Asian Rhinos

An Action Plan for their Conservation

Compiled by
Mohd. Khan bin Momin Khan
Chairman
IUCN/SSC Asian Rhino Specialist Group

WWF

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Cover photo: Young adult male Javan rhinoceros (*Rhinoceros sondaicus*) **(photo by Alain Compost)**

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Foreword

In May 1988, I spent a couple of days at the Kaziranga National Park in Assam, India, admiring the one-horned rhinoceros, both young and old, which have a happy home there. However, in September 1988, I learnt with sorrow that nearly 40 of them died both due to floods and poaching. Shifting cultivation is still widely practised in the hill states surrounding Assam and as a result, siltation is heavy in the Brahmaputra and Barak valleys. During the monsoon season, Kaziranga often becomes flooded, and the animals have to run for shelter to areas of higher elevation, where they fall easy prey to poachers.

The great one-horned or Indian rhino, the lesser one-horned or Javan rhino and the Asian two-horned or Sumatran rhino, in spite of their spectacular nature, constitute the most threatened species of mammal on earth. The most serious threat they face is from poaching for their horn. Compounding this vicious threat is the harm done to their habitats through environmental degradation. However, the success of the conservation measures already adopted in India, Nepal and Malaysia indicates that we can still save this endangered animal and preserve all the three species of Asian rhinoceros for posterity. It is in this context that the Asian Rhino Action Plan is both timely and visionary. This action plan represents the first attempt to design a comprehensive strategy for the conservation of all the three species. Detailed guidelines are given for the conservation of each species in its native habitat. The suggestions are practical and can be implemented effectively, given the necessary blend of political will, professional skill and people's action.

We owe a debt of gratitude to the members of the IUCN/SSC Asian Rhino Specialist Group, and particularly to its dedicated and distinguished Chairman, Mr Mohd Khan bin Momin Khan, for the hard work they have put into the preparation of this action plan. Mr Khan has acted as the principal catalyst and compiler of this important document.

Our thanks are also due to the United Nations Environment Programme (UNEP), the World Wide Fund for Nature (WWF), and the Sumatran Rhino Trust for their strong support which has made the preparation and publication of this action plan possible. I would also like to record my appreciation of the valuable contribution of Dr Simon N. Stuart, Species Programme Officer of SSC, for preparing the document for publication.

Monkombu S. Swaminathan
President, IUCN

Acknowledgements

I would like to express my appreciation and thanks to all those who attended the ARSG meetings and participated in the discussions on how to prepare this action plan. The comments and opinions of many representatives from international and non-governmental organisations have helped to introduce and strengthen specific recommendations for the conservation of these species. In particular, the meetings have provided the opportunity to share expertise, ideas and experiences associated with our common objective: to conserve the Asian rhinos.

The following people attended the ARSG meetings and made valuable contributions during the drafting of the plan: Rubini Atmawidjaja, Syafii Manan, Widodo Sukohadi Ramono, Charles Santiapillai, Francisco Nardelli, Tom Foose, Eric Dinerstein, Steve Edwards, Abang Kassim, Mahedi Andau, Louis Ratnam, Jasmi Abdul, Zaaba Zainol Abidin, Zainal Zahari Zainuddin, and Shariff Daim. Special thanks are also due to the following for their help and advice: M.T. Abdullah, H. Amman, J. Aspinall, T. Beck, R. Blouch, R. Flynn, I. Grimwood, P. Lahan, A. Laurie, Sukianto Lusli, E. Bradley Martin, J. McNeely, D.A. Parkinson, R. Pellew, M.K. Ranjitsinh, S. Deb Roy, Haeruddin Sajuddin, R. Schenkel, U. Seal, S. Stuart, N. van Strien, P. Suvanakorn, W. Thomas, J. Thorsell, and W. Ziegler. Mohd Samsuddin Mohd Suri, Rahmat Topani, Che Ali Che Aman, and Rubiah Abdullah assisted in the preparation of the action plan draft.

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Mohd Khan bin Momin Khan
Chairman
IUCN/SSC Asian Rhino Specialist Group

1. Introduction

The foundation for this action plan was laid by Professor Ruedi Schenkel, and his wife Lotte, at the Bangkok meeting of the IUCN/SSC Asian Rhino Specialist Group (ARSG) in 1979. As the first ARSG Chairman, he was was instrumental in creating the interest for the intensive surveys, studies, and conservation activities that have since been carried out.

Today all three species of Asian rhinoceros are among the rarest species of animal in the world. And yet, during the last century the greater one-horned rhinoceros was killed for sport. The Maharajah of Cooch Bihar alone killed 207 rhinos between 1871 and 1907. This gives an idea of the former abundance of the species. Perhaps more significantly than over-hunting, agricultural development to meet the needs of the rapidly expanding human population resulted in extensive losses of rhino habitat. These two pressures on the species brought it to the brink of extinction. By 1908 there were only a handful of animals remaining, mainly in Kaziranga in Assam, India, and Chitawan in Nepal. In order to save the species, Kaziranga was made a forest reserve in 1908 and a wildlife sanctuary eight years later, and was essentially closed to the public until 1938.

As a result of these and other conservation activities, the great one-horned rhinoceros is now considered to be the least threatened of the Asian rhinos. Numbers have increased and the species has been translocated successfully to establish new populations within its former range (though additional translocations would be most desirable). The total population is estimated to be more than 1,700 animals, and the Indian and Nepalese authorities deserve much credit for bringing the situation under control, though continuing strict conservation measures will be needed for some time.

The Javan rhinoceros formerly occurred through most of south-east Asia, but has disappeared from almost all of its former range in Assam, Burma, Thailand, Malaysia and Sumatra, and is currently restricted to Java, with scattered populations still surviving in Cambodia, Laos and Vietnam. The cause of decline is mainly attributable to the excessive demand for rhino horn and other products for Chinese and allied medicine systems.

The animals on Java are restricted to the Ujung Kulon National Park, where, as a result of strict protection, the population increased from about 25 animals in 1967 to 50-54 animals in 1984. However, more recent information is lacking, and the status of the species in the Indochinese countries is not yet adequately known.

The Sumatran rhinoceros occurs more widely than the other two species in highly scattered and fragmented populations. Little is known about the current status of the population restricted to northern Burma. Most animals probably occur in Peninsular Malaysia and Sumatra. On Sumatra there are perhaps 420-785 animals, with viable populations possibly surviving in Gunung Leuser, Kerinci Seblat, North Aceh (Gunung Abongabong and Lesten-Lukup) and Barisan Selatan. Sizeable populations also occur on Peninsular Malaysia in Taman Negara National Park and Endau Rompin. Small, but important populations also survive in Sabah, Sarawak and possibly Kalimantan.

The ARSG held a meeting in Frazer's Hills, Malaysia, in 1982, where, for the first time, a critical analysis of Asian rhino distribution, numbers and conservation requirements was carried out. This led to the October 1984 meeting in Singapore, at which a strategy for the captive breeding of the Sumatran rhinoceros in Malaysia, Indonesia, and European and North American zoos was endorsed. Strong protests from the public in Malaysia in fact prevented any animals from being sent overseas from that country. This highlighted the need to develop a comprehensive conservation action plan for all three species of Asian rhino, in which captive breeding could be set within the the overall conservation objectives for each species.

The ARSG therefore met again in Jakarta in 1986 and Kuala Lumpur in 1987, and this action plan is the result. In addition to the decisions taken at these meetings, the plan has also benefitted from much useful advice received from ARSG members and others. There is now much to be done in the implementation of the various recommendations. This action plan should be studied carefully, and should be revised and improved as necessary in the years to come.

2. The Asian Rhinos: Three Species on the Brink of Extinction

This action plan is intended to recommend both general strategies and specific measures to protect and preserve the three species of Asian rhino: the great one-horned or Indian rhino, *Rhinoceros unicornis;* the lesser one-horned or Javan rhino, *Rhinoceros sondaicus;* and the Asian two-horned or Sumatran rhino, *Dicerorhinus sumatrensis.*

The three species of rhino in Asia are among the most remarkable animals on earth, and are of great cultural importance in Asia. Tragically, all three species are now in a very precarious situation. They once ranged widely across southern and south-eastern Asia, but all are now reduced to small pockets. Although this decline is in part related to habitat shrinkage and fragmentation, it seems likely that all these species have been declining for many centuries, principally due to the excessive demand for rhino horn for use in oriental medicine. This represents one of the least sustainable uses of a natural resource ever, and poaching of all three species continues today. This action plan should therefore be seen in the context of continuing attempts to close down the trade in rhino products.

Two of the species, the great one-horned and the Javan, are quite closely related to each other. However, the Sumatran rhinoceros (sometime called the hairy rhino) is particularly distinct. The great one-horned is a species of the open and marshy habitats of the Terai and the Brahmaputra Basins. The other two species are denizens of the rainforest, and consequently, accurate information on their status is difficult to obtain.

Protection of both animals and their habitat is necessary for conservation programmes for Asian rhino. However, such protection is unlikely to be sufficient. The combined pressures of habitat destruction and poacher activity are both reducing and fragmenting rhino populations in the wild. When populations become small and fragmented, they become vulnerable to extinction for genetic and demographic reasons, in addition to the direct threats of habitat disturbance and poaching. Moreover, the smaller the population, the greater these genetic and demographic threats become. As a consequence, it becomes essential to maintain some Minimum Viable Population (MVP) size or sizes to preserve the species against the genetic and demographic problems. MVPs also imply minimum areas necessary to accommodate populations of the specified sizes. Determination of what MVP and area are required is a central problem for the emerging science of conservation biology. This action plan for Asian rhino has been formulated with reference to the principles of conservation biology (see Appendix 1). Thus, many of the goals, objectives and recommendations are oriented to the maintenance or attainment of genetically and dcmographically viable populations of rhino.

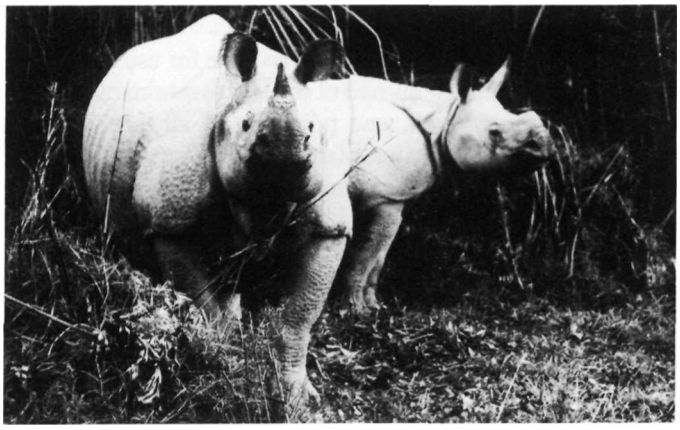
2.1 The Great One-horned Rhinoceros

The great one-horned rhinoceros once existed across the entire northern part of the Indian subcontinent from Pakistan to the Indian - Burmese border, and including parts of Nepal and Bhutan. It may have also existed in Burma, southern China and Indochina. The species now exists in a few small population units generally situated on the northern border of eastern India and in Nepal. The past and present distributions are displayed in Figures la and 1b.

The great one-horned rhinoceros is the least threatened of the Asian species. Populations have increased and rhino have been successfully translocated to re-establish populations in areas where the species had been exterminated. The total estimated number is about 1,700 animals (see Table 1). There are about 75 in captivity.

The species has been intensely protected by the Indian and Nepalese wildlife authorities and the situation until recently seemed under control. However, the expanding population pressure adjacent to these rhino areas, coupled with the great value of its horn, has recently resulted in significant losses to poachers. Recent reports indicate that 238 rhinos were lost in India between 1982 and 1985, though this rate of attrition has now been slowed down considerably.

