IN PURSUIT OF THE SUMATRAN RHINO

A Proposal

Thomas J. Foose, Ph.D.
AAZPA Conservation Coordinator
7 December 1982

INTRODUCTION

This is a preliminary proposal to the AAZPA Board and Sumatran Rhino Interest Group to proceed with explorations toward establishing a captive population and program to assist with preservation of this species. More specifically, this proposal is an application for approval from the AAZPA for an exploratory trip to be conducted by Tom Foose or another SSP representative in the first half of 1983 to Malaysia and Indonesia to advance this project. Other steps to develop this program are also proposed.

BACKGROUND

The Asian two-horned rhino (Dicerorhinus sumatrensis) may be the most gravely endangered of the 5 surviving species of this family (Table 1). Although the total population estimated for the Javan rhino is lower, its situation seems more sanguine because of an active program of protection by conservationists (WWF 1981-82). Moreover, the Javan is not the only representative of its genus. The Indian rhino is at least superficially similar despite ecological differences from the Javan (Groves 1967). In contrast, the Sumatran rhino is the sole survivor of a formerly more successful genus and is considered representative of a primitive type from which other extant rhinos may have evolved (Groves and Kurt 1972).

Information available from recent and reliable reports on the distribution of surviving Sumatran rhinos is summarized in Tables 2 and 3 and Figures 1 and 2. Numbers are precariously low and the decline continues inexorably. Both Borner (1979) and Flynn & Abdullah (1982) document the disappearance of rhinos from areas of former occurrence, even of moderate abundance, during the last ten years. One by one, the last remnants are being lost.

Moreover, even where rhinos do and will survive in natural habitats, populations may be so small and fragmented as to be genetically unviable. Population biologists have advised that a genetically effective population of 500 may be necessary for long term survival of a species (Franklin 1980, Soule 1980). A number of population biologists believe even this number may be too few. Extinction due to loss of genetic diversity and vitality is not the only problem.

Small populations are vulnerable to extinction from other types of perturbations such as natural disasters, demographic stochasticity, etc. (Shaffer 1981).

In the case of the rhinos, there is yet another, probably greater threat. Poachers may be the final executioner. Unless sanctuaries can be secured against poachers, there is no hope for this species in the wild.

Field conservationists have contended that there are several sanctuaries and populations that might be preservable in the wild (Borner 1979; WWF 1981; Andau and Payne 1982; Flynn and Abdullah 1982; Clive Marsh, personal communication). The five most probable places are designated by asterisks in Table 2: Gunung Leuser and perhaps Kerinci/Seblat in Sumatra; Endau Rompin and Taman Negara in Western Malaysia (Peninsular Malaysia); and the Silabukan/Lumerau and South/South East Forest Reserves in Sabah. not an official name; just a region.

The other surviving rhinos are fragmentally distributed over the range of the species in remnants of one to five animals usually in areas with poor protection. These remnants have little or no prospect for survival biologically or politically in their present location. A viable alternative would be to collect some of these animals for a captive population. Collectively, these remnants represent an appreciable number of animals (Table 3).

An alternative to captivity for the remnants might be to translocate them into the possibly protectable reserves and preservable populations. However, as Andau and Payne (1982) in part observe, there are formidable risks and problems with such an enterprise.

(1) Not enough is known about the ecology of rhinos to assure the success of translocation.
(2) Security of the possibly preservable sanctuaries and populations is far from certain.
(3) Genetic management could be maximized in a captive situation.

Even if a few populations of Sumatran rhino can be preserved in the wild, it may still not be possible to maintain large enough numbers (i.e. the N_E) for long term survival. Successful protection of the major sanctuaries and populations designated in Table 2, an objective of a great uncertainty, would probably only

produce a total of 550 rhinos. These estimates are predicated on the area of the sanctuaries that can probably be protected and a maximal density of one rhino/40 km^2 suggested by the ecological studies of Flynn and Abdullah (1982). Certainly, none of the separate populations enumerated in Table 2 could constitute a genetically effective number, N_E, sufficient for long term survival of the species. If interactively managed to constitute a single population biologically through carefully regulated exchanges of animals periodically, these demes might be viable genetically. An N_E of 550 would be just at the threshold for long term viability prescribed by the population biologists. However, in the wild N_E's are usually well below the actual population. The subdivision of the population into several demes might compensate somewhat but the number of the different populations would still be low. Moreover, it cannot be overemphasized that protection of these populations and sanctuaries in the wild is a very uncertain prospect. For example, the June 1982 issue of the Malayan Nature Journal is devoted to articles about encroachment into Taman Negara National Park.

