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Cover photo of black and white ruffed lemur by M. Dulaney

IN SITU AND EX SITU EFFORTS TO SAVE THE SUMATRAN RHINOCEROS (*Dicerorhinus sumatrensis*)

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BACKGROUND

During this last decade and a half of the 20th century and the 2nd millennium, there has been a very challenging and, at times, most controversial program in progress to help prevent the Sumatran rhino (*Dicerorhinus sumatrensis*) from going extinct. The controversies have ebbed and flowed, but throughout, a number of people originally involved have worked to the present day unaffected by the adverse criticism. The species that was at the center of the controversy still is critically endangered. It is a well-known fact that the rhinos have disappeared at an alarming rate, and they are included in the IUCN list of the ten most endangered species of the world.

Status

The Sumatran Rhinoceros has survived largely because it inhabits mountainous forests not subjected to development and logging. Numbers, however, have continued to decline at a rapid rate with heavy losses over the last 10-15 years. Today about 300 rhinos are estimated to survive in the wild. Figures 1-3 provide the current numbers and distribution of the Sumatran rhino in Peninsula Malaysia, Sabah, and Indonesia. Table 1 presents the various estimates of Sumatran rhino populations over the years.

Table 1. Estimates Of Populations

	Country									
Reference	Peninsular Malaysia	Sabah	Sarawak	Kalimantan	Sumatra	Thailand	Myanmar	Cambodia	Indonesia	World
Medcafe, 1961	50									
Anon, 1962										100-170
Burton, 1963				20-30	20		26			76-86
Hislop, 1966	10-30									
IUCN, 1967	30			10		60	20-30	10		136-146
Stevens, 1968	20									
Schaurte, 1968										150-170
Schenkel & Lang,1969										50-100
Bajaruddin, 1971									80-90	
Ng Poh Tip, 1973	18-22									
Asian Rhinos Action Plan, 1989	67-109	38	5-15	?	290-785	6-15	6-7			
Asian Rhinos Action Plan, 1993	85-126	48-68	10		197-274	10	6-7			
Asian Rhinos Action Plan, 1995	41.34.4 (79)	20-30			36.64 48 (148)	1				