In both these countries the programmes of protection and translocation should be continued. This is particularly so in



Great one-horned rhinoceros (Photo: Peter Jackson)

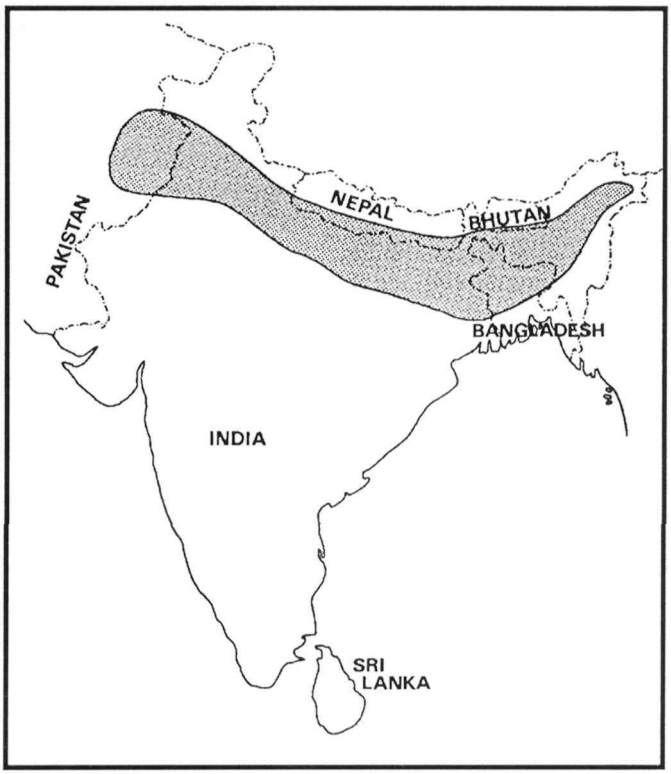


Figure la Approximate former distribution of the great one-horned rhinoceros (shaded area).

Figure 1b Current distribution of the great one-horned rhinoceros. 1: Kaziranga; 2: Laokhowa; 3: Orang; 4: Pobitora; 5: Manas; 6: Chitawan; 7: Dudhwa; 8: Bardia. Note: tiny pockets also exist elsewhere in Assam and in West Bengal, but are not mapped.

Table 1. Population estimates of the great one-horned rhinoceros

Country	Location	No of Rhino	Habitat Availability		Protection Status	Potential Carrying Capacity
			Presently (Km^2)	Potentially (Km^2)		
Bhutan/India	Manas	80	391	391	Wildlife Sanctuary	> 100
India	Dudhwa	7	490	490	National Park	>100
India	Kaziranga	1,080	430	?500	National Park threatened by railway	1,080
India	Laokhowa	5	70	70	Wildlife Sanctuary	?
India	Orang	65	76	76	Wildlife Sanctuary	> 100
India	Pobitora	40	16	16	Wildlife Sanctuary	40
India	Pockets in Assam	25	?	?	Insecure	?
India	Pockets in West Bengal	32	?	?	Insecure	?
Nepal	Royal Bardia	13	968	968	Wildlife Reserve	?400
Nepal	Royal Chitawan	375	92	?l,200	National Park	?400
Pakistan	Lal Sohanra	2	?	?	National Park	?
TOTAL		**1,724**				**2,200** +

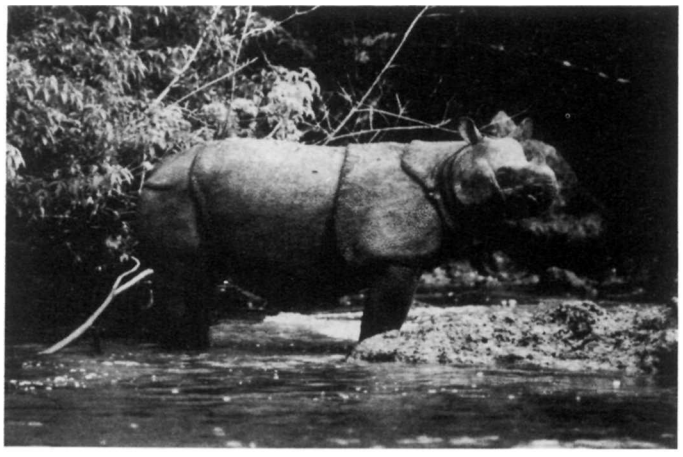
Table 2. Population estimates of the Javan rhinoceros

Country	Location	No of Rhino	Habitat Availability		Protection Status	Potential Carrying Capacity
			Presently (Km^2)	Potentially (Km^2)		
Indonesia	Ujung Kulon	50-54	761	761	National Park	?<100
Cambodia	Various	?	?	?	Not known	?
Laos	Various	?	?	?	Not known	?
Vietnam	Nam Cat Tien	Small numbers	350	?	National Park	?
Vietnam	Bugiamap	Small numbers	160	?	Reserve	?
Vietnam	Various	?	?	?	Not known	?
TOTAL		**50-54** +				?

India where there remain many areas which historically had rhino populations. These areas should be protected and new populations established in them through translocations from areas where populations now exist in sufficient numbers to be unaffected by animals being taken out of them.

2.2 The Javan Rhinoceros

The principle surviving population of the Javan rhinoceros is located on the Ujung Kulon peninsula, which forms the westernmost extremity of the island of Java. An estimated 50 animals now live in the area. The species was once widespread throughout the Oriental Realm from Bengal eastward to include Burma, Thailand, Cambodia, Laos, Vietnam and southwards to the Malay Peninsula and the islands of Sumatra and Java. About 150 years ago the species occurred as three discrete populations. The first, belonging to the subspecies *inermis* (now almost certainly extinct) was found from Bengal to Assam and eastwards to Burma. The second subspecies *annamiticus* occurred in Vietnam, Laos, Cambodia, and the easternmost part of Thailand. The third subspecies, the nominate form, was found from Tenasserim, through the Kra Ithmus into the Peninsula and Sumatra and in the western



Javan rhinoceros (Photo: Alain Compost)

half of Java. All these populations have disappeared, except for in Ujung Kulon and some scattered remnants surviving in Indochina. The Javan rhino has the distinction of being the rarest large mammal in the world. Population estimates are given in Table 2, and the past and present distributions are displayed in Figures 2a and 2b.

The 50 or so Javan rhinos in Ujung Kulon are in a national park and the population size is probably limited to the

Figure 2a Approximate former distribution of the Javan rhinoceros (shaded area).

effective carrying capacity of the area. One danger to these animals comes from disease, which could potentially wipe out the entire population. In 1981-1982, this threat became a reality when an unknown disease actually killed at least five animals in Ujung Kulon. In addition, any such small population of rhinos faces a permanent threat from poachers. There are no Javan rhinos in captivity.

Figure 2b Current distribuition of the Javan rhinoceros. 1: Ujung Kulon; 2: Nam Cat Tien; 3: Bugiamap. Note: the records mapped in Laos and Kampuchea refer to scattered sightings, and it is not clear whether any of these constitute substantial populations.

It is suggested that the situation facing this species be looked at very closely to see if recommendations to translocate some animals into other areas, such as Way Kambas or southern part of Bukit Barisan Selatan National Park in Sumatra should not be seriously considered. A single small population is always extremely vulnerable. It must be kept in mind that the Ujung Kulon peninsula is on the Sundaic edge volcanic line and that during the Krakatau eruption in 1883, the entire peninsula was affected by tidal waves and ash rains which destroyed much of its terrestrial life.

A second approach is that the Indonesian authorities should also consider bringing some animals into a captive breeding project to be based at least partly in Indonesia.

Better exploration of the situation in Vietnam, Laos and Cambodia also needs to take place, with the option of captive breeding again being considered. Such information might become available as fieldwork on the kouprey *Bos sauveli* conservation programme get underway.

2.3 The Sumatran Rhinoceros

The Sumatran rhinoceros was once found from the foothills of the Himalayas in Bhutan and eastern India, through Burma, Thailand, and the Malay Peninsula, and on the islands of Sumatra and Borneo. There have also been unconfirmed reports of the species in Cambodia, Laos and Vietnam. The past and present distributions are displayed in Figures 3a and 3b and population estimates are given in Table 3. In general this species has survived much better in its native habitats than the Javan rhino. This may be partly because it mainly inhabits the mountains and forests of higher elevations which were not so subject to development and logging. In contrast the Javan rhino is a species of the coastal plains and river valleys.

At present the species survives in pockets in Burma, Thailand, the Malay Peninsula, Sumatra and Borneo. Little is known of its status in Burma which holds the subspecies *lasiotus.* The nominate subspecies *sumatrensis* is now represented by animals in Thailand, Peninsula Malaysia and in Sumatra. There has been little recent news of animals in Thailand and its continuing occurrence there is now in doubt. In the Peninsula there are an estimated 100 animals surviving in several isolated pockets of which perhaps only two are in protected areas of sufficient size to guarantee long term viability. All these animals have to be closely protected.

The largest number of the subspecies *sumatrensis* now survives on the island of Sumatra and it is possible that several hundred animals still exist. However, the island is now in a phase of intense development resulting from Indonesia's transmigration programme and the habitat available to the species is being rapidly reduced. In addition the sheer size of the island, compared to the available staff for protecting the species, makes adequate protection almost impossible. Even in areas where there is a strong presence of protection staff, poaching is active. This is evidenced by the fact that in a project to capture animals for a captive breeding programme in an area where numerous wildlife staff are positioned, animals are being caught with fresh snare wounds on their legs.

The rhinos in Sumatra are too widespread and in too many pockets for all of them to be protected adequately in the ranges where they still survive. As a result, they are subject to

Table 3. Population estimates of the Sumatran rhinoceros

Country	Location	No of Rhino	Habitat Availability		Protection Status	Potential Carrying Capacity
			Presently (Km^2)	Potentially (Km^2)		
Burma	Schwe-u-daung	Perhaps survives	207	?	Game sanctuary	?
Burma	Tamanthi	Perhaps survives	2,150	?	Game sanctuary	?
Burma	Lassai tract	6-7	?	?	Unknown	?
Indonesia (Kalimantan)	near Sabah border	Perhaps survives	?	?	Unclear	?
Indonesia (Sumatra)	Gunung Leuser	130-200	1,400	8,000	National Park but disturbance & poaching	140-800
Indonesia (Sumatra)	Gunung Patah	Numbers unknown	400	500	No information	40-50
Indonesia (Sumatra)	Kerinci Seblat	250-500	5,000	10,000	Little protection proposed National Park	500-1,000
Indonesia (Sumatra)	Gunung Abong-abong and Lesten-Lukup	15-25	?	?	Not protected	?
Indonesia (Sumatra)	Berbak	Perhaps extinct	?	?	Nature Reserve	?
Indonesia (Sumatra)	Torgamba	Very few	?	?	Being deforested	?
Indonesia (Sumatra)	Barisan Selatan	25-60	700	3,600	National Park, deforestation occurring	70-360
Malaysia (Peninsula)	Endau Rompin	10-25	1,600	1,000-1,600	Reserve, National Park proposed	110-160
Malaysia (Peninsula)	Taman Negara	22-36	4,400	4,400	National Park	220-440
Malaysia (Peninsula)	Sungai Dusun	3-4	40	140+	State Wildlife Reserve	15
Malaysia (Peninsula)	Gunung Belumut	3-5	230	230	Wildlife Reserve proposed	23
Malaysia (Peninsula)	Mersing Coast	5-6	?	Probably none	Being deforested	0
Malaysia (Peninsula)	Sungai Depak	2-4	?	Probably none	Being deforested	0
Malaysia (Peninsula)	Sungai Yong	3-5	?	Probably none	No information	0
Malaysia (Peninsula)	Kuala Balah	2-4	?	Probably none	Being deforested	0
Malaysia (Peninsula)	Bukit Gebok	2	?	None	Being deforested	0
Malaysia (Peninsula)	Krau Reserve	1	500	500	Insecure	50
Malaysia (Peninsula)	Sungai Lepar	2	1,000	0	Unprotected and being deforested	0
Malaysia (Peninsula)	Ulu Atok	1	?	?	No information	?
Malaysia (Peninsula)	Ulu Selama	6-7	?	?	Unprotected	?
Malaysia (Peninsula)	Ulu Belum	2-4	?	?	Insecure	?
Malaysia (Peninsula)	Bubu Forest	2	?	?	No information	?
Malaysia (Peninsula)	Kedah	1	?	?	Insecure	?
Malaysia (Sabah)	Tabin Reserve	20+	1,200	1,200	Perhaps protectable	120
Malaysia (Sabah)	Kretam/Dent Peninsula	8	1,000	0	Being converted to agriculture	0
Malaysia (Sabah)	Danum Valley	10	2,000	2,000	Perhaps protectable	200
Malaysia (Sarawak)	Limbang	5-15	600	600	Protection proposed	60
Thailand	Phu Khieo	Perhaps survives	1,560	?	Protected area	?
Thailand	Tenasserim Range	6-15	?	?	Insecure	?
Thailand	Khao Soi Dao Reserve	Perhaps survives	745	?	Protected area	?
TOTAL			**536-962**			**1,548-3,278**

Figure 3a Approximate former distribution of the Sumatran rhinoceros (shaded area).