The potential of a captive population of several hundreds managed to maximize its genetically effective size could be a vital reservoir to reinforce and replenish the wild stock until or unless larger reserves could be secured in the wild. Survival of the Sumatran rhino (and many other species) may well depend upon an interactive system of both wild and captive populations.

The possible importance of a captive population is not a new idea. At least as early as 1959, the potential of a captive population to preserve the species was recognized (Anderson 1961). In that year, an expedition was sponsored by the Copenhagen, Basel and Boger Zoos to collect rhino along the Siak River in Sumatran. Ryhiner and Skafte conducted the operation.

Ten rhinos were collected in an unprotected area. Estimates of the local population at that time was 40-60 rhinos. Unfortunately, only one male was among the ten collected and he escaped. A female was consigned to each of the three zoos, the other six were released. Of the three placed in zoos, the animals at Bogor and Basel both died in 1961. The female at Copenhagen survived until 1972 when it succumbed to vandalism. Perhaps even sadder than the abortive results of this well intentioned endeavor is the fact that a survey by

Borner in 1975 discovered no evidence of rhino in the same Siak River area where in 1959 the species was described as plentiful and the 10 were actually collected. Borner concluded the Sumatran rhino had been exterminated in this region.

In 1976, Borner, who had conducted an extended study of the rhino all over Sumatra for IUCN/WWF and the Indonesian Government (Borner 1979), prepared a proposal for establishment of a captive population founded by remnant individuals and groups of Sumatran rhino with virtually no hope of surviving in their habitat and hence of contributing to perpetuation of the species. Naturally, this proposal was very knowlegeably and thoroughly prepared. Implicitly, the Borner proposal had the moral support of WWF and IUCN. The proposal was circulated to several zoos. Unfortunately, none of the individual institutions could provide the commitment of resources and leadership to implement this project. So the proposal expired and Borner moved onto other assignments in Africa where he still is located.

The current AAZPA initiative on Sumatran rhino commenced with the formal inception of the Species Survival Plan and the appointment of an AAZPA Conservation Coordinator. Because of its desperate situation, the Sumatran rhino was one of the four species designated by the SSP in 1981 as part of its strategic program for the entire family Rhinocerotidae. Preliminary explorations were initiated for this ambitious enterprise.

The first really productive lead and contact were established through the New York Zoological Society in the autumn of 1981 with Dr. Clive Marsh. Dr. Marsh has considerable field experience in South East Asia and is currently employed as the Conservation Officer for the Sabah Foundation which is one of the main forest development companies in that country. Through Clive much information has been obtained on the rhino situation in Sabah, and promising contacts have been established with wildlife officials there, principally ~~Phillip~~ Patrick Andau, Assistant Chief Game Warden.

Basically, a few rhinos survive in Sabah. The largest concentration seems to be in the Silabukan/Lumerau Forest Reserves under concession to the Sabah Foundation. This company is, of course, engaged in development of the forests

for human needs. However, they are also committed to conservation and in particular are concerned about survival of the rhinos. It is now believed there may be some hope to preserve the rhinos and habitat in the Silabukan/Lumerau Reserve (Figure 2).

However, there are a number of rhinos evidently inhabiting areas around the Silabukan Reserve that are going to be converted to agriculture (Area 2 on Figure 2). Wildlife officials in Sabah (Andau and Payne 1982) have strongly recommended these animals be collected for a captive population and have tentatively invited the AAZPA to organize this effort. The Sabah Foundation has also indicated they would provide logistical and perhaps other support for a project to collect rhinos for a captive program.