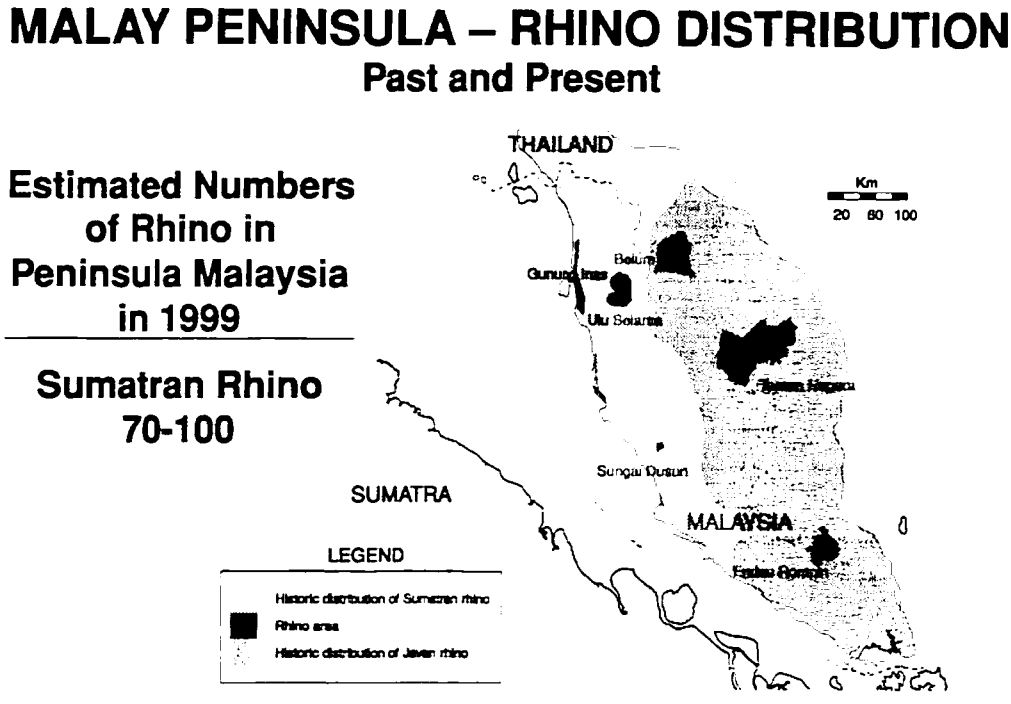

Figure 1. Malay peninsula - rhino distribution

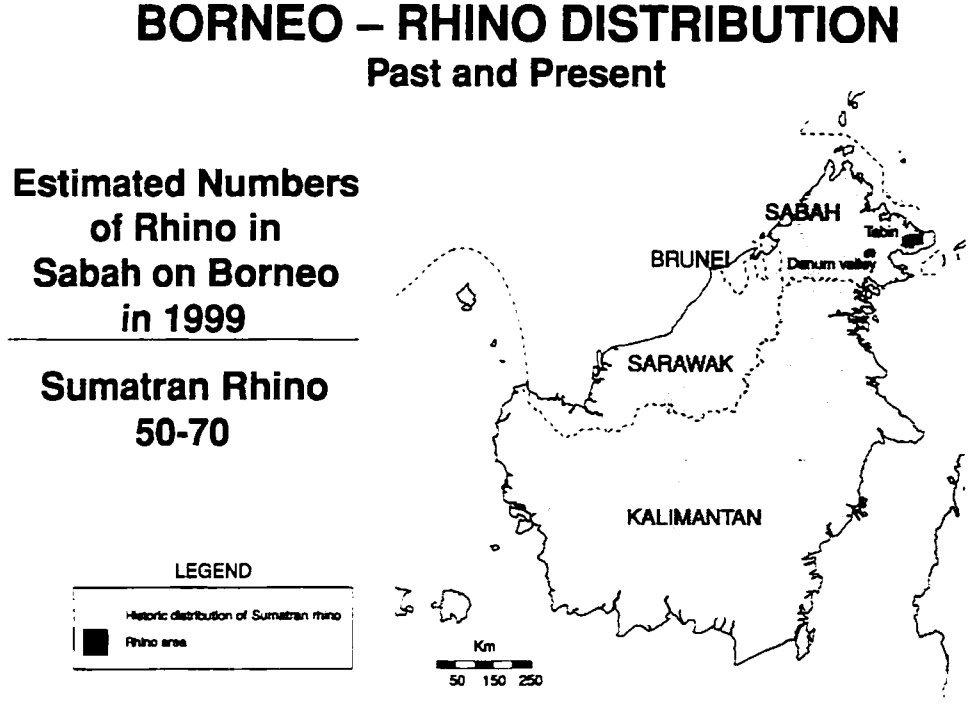

Figure 2. Borneo - rhino distribution

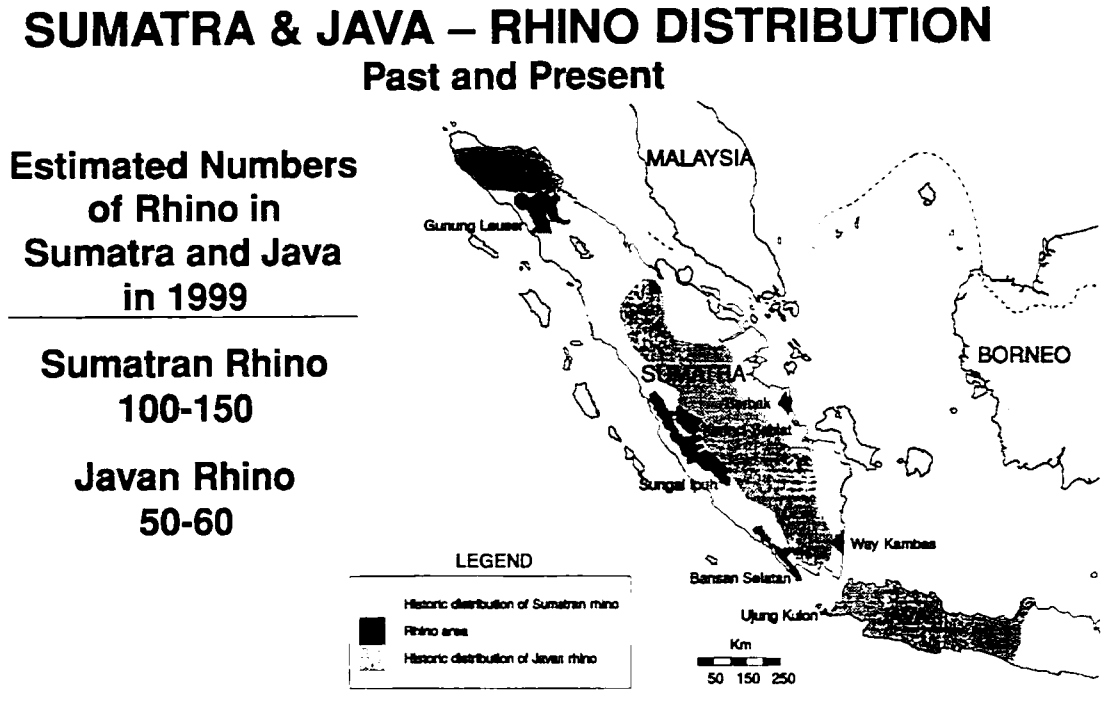

Figure 3. Sumatra & Java - rhino distribution

In Peninsula Malaysia, serious efforts to conserve the rhinos in situ started in the early sixties at Sungai Dusun and Ulu Selama. There were a lot of forests then, and the rhinos only needed protection for their survival. Both areas were largely inaccessible and could only be reached on foot. Concern over the survival of the rhinos slowly increased over the years as forests were rapidly opened for development. The Sumatran rhinos were also known to occur in the Endau-Rompin area of Johore and Pahang. In the mid seventies, studies revealed the existence of 20-25 rhinos in that area. Surveys were also made in Taman Negara and finally the Belum area of Perak received a lot of attention from naturalists and scientists. The surveys and studies have revealed the occurrence of viable populations of rhinos in the four areas.

In Indonesia efforts commenced about the same time but have fluctuated with serious lapses occurring during most of the 1980's.

Causes of Mortality

The high commercial value of rhino horns for Asiatic traditional medicines created the demand that is associated with the intensive illegal killing. Added to the threats is the loss of habitat that resulted in the decline of rhino populations. The Sumatran rhinoceros is listed on Appendix 1 of CITES and, in spite of measures taken by individual range states, decline and even extinction of some populations have continued.

The Sumatran rhinos are killed either by gun or trap, the latter being more common. There are many types of traps varying from pits to snares. The steel-wire snare is the most commonly used and certainly the most effective. The snares are very difficult to detect, and the trappers never wait for animals to be trapped. Instead, trappers usually enter deep into the forests, quickly set the steel-wire snares and move out.

Traps are checked a few months later without any consideration given to the sufferings of the unfortunate rhinos or other animals caught in the snare. Although rhino carcasses have been found, no one has been arrested for snaring rhinos.

Effective protection is obviously the most important measure that must be taken to conserve the Sumatran rhinoceros. Protective measures have to be evaluated to test their effectiveness. Success will be indicated by an increase in rhino populations.

There is a need to come to terms with the fact that large areas of forests were cleared in Malaysia and Indonesia, and most now are accessible to poachers. Comprehensive protective measures are difficult to take because of the vast areas to be covered and the lack of personnel, equipment and funds. The Sumatran rhinos are now confined to a number of protected areas in Malaysia and Indonesia, and considerable effort is being made to protect them.

Range States and Non-Governmental Organization (NGO) Efforts

