report on different field investigations on the plight of the Javan rhino in Vietnam. From these investigations it became clear that local people had seen rhinos on different occasions and in different places in southern Vietnam over the past decades. But the last observation of rhino in northern Vietnam was from 1964 and the species is considered extinct in that part of the country.

Schaller et al. (1990) provide an overview of rhino sightings and killings during the late 1970s and 1980s. These are all from the Dong Nai river area, where Dong Nai, Lam Dong, Song Be (now divided in Song Be and Binh Phuoc) and Dac Lac province border one another.

Santiapillai et al. (1993) report tracks only in Lam Dong province and an animal which crossed the river into Song Be province. By that time the rhinos of Dong Nai province may have permanently retreated into Lam Dong province, ranging throughout the 35,000 ha Cat Loc area.

Recent field investigations (Sung et al., 1998; Dang and Khanh, 1999) confirm that Javan rhinos

Table 4. Recent numbers of Javan rhinos in Cat Tien National Park.

Year	Minimum estimate	Maximum estimate	Source
1989	10	15	Schaller et al., 1990
1991	8	12	Santiapillai et al., 1993
1993	7	9	Haryono et al., unpubl.
1998	5	7	Sung et al., unpubl.
1999	7	8	Dang and Khanh, unpubl.

in Vietnam only remain in the Cat Loc area but that its range has been reduced to a mere 6,500 ha.

The number of rhinos in Vietnam has been falling steadily over recent years. The most recent estimate (Dang and Khanh, 1999) is that there are just seven or eight animals surviving (Table 4).

Based on the literature review, the following conclusions can be drawn:

- The number of Javan rhinos in Vietnam is slowly but steadily diminishing.
- The range of Javan rhinos in Vietnam has progressively been declining.
- The most critical threat to the future survival of Javan rhinos in Vietnam is the continued conversion of forestland into agricultural land.
- Poaching seems to have been gradually brought under control by the Vietnamese authorities.

CONCLUSION

In order to safeguard the future existence of the Javan rhino in Vietnam, many activities have to be deployed and basically at the same time. These activities are as follows and a number of them are being worked upon by the government of Vietnam and various donors (see Introduction).

Improved protection

The first and foremost requirement to safeguard this population is to ensure that potential poachers do not get a chance and that the current range is free from any human intervention. After the integration of Cat Loc into Cat Tien National Park, the Park

authorities deployed 25 additional forest guards to Cat Loc to assist the seven existing forest guards in the area. Much increased patrolling of the area resulted in numerous cases in which people cutting trees, hunting and a complete illegal sawmill were involved. The more active presence of the Park authorities understandably causes unrest amongst some people. The people living within the protected area would especially like to see the question as to whether or not they need to be resettled resolved soon.

Two new guard posts have been built and equipped by the CTNPPC, which also has provided means of transportation and allowances. WWFUS funded a training course on patrolling and protection techniques and provided field gear and allowances for forest guards organised in five teams. The USFWS funded an information campaign under which materials will be printed targeting different audiences such as decision-makers and children.

Cat Tien National Park authorities have a good relation with the provinces, districts and communes which border the National Park and collaborate closely with them. Dong Nai province especially has provided substantial support to the National Park. All government levels not only have shown their support to forest protection activities in the Park but also have assisted the Park actively with conservation education and have encouraged its residents to participate in active environmental protection and management.

A large World Bank assisted project is scheduled to start its implementation phase in September 1999 in the buffer zone of Cat Tien National Park and will build upon the experience gained by the various governmental bodies. It seeks to develop infrastructure and alternative livelihood sources for the people in the buffer zone with an aim to reduce the dependence of these people on the natural resources within the protected area.

Protected area zoning

The case of Cat Loc shows that conserving a highly endangered species and economic development of

local communities do not go together very well. Recent history shows how rapidly poorly endowed people seeking economic security by converting forestland into cashew nut plantations have pushed the last surviving rhinos into a fast diminishing area.

In order to find and agree on a suitable balance between economic development and conservation, it has been proposed to execute a zoning exercise. Various levels in the government of Vietnam have welcomed this idea. This exercise will define which areas will have to be strictly protected and in which areas a partnership approach between the Park and local communities could be established. A clear demarcation of the Cat Loc boundaries and possible future sub-boundaries of multiple-use zones is urgently required. If deemed necessary, the exercise could indicate the need to resettle some local communities currently living in the most ecologically sensitive areas. If that is the case, an intensive consultation process with the communities involved will be started during the preparation of the resettlement action plan and its implementation. In this manner the incorporation of these community aspirations and ideas will be best guaranteed.

Officials in the National Park and Lam Dong province are well aware of the fact that the current rhino range (6,500 ha) is too small to maintain a viable rhino population. The inhabited area between Cat Loc and Nam Cat Tien forms an obstacle for the rhinos to re-enter their previous range within Dong Nai province. Therefore the establishment of a corridor between the Nam Cat Tien and the Cat Loc sectors of the park is of utmost importance. Lam Dong province officials support plans to implement activities which seek to re-arrange people living within the protected area and assist them in seeking stable lifestyles in order to ensure that more area is available to the rhinos.

Further Research and Monitoring

A better knowledge of the rhino population's sex and age distribution is urgently required because such information has a bearing on concrete management activities. The camera trapping exercise will therefore be continued. Rhino monitoring surveys using the footprint methodology are foreseen for 2001 and 2003.