Additional rhinos probably occur elsewhere in Sabah. There is another population in the ~~South/South East Forest Reserve~~ Forest Reserves of South and South East Sabah that may also be protectable in the wild.

Extensive discussion of the proposal to establish a captive population and program occurred at the IUDZG Rhino Symposium in London, August 1982. In attendance were representatives of major zoos around the world as well as many field conservationists including members of both the SSC Asian and African Rhino Groups and SSC Chairman Gren Lucas. Indeed, the Symposium provided Foose, Rabb, and Maruska the opportunity to confer directly with Clive Marsh and also with Andrew Laurie, a member of the Asian Rhino Group with much experience on rhinos in Asia. There was general agreement that a captive program would be a constructive, if not crucial, contribution to preservation of the Sumatran rhino. The sole qualification placed on the proposition was that only animals outside the main sanctuaries and populations be considered candidates for the captive programs.

Possibilities in Sabah were explored further by Dr. Archie Carr, Assistant Director of the N.Y.Z.S. Animal Conservation and Research Center, during his recent attendance at the World National Parks Congress in Bali, Indonesia. Clive Marsh and Sabah officials were also there. They were most encouraging about an AAZPA project, assuring Carr that it would be politically feasible. Indeed, they stated the Wildlife Department of Sabah would ~~extend an official invitation to~~ welcome the AAZPA to conduct an exploratory expedition to assess logistical and bio-

logical feasibility of the project. They propose the trip occur in the first half of 1982. ~~The invitation is expected in the near future. It~~ appears important that the AAZPA decide if they will pursue this project as soon as possible so the exceptional interest and momentum of the Sabah officials are not lost.

Good opportunities appear also to exist to extend this kind of project into Western Malaysia (Peninsular Malaya). As in Sabah, there appear to be an appreciable number of animals distributed as invaluable remnants in the country (Table 3). Another important contact that has been established is with Dr. Rodney Flynn who has recently completed a 5 year study of Sumatran rhino in Peninsular Malaya. He has provided invaluable information on the ~~biological and political~~ situation there. Moreover, he too has acknowledged the inviability of the rhino remnants, especially in genetic terms (Flynn and Abdullah 1982).

Politically, ~~Peninsular Malaya~~ and Sabah are ~~states~~ in the Federation of Malaysia. ~~All~~ Indications are that a project to collect animals in both Sabah and West Malaysia would be feasible politically. Mohd. Khan bin Momin Khan who is the Director-General of the Malaysian Department of Wildlife and National Parks has been cited in a recent article on rhinos in ~~Asia Week~~ (June 1982) as being supportive of a captive program to reinforce wild populations.

Any attempt to develop a captive program for Sumatran rhino should be a part of a global strategy for preservation of the species. The IUCN SSC Asian Rhino Specialist Group should be the coordinator of such a strategy. Sanction from the Asian Rhino Group for an SSP project would be highly desirable, perhaps essential. Unfortunately, the Asian Rhino Group has not yet endorsed AAZPA SSP endeavors. Conway and Foose apprised Asian Rhino Group Prof. Dr. Rudolf Schenkel of AAZPA interest in a letter of 17 February 1982. The objective was to establish a dialogue with Dr. Schenkel and the Group. Schenkel responded to the letter on 29 April 1982. His position was noncommittal but he stated he would present the AAZPA overtures at the next meeting of the Asian Rhino Group in Kuala Lumpur in June 1982 and advise us of their position. Another partial session of the Asian Rhino Group was also convened at the general SSC Meeting in Kuala Lumpur in October. Schenkel has not responded since his April letter.

Some other members of the Asian Rhino Group have been quoted in print (e.g., Asia Week 1982) or have personally communicated that they are supportive of a captive program as vital to survival of the species. The IUCN SSC Action Plan has advocated a captive propagation program. But Schenkel evidently has reservations although they have not been explicated to the AAZPA. It seems critical that whatever differences may exist between the Asian Rhino Group position and the AAZPA interests be resolved.