Governments of both Malaysia and Indonesia have provided personnel and equipment for rhino management. The protected areas are created by these governments. Personnel are appointed on a permanent basis and are paid salaries and benefits. There cannot be any doubt about these Governments contributing significantly to rhino conservation. Additionally, contributions from non-governmental sources have been substantial in the last five years.

The Asian Rhino Specialist Group (AsRSG), International Rhino Foundation (IRF) and other NGOs have worked closely with the governments of Malaysia and Indonesia to develop and support conservation programs for the Sumatran rhino. A Global Environment Facility (GEF) project that was jointly planned and developed secured two million dollars over a period of three years to initiate a system and program of anti-poaching teams known as rhino protection units (RPUs). However, funds were limited and plans accordingly had to be tailored to fit within certain limits. Lessons learned in the past (since 1978) provided valuable clues regarding what urgently needed to be done.

A total of 27 RPUs have been organized for the Sumatran rhino under the GEF/AsRSG/IRF program: 13 in Indonesia, 10 in Peninsula Malaysia, and 4 in Sabah. Recently, 3 more RPUs have been formed for Javan rhino in Indonesia. The total cost of the RPU program is approximately $500,000 per year.

To supplement and extend support beyond the duration of the GEF grant, the AsRSG and IRF have provided and recruited significant other funds for the RPUs. Other major contributors to the RPU program have been the Rhino and Tiger Conservation Fund (RTCF) of the U.S. Fish and Wildlife Service, the Bowling for Rhinos Program of the American Association of Zoo Keepers, and more recently, the WWF-Indonesia Program with funds from other WWF National Organizations.

Effective Measures Needed

It was obvious that law enforcement officers had to spend long periods of time in the forests, particularly in areas where rhinos live. This was by no means an easy task since the wildlife rangers had to work in the forest up to three weeks of each month every month of the year. Unfortunately, it is the only way to protect the rhinos in the tropical rainforest where the presence of enforcement officers will keep poachers away. Needless to say, the wildlife rangers have to be paid allowances for the periods they spend in the forests. The often serious shortage of funds for field support has left forests without wildlife rangers. Poachers move into these unprotected areas and cause heavy wildlife mortalities.

To determine if protective measures are effective, changes in the extent of illegal hunting and the status of populations in range states must be monitored. Law enforcement personnel must report on illegal activity, especially the discovery of snares which are destroyed immediately. Used cartridges of shot-guns and other signs of weapons and traps that are found should also be reported. The evidence gathered will provide some insight or level of understanding about the poachers involved in the illegal activity.