Figure 3b Current distribution of the Sumatran rhinoceros. 1: Lassai tract; 2: Tamanthi; 3: Schwe-u-daung; 4: Phu Khieo; 5: Khao Soi Dao; 6: Tenasserim Range; 7: Kedah; 8: Ulu Selania; 9: Bubu Forest; 10: Kuala Balah; 11: Sungai Depak; 12: Sungai Yong; 13: Taman Negara; 14: Sungai Lepar; 15: Ulu Atok; 16: Ulu Belum; 17: Sungai Dusun; 18: Krau Reserve; 19: Bukit Cebok; 20: Endau Rompin; 21: Mersing Coast; 22: Gunung Belumut; 23: Lesten Lukup; 24: Gunung Abongabong; 25: Gunung Leuser; 26: Torgamba; 27: Berbak; 28: Kerinci Seblat; 29: Gunung Patah; 30: Barisan Selatan; 31: Limbang; 32: Kretam; 33: Tabin; 34: Danum Valley; 35: Sabah border.

Sumatran rhinoceros
(Photo: Department of Wildlife and National Parks, Malaysia)

heavy poaching pressure both from hunters with firearms and from trappers who use wire snares and other traps that maim and kill animals. The total world population is now thought to be between 500 and 900 animals (see Table 3) and the annual loss may be as much as 10 percent of that population. There is evidence that breeding in the wild is taking place but the rate of such recruitment to the population is not known. Presently, there are 16 animals in captivity.

The subspecies *harrissoni* is possibly the most endangered of the subspecies and now exist in a few rapidly dwindling pockets in eastern Sabah. There may be less than thirty animals still surviving in the state and the rate of poaching is believed to be high. The Sabah state is at present engaged in a programme to capture these high risk animals and put them into the safety of a captive breeding programme. Recently it was discovered that a small group of this subspecies survives in the upper Limbang catchment in Sarawak. Efforts are now being made to monitor this group and protect them from poachers. It is also possible that populations remain in eastern Kalimantan.

An extensive international cooperative programme for the conservation of this species is already being implemented. There are ongoing efforts to establish captive breeding centres for the species in Indonesia and in Malaysia (both the Peninsula and in Sabah) where the active trapping of animals is now being carried out. Captive breeding is also being planned in the United States and the United Kingdom, using animals of Indonesian origin. The Peninsular Malaysian programme also calls for the setting up of "gene pools" where the species will be allowed to breed in semi-wild conditions in large fenced areas.

All of these efforts are components of a global captive propagation programme being developed for this species under the general guidelines of the Singapore Proposals (see Appendix 2) adopted by the Asian Rhino Specialist Group (ARSG) and IUCN in 1984 and in accordance with the specific provisions of the national plans and bilateral agreements that have been formulated. A major guideline of note is that no mixing of animals from the four major regions of their range (Burma, Peninsula, Sumatra, and Borneo) be undertaken until there has been adequate genetic investigation of any significant differences between these geographically disjunct populations.

2.4 Conclusion

Finally, it should be emphasised that members of the IUCN/SSC Asian Rhino Specialist Group should work together for the maximum benefit of all these species, and should carry out their tasks and agreements in a manner that will encourage and engender future and long-term cooperation. The importance of respecting absolutely the authority in each country that is responsible for the conservation of wildlife in general, and the rhino species in particular, cannot be overemphasised.

Great one-horned rhinoceros (Photo: Peter Jackson)

3. The Great One-horned Rhinoceros: An Action Plan

3.1 Introduction

The past and present status of this species is summarised in Chapter 2. The total estimated number is around 1,700 animals. The species has been well protected by the Indian and Nepalese wildlife authorities and the situation had seemed to be under control. However, the increasing human population pressure and the poverty of the villagers who surround these rhino sanctuaries, coupled with the great value of its horn, have resulted in significant losses to poachers in India and this still poses a threat to rhinos in Nepal. At present, the poaching in India is being brought under control.

The emphasis of this action plan is to consider what needs to be done to preserve the species in perpetuity. Thus, the main objectives that should govern immediate conservation actions are detailed along with specific recommendations derived from these objectives. Application of these recommendations is considered separately for Nepal and India.

3.2 Objectives

1. To maintain a total wild population of at least 2,000 rhinos.

2. To maintain these rhinos in at least six major sanctuaries in the current range of the species: Kaziranga, Manas, Orang and Dudhwa in India; Chitawan and Bardia in Nepal.

3. To expand this number of rhinos and sanctuaries when and where possible.

4. To respond to specific threats to viable populations in the wild (especially anti-poaching measures) as required.

5. To maintain a captive population capable of long-term viability to guard against any unforseen extinction of the wild population.

6. To continue efforts to close down the trade in rhino products.

3.3 General Recommendations

1. Concentrate efforts on areas in which reasonably viable wild populations (> 100 rhinos) in the wild can be established:

   India: Kaziranga
   Manas (partly in Bhutan)
   Dudhwa
   Orang

   Nepal: Chitawan
   Bardia

   Such efforts should include anti-poaching measures, training of staff, public education campaigns, ecological studies and population monitoring. In addition, methods which allow local people to benefit from the existence of the rhinos (such as tourist revenues) should be investigated.

2. Calculate the resources currently available and those additionally required to provide adequate protection for these populations. Develop project proposals to donors for the additional resources, as needed.

3. Assess the value to the conservation of the species of the small remnant populations of rhinos, e.g. Jaldapara, through better information on current status and cost-benefit analyses of increased protection and management in such areas.

4. Conduct biochemical and genetic studies to determine whether the now disjunct populations in the Terai and the Brahmaputra Basin constitute evolutionarily significant units (ESUs) justifying preservation as separate entities. Encourage zoos to provide tissue and blood from their animals to begin these investigations as soon as possible.

5. Continue efforts to establish other wild populations elsewhere in India and Nepal through translocations. But such translocations should be limited to sanctuaries where the carrying capacity exceeds 100 rhinos. It is recom-

mended that 30-40 rhinos be translocated as the foundation for new populations and that there be follow-up surveillance to measure the success of the translocations.

6. Investigate alternatives to the proposed highway through the Bardia Reserve and the railway line bordering the Kaziranga National Park.

7. Expand the captive population to at least 150 rhinos, mainly through propagation of rhinos already in zoos. Evaluate the need for and benefit of more founder stock from the wild, through population viability analyses (PVA) and with reference to results from the ESU investigations (see no. 4 above).

8. Encourage wildlife officials and their governments in India and Nepal to participate more fully in the activities of the IUCN/SSC Asian Rhino Specialist Group (ARSG). In this regard, the 1986 Jakarta meeting of the ARSG proposed that future meetings of the Group be held in India and Nepal, as well as in the South-east Asian countries.

9. Continue measures to prevent illegally poached rhino horn from leaving India for markets in eastern Asia.

3.4 Nepal: Specific Recommendations

The conservation of the great one-horned rhinoceros in Nepal represents a conservation success story. In around 1960, the Chitawan population had plummeted to around 60 rhinos. In 1987 the Chitawan population was estimated at between 360-380 animals. At present, the population is increasing at a rate of about 2% per year. With the control of poaching and habitat destruction, recruitment has been so strong that translocations of rhinos to other reserves has already begun. In this manner Nepal has led the way for other Asian nations in its efforts to preserve an important constituent of the regional megafauna. Nevertheless, the conservation effort for great one-horned rhinoceros in Nepal is far from over. This section of the action plan spells out and prioritises what must be done to ensure the long-term viability of the species in Nepal and in the region.

The action plan for Nepal emphasises continued efforts to translocate rhinos, and continued monitoring of the Chitawan population. Recommendations as they apply to the situation in Nepal are as follows (each recommendation below is in the same order and numbering as the General Recommendations earlier in this chapter):

1. Concentrate efforts on areas in which reasonably viable wild populations (>100 rhinos) in the wild can be established.

In Nepal, these areas are Chitawan and Bardia. The Chitawan rhino population was first estimated using a photo registration technique in 1975. After a lapse of over 10 years, the population was censused in the spring of 1986, 1987, and 1988. These estimates have proved invaluable for monitoring the second largest population of the great one-horned rhinoceros. In particular, they have greatly improved the translocation efforts by providing data on the structure of the Chitawan population, and the sex, relative age, and home range of animals considered suitable for translocation. Thus, a real benefit from intensive monitoring is that it reduces the amount of search time required to locate quickly rhinos of the appropriate age and sex.

Great one-horned rhinoceros (Photo: Peter Jackson)

The continuation of the ongoing ecological studies in Chitawan also augments efforts to monitor rhino numbers. Research in Chitawan has demonstrated that the most accurate way to census rhinos is to photograph all individuals encountered. Because other research projects involve frequent searching through rhino habitats, efforts to measure accurately such important parameters as annual calf recruitment, date of birth, and mortality have become much easier. Clearly, there is no substitute for being out in the field in order to monitor the population, and such research projects conducted by Nepali and expatriate collaborators are providing for close surveillance of the rhino populations.

In association with the continuing reintroduction of the species to the Royal Bardia Reserve, a reserve employee should be assigned full-time to carry out an annual census of the reserve's rhinos. In addition, serious thought should be given to supporting a Nepali graduate student to monitor and study relocated animals. Radio-collaring all animals involved in the third phase of the reintroduction would ease the task of monitoring the status of the founder population.

In and around both Chitawan and Bardia, anti-poaching measures must be maintained, and training of staff in wildlife and protected area management should be continued. Public awareness programmes need to be developed around both these areas, together with the investigation of methods that allow local human populations to derive economic benefits from the existence of the rhinos.

2. Calculate the resources currently available and those additionally required to provide adequate protection for these populations.

Current resources appear to be sufficient to ensure the conservation of the rhinos at Chitawan. However, a recent report on the management of Bardia and its new rhino population has been submitted to the government of Nepal. Many of the recommendations in this report are worth pursuing, all aimed at improving its conservation status. The construction of an electric fence along the southern periphery of the Bardia Reserve is of particular importance.

3. Recommendation number three is not relevent to Nepal.

4. Biochemical and genetic studies to determine whether the now disjunct populations in the Terai and the Brahmaputra Basin constitute evolutionarily significant units (ESUs) and justify preservation as separate entities.