In conclusion, an appreciation of the need for a captive propagation program for Sumatran rhino has existed and has been expanding over the last 25 years. What has been lacking has been the commitment of sufficient resources, sustained initiative, and perhaps scientific perspective to pursue this project to fruition. The AAZPA seems in an almost unique position to provide this kind of leadership and resources.

THE SPECIES SURVIVAL PLAN OF ACTION

The objective of the SSP project would be to establish a captive population and program for propagation of Asian two-horned rhino to reinforce the efforts to preserve this species in the wild. Animals collected for the captive program would derive from the population remnants with no hope of survival in the wild because:

(1) the groups are too small and fragmented to be genetically viable and

(2) their habitat is destined for destruction and they seem inevitable victims of the poachers.

Because of political receptiveness as well as the biological situation (Table 3), it is proposed the collecting project would commence and concentrate in Sabah. Subsequently, or perhaps almost concurrently (depending on resources and feasibility), the operation could be extended to Peninsular Malaya where even more rhino remnants might be available. If interest, opportunity, and resources exist the project might eventually include Sumatra or even Indonesian Borneo.

It will be important to pursue as many sources of founder stock as possible. The species has been so decimated in the wild that no one area is likely to pro-

vide the genetic diversity or simple numbers advisable to found a captive population. Of course, even one pair of rhinos in captivity would provide more hope than exists now. However, 5 to 10 pairs would be optimal. The upper limit might be realistic if Western Malaysia and eventually Sumatra can be included.

One possible complication that must be considered is reproductive barriers between members of the disjunct Mainland and Island populations. Three extant subspecies are normally recognized (Groves and Kurt 1972). The northern most D. s. lasiotis probably would not be involved in the project being presently proposed. However, D. s. sumatrensis (Sumatra and West Malaysia) and D. s. harrisoni (Borneo) would be. If no reproductive isolation exists, it is recommended there be no further concern with maintaining subspecific distinction in a captive population.

become available

Depending on the number that ~~could be collected~~, it is proposed that ~~the~~ rhinos brought to U.S.A. be placed in 2 to 4 zoos with rhino experience and expertise. San Diego, St. Catherines, Miami, and Los Angeles seem likely candidates.

There should be no misconception that capture of Sumatran rhinos will be anything but formidable, perhaps the most ambitious project the AAZPA has ever attempted. It will be costly! Almost certainly $1,000,000 or more will be required to produce results. But preliminary explorations have been encouraging on the possibility of substantial support from outside donors. It will be slow. The field conservationists consulted so far suggest that a collection team will have to be in the field for perhaps 3 years or more. It will be difficult. The rhinos are rare and they are elusive. If they weren't they would already be extinct. However, 10 rhinos were collected in 1959. Borner delineated a rather precise and plausible protocol in his 1976 proposal. The likely key to success would seem to be orientation of the traps (most likely some kind of stockade to minimize trauma) around the wallows or saltlicks which are the center of a rhino's activity. By utilizing and perhaps supplementing natural saltlicks, it is believed rhinos could be attracted to areas where traps would be placed. Very Comments.

Critical to the success of this project will be the selection of a field manager of the collecting operation. Capture of the Sumatran rhinos will be an

arduous, protracted, and probably frustrating enterprise. It will be vital to secure the services of someone who not only is an expert in modern technology of large animal capture but also is acquainted with the environmental and political conditions of operating in the tropical forests of South East Asia.

Several candidates have been identified for this function. One is Tony Parkinson, a veteran trapper formerly in the employ of John Seago but now resident in South East Asia. In recent years, he has been employed by President Marcos of the Phillipines to direct the project on captive propagation of tamarou (Bubalus mindorensis). If available, he may be an excellent choice. I support wholeheartedly — definitely for 1st appraisal, & hopefully the Catch

However, consideration is probably also due to three other persons with extensive field experience with Sumatran rhinos. Markus Borner is one. He conducted a 3 year study of the species in Sumatra and prepared in 1976 a rather elaborate proposal delineating a viable protocol for collecting rhinos. A major problem with Borner may be availability. He has moved to Africa where he is engaged in conservation projects.