Poachers obviously sell the horns to traders for high prices. There have been cases of seizures from traditional medicine shops in the range states. Two seizures in Malaysia accounted for eight Sumatran rhinos, a significant number considering the species' small population. The trade route and consumers need to be identified. Trade indicators are important to understand casualties but more emphasis must be put on law enforcement to measure changes in the level of illegal hunting and the status of populations in the range states.

INITIATING A CAPTIVE BREEDING PROGRAM

Origins

Because of the difficulty of ensuring the survival of the Sumatran rhino through protection in the wild alone, a diversified strategy was recommended in the early 1980s that would add captive breeding as a second component to the conservation program. In 1984, a meeting was held under IUCN Species Survival Commission (SSC) auspices in Singapore to deliberate the pros and cons of captive breeding. Singapore was chosen as a neutral country for the meeting. The objective of the meeting was clearly focused on ex-situ conservation as a first step to in-situ conservation. It was quite a stormy meeting, probably with the majority of people against the idea of bringing the Sumatran rhinoceros into captivity.

It was finally decided to rescue doomed animals for captive breeding and to initiate three separate captive breeding programs: Peninsula Malaysia; Indonesia; and Sabah. It was a good decision as far as the doomed animals were concerned, but still, there were some people who wanted nothing to do with captive breeding. They claimed they would rather leave the animals alone to eventually die out with pride. Those people have had their wish come true as most of these doomed animals have suffered mortality.

However, there also were people with a strong conviction in supporting ex-situ conservation. Their belief was largely based on the fact that the species had become extinct in neighboring countries and was disappearing in most of its range in Malaysia and Indonesia. Proponents of captive breeding for the Sumatran rhino also cited the reasonable success that had occurred with the captive programs for Indian, black, and white rhino.

Unbelievable First Experience

The thought of an April fool joke crossed my mind that morning in 1984 when we rushed down to Jeram, Selangor in response to a report of a rhino capture. We were shocked to see a Sumatran rhinoceros tied by its neck to an oil palm tree. All four legs were also tied together.

We carefully untied her legs, and the animal stood up. She remained still for several minutes in the same spot, then tried several times to walk away. She was held back by the rope. She ate several species of leaves that were offered to her, and to our pleasant surprise, she became quite docile. The large crowd of people who had gathered did not seem to frighten her, probably because she was used to the presence of plantation workers who had chased her into a canal, tied her and dragged her to the oil palm.

Capture Technique

Malaysians were not against ex-situ conservation but objected strongly to any rhino being exported. Indonesia had more rhinos, and it was agreed that about 10-12 rhinos should be sent to the United Kingdom and the United States. Simultaneously, ex-situ conservation would also be initiated in Indonesia.

To capture rhinos, drop-door corral traps (thought to be the most suitable) were built in Tenggaroh, Johore and near Pekan Baru, Sumatra. We incorporated a transfer compartment. The corral was large and cleverly built around an active wallow. The wooden poles were cut from a different area and carried over a long distance to minimize disturbance. A rhino unsuspectingly walked to its wallow, and the door dropped as it stepped on the trigger mechanism. We had captured our first rhino.

Our excitement, however, was short-lived as the animal escaped through a weak point in the transfer compartment. That escape may have been a blessing in disguise, because the first rhino captured in Indonesia died in the trap. The animal actually struggled continuously to escape through some openings in the corral, repeatedly hitting itself against the wall of the trap and dying of self-inflicted injury. The death of this rhino was quite tragic and frightened everyone. It was a very bad start to a very sensitive project, and it was decided to replace the corral with a pit trap.

The pit trap also had to be modified after sambar deer, tapirs, an elephant, a motorcycle and even a Land Rover fell into it in Peninsular Malaysia. However, the pit trap was improved and became the most effective method of catching Sumatran rhinos.

Results of Capture

Over the years, in Malaysia and Indonesia combined, a total of forty rhinos have been captured by pit traps. Table 2 summarizes the number of rhinos captured in each region, their ultimate destinations and what has occurred with these animals. Unfortunately, mortality has been high and there has been no reproduction (i.e., no rhino both bred and born in captivity).