The two largest populations of great one-horned rhinoceros, in Chitawan and Kaziranga, are separated by a distance of 1,200 km. Until the early part of the last century, these isolated populations were contiguous. Nevertheless, there is still some question about possible genetic differences between the Kaziranga and Chitawan populations. Moreover, both current populations were once reduced considerably and both are probably descended from less than 60 animals.

A genetic analysis of rhinos in Chitawan has already begun with the collection of 15 blood and tissue samples from free-ranging animals. It is strongly recommended that North American and European zoos cooperate in this endeavor. Nearly all the animals in captivity result from Kaziranga stock, so the estimating of genetic relatedness can be done without having to sample the wild Kaziranga population.

5. Continue efforts to establish new wild populations through translocations.

Reintroductions should be limited to sanctuaries capable of supporting rhino populations in excess of 100 animals. A minimum of 30-40 rhinos should be used to form the foundation of new populations, and follow-up surveillance should be initiated to measure the success of such reintroductions.

Nepal has attracted world-wide attention with its bold and highly successful reintroduction effort in Bardia. However, the most reliable data from the genetic management of endangered species suggests that this effort is only about one-third complete. To maintain 90% of the genetic variability of the Bardia population for the next 200 years requires a founder group of at least 30 and preferably 40 animals (see Appendix 1). Because of the small number of founders reintroduced, the Bardia population faces a high probability of rapid extinction due to demographic or random events. At present, if no more rhinos are added to Bardia, the best available evidence indicates that the population might not last longer than 75 years before the deleterious effects of inbreeding start to threaten its continued existence. A greater investment now will return real conservation dividends if the founder group is substantially increased. This is especially true if only a percentage of the rhinos relocated to Bardia actually breed and produce offspring.

An important caveat in the relocation effort is that animals should be shifted only to those reserves which can ultimately support more than 100 individuals. The rationale behind this criterion **is** spelled out in Appendix 1 of this action plan. In this light, the potential of Sukla Phanta Wildlife Reserve as a future rhino sanctuary must be considered.

6. Investigate alternatives to the proposed highway through the Bardia Reserve.

The effects of the East-West highway on the integrity of the Bardia Reserve deserves more study and attention. It is essential that **this** new development does not cause environmental degradation **in** the reserve.

7. Expand the captive population to at least 150 rhinos, mainly through propagation of rhinos already **in** zoos.

Evaluate the need for, and benefit of, more founder stock from the wild, through population viability analyses (PVA) and with reference to results from the ESU investigations.

Eventually, all the great one-horned rhino in captivity must be managed as one population. In order to maintain an MVP of great one-horned rhinoceros in captivity, the mumbers must be increased to at least 150 individuals. At present 75 animals are housed in North American and European zoos. There is an International Studbook and an organized captive propagation programme in North America.

8. Encourage wildlife officials and the government in Nepal to participate more fully in the activities of the IUCN/SSC **Asian Rhino Specialist Group.**

In this regard, the proposal from the 1986 Jakarta ARSG meeting that a future meeting be held in Nepal should be implemented.

9. Recommendation number nine is not relevant to Nepal.

3.5 India: Specific Recommendations

Because of the large size of the Kaziranga great one-horned rhinoceros population and the extensive network of reserves across northern India, great opportunities exist for future translocation efforts. This effort has already begun in Dudhwa National Park. The ultimate objective that the great one-horned rhinoceros conservation programme in India should address and consider is the issue of reestablishing the species in as many reserves as possible where the potential carrying capacity for the species exceeds 100 animals. Additional protection will need to be afforded the species in its relocation sites.

Recommendations as they apply to the species in India follow (each recommendation below is in the same order and numbering as the General Recommendations earlier in this chapter):

1. Concentrate efforts on areas in which reasonably viable wild populations (> 100 rhinos) in the wild can be established.

In India, these are: Kaziranga, Manas (which overlaps into Bhuta), Dudhwa and Orang (though others might be created through further translocations).

In addition, it would be useful to harmonize the population census techniques used in India with the photo-registry technique currently used in Nepal. Exchange visits between rhino researchers and managers in Chitawan and Kaziranga and Manas should be arranged.

The human pressures around the actual and potential rhino reserves in India are extremely severe, and are likely to become worse. For the long-term security of the rhinos, a number of actions are required:

- maintenance of ongoing anti-poaching measures, and the implementation of such measures for newly established populations (e.g. Dudhwa);

- public awareness and education programmes around all rhino reserves;

- an investigation into the possibilities of local people deriving economic benefit from rhino conservation in then-areas (possibly through tourist revenues);

- maintenance of wildlife management and protected areas training programmes for staff at all levels.

2. Calculate the resources currently available and those additionally required to provide adequate protection for these populations.

The Indian Government should be encouraged to declare whether additional resources are needed for its rhino recovery programme. If so, these should be specified, and the necessary funds sought.

3. Assess the value to the conservation of the species of the small remnant populations of rhinos (e.g. Jaldapara), through better information on current status and cost-benefit analyses of increased protection and management.

In particular, investigations are needed of the various small populations in Assam and West Bengal, which will never be viable in themselves, to determine whether these animals might best be used as founder stock for reintroductions elsewhere.

4. Conduct biochemical and genetic studies to investigate if now disjunct populations in the Terai and the Brahmaputra Basin constitute evolutionarily significant units (ESUs) justifying preservation as separate entities.

See recommendation for Nepal.

5. Continue efforts to establish other wild populations elsewhere in India and Nepal through translocations.

Much deserved credit has been given to the Indian Government for its successful reintroduction of rhinos to Dudhwa National Park. However, with a founder stock of only seven animals, the operation cannot yet be considered complete. To avoid the problems of inbreeding, it would be advisable to move in another 30 animals. Other sites for reintroduction should also be considered.

Reintroductions should be limited to sanctuaries capable of supporting rhino populations in excess of 100 animals. A minimum of 30-40 rhinos should be used to form the foundation of new populations, and follow-up surveillance should be initiated to measure the succss of such reintroductions.

6. Investigate alternatives to the proposed railway line bordering the Kaziranga National Park.

It is essential that the integrity of this outstanding area, containing the largest population of any species of rhino in the world, is not jeopardised by such a development.

7. Expand the captive population to at least 150 rhinos, mainly through propagation of rhinos already in zoos.

See recommendation for Nepal.

8. Encourage wildlife officials and the government in India to participate more fully in the activities of the IUCN/SSC Asian Rhino Specialist Group.

In this regard, the proposal from the 1986 Jakarta ARSG meeting that a future meeting be held in India should be implemented.

9. Continue measures to prevent illegally poached rhino horn from leaving India for markets in eastern Asia.

Continued instances of poaching in India suggest that the government cannot afford to ease off in its attempts to close down the illegal exports of rhino horn from the country.

3.6 Conclusion

Of the three Asian species of rhino, the great one-horned rhinoceros seems to be in the best situation at this time. However, significant threats, such as problems of habitat disturbance and poacher activity still exist. The species can be monitored with relative ease, in comparison with the other two species, because of the habitats it favours. It occurs at its highest densities in the early successional habitats, which regenerate quickly, often within 1-2 years of a major disturbance. This contrasts with the habitat requirements of the Sumatran and Javan rhinos which are more heavily dependent on primary rain forest. Thus, it does not require generations of patience to restore the great one-horned rhinoceros's habitat, but rather continued vigilance in protecting the population, and courage on the part of wildlife managers and conservationists to expand the already successful translocation programme.

4. The Lesser One-horned or Javan Rhinoceros: An Action Plan

4.1 Introduction

The only easily accessible and well known population of the Javan rhinoceros occurs in the Ujung Kulon National Park in West Java. The species has the distinction of being probably the rarest large mammal in the world. The most important threat to the species is from poaching. In Indochina, there might also be the threat of habitat destruction (it being an inhabitant of tropical lowland forest).

In Indonesia, the Javan Rhino has been legally protected since 1931. Ujung Kulon National Park was set aside for the conservation of the species. The area is managed by the local wildlife directorate, the PHPA (Perlindungan Hutan dan Pelestarian Alam), which oversees the conservation and the management of wildlife. This Directorate General comes under the Ministry of Forestry.

The situation in Vietnam, Laos and Cambodia is very unclear. There have been a number of scattered records from all three countries in recent years, but nothing to suggest that there are any concentrations of animals that could form viable populations.

4.2 Objectives

1. To preserve the remnant populations in the wild.

2. To locate and/or establish other populations in the wild.

3. To develop a captive propagation programme to reinforce this species in the wild, but in a way that minimizes the demands on the tiny wild population.

4. To continue efforts to close down the trade in rhino products.

4.3 General Recommendations

1. Conduct an intensive survey in Ujung Kulon National Park, Java, to determine more precisely the size and composition of the population surviving there. The intensive survey should be carried out by competent ecologists.

2. Determine what resources are currently available, and those that are additionally required, to provide adequate protection for the population in Ujung Kulon. This should include a consideration of human needs in the buffer-zone outside the park.

3. Investigate the status of Javan rhino in Vietnam, Laos and Cambodia. This investigation should be conducted in conjunction with the Kouprey Conservation Programme.

4. Develop as soon as possible a captive propagation programme, based on information obtained by the intensive survey of Ujung Kulon and the explorations in Indochina.

5. Formulate guidelines, and perhaps conduct a search, for a site to establish additional wild populations in South-east Asia. Animals should be made available for reintroduction from the captive breeding programme.

6. Introduce and enforce strict measures to ban the use of Javan rhino products in all countries, especially in Laos, where internal consumption is still permitted. More severe measures against poachers and traders are needed.

4.4 Indonesia (Java): Specific Recommendations

The situation of the Javan rhino is an emergency, and only a broad, integrative conservation programme is likely to save it from extinction. Because of the uncertainty of the situation in Indochina, initial efforts must be direct to the animals in Ujung Kulon National Park. With such a small population, and continuing incidences of poaching, the following actions are necessary (each recommendation below is in the same order and numbering as the General Recommendations earlier in the Chapter):

1. Conduct an intensive survey of the species in Ujung Kulon National Park.

This is an essential pre-requisite to recommending further conservation action. The survey is of such importance that it should be led by top quality ecologist should concentrate on the size, composition and habitat preferences of the population occurring there, and should assess the principal threats to its continued survival. Standardised censuses should be carried out annually thereafter.

Javan rhinoceros (Photo: Alain Compost)

2. Determine what resources are currently available, and those that are additionally required, to provide adequate protection in Ujung Kulon.

This should lead to a comprehensive management plan for the entire area, which should include:

- strong anti-poaching measures;

- training of PHPA staff at all levels in wildlife and protected area management;

- an extensive public education programme among local people as to the unique importance of Ujung Kulon National Park and its rhinos;

- initiation of appropriate forms of development in a buffer-zone outside the park to enable local people to derive tangible economic benefits from the park.

3. Recommendation number three is not relevant to Indonesia.

4. Develop as soon as possible a captive propagation programme.

This is is essential, since the population in Ujung Kulon is not large enough, and probably never could be, to be viable in genetic and demographic terms. The only possibility to expand the population rapidly, and thereby arrest the continuing loss of genetic variation, is to develop a captive breeding programme. This should be done as a collaboration between the Indonesian Government and North American and European zoos. The programme will need to consider where the initial breeding centre should be located and how to expand the population as quickly as possible, and yet minimise demands on the wild population.

5. Formulate guidelines, and perhaps conduct a search, for a site in which to establish additional wild populations in South-east Asia.

This is a very high priority, which should follow on from the captive breeding programme. The area to be selected should be within the historical range of the species, with suitable habitat for the animals to survive at a relatively high density, of sufficient size to support a viable population, and with good security against poachers.