Nico Van Strien is another researcher who has studied rhino in Sumatra for years (Van Strien 1974, 1978). Reportedly, he has critically analyzed the problems with the abortive capture project of 1959 and so could be a prudent selection. Again, availability may be a problem.

Yet a fourth person that might be recruited is Rodney Flynn. In addition to his extended research experience with rhinos in Malaysia, he did initiate an attempt to capture some to attach radio-telemetry devices. Unfortunately, his permit was revoked for political reasons before there was any opportunity for success. But at least he has acquired relevant experience.

The exploratory trip by Foose or another representative of the SSP could determine much about political and biological feasibility and requirements. However, logistical and operational feasibility should be assessed by one of the persons who might manage the collecting project.

Therefore, in the "Recommendations and Proposals Section" it is suggested that one or another of these candidates accompany the SSP representative on the exploratory trip. If the AAZPA decides to proceed, contact should occur immedi-

ately with each of these persons to assess further their appropriateness and availability, and to arrange for their possible participation. At the least, the SSP representative should try to visit with Parkinson, Van Strien, and perhaps Flynn during the trip.

Bill Conway had also suggested previously that the exploratory trip would be enhanced if an international representative for IUCN could participate. Preliminary investigation of this suggestion has indicated that such involvement might be premature or even counterproductive until the AAZPA is sure the project is reasonably feasible as determined by the exploratory trip herein proposed. Nevertheless, this suggestion can be explored further.

Finally, it should be reiterated that an SSP project to establish a captive program should be an integral part of a global strategy involving both captive and wild populations. Hence, it would be optimal if any SSP project would be conducted in conjunction with efforts to preserve the major populations and sanctuaries in the wild. Excellent opportunities would seem to exist for this kind of cooperation in both Sabah and West Malaysia. World Wildlife Fund might be a possible collaborator. However, as an alternative or addition, there is at least one other possibility in this area. The Animal Conservation and Research Center of the New York Zoological Society has indicated an interest in such a collaborative effort. Assuming familiarity does not breed contempt or other unwanted progeny, the advantages of such an association seem obvious.

IMPLICATIONS FOR THE AAZPA

The attempt to establish a captive program and population for the Sumatran rhino will be a formidable and novel undertaking for the AAZPA. But the species and the situation are unique. The magnitude of this project financially, politically, and biologically seems to require the kind of collective approval that perhaps only the AAZPA can presently provide.

Is this then the first of an endless series of similar projects? Certainly other species are in need of rescue efforts. Already the IUCN Pig and Peccary Group have approached the SSP to assist with a captive program for the Giant or Chacoen peccary (Catagonus wagneri). It seems inevitable that as the importance of the SSP grows, there will need to be increasing interactions be-

tween the captive and wild populations and programs.

Despite these prospects, it should and can be argued cogently that the Sumatran rhino venture will not necessarily establish a precedent for other initiatives of this scope by the AAZPA or its Conservation Coordinator. While there are other projects for which AAZPA involvement could be solicited, none has been suggested or anticipated where such a unique species seems to depend so exclusively on SSP leadership and resources for success. The Sumatran rhino project could easily be one of a kind.

One immediate concern that has been expressed is the impact of a prolonged absence by the Conservation Coordinator on the SSP programs. Undeniably, there would be some disruption to the program and burden on other persons involved in the SSP. However, it is believed these problems could be minimized. Since the priority this year for the SSP is for consolidation of existing programs, much of the activity could and should devolve on Species Coordinators. Moreover, efforts can be intensified to anticipate, and organize better, work that might normally occur during this period. Ed Schmitt believes that he could realistically provide requisite coverage. Surely, everyone would be very appreciative of a respite from the deluge of paper that normally emanates from the Conservation Coordinator's Office.

In conclusion, although the risks and commitments for the project are great, the benefits are perhaps even greater. Beyond the gratification and significance of perhaps preserving one of the planet's most interesting creatures, the stature that would accrue to the AAZPA could be incalculable.