Table 2. Summary - Captive Programs Sumatran Rhino - 1984 to 1999

Country	Captured	Born	Imported	Exported	Released	Died	Alive
P. Malaysia	3/9	0/1	1/0	0/2	0/0	2/2	2/6
Sabah	8/2	0/0	0/0	0/0	1/0	6/0	1/2
Indonesia	7/11	0/0	0/1	4/7	0/0	3/3	0/2
Thailand	0/0	0/0	0/1	0/0	0/0	0/1	0/0
UK	0/0	0/0	1/2	0/0	0/0	0/2	1/0
USA	0/0	0/0	2/5	0/0	0/0	1/3	1/2
Total	18/22=40	0/1	4/9	4/9	1/0	12/11=23	5/12=17

Ten animals eventually were trapped in Peninsular Malaysia. Additionally, a calf was produced by a female that was pregnant when captured, and a very young male was found abandoned, making the total captive population in Peninsular Malaysia twelve animals. Ten rhinos were captured and managed in Sabah. The captive breeding program was initiated with great enthusiasm and with the best of intentions, but there were more problems.

CAPTIVE BREEDING EFFORTS IN MALAYSIA

Under the watchful eyes of project personnel. the first female captured by a pit trap was put together with the female we had found tied to the oil palm. The rhinos appeared friendly at first, sniffed and walked together for several minutes but then started fighting and rather fiercely. They were quickly separated.

The first male rhino captured on 26th March 1986 was immature. The male was later paired with females. The animals were paired up for 3 hours every morning under the watchful eyes of the officers and wildlife rangers. The male would be separated by an officer or a wildlife ranger when the female was attacked.

The rhinos were also put together when the females were thought to be close to estrus. An ultrasound scanner was used to monitor estrus, but the males still were aggressive. It was thought that large fenced areas would provide the cover for females to take shelter and hide from the aggressive males. A ten acre area of forest in Sungai Dusun was fenced for the purpose and larger areas of twenty five acres were developed in Way Kambas, Indonesia. Efforts to breed the rhinos have continued with more vigour using both the gene pool concept and the paddock The Department has five of six females in good breeding condition and two adult males.

The mortality of four animals or 33% in Peninsular Malaysia occurred in the first 4 years of the captive breeding project. The young male did not survive, a female given to Thailand died of an accident, another female died of cecal impaction, and the last mortality occurred on 23rd September 1988 when a female died of salmonella.

The project was the first sustained effort to bring in the animals for breeding. The best and most experienced officers had been put on the project. Funds and equipment had been adequately provided. The project would have been rated a great success if a few calves had been produced in captivity. Unfortunately, no female has produced a calf, and more efforts are needed to achieve this main objective of the project.

CAPTIVE BREEDING EFFORTS IN THE UNITED STATES

Initial Struggles

The Sumatran rhinoceros breeding program has been a difficult learning experience for the United States and only now is beginning to show promise. Similar to the experience in Malaysia, mortality initially was high. Of the seven animals sent to the U.S., only three currently survive. Two animals died of intestinal torsions, one died of liver disease and one of kidney failure. The last male Sumatran rhino in the U.S. was almost lost when he stopped eating, lost weight and finally refused to get up. Desperate to keep him alive, keepers and veterinary staff had fresh, leafy ficus branches flown to Cincinnati, and when it was offered to the male, he immediately got up and started eating. Since then, the Sumatran rhinos have received fresh browse daily as a major part of their diet, and their health has been excellent for the past several years.

Attempts to Breed

Initial attempts to introduce the Sumatran rhinos for breeding often resulted in aggressive chases that put the female at risk of serious injury. These experiences made animal managers wary of introducing the female to the male when she was not in estrus. However, there were no obvious behavioral signs of estrus, so introducing the animals only during estrus was not possible. In fact, we did not even know if the females were exhibiting reproductive cycles.

Intensive Research

Due to the docile nature of the Sumatran rhino and the excellent animal handling facilities at the Cincinnati Zoo, it was feasible to initiate an intensive research project. Our goal was to gain an understanding of the reproductive physiology of the female Sumatran rhinoceros and use that knowledge to help develop a successful captive breeding program. Serial rectal ultrasound examinations were conducted to monitor ovarian activity, fecal and blood samples were collected to measure hormone levels and animal behavior was recorded. These data helped us determine that one female was not exhibiting ovarian activity and probably had reached reproductive senescence. However, the other young female was reproductively active and, after 2 years of collecting data and some trial and error, an effective breeding program was developed.

Why Has It Been So Difficult

There still is much to learn about breeding the Sumatran rhinoceros in captivity, however, in retrospect, we can begin to understand why it has been so difficult. In our experience, there have been no reliable behavioral signs of estrus demonstrated by the animals. Furthermore, we discovered that the female appeared to be an induced ovulator (ovulates only when bred) and receptivity does not coincide with the development of a very large follicle. Instead, she is receptive when the follicle reaches a moderate size and progesterone is baseline. When allowed to breed during her receptive period, the female ovulates and, if not pregnant, will be receptive again in about 21 days. However, if she is not bred, she does not ovulate, and her reproductive cycle can become irregular making it difficult to predict the next estrus.