6. Enforce strict measures to prohibit the use of Javan rhino products in Indonesia.

This is to include the application of the strongest possible penalties against poachers and traders.

4.5 Vietnam, Laos and Cambodia: Specific Recommendations

Because of the very uncertain situation of this species in Indochina, only recommendations number three and six apply at this stage. Surveys should be coupled with the Kouprey Conservation Programme, and probably will not require additional funding. A survey in Nam Cat-tien National Park and Bugiamap Reserve in Vietnam is of particular importance. An internal ban on the use and marketing of rhinoceros products in Laos is also needed.

4.6 Conclusion

A recovery programme for the Javan rhinoceros is one of the most pressing species conservation priorities in the world. The loss of this species would be a supreme act of negligence on behalf of the conservation community.

5. The Asian Two-horned or Sumatran Rhinoceros: An Action Plan

5.1 Introduction

The Sumatran rhinoceros is a species of rainforest in hilly and mountainous areas. It is much more widely scattered, often in tiny inviable populations, than the other two species. As a result, it is more difficult to make decisions as to the most appropriate priorities for its conservation, especially since a number of national and state governments are involved. Although not yet as critically threatened as the Javan rhinoceros, this species is probably experiencing the most serious level of poaching for its horn of all the Asian rhinos. In some areas it is also threatened by habitat destruction. In view of these complexities, it has been felt best to handle the specific recommendations for each country in a slightly different way from the previous two species.

Development of captive populations in North America and England, as well as in the countries of origin, is considered important for several reasons:

1. There are significant risks (e.g. disease epidemics, natural disasters, etc) of having all the rhinos in only a few places. To ensure maximum security, the population should be distributed as widely as possible.

2. For long-term viability, the captive population needs to be larger than existing South-east Asian facilities can reasonably accommodate.

3. There are appreciable resources and expertise in North American and British zoos that can be utilized to expedite the expansion of the captive population.

Sumatran rhinoceros
(Photo: Department of Wildlife and National Parks, Malaysia)

However, it should also be noted that for a variety of reasons the mortality among animals that have been transported beyond the borders of their countries is extremely high. Of the five animals moved so far three have died, a 60 percent mortality. This does not compare well with the overall mortality of the capture programme in which five animals have died out of 17 captures (29.4 percent). In fact the mortality falls to 15.4 percent (two mortalities out of 13 animals) if the mortalities of exported animals are excluded from the calculations.

Therefore, it is essential that certain conditions be satisfied when animals are to be transported to foreign destinations. These are:

1. There must be accurate and as complete information on the animal/animals as possible. This should include complete veterinary records.

2. The animals should not only be in excellent health but should be free from any significant physical deformities or injuries. As far as possible the animals should be in perfect condition.

3. The animals should be physically prepared for their new homes and should be preconditioned, at least partially, to the new diet regime before they are moved.

5.2 Objectives

1. To develop populations of at least 700-1,000 rhinos in each of the major regions of its range: Sumatra, Borneo, Peninsular Malaysia and adjacent mainland, and northern Burma.

2. To preserve, manage and where appropriate expand all populations that have the potential to increase to 100 animals or more.

3. To determine if the populations in each major part of its range (listed under objective 1 above) constitute valid subspecies or evolutionary significant units (ESUs), justifying preservation as separate entities by conservation programmes.

4. To locate or establish additional viable populations, especially on the mainland and Borneo..

5. To develop a captive population of 150 rhinos distributed in zoos worldwide: South-east Asia, North America, and Europe. Establish this captive population with at least 20 pairs of founders from the wild.

6. To experiment with the gene pool concept.

7. To continue efforts to close down the trade in rhino products.

5.3 General Recommendations

1. Concentrate initial *in situ* conservation efforts on the seven, or so, populations considered to be reasonably viable according to current information and analysis (see Table 3).

2. Calculate the resources currently available and additionally required to provide adequate protection for these populations.

3. Ensure improved legal protection status of all areas with viable, or potentially viable, populations (particular attention to be given to Kerinci-Seblat in Sumatra and Endau Rompin in Peninsular Malaysia).

4. Conduct biochemical genetic studies, initially using blood and tissue from captive animals, to investigate if there is more than one ESU in this species.

5. Organise surveys as soon as possible in Kalimantan (highest priority), Thailand, and northern Burma to ascertain whether appreciable populations of rhino survive there.

6. Continue the capture of "doomed" animals to provide founders for the captive population and the gene pool experiments, as well as stock for possible translocation after sufficient animals have been obtained for the *ex situ* programmes.

7. Develop an experimental "gene pool" in order to learn as much as possible about the management of the animals (initially at Sungai Dusun in Peninsular Malaysia).

8. Manage the captive animals as part of the overall conservation programme for the species, and discourage all movements of captive rhinos (including as gifts), unless this is endorsed by IUCN. Details on how the animals should be managed in captivity are available from the ARSG. Guidelines for captive management are given in Appendix 3.

9. Improve the effectiveness of law enforcement throughout the species' range with respect to anti-poaching measures and trading in Sumatran rhinoceros products. The strictest possible penalties should be applied to offenders.

5.4 Indonesia: Specific Recommendations

The total population of the Sumatran rhinoceros in Indonesia is estimated to be between 420-785, all in Sumatra, with the possibility of a few existing in Kalimantan (see Table 3).

In Indonesia this species has been legally protected since 1931. A number of reserves have been set aside for the conservation of wildlife, including this species, notably the Gunung Leuser, Kerinci-Seblat, and Barisan Selatan National Parks in Sumatra. These are all managed by the PHPA (Perlindugan Hutan dan Pelestian Alam), a Directorate General which comes under the Ministry of Forestry.

A programme of bringing animals into captivity is currently underway for doomed rhinos in Sumatra. This is being organised by the American Association of Zoological Parks and Aquaria (AAZPA), and the Howletts and Port Lympne Zoo in Britain. This programme is still in an early Phase, but it is envisaged to include captive breeding in Indonesia, Britain and the United States.

The goal is to ensure the survival of viable populations of the Sumatran rhino in Indonesia in its natural habitat.

1. Protection

Better protection is needed of the known viable rhino populations in Kerinci-Seblat, Gunung Leuser and Barisan Selatan National Parks in Sumatra. Such improved protection should include the following aspects:

- an increase in anti-poaching efforts;

- appropriate forms of sustainable development in the buffer-zones around these parks, to enable people to derive economic benefits from the protected areas;

- a public education programme on the importance of these national parks and their rhinos;

- a training programme for all levels of staff working in wildlife and protected area management. This should include training in captive management of rhino;

- formal gazettment of the national park at Kerinci-Seblat.

2. Monitoring

Monitoring should be done on as many rhino populations as possible on a regular basis to assess the trends, distribution, movement and habitat preferences of the species. Censusing should preferably be carried out annually by teams of people following standardised methods. Surveys also need to be carried out to determine the distribution and abundance of the species outside the protected areas. In particular, surveys should be carried out to assess the status of rhino, if any, in Gunung Patah, Gunung Abongabong, Lesten-Lukup, and in Kalimantan (along the border with Sabah, and northern Sarawak opposite the upper Limbang catchment).

3. **Capture and translocation**

It is important to identify areas that are destined to be converted to other land uses incompatible with wildlife conservation, and hence determine whether it is necessary to translocate rhinos to another, safer area or into the captive population. The target area must have adequate habitat to sustain a viable population of rhino. For the management of captive animals in Indonesia, the principles outlined for Malaysia, and in Appendix 3, apply.

4. Research

Research on rhino populations in the national parks and other protected areas should be carried out with a view to determining their number, breeding performance and habitat requirements. It is also necessary in order to determine the threats to the animals in each area and to devise appropriate conservation action.

5. Trade

It is clear that an illegal trade exists in Sumatran rhino horn, from Sumatra to Singapore and possibly other countries. It is recommended that the governments concerned make a concerted effort to bring the situation under control. This trade is probably the most serious threat to the species at the present time.

5.5 Malaysia: Specific Recommendations

The management of wildlife in Malaysia is governed by three different legislative measures. In the Peninsula, the Wildlife Protection Act of 1972 provides wildlife protection for the 11 states. In Sabah and Sarawak, the Fauna Conservation Ordinance and the Wildlife Protection Ordinance make necessary provisions for wildlife administration respectively. The Sumatran rhino is protected by law throughout Malaysia. Of 20 known populations in Malaysia, 16 are considered inviable and only four (Taman Negara, Endau Rompin, Tabin and Danum Valley) are considered reasonably viable for long-term genetic management. Habitat destruction through logging, agricultural development, human settlement, and shifting cultivation are the main causes of the population decline. Poaching has been brought under control in the Peninsula but remains a serious problem in Sabah.

The goal is to maintain viable populations of the Sumatran rhinoceros in the wild in Malaysia. The objectives of the action plan for Malaysia are:

- to protect and manage the rhino and its habitat;
- to gather information on the viability of the populations and exact habitat requirements for rhinos;
- to promote scientific research and dissemination of information on captive individiuals;
- to build up the captive population so as to make animals available for reintroduction.

1. Sabah

a. Wildlife conservation and management in the state of Sabah is the responsibility of the Wildlife Division of the Forestry Department. The current strength of the Division is inadequate for effective protection and research to be conducted for the rhino in particular and wildlife in general. As a long-term measure, the Wildlife Division should be strengthened in terms of staffing, funding and logistical support.

b. The Fauna Conservation Ordinance 1963 is the wildlife legislation for the state of Sabah. Current penalties for poaching of rhinos and relevant provisions are considered inadequate to deter poaching or to ensure that offenders are brought to book. It is therefore recommended that the ordinance be reviewed to provide for heavier penalties for poaching of rhinos, and the powers of wildlife officers be reviewed to enable them to carry out their duties effectively.

c. Currently, only three breeding populations of the Sumatran rhino are known in Sabah, in the Tabin Wildlife Reserve, the Danum Valley Conservation Area, and the Kretam area (although there are other scattered records from south-eastern Sabah). The status of these three areas needs to be reviewed to determine how much land and habitat needs to be protected. In addition, sufficient manpower and facilities should be assigned to these two areas. Public education programmes should be instigated around these areas, and appropriate forms of buffer-zone development should be considered.

d. At least two of the known populations are considered to be reasonably viable for long-term genetic management (Tabin has approximately 20, and Danum about 10 individuals). It is recommended that surveys be conducted to determine whether further breeding populations exist, and to locate other isolated individuals.

e. It is recommended that the capture of isolated or threatened rhinos be continued for captive breeding or translocation purposes. Breeding between individuals from different geographical regions (e.g. Peninsular Malaysia and Sabah) should be avoided (unless further studies show that there are no appreciable genetic differences between these areas).

2. Sarawak

a. A detailed study of the rhino population is needed in order to demonstrate that the area should be declared a national park or a rhino reserve.

b. Constant monitoring of the Ulu Limbang population is

needed to determine its true extent, and its protection requirements.

3. **Tainan Negara and Endau Rompin (Peninsular Malaysia)**

a. These are the two viable populations in Peninsular Malaysia. Constant surveillance should be carried out on these populations. As a matter of the highest priority, the state governments of Pahang and Jahare should be encouraged designate Endau Rompin as a National Park.

b. Extensive habitat evaluation should be carried out to determine the carrying capacity of the areas. This information is important to determine whether these are suitable sites for the future release of animals translocated from doomed populations.

4. Sungai Dusun Wildlife Reserve (Peninsular Malaysia)

a. The "gene pool" concept, in which rhinos would be managed in a semi-wild state, should be implemented at this site. The founder population may consist of five breeding females and at least two sexually mature bulls.