RECOMMENDATIONS AND PROPOSALS

1. Formalize the Sumatran Rhino Interest Group into an SSP Propagation Group that would be composed of:

   Bill Conway - New York - Species Coordinator
   Chuck Bieler - San Diego
   Ed Maruska - Cincinnati
   Bill Zeigler - Miami
   Mike Dee - Los Angeles
   Wilbur Amand - Philadelphia

Elvie Turner - Fort Worth
George Rabb - Brookfield
Peter Karsten - AAZPA President
Bob Wagner - AAZPA Executive Director
Tom Foose - AAZPA Conservation Coordinator
Ed Schmitt - WCMC Chairman, ex officio
Alan Shoemaker - Studbook Adviser, ex officio
John Seidensticker - National, Special Adviser

2. Conduct an exploratory trip by a representative of the SSP to Malaysia and Indonesia from mid March to early May 1983.
The purpose of the trip would be to visit as many sites, scientists, and officials as possible to assess logistical, political and biological feasibility of collecting rhino for a captive population. The suggested itinerary is U.S.→ Manila → Sabah → Peninsular Malaya → Singapore → Java → Sumatra → U.S. Tom Foose, AAZPA Conservation Coordinator, is proposed as the SSP representative. Additionally, it may be important to recruit as other participants in this expedition persons who might be employed as the actual field managers of the collecting operation. Highly attractive candidates for this function are Tony Parkinson, Markus Borner, Niko Van Strien, and Rodney Flynn.

3. If the trip is approved, immediately notify persons in Sabah of our intentions and arrange for the visits to Western Malaysia, Sumatra, and Java.
Letters should be directed to:

(6) Clive Marsh - ~~Primary~~ Initial contact for AAZPA in Sabah.
(2) ~~Phillip~~ Patrick Andau - Assistant Chief Game Warden for Sabah.
(1) Mohd. Khan bin Momin Khan - Director-General of the Malaysian Department of Wildlife & National Parks.
(4) Nico Van Strien - Probably most knowledgeable person on Sumatran rhino in area.
(3) Markus Borner - Former field researcher on Sumatran rhino.
(5) John Payne - Conservation Officer, WWF-Malaysia

(4) Tony Parkinson - Tropical trapper.

(5) Rudolf Schenkel - Chairman, IUCN Asian Rhino Specialist Group

Foose can prepare these letters.

4. Intensify efforts to secure official sanction from the IUCN SSC Asian Rhino Group for the project.

Attempts to establish a dialogue with Chairman Dr. Schenkel have not been entirely successful. It does seem a direct discussion with Schenkel would be constructive, perhaps critical. Therefore, it is further suggested that Schenkel be invited to the U.S. (New York or Brookfield seem logical places) in January or February 1983 for consultations. The trip could perhaps be further justified and supported by arranging for Dr. Schenkel to present a seminar on his work with the Javan and other Asian rhinos.

5. It would also be advantageous for the SSP representative to confer directly with Dr. Rodney Flynn who recently completed a 5 year study of Sumatran rhino in West Malaysia. Flynn is currently at the University of Alaska. The SSP representative could conceivably consult with him en route to Asia. But again, there should be great interest in arranging for Flynn to present a seminar on his work at N.Y.Z.S. or Brookfield. A detailed description via slides of his experience could significantly enhance SSP endeavors.

6. Confirm financial contributions toward the trip from zoos interested and involved in the project.

Five zoos indicated, at Phoenix, they would contribute. Two others not represented by their executive officers believed their institutions would. Knowing how much money could be amassed from these sources, any additional funds needed would then be solicited from other donors.

7. Explore possibilities that the AAZPA SSP effort to establish a captive population could be coordinated with a program of field research and management on the species in the wild in Sabah and perhaps West Malaysia.

The New York Zoological Society Animal Conservation and Research Center has indicated an interest in such a cooperative project. WWF-Malaysia already has a project in progress in Sabah.