The Challenge Still Ahead

Overall, research already has had a successful impact on promoting natural breeding of this endangered species. Of the first nine completed copulations, three resulted in pregnancy, but each was lost early in gestation. The longest pregnancy lasted only 3 months. The cause for early pregnancy loss in this young, healthy female is unknown. This unexpected problem represents the final hurdle we must overcome in achieving our goal of producing a Sumatran rhino calf.

CAPTIVE BREEDING EFFORTS IN INDONESIA AND THE UNITED KINGDOM

Of the 6 (3.3) rhinos that were captured and remained in Indonesia, all but 1 female have died. Of the 3 (1.2) rhinos that were captured in Indonesia and translocated to the United Kingdom, only the male survives. The female that was received from Peninsula Malaysia also survives. In 1993, in recognition that traditional captive breeding methods were not succeeding with the Sumatran rhino, the Department of Nature Protection and Conservation (PKA, then known as PHPA) joined with Taman Safari Indonesia, the International Rhino Foundation and Yayasan Mitra Rhino (The Rhino Foundation of Indonesia) to develop a managed Sumatran rhino breeding center in native habitat at Way Kambas National Park in Sumatra. The objective is to move animals still surviving in zoos back to native habitat to be able to provide greater space and more natural conditions in the belief that these changes might induce the rhino to reproduce. The 3 (1.2) rhinos that had survived in the Indonesian and U.K. zoos have now been moved into a 250 acre (100 hectare) area of native forest enclosed by an electric fence. Each rhino has access to about 50 acres when by itself and even more when placed with another for attempted breeding.

WHERE WE ARE TODAY

There Has Been Progress

The species is better understood today than ever before with regard to captive management. Growth rates of the young and other body dimensions of the animals have been collected. The food, health, space and other living requirements of the species in captivity have been studied, and their reproductive physiology is no longer such a mystery.

Though many may have given up on the Sumatran rhino captive breeding program, for those of us still committed to it, there is much progress to appreciate. Although each of the four facilities involved is following a different management strategy, breeding behavior between pairs now has been observed at all of them. In fact, in the last two years, six female and four male Sumatran rhinos reportedly have been engaged in breeding activity. This encouraging information certainly is the most promising reported since the captive breeding program began.

Moreover, all four facilities are communicating, cooperating, and coordinating closely. In February 1999 under AsRSG/IRF auspices, there was a global masterplan meeting of representatives from four facilities. The meeting was held at Sungai Dusun, Malaysia. Institution-by-institution and animal-by-animal assessments and recommendations were formulated for each of the 17 (5.12) Sumatran rhinos still under managed conditions (Table 3). The assessments and recommendations were based, in part, on reproductive exams. These exams were conducted on several rhinos by a team of scientists from the four facilities, as well as other experts. Reciprocal visits of scientists and managers have occurred among the 4 facilities. AsRSG and IRF have also facilitated funding for the programs: e.g., IRF has supported some of the research at the Cincinnati Zoo; Cincinnati Zoo, IRF, Los Angeles Zoo and SOS Rhino have provided funds for Sungai Dusun; and IRF has provided most of the monies for development and operation of the Sumatran Rhino Sanctuary at Way Kambas with contributions from White Oak Conservation Center, the Disney Wildlife Conservation Fund, Taman Safari Indonesia, the Wildlife Conservation Society (WCS), the Cincinnati Zoo, the Los Angeles Zoo, the Zoological Society of San Diego, the Zoological Parks Board of New South Wales, the Melbourne/Weribbe Zoos, and the Adelaide Zoo.

Furthermore, studies of the species in the wild have not been neglected. The population and distribution of the Sumatran rhinoceros is well known in Peninsular Malaysia and Sabah, and significant effort is being made to conserve them. However, much more needs to be done if the species is to survive.