5. Malacca Zoo (Peninsular Malaysia)

a. A captive breeding stock of at least two males and four females should be established.

b. The ARSG should pool all essential data from attempts at captive breeding of the species (including from attempts outside Malaysia) in order to ensure that maximum possible use is made of the limited supply of animals. Such data would include aspects of physiology, pathology, parasitology, feeding, growth and reproduction. The computer database facility at Malacca needs to be upgraded for this purpose. This database would be of use to other breeding facilities at Sungai Dusun, Tabin, Ragunan Zoo, Los Angeles Zoo and Howletts and Port Lympne Zoo. In this way, Malacca Zoo would act as a reference centre for the overall captive breeding programme.

6. Other areas in Peninsular Malaysia

a. Rhinos in isolated and threatened areas will be captured for the "gene pool" and captive breeding programme at Malacca zoo. When these facilities have reached the maximum holding capacity, the newly captured animals could be relocated in Taman Negara and Endau Rompin. It is also proposed that the Malaysian animals largely be kept within the country for the time being for the following reasons:

- That no mixing of animals from the four major regions of their range (Burma, Peninsula, Sumatra and Borneo) be undertaken until there has been adequate genetic investigation of any significant differences between these geographically disjunct populations.

- That all the animals now currently being caught are prioritised for the captive breeding and gene pool programme, which will require between 10 and 20 animals. Once sufficient animals are available for the breeding programmes in the Peninsula, and if it can be shown that they are genetically similar to animals from other areas, then further animals, if caught, could be considered for overseas captive breeding programmes.

5.6 Thailand

The current status of the species in Thailand is obscure, and requires investigation. If any animals survive, it is most unlikely that they do so in viable populations. As such, any animals would best be captured for a captive breeding programme (perhaps in conjunction with Peninsular Malaysia), pending reintroduction to a suitable site at a later date.

Rhino products, almost entirely of imported origin, are still available in Thailand. Although rhinos are strictly protected in Thailand, there is currently insufficient legal capacity to control the importation of rhino products. The government of Thailand is strongly urged to take action on this.

5.7 Burma

That the isolated subspecies lasiotus survives in northern Burma is confirmed by the continuing appearance of rhino products of Burmese origin in northern Thailand. As the situation permits, the status of the species in northern Burma should be investigated to determine the necessary in situ and ex situ conservation requirements.

5.8 Conclusion

The Sumatran rhino is an instance of a species where there is still time to act to reverse the current rapid decline in the population. Current efforts at all levels must therefore be intensified if a "Javan rhino" type crisis is to be avoided.

6. Action Plan Summary

This chapter summarises Chapters 3, 4, and 5 on the great one-horned, Javan and Sumatran rhinoceroses respectively. The goals for each of the action plans are highlighted as the following:

1. Preserve and manage the great one-horned, Javan and Sumatran rhinos as species and as components of their ecosystems.

2. Therefore, maintain viable populations *in situ* of all Evolutionary Significant Units (ESUs) of the three species against the pressure of habitat destruction and poacher activity.

3. To achieve this goal, develop populations of 2,000-3,000 individuals of each species. Ensure that for each species their populations are distributed across at least five separate sanctuaries, each of which should be capable of accommodating a minimum of 100 rhinos, preferably more. It is highly desirable to have two or more sanctuaries that can accommodate at least 400-500 rhinos each, though this might no longer be feasible for two of the species.

4. For Javan and Sumatran rhino in particular, Goal 3 will entail substantially expanding the existing population and establishing additional sanctuaries. For all three species, a total population larger than the minimum (i.e. 2,000), and additional sanctuaries capable of accommodating reasonably viable populations (> 100), are highly desirable.

5. "Doomed" rhino (i.e. individuals which are outside populations of reasonable viability and which cannot be protected with available or acceptable levels of resources) should be used for captive propagation, "gene pools", or be translocated to other natural sanctuaries where they may be part of viable and protectable populations.

6. Develop captive populations of at least 150 rhinos for each of the three species to reinforce the populations in the wild.

7. Encourage and assist efforts to reduce further the trade in rhino horn. Specifically:

   - There needs to be more enforcement of laws against internal trade in rhino horn and products, particularly in Singapore, Thailand, China, Hong Kong, and Taiwan. Use of substitutes for rhino horn needs to be promoted.

   - Efforts to prevent the illegal international commerce in rhino horn. Export of horn from India and Sumatra needs particular attention;

   - The internal trade of horn in Laos needs to be prohibited.

8. Implement public awareness and education campaigns in the vicinity of *in situ* rhino populations, to draw the attention of local communities to the importance and rarity of the rhinos, and thereby to mobilise public opinion in support of their conservation.

9. Continue wildlife management training programmes with a particular emphasis on developing an indigenous capacity to monitor and manage wild rhino populations, to capture, translocate, and reintroduce rhinos, and to maintain and breed them in captivity.

10. Continue protected area management training programmes, with an emphasis on survey techniques, anti-poaching measures, and village extension work. Devise methods whereby villagers can derive economic benefits from the protected areas.

11. As the situation permits, investigate the status of the Javan rhino in Indochina, and the Sumatran rhino in northern Burma, with a view to assessing what, if any, conservation activities should be undertaken.

Appendix 1: Principles of Conservation Biology for the Asian Rhinos

Preface

This appendix is an attempt to apply principles of conservation biology to Asian rhinos. As such it concentrates on the genetic and demographic problems of small and fragmented populations. The science of conservation biology is in early stages of evolution. Many aspects are still controversial or unvalidated. Moreover, genetics and demographics are only two of the factors that must be considered in developing conservation strategies and programmes. Thus the conclusions of this appendix should not be considered as absolute or definitive. However, it is important to be aware that these genetic and demographic problems may very well exist and to adhere to principles as discussed in this appendix as far as possible.

Introduction

Protection of both animals and their habitat is necessary for conservation programmes for Asian rhino. However, such protection may not be sufficient. The combined pressures of habitat destruction and poacher activity are both reducing and fragmenting rhino populations in the wild. When populations become small and fragmented, they become vulnerable to extinction for genetic and demographic reasons (Figure 4) in addition to the problems with habitat and from poachers. Moreover, the smaller the population, the greater these genetic and demographic threats become.

As a consequence, it becomes essential to maintain some minimum viable population (MVP) size or sizes to preserve the species against the genetic and demographic problems. Determination of what MVP is required is a central problem for the emerging science of conservation biology. This section of the Asian Rhino Action Plan is intended as an initial attempt to apply the principles of conservation biology to strategies and programmes for preservation of Asian rhino.

It is possible through appropriate population viability analyses (PVA) to prescribe the size of the population that will be required to achieve some level of genetic and demographic security. As explained more fully below, preliminary analyses suggest that minimum populations of 100 may be required for each separate wild population of rhino to be genetically and demographically viable over the next 150-200 years.

However, it should be emphasised that a recommended MVP is not necessarily the actual population now existing in a defined area of the natural range of the species. Instead, the MVP represents a minimum number that the area currently occupied by a given population must ultimately be able to sustain, assuming the rhinos can be protected and hence permitted to grow in number to the carrying capacity of the habitat. Thus, the MVP will by extension prescribe a minimum viable area required by this number of rhinos for each *in situ* population. Obviously, the size of this area will depend upon the density of rhinos that an area can accommodate.

Problems of Small Populations

Small populations lose genetic diversity rapidly at both the population and the individual level. At the population level, genetic diversity is vital to permit adaptation to continually changing environments. At the individual level, genetic variation is required to maintain the 'Vigor" of animals; loss of diversity in individuals is known as inbreeding and the phenomenon of decline in "vigor" (i.e., survival and fecundity) is inbreeding depression.

Conservation biologists have recommended that genetically effective populations of 50 are necessary for the shorter-term (5-10 generations), mainly to counteract inbreeding depression. Genetically effective populations of 100 to 500 may be necessary over the longer term (10 or more generations) to maintain adaptability.

However, the population size of relevance is not merely the census number. Rather it is the genetically effective size (N_e) which depends on how the animals are actually reproducing to transmit genes to the next generation. Very generally, the genetically effective size of a population depends on:

- the number of animals actually reproducing;
- the sex-ratio of the reproducing animals;
- the relative lifetime number of offspring (i.e. family size) of animals in the population.

For example, animals that do not reproduce at all do not contribute and thereby reduce the genetically effective size of the population below the census number. Alternatively, if a few animals do most of the breeding, again the genetically effective size is reduced. In natural populations, N_e is almost always only a fraction (25-75%) of the census number (N). Thus, to achieve an N_e of 50,70-200 actual animals might be required.

A preliminary analysis of the population biology of Asian rhinos suggests that the N_e/N ratio for this species in the wild might be of the order "0.5". Therefore, an MVP of 100 would be required to achieve an N_e of 50 for each separate population of Asian rhino.

Demographically, small populations are very vulnerable to natural disasters, disease epidemics, distortions of sex ratios (i.e., all animals born to the small number in the population being of one sex) and other ecological vicissitudes. Conservation biology models suggest that populations smaller than 25-50 total individuals are seriously at risk due to demographic problems of this nature.

Minimum Viable Population

Recognising the significance of these genetic and demographic problems, the concept of Minimum Viable Populations (MVP) has become central to modern conservation biology and strategies. MVPs are critical to populations in the wild or in captivity. In the wild, MVPs are important for the size, shape, number, interaction and security of reserves. In captivity, MVPs relate to the carrying capacity that is developed for the captive population and the number of founders needed to establish it.

MVPs depend on both the genetic and demographic objectives of a conservation strategy and on biological characteristics of the species under consideration. Genetic and demographic objectives of relevance are: the nature and amount of genetic diversity that is to be preserved and the length of time over which this variation is to be maintained.

1. The kind and level of genetic diversity to be preserved. Obviously, the optimal objective is to retain all or as much of the diversity as possible. However, with the restricted populations possible (in the wild or captivity) and limited resources for conservation, something less than all may have to be accepted at least for some period of time, e.g. "the demographic winter". This term has been created to denote that period of the next 200 to 500 years when human population growth and development will continue and intensify its devastation of wildlands, destruction of wildlife, and general disruption of ecological systems and balances on the planet. In any case specifying the kind and level of diversity to be preserved will prescribe MVPs required. Preserving rarer alleles (i.e. specific varieties of genes) will