ITINERARY FOR PROPOSED TRIP

- Depart U.S. for Far East about 15 March.
- First stop 3 days in Manila to consult and perhaps entrain Parkinson. invite Khan to Sabah during that time
- Proceed onto Sabah to explore situation. Propose 14 days in this country.
- From Sabah to Kuala Lumpur and Peninsular Malaya for 14 days to confer with Mohd. Khan bin Momin Khan and to visit as many other officials as necessary and sites as possible.
- Next to Singapore for 3 days to visit with Bernard Harrison about Singapore Zoo's possible participation in the project.
- From Singapore to Java to consult with Nico Van Strien (probably most knowledgeable person in area on Sumatran rhino) and other Indonesian scientists and officials. Van Strien is in Bogor where it will also be necessary to obtain permit to visit Sumatra. A visit to Udjung Kulon, sanctuary for the last Javan rhinos would also be highly informative. Propose 7 days in Java.
- Then onto Sumatra to visit the main sanctuary in the world for Sumatran rhino at Gunung Leuser. Flight would be initially to Medan, then onto the Dutch Orang Station at Ketambe. Propose 7 days in Sumatra.
- Home through ~~Singapore~~ maybe K.L., to confer with Khan
- Total expedition would require 50 days.

REFERENCES

Andau, P.m. and Payne, J.
1982. The Plight of the Sumatran Rhinoceros in Sabah. Unpublished Manuscript.

Asiaweek
1982. Extinction is forever. Article in AsiaWeek of 9 July 1982.

Anderson, S.
1961. Sumatran rhinoceros at Copenhagen Zoo. International Zoo Yearbook. 3:56-57.

Borner, M.
1976. Sumatran Rhinoceros: Establishment of a captive breeding unit: Proposal. Unpublished manuscript.

Borner, M.
1979. A field study of the Sumatran rhinoceros. Ph.D. Thesis. University of Basel, Switzerland.

Flynn, R.W. and Abdullah, M.T.
1982. Distribution and Status of the Sumatran Rhinoceros in Peninsular Malaysia. Submitted to Biological Conservation.

Franklin, I.R.
1980. Evolutionary change in small populations. In Conservation Biology, edited by M. Soule and B. Wilcox. Sinauer Associates; Sunderland, MA.

Groves, C.P.
1967. On the rhinoceros of Southeast Asia. Säugetierk Mitt. 15:221-237.

Groves, C.P. and Kurt, F.
1972. Dicerorhinus sumatrensis. Mammalian Species. American Society of Mammologists.

McNeely, J. and Cronin, F.W.
1972. Rhinos in Thailand. Oryx. 11:457-460.

McNeely, J. and Laurie, A.
1977. Rhinos in Thailand. Oryx. 13:486-487.

Shaffer, M.L.
1981. Minimum population sizes for species conservation. Bioscience. 31:131-134.

Skafte, H.
1961. A contribution to the preservation of the Sumatran rhinoceros. Acta Tropica. 18:167-176.

Skafte, H.
1964. Rhino Country. Robert Hale, Ltd.; London, U.K.

Soule, M.E.
1980. Thresholds for survival, maintaining fitness and evolutionary potential. In Conservation Biology, edited by M. Soule and B. Wilcox. Sinauer Associates; Sunderland, MA.

Soule, M. and Wilcox, B.
1980. Conservation Biology. Sinauer Associates; Sunderland, MA.

Van Strien, N.J.
1974. The Sumatran or Two-Horned Rhinoceros - A Study of Literature. Mededelinger Landbouwhogeschool Wageningen. (Nederland). 74-16.

World Wildlife Fund
1981. World Wildlife Fund Yearbook 1981-82. WWF; Gland, Switzerland.