Table 3. Reproductive Status of Sumatran Rhinos in Breeding Centres

REPRODUCTIVE STATUS OF SUMATRAN RHINOS IN BREEDING CENTRES

Facility	Sex	Name	Captured	Estimated age	Cycling	Pathology	Copulation	Pregnancy NOW	Pregnancy PAST	RECOMMENDATIONS
Dicerorhinus sumatrensis sumatrensis - Malaysia										For all females start faecal hormone analysis, and vaginal smear analysis if trial successful.
Sungei Dusun & Melaka, MALAYSIA										All animals X-ray dentition for age assessment. Cinclan. to develop.
	♀	MINAH (Born in facility)	[1987]	11	Y	N	Y(1x/wk)	?	N	Confirm pregnancy. Bloodplasma-Abri. Isolate from male when confirmed
	♀	PANJANG (Melaka)	1987	17	Y	N	N	N	?	Introduce to male soonest
	♀	SEPUTIH	1988	20	Y	N	N	N	?	With male, continue till copulation.
	♀	MAS MERAH	1987	20	Y	Y	N	N	?	Evaluate estrous state for 3 months before pairing with Shah. Ultrasound
	♀	RIMA	1986	20+	Y	N	Y(1x/wk)	?	Y	Confirm pregnancy. Bloodplasma-Feb
	♀	JERAM (Melaka)	1984	25+	N	Y	N	N	?	Keep for exhibit
	♂	ARA	1994	10+			Y		?	Evaluate sperm if pregnancies do not occur
	♂	SHAH	1988	14			N		N	Evaluate sperm
Dicerorhinus sumatrensis sumatrensis - Indonesia										
SRS -Way Kambas, INDONESIA										
	♀	BINA	1991	15+	Y	N	?	?	?	Continue current protocol till pregnant. Ultrasound Feb
	♀	DUSUN (from Malaysia	1986	17+	?	N	N	N	?	Ultrasound Feb. Develop hormonal therapy to stop lactation/induce estrus
	♂	TORGAMBA	1985	20			?		?	Evaluate sperm
Cincinnati Zoo, USA										
	♀	EMI	1991	8	Y	N	Y	N	Y	Continue current protocol. Move male after conception. Progesteron supim
	♀	RAPUNZEL	1989	20+	N	Y	N	N	?	Biopsy on uterine 'mass'. Possibly hormonal stimulation
	♂	IPUH	1990	20+			Y		Y	
Dicerorhinus sumatrensis harrissoni - Borneo										
Sepilok & Tabin, SABAH										
	♀	LUNPARAI (Tabin)	1989	13	Y	Y	Y	N	?	Move to new facilities in Lokaw soonest
	♀	GOLOGOB	1994	18	Y	Y	Y	N	?	Continue attempts to breed when male healthy
	♂	TANJUNG	1994	15			Y		?	Evaluate sperm; Try to breed with Gologob as soon as feasible

Protection

No species has been more heavily poached than the Sumatran rhinoceros Controlling the poaching has been an uphill battle that has required the support and co-operation of all Malaysians and Indonesians. Over the years several animals have been killed by shotguns, but the main culprit has been the steel-wire snare. Carcasses of five animals were once discovered in the forest of Johore.

Protection of the Sumatran rhinoceros is obviously very difficult because of the high commercial value of the horns. Success will only be achieved by very determined and dedicated personnel of the Wildlife Department. There is no alternative for wildlife officers but to spend long periods of time in areas where the rhinos are known to exist. Leaving the forest unattended will result in poaching and rhino mortalities.

It deserves mentioning that the number of areas holding rhinos are so few that every effort is being made to guard them. Locations where the animals occur are adequately known to the Wildlife Department so that protection efforts may be focused on them. The personnel are required to work very hard and spend most of their time away from their families. They must be adequately rewarded.

Ideally, there should be guard posts in strategic places to accommodate the rhino personnel. Transport and equipment are very important to effectively carry out the fieldwork. Field allowances are the most sensitive issue that must be dealt with in favor of the workers. There is a very urgent need for the authorities to solve these problems if the rhinos are to be saved.

The 3-year RPU project for Malaysia and Indonesia funded by the GEF/UNDP at a cost of US$2 million ended in December last year. The RPUs have proven effective in reducing or eliminating poaching. This project is being continued over the next 3 years with assistance from the AsRSG/IRF, the USFWS RTCF, the AAZK BFR, WWF, and others in co-operation with the governmental wildlife departments in Malaysia and Indonesia.

Moreover, an important linkage has developed between the managed breeding programs and the RPUs. There are plans in progress to use the managed breeding facilities as the centerpieces of a conservation tourism program that is projected to be capable of generating significant funds for support of the RPUs. Figure 4 provides an overview of the structure and relationship of the linkage of these two programs in Indonesia. Similar plans are under development for Malaysia.

CLOSING

Saving the Sumatran rhino from extinction still is a formidable challenge and the outcome is not clear. However, the dual, diversified, and integrated strategy of rhino protection units and managed breeding centers seems to offer the best hope for success. The personnel involved with saving the Sumatran rhino are very dedicated and committed to conserving this species. Those responsible for managed breeding efforts are more determined than ever before to succeed in producing the first sustained pregnancies. We are hopeful that some or all of the eight to ten females considered capable of breeding will achieve and maintain pregnancies this year.