In the near future a DNA analysis study will start, funded by the USFWS. Rhino dung will be collected and analysed for traces of intestinal DNA by the Columbia University in the USA. It will be extremely difficult to find fresh rhino dung in the rugged terrain of Cat Loc and therefore data collection will be of rather an opportunistic nature. Nevertheless it is hoped that more insight will be gained on the sex structure of the population. This exercise is led and co-ordinated by WWF-Indonesia, which executes a similar survey amongst the rhinos of Ujong Kulon.

Habitat improvement

Currently the CTNP/CP is executing an assessment of the food availability for rhinos. First of all an inventory is being made of the food plants as there is little known on this subject while the plant species in Ujong Kulon (Amman, 1985) differ considerably from the ones in Cat Loc and can thus not be taken as guidance. The next step will be to make some trials with habitat manipulation and improvement and monitor the rhino's response. If these trials look promising, habitat improvement on a larger scale could be implemented.

Translocation

Some specialists have suggested capturing the rhinos from Cat Loc and moving them to the Nam Car Tien section of the Park where the habitat seems better and security is better organised and there is no issue of conversion of forestland into farmland. Also, the Action Plan for the Survival of the Vietnamese rhino (1998/9) foresees translocation of these rhinos. The Plan states this translocation should be a rescue operation in case protection in Cat Loc has not improved by the year 2000. Ideally rhino numbers should increase. Capturing the rhinos right now in this difficult-to-access terrain is likely to be extremely difficult and expensive. In addition, losing just one rhino in the process will be a disaster for the population.

Therefore the short-term strategy should be to ensure the survival of the rhinos in Cat Loc so that the population can start growing. Whenever a relatively large and stable number (e.g. 15) of rhinos

exists in Cat Loc, some of them should be captured and translocated to Nam Cat Tien. This will have to be done because the protected area of Cat Loc (in total 35,000 ha) is too small to keep more than about 35 rhinos. In order to maintain a stable number of rhinos, sooner or later some rhinos will have to be translocated elsewhere. One could only work towards this goal and hope that the plight of the rhinos in Cat Tien National Park will improve in such a way that translocation of rhinos becomes necessary.

REFERENCES

- Action Plan 1998/1999 for the Survival of the Vietnamese rhino in Cat Tien - Cat Loc National Park, Vietnam (unpubl.) Report under the auspices of the International Rhino Foundation and the US-Fish and Wildlife Service, Hanoi, Vietnam, 1998.
- Amman, H. (unpubl.) Contributions to the Ecology and Sociology of the Javan Rhinoceros (*Rhinoceros sondaicus* Desm.) Inaugural dissertation, University of Basel, Switzerland, 1985.
- Bembrick, Je and Cannon, Ze (unpubl.) A Report on the Siamese Crocodile, *Crocodylus siamensis*, in Car Tien National Park Technical Report No. 1 to WWF - Cat Tien National Park Conservation Project, Vietnam, 1999.
- Dang, N.X. and Khanh, P.H. (unpubl.) The 1999 Survey of Javan Rhinoceros, *Rhinoceros sondaicus annamiticus*, in Cat Tien National Park, Vietnam Technical report No. 3 to WWF - Cat Tien National Park Conservation Project, Vietnam, 1999.
- Foose, T.J. and van Strien, N. (Eds.) (1997) *Asian Rhinos - Status Survey and Conservation Action Plan*. IUCN, Gland, Switzerland.
- Griffiths, M. (unpubl.) Javan Rhino Census January 1991 through August 1992 Progress Report to WWF, Indonesia, 1992.
- Haryono, Me, Sugarjito, J., Giao, P.M., van Dung, V. and Dang, N.X. (unpubl.) Report of Javan Rhino (*Rhinoceros sondaicus*) Survey in Vietnam Technical report to WWF, Hanoi, Vietnam, 1993.
- Ministry of Forestry/World Wide Fund for Nature (unpubl.) Management Plan and Proposal for Implementation of the Cat Tien National Park, Mimeo Hanoi, Vietnam, 1994.
- Polet, G. (in press) Partnership in Protected Area Management; the case of Cat Tien National Park - Southern Vietnam, Centre for Environmental Science, Leiden University, The Netherlands.
- Polet, G. and Khanh, P.H. (unpubl.) The List of Birds of Cat Tien National Park, Ho Chi Minh City, Vietnam, 1999.
- Santiapillai, C., Giao, P.M. and van Dung, V. (1993) Conservation and Management of Javan Rhino (*Rhinoceros sondaicus annamiticus*) in Vietnam. *Tiger Paper* 20 (4).
- Schaller, G.B., Dang, N.X., Thuy, L.D. and Son, V.T. (1990) Javan Rhinoceros in Vietnam. *Oryx* 24 (2).
- Strien, N.J. van (1986) The Sumatran Rhinoceros *Dicerorhinus sumatrensis* (Fischer, 1814) in the Gunung Leuser National Park, Sumatra, Indonesia. Its Distribution, Ecology and Conservation. *Mammalia Depicta* 12, 200 pp.
- Sung, C.V., Huynh, D.H., Dang, N.X., Canh, L.X., Giao, P.M. and van Strien, N. (unpubl.) A Report on the Results of Training and Field Survey of Javan Rhinoceros in Car Loc Nature Reserve (South Vietnam), April - May 1998, Mimeo Hanoi, 1998.