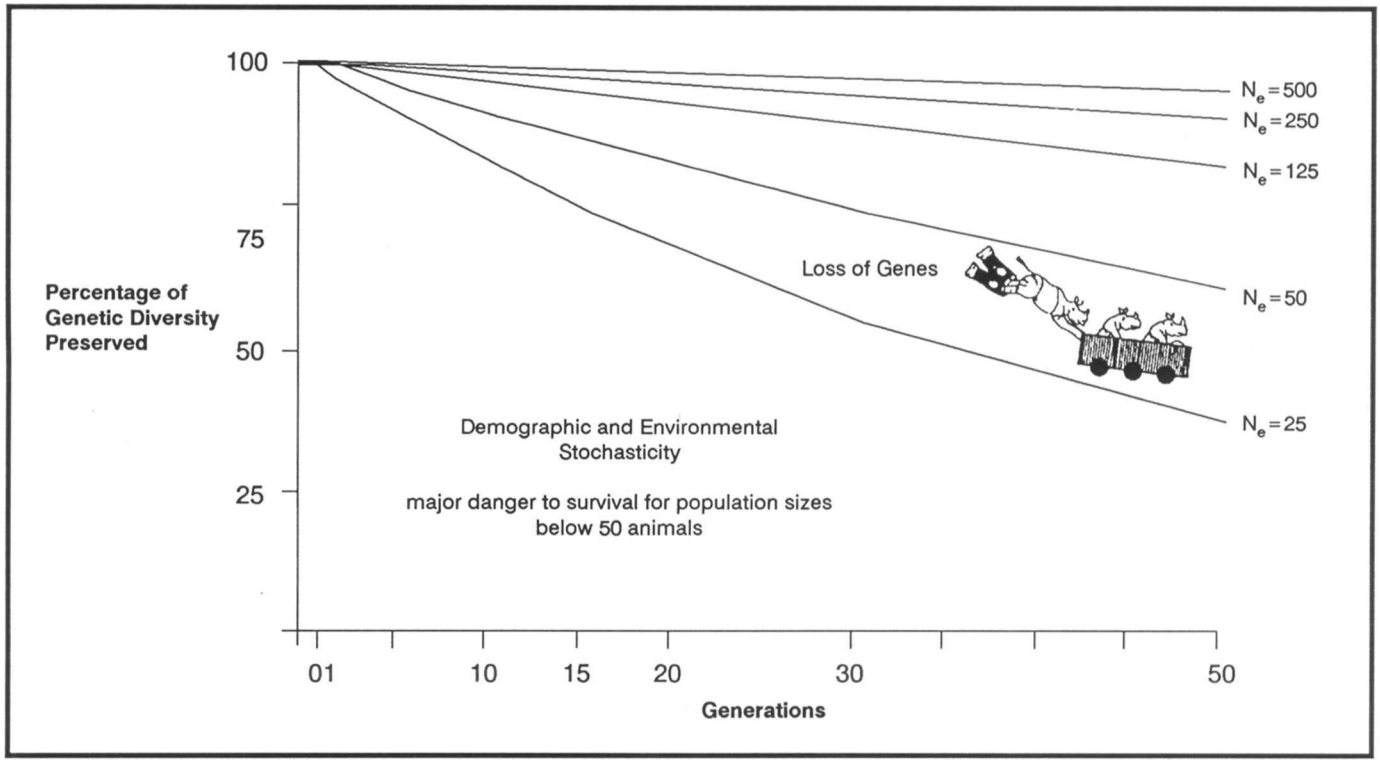


Figure 4. Decline of genetic diversity for various effective population sizes (N_e) possible for a total population (N) of 250.

require larger MVPs than merely maintaining average heterozygosity (some variation of any, non-specific kinds). Preserving 95% of average heterozygosity will require an MVP twice as large as 90% will. Unfortunately, population geneticists are not certain or agreed how much diversity is enough but levels of at least 90% of average heterozygosity have been strongly suggested.

2. How long must this level of genetic diversity be preserved? The optimal answer is indefinitely, i.e. the species will have enough variation to continue to evolve as environments change and to maintain adequate levels of vigor. But again, there may have to be compromises. Hopefully, intensive programmes will be needed only through the "demographic winter", which may in general continue for 200 to 500 years. However, the winter may vary on a species-by-species and area-by-area basis. Several reintroduction projects using captive stock of species extinct in the wild are in progress even now. But these opportunities are likely to be limited and often transient over the next century or two.

Biological characteristics of importance are: the generation time of the species; the N_e/N ratio of the populations; the number of founders that establish a population; the reproductive rate or recovery potential; and the degree of subdivision of the overall population.

1. The generation time of the species. Genetic diversity is lost generation by generation, not year by year. Thus some given period of time, e.g. 200 years, represents more generations, hence more opportunity to lose diversity, for a species like a tarsier than it does for a species like a rhino.

2. The N_e/N of the population. Loss of diversity depends on population size. However as discussed above, the population size of relevance is not simply the census number. Rather, loss of diversity depends on the way in which members of the population breed with one another to transmit their genes to the next generation. Such factors as animals not reproducing at all, uneven numbers of the males and females reproducing, or some animals having many more offspring than others can greatly reduce the genetically effective size far below the actual census number of a population. Normally N_e is less, sometimes much less, than N; and hence MVPs must be larger than the population size prescribed by genetic calculations since these prescriptions are always in terms of N_e.

3. The number of founders that establish a population. Founders are animals out of the wild population that are used to establish a captive or a new (including recovering) wild population; conversely, they could be animals from captivity that are used to re-establish a species in the wild. In general, the larger the number of founders, the smaller the MVP needed for some genetic objectives. However there is a point of diminishing returns so that usually 20-30 effective founders may be adequate. To be effective, a founder must reproduce. Thus, if capture programmes are planned carefully, source (e.g. wild) populations do not have to be decimated to create new (e.g. captive) ones.

4. The reproductive rate or recovery potential of the population. Much genetic diversity can be lost either as a population grows from its foundation size to its carrying capacity or during recovery from periodic reductions. In general, the higher the reproductive rate and hence growth or recovery to carrying capacity, the less genetic diversity is lost.

5. The degree of subdivision or fragmentation in the population. If a species population is fragmented into a number of subdivisions which are isolated from one another, animals may not be able to move around for breeding and hence exchange of genetic material. Such situations can cause loss of genetic diversity. On the other hand some subdivision may assist retention of some kinds of genetic diversity. The important point is that conservationists must analyse the genetic processes in the species under

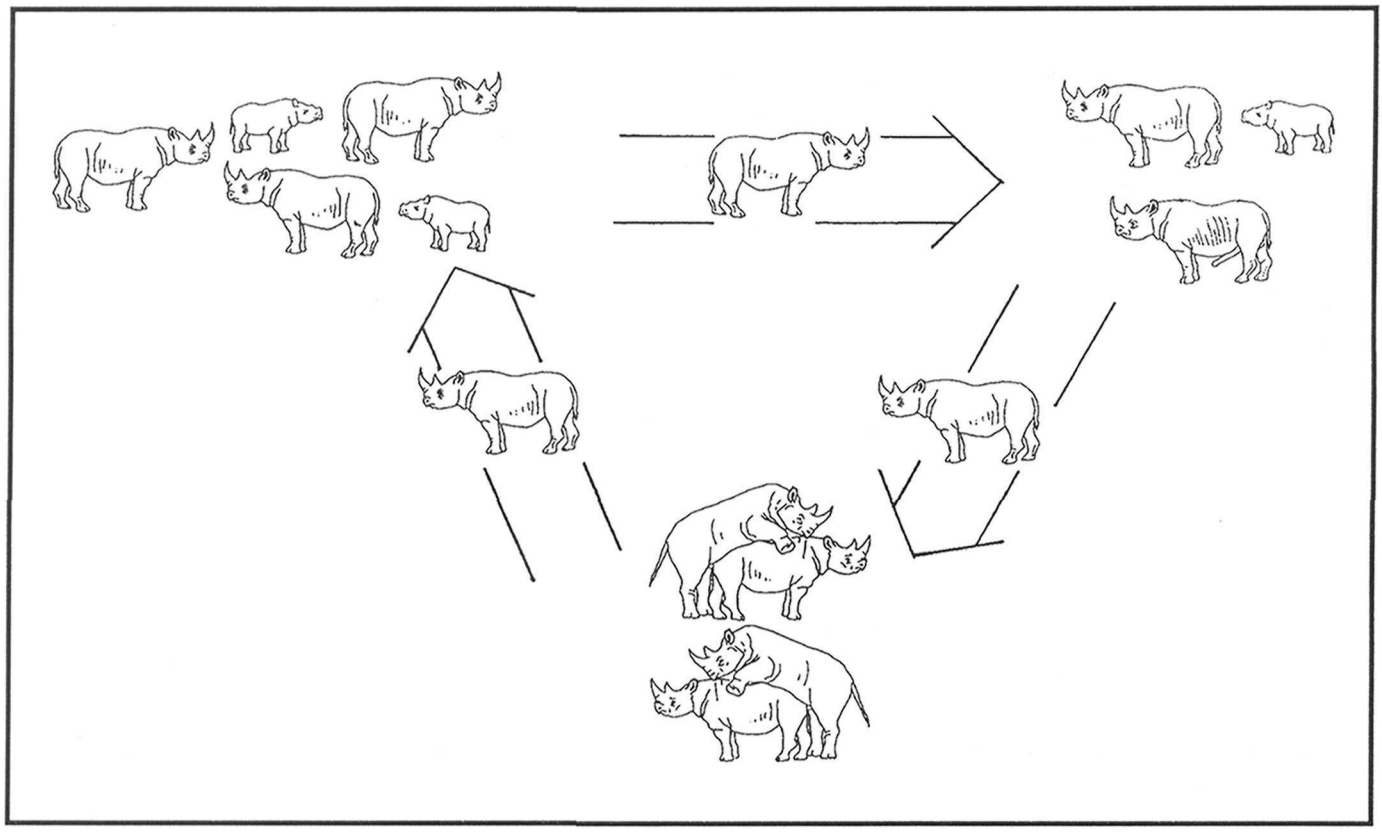


Figure 5. Managed migration among populations of rhino.

consideration and develop an appropriate management plan that may include artificial movement or manipulation of animals thus synthesising many separate smaller populations into a so-called metapopulation capable of greater long-term viability.

Finally, it must be emphasised that there is no single minimum viable population that applies to all species or to all situations for any given species. Rather, MVPs will vary depending on the objectives of the programme and circumstances of the species. Indeed, some conservation biologists are recommending that the term MVP be replaced by simply viable population (VP). But all conservationists agree that the kind of population viability analysis (PVA) described in this section is critical to successful conservation strategies and programmes for endangered species.

Population Viability Guidelines for Asian Rhino in the Wild

Based on considerations of conservation biology, habitat destruction, and poacher activity, it actually seems useful to distinguish three categories of Asian rhino populations in developing action plans:

1. Reasonable Viability

A minimum number of 100 rhinos seems to be indicated by PVA for a population be genetically and demographically viable for periods of time in the order of 150 years. To maintain such populations, areas of 100 km^2 or less will be required in the productive riverine habitats frequented by the great one-horned rhinoceros, and of 1000 km^2 or more in the mid-montane zones inhabited by the Sumatran rhinoceros. Naturally, area requirements may also vary somewhat depending on the actual carrying capacity of a particular habitat. Longer term viability (>10 generations) will then require that enough of the separate populations of 100 be maintained to achieve a metapopulation with an N_e of perhaps 500 for each species. Because of N_e/N ratio effects, such mctapopulations for each species will need to be 2,000 to 3,000 rhinos.

2. Limited or Uncertain Viability

Populations with fewer than these numbers of rhinos, actually or potentially, may have shorter-term viability and value for the preservation of the species. Artificial migration (i.e., managed movement) of rhinos periodically between smaller populations may effectively render them a single larger population and would thereby enhance the viability of such remnant rhino populations, as discussed further below (Figure 5). However, the cost of such operations will be high and their success uncertain.

There may be other factors that render a population smaller than the MVP guidelines for long-term viability worthy of attempted preservation. Uniqueness may be a consideration, e.g. the Sarawak or Thai populations of Sumatran rhino. Indeed, the entire matter of subspecies or better "evolutionarily significant units" (ESUs) must be considered when developing action plans. Smaller populations may also provide important research, educational or other opportunities. The Sungai Dusun Reserve for Sumatran rhino in Peninsular Malaysia is a case in point.

However, realistic cost-benefit analyses need to be performed on each of the rhino populations of limited viability to determine if intensive and interactive management is feasible in both logistic and economic terms. This cost-benefit analysis should above all else demonstrate that attempts to preserve these smaller remnants of rhinos do not divert or dissipate resources needed to protect the larger, reasonably viable populations.

3. Inviable or "Doomed"

A "doomed" rhino is defined as an animal that is considered to have no possibility of contributing to the survival of the species in its current situation because:

a. It is not part of a population large enough to be viable in genetic

and demographic terms, and/or

b. The animal cannot be protected from habitat destruction or poacher activity with acceptable or available levels of resources.

Single animals or isolated groups that do not satisfy the MVP criteria and which cannot be protected from habitat destruction or poacher activity with available or acceptable levels of conservation resources are "doomed".