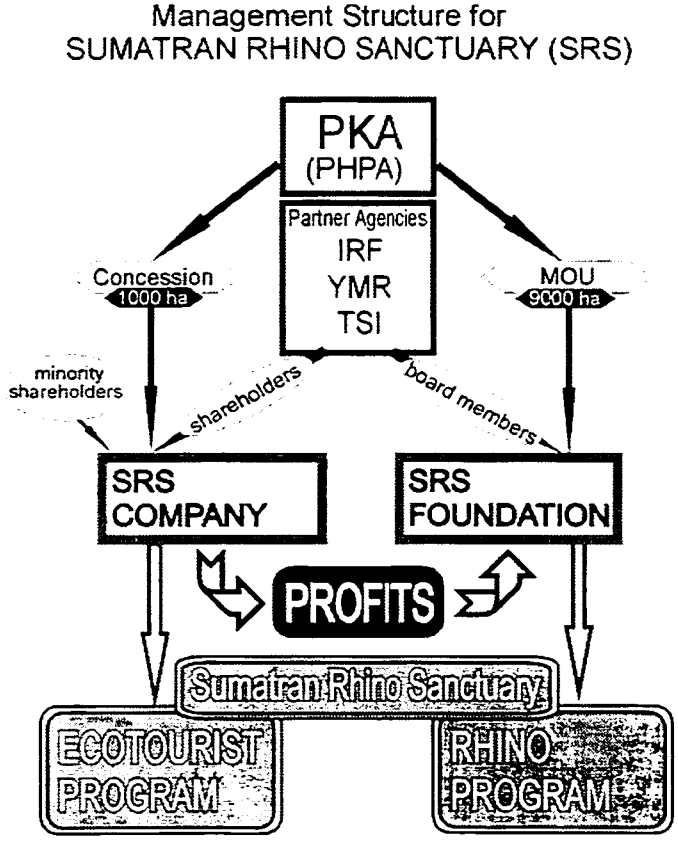

Figure 4. Management Structure for Sumatran Rhino Sanctuary (SRS)

References

Khan MMK. 1989. Asian Rhinos: An Action Plan for Their Conservation. IUCN, Gland.

Foose TJ and NJ van Strien. 1997. Asian Rhinos: Status Survey and Conservation Action Plan, New Edition. IUCN, Gland.

Foose TJ. 1999. The International Studbook for Sumatran Rhinoceros. IRF, Cumberland, OH.

Strien NJ van. The Sumatran Rhinoceros or Two-horned Asiatic Rhinoceros. A Study of Literature.

MONITORING FECAL PROGESTOGEN METABOLITES IN THE SUMATRAN RHINOCEROS (*Dicerorhinus sumatrensis*) BY ENZYME IMMUNOASSAY

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The Sumatran rhinoceros (*Dicerorhinus sumatrensis*) is listed as critically endangered by the IUCN and is also listed in Appendix I of CITES. This species has proven to be difficult to breed in captivity, with no offspring produced in over 100 years. Measuring fecal progestogen metabolites by radioimmunoassay (RIA) using a monoclonal progesterone antibody (provided by J. Roser) that cross-reacts with several fecal progestogen metabolites, has proven useful in monitoring the reproductive cycle of numerous rhino species, including the Sumatran rhinoceros. This information may enable animal managers to improve reproductive performance of this endangered species. However, few laboratories associated with facilities that hold Sumatran rhinos are equipped to conduct assays involving radioactivity (i.e. RIA). Therefore, the purpose of this study was to develop an enzyme immunoassy (EIA) protocol comparable to the existing RIA for use in monitoring fecal progestogen metabolites of the female Sumatran rhinoceros.

Fecal samples (n=170) were collected over a period of 182 days from an 8 year old female Sumatran rhinoceros housed at the Cincinnati Zoo and Botanical Garden, Ohio. This female had previously been shown to exhibit regular ovarian cyclicity, as evidenced by ultrasound examinations and RIA analysis of fecal samples. The samples were frozen immediately after collection and sent to the Conservation and Research Center in Front Royal, Virginia for analysis.

The samples were dried, crushed and extracted with ethanol (92% extraction efficiency). As a preliminary validation, parallelism was determined between serial dilutions of pooled fecal extracts and the standard curves of both the RIA and a new EIA method which used a biotinylated label (provided by F. Schwarzenberger) and the same progesterone monoclonal antibody described above. Each sample was then analyzed for progestogen metabolites using both assays. Over the sampling interval, the progestogen profile initially reflected a partial luteal phase, followed by a prolonged elevation in progestogens which was diagnosed as a pregnancy by ultrasound. The pregnancy was lost after 37 days of elevated progestogens and was followed by 3 cycles (identified as prolonged increases followed by gradual decreases in progestogens) with an average length of 20 days (based on the interval between nadir values). The progestogen patterns generated from both assays were similar, with a correlation coefficient of 0.705.

These results demonstrate that EIA with an appropriate broad-spectrum antibody can be used to monitor the reproductive cycle of the female Sumatran rhinoceros by measuring the excretion of fecal progestogen metabolites. This assay not only will simplify the processing of samples collected from captive animals but will also allow field researchers to monitor the reproductive cycles of animals in conditions where it is impossible to gain access to laboratories equipped to handle radioactivity.