Protectability of Rhinos and their Habitat

Assessment of risks to viability from habitat destruction and poacher activity have been discussed previously in van Strien (1985b). Factors that need to be considered in evaluating the protectability of rhinos and their habitat include:

- ecological situation, including the location of the area in relation to other places occupied by rhino;
- legal status, i.e. whether or not the area has been gazetted as a protected area;
- land use plans and the stage of their development;
- pressure to use the area;
- alternatives available to use of land and their cost;
- level of poaching;
- type of poaching: trappers in Sumatra versus Dyaks in Borneo; it will be cheaper to protect in Sumatra;
- accessibility of the area;
- present and future manpower to protect the rhinos;
- cost of protection in relation to other demand on resources.

Viable Populations of Asian Rhinos

Currently, five populations of great one-horned rhino, seven populations of Sumatran rhino and possibly one population of Javan rhino seem to satisfy the criteria for minimum viable size, as well as probable protectability (see Table 4).

Table 4. Viable populations of the Asian rhino

Species	Country/State	Population
Great One-horned Rhino	India	Kaziranga
		Manas
		Orang
	Nepal	Chitawan
		Bardia
Sumatran Rhino	Peninsular Malaysia	Taman Negara
		Endau Rompin
	Sabah	Tabin
		Danum Valley
	Indonesia	Gunung Leuser
		Kerinci Seblat
		Barisan Selatan
Javan Rhino	Indonesia	Ujung Kulon

Table 5. Population viability analyses (PVA) for captive populations of Sumatran rhino.

A. Example of PVA software output

Effective population size (N_e) and carrying capacity necessary for maintaining the specified amount of genetic diversity for a specified time period.

Years per generation:	15	No. generations during period:	15
Yearly % growth rate:	1.03	Gen. growth rate:	1.56
Effective no. of founders:	20	Gen. expon. growth:	0.44
Estimated N_e/N ratio:	0.5		
Desired % heterozygosity retained	90		
Length of time period:	225 years		

Effective Size required to maintain desired amount of original variation for the specified length of time: 118

Carrying Capacity necessary to maintain desired amount of the original variation over this time: 236

B. Actual captive population sizes required to preserve 90% average heterozyosity for indicated number of years commencing with indicated number of effective founders

Generation time = 15 years
Population growth rate = 1.03
N_e/N ratio = 0.5

		Years				
		75	**150**	**225**	**300**	**375**
Effective Founders	**10**	-	-	-	-	-
	15	73	275	516	857	1226
	20	62	131	236	367	477
	25	50	121	189	273	362
	30	30	103	170	241	316

c. Actual captive population sizes required to preserve 90% average heterozygosity for 225 years with indicated N_e/N ratios commencing with indicated number of effective founders (assuming slow population growth rate)

Generation time = 15 years
Population growth rate = 1.03
N_e/N ratio = 0.5

		N_e/N				
		0.3	**0.4**	**0.5**	**0.6**	**0.7**
Effective Founders	**10**	-	-	-	-	
	15	861	645	516	430	369
	20	393	295	236	196	168
	25	315	236	189	158	135
	30	283	212	170	141	121

D. Actual captive population sizes required to preserve 90% average heterozygosity for 225 years with indicated N_e/N ratios commencing with indicated number of effective founders (assuming faster population growth rate)

Generation time = 15 years
Population growth rate = 1.05
N_e/N ratio = 0.5

		N_e/N				
		03	**0.4**	**0.5**	**0.6**	**0.7**
Effective Founders	**10**	1758	1318	1055	879	753
	15	449	337	270	225	193
	20	323	242	194	161	138
	25	288	216	173	144	123
	30	270	202	162	135	116

There is also the possibility that there are other populations that can satisfy long-term viability criteria: e.g. Gunung Abongabong and Lesten-Lukup in Central Aceh (Sumatra) or on Borneo in Kalimantan-Sarawak for Sumatran rhino; in Dudhwa for the great one-horned rhino; in Indochina for Javan rhino. But more surveys must be conducted to secure information on these possibilities.

Rhinos outside populations and areas that do not satisfy the minimum viable size criteria will be of limited or uncertain viability and should be subjected to cost-benefit analyses to determine if they should be designated as inviable or "doomed".

Options for Doomed Animals

Two options seem possible to attempt redemption of "doomed" rhinos:

1. Translocation

There are two variations of this option:

a. One-time movement of the animal to a larger and/or safer situation.

b. Periodic movement of animals among population remnants which are too small to be viable by themselves but which might be managed by such artificial migration of genetic and demographic material to constitute a single larger population which could be viable.

The latter variation has been proposed for black rhinos in Africa and great one-horned rhinos in both Nepal and India. However, the option may be much less applicable to Sumatran or Javan rhino. This kind of intensive management and artifical migration requires considerable information on the subpopulations, i.e. sexes, parentage, etc. Such information will be much more difficult to collect on forest-dwellers like the Sumatrans than on largely savanna animals like the black rhino.

The cost of moving many animals among a large number of very small populations and indeed of trying to protect numerous fragments also argues for a minimum size for such subpopulations. Although theoretically small populations of any size might be interactively managed to create larger metapopulations, the limited resources available for protection and manipulation of animals in the wild can be extended only so far.

Many problems are perceived and have already been observed with translocations of rhinos and other vertebrates.

a. New animals may be disruptive to the social organization of resident populations.

b. Translocated animals may be disoriented in the new habitat and actually try to repatriate themselves.

c. Translocated animals may introduce diseases and parasites.

d. The habitats to which animals are translocated may already be saturated under prevailing conditions, e.g. poaching pressures as well as non-human aspects of the environment.

e. It may still not be possible to protect animals from poachers.

2. Captive Propagation

A number of clear advantages can be recognised for captive propagation.

a. Protection from poachers.

b. Moderation of environmental stochasticity or vicissitudes.

c. Management to maximise preservation of genetic diversity.

Considering these factors, it appears that establishment of a viable captive population should have priority over attempts at translocation of "doomed" rhinos. Once a viable foundation for a captive population is established, if there are more "doomed" rhinos that need to be rescued, perhaps translocation experiments can be attempted if adequate habitat and resources are available.

Population Guidelines for Asian Rhino in Captivity

Because of the limited space and resources available in ex situ facilities, MVPs may have to be, and probably can be, even more precisely defined for captive than for wild populations. An objective for captive propagation of attempting to preserve 90% of average heterozygosity for 200 years are common recommendations of conservation biologists considering carefully principles of population genetics (e.g. inbreeding) and demography, as well as the likely period of time that human pressures will be most intense on wildlife.

To achieve the objectives of preserving a significant fraction (90%) of the wild gene pool for an appreciable period of time (e.g, 200 years), a number of combinations of ultimate carrying capacity, initial founder numbers, and population growth rates will produce the desired results. Table 5 provides some examples of the kinds of calculations that can generate guidelines (using the Sumatran rhino as an example). Despite some flexibility, the constraints imposed by the biological characteristics of the species will prescribe a critical minimum for the number of founders (i.e., animals out of the wild) that will be needed to establish the captive population.

Considering these factors for Asian rhino, a minimum of 20 pairs out of the wild over the entire range of the species (e.g., in the case of Sumatran rhino, 11 pairs out of Sumatra, 5 out of Peninsular Malaysia, and 4 out of Borneo) seems necessary as a viable foundation for the captive population, which itself will be distributed over Peninsular Malaysia, Sabah, Indonesia, Great Britain, and the United States.

If and where subspecies are validated so that they should be preserved as separate entities, then a larger number of founders may be needed to achieve the same genetic and demographic objectives.

Mechanics for Designation of Animals as Doomed

- It will be the responsibility of the countries of origin to provide the information and the initial recommendations to decide which animals should be considered doomed and hence candidates for capture.

- The IUCN/SSC Asian Rhino Specialist Group should review and ratify these decisions using the criteria delineated in this Appendix.

- Each country with Asian rhinos should systematically analyse all known populations and submit recommendations for "doomed" or "not doomed" as soon as possible. Tables 1-3 represent the kind of compilation of population and habitat sizes that can serve as the basis for analysis. Such a systematic and comprehensive analysis will in essence constitute the nucleus of a global masterplan for conservation of all three species.

- In the meantime, urgent cases that represent both a need and an opportunity for capture to found the captive population should receive immediate attention by the countries of origin and then the IUCN/SSC Asian Rhino Specialist Group.

Appendix 2: The Singapore Proposals on the Sumatran Rhinoceros Conservation Programme

1. The primary goal is long-term survival of the Sumatran rhino as a species and a component of natural ecosystems.

2. A comprehensive masterplan for conservation of the species will be developed, which will be collaborative and multinational in nature and which will identify and integrate all of the actions necessary to achieve the primary goal.

3. Development and oversight of the masterplan will be the responsibility of the IUCN/SSC Asian Rhino Specialist Group.

4. The conservation programme will include to following three fundamental activities:

   a. Development of an education programme to enhance public awareness and support for the Sumatran rhinoceros.

   b. Provision of primary support for a programme of conservation for the Sumatran rhinoceros as viable populations in sufficiently large areas of protected habitat.

   c. Establishment of a captive breeding programme for the preservation of the genetic divesity of the Sumatran rhinoceros in the countries of origin, including Indonesia, Malaysia and Thailand, and in North America and Europe, using animals with no hope of survival in the wild. The parties are committed to contribute to each of these in each country as mutually agreed, with details subsequently recorded in a bilateral memorandum of understanding or similar document.

5. The following principles and actions are to be observed in the captive propagation programme:

   a. Animals selected for capture in the wild are to be "doomed" individuals or come from "doomed" populations or habitats; that is, those whose future long-term viability or contribution to the survival of the species is determined to be unsatisfactory as measured by objective criteria subject to continuing refinement.

   b. Currently presumed subspecies stocks will not be mixed, either in captive breeding or in the wild translocation, until further work is done on their taxonomy.

   c. The zoo communities will provide support and technical assistance in field capture and transfer operations.

   d. Bilateral agreements will provide for captive breeding programmes in the countries of origin as well as in the United States and United Kingdom.

   e. Animals sent abroad will be on breeding lone from the countries of origin, or under some similarly equitable ownership agreement of sufficient time span to protect all interests.

   f. All animals placed in captivity and their future progeny will be managed cooperatively as part of a "world population" in the light of the primary overall goal of the programme. Decisions will be taken by consultation among the owners and interested parties with oversight provided by the IUCN/SSC Asian Rhino Specialist Group.

   g. Bilateral agreements will provide for appropriate support, training and technical assistance in captive breeding in the countries of origin.

Appendix 3: Captive Management Guidelines for the Sumatran Rhino

Because of the limited supply of animals, every possible step must be taken to minimise mortality. The following aspects should be taken into consideration:

1. Basic requirements. There should be large enclosures, and public access should be strictly limited. The paddock area must have plenty of shade, and it is essential that the animals have a place where they can wallow in mud. A holding pen should be connected to the paddock, constructed in such a way as to give the animals shelter from adverse weather conditions. The holding pen should also have facilities that permit veterinary care to be performed. The diet should be kept as similar as possible to that in the wild; the species is a browser and needs large amounts of food, rich in fibre.

2. Breeding loans should take place within the same ESU (in this respect, taxonomic studies are urgently required). The reproductive rate is slow, and so it is therefore recommended that females be considered for long-term loans, and males for short-term loans, taking into account the necessary genetic and demographic requirements.

3. Training is an important aspect of the programme, and should include all aspects of veterinary care and genetic analysis. The trained personnel should follow standardised procedures for the physical examination of animals; in particular, body measurements and growth rates should be recorded; and all appropriate records should be sent on a yearly basis to the International Studbook Keeper.

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