TABLE 1

RHINOS IN THE WILD

	SPECIES	ESTIMATED NUMBERS	DISTRIBUTION	POPULATION TRENDS
AFRICAN	BLACK	14,000-24,000	Many Populations in Subsaharan Africa	Declining Precipitously
	WHITE:			
	NORTHERN	1,000	Two Main Populations	Decreasing Rapidly
	SOUTHERN	2,600-2,800	Several Populations; More Being Established	Increasing
ASIAN	INDIAN	~ 2,000	Several Populations in India and Nepal	Increasing or Stable Temporarily
	JAVAN	< 57-66	One Population	Increasing
	SUMATRAN	118-254	Small and Fragmented Populations Over a Wide Range in S.E. ASia	Decreasing

TABLE 2

SURVEY OF SURVIVING ASIAN TWO-HORNED RHINOS

AREA OR COUNTRY	LOCATION	ESTIMATE OF RHINOS	HABITAT AVAILABILITY PRESENTLY (Km^2)	HABITAT AVAILABILITY POTENTIALLY (Km^2)	HABITAT STATUS	REFERENCE	POTENTIAL CARRYING CAPACITY*
Sabah	Silabukan/Lumerau**	~~7-12~~ 20<	250-1000	1000	Perhaps protectable.	Andau & Payne 1982	25
	Around Silabukan	5+	~1000	None	Being converted to agriculture.	Andau & Payne 1982	None
	S./SE. Forest Reserve**	Some	~2000	2000	Perhaps protectable.	Andau & Payne 1982	50
	TOTAL	15-30					
West Malaysia (Peninsular Malaya)	Endau Rompin**	20-25	1600	1000-1600	1000 km^2 Reserve;Park proposed.	Flynn & Abdullah 1982	25-40
	Taman Negara**	8-12	4400	4400	National Park, but under pressure.	Flynn & Abdullah 1982	110
	Sungai Dusun	4-6	40+	140+	State Wildlife Reserve	Flynn & Abdullah 1982	10
	Gunung Belumut	2-3	230	230	Wildlife Reserve proposed.	Flynn & Abdullah 1982	8
	Mersing Coast	0-1	N.A.	Prob. None	Being deforested.	Flynn & Abdullah 1982	0
	Ulu Lepar	3-5	1000	1000	Unprotected and being deforested.	Flynn & Abdullah 1982	0
	Sungai Depak	3-5	N.A.	Prob. None	Being deforested.	Flynn & Abdullah 1982	0
	Kuala Balah	3-4	N.A.	Prob. None	Being deforested.	Flynn & Abdullah 1982	0
	Bukit Gebok	1-2	N.A.	None	Being deforested.	Flynn & Abdullah 1982	0
	Krau Reserve	0-1	500	500	Unstable.	Flynn & Abdullah 1982	12
	Ulu Selama	3-5	N.A.	N.A.	Unprotected.	Flynn & Abdullah 1982	?
	Ulu Belum	3-5	N.A.	N.A.	Unsecure area.	Flynn & Abdullah 1982	?
	Thai Border	0-1	N.A.	N.A.	Unsecure.	Flynn & Abdullah 1982	?
	TOTAL	50-75					
Sumatra	Gunung Leuser**	25-100	1400	8000	National Park but disturbance.	Borner 1979; WWF 81-82	200
	Kerinci/Seblat**	15-20	2000	4000	Protection meager.	Borner 1979	100
	Torgamba	1-5	?	?	Being deforested.	Borner 1979	0
	Sumatera Selatan	2-5	500	?	Deforestation occurring.	Borner 1979	10
	Siak River Region	None	?	None	Being heavily developed.	Borner 1979	0
	TOTAL	43-130					
Kalimantan	Banumuda	0	N.A.	N.A.	Being deforested.	WWF Yearbook 81-82	0
Thailand	Phu Khio Reserve Tenasserim Range Khao Soi Dao Reserve	6-15	N.A.	N.A.	Unstable.	McNeely & Cronin 1972 McNeely & Laurie 1977 Asia Week 1982	0
Burma	Schwe U Daung Reserve	4	N.A.	N.A.	No information.	Borner 1979	?
	Elsewhere	?	N.A.	N.A.	No information.	None recent and reliable.	?
Indochina		?	N.A.	N.A.	Very unstable.	None recent and reliable.	0
TOTAL		118-254	~15000	~22000	None totally secure.		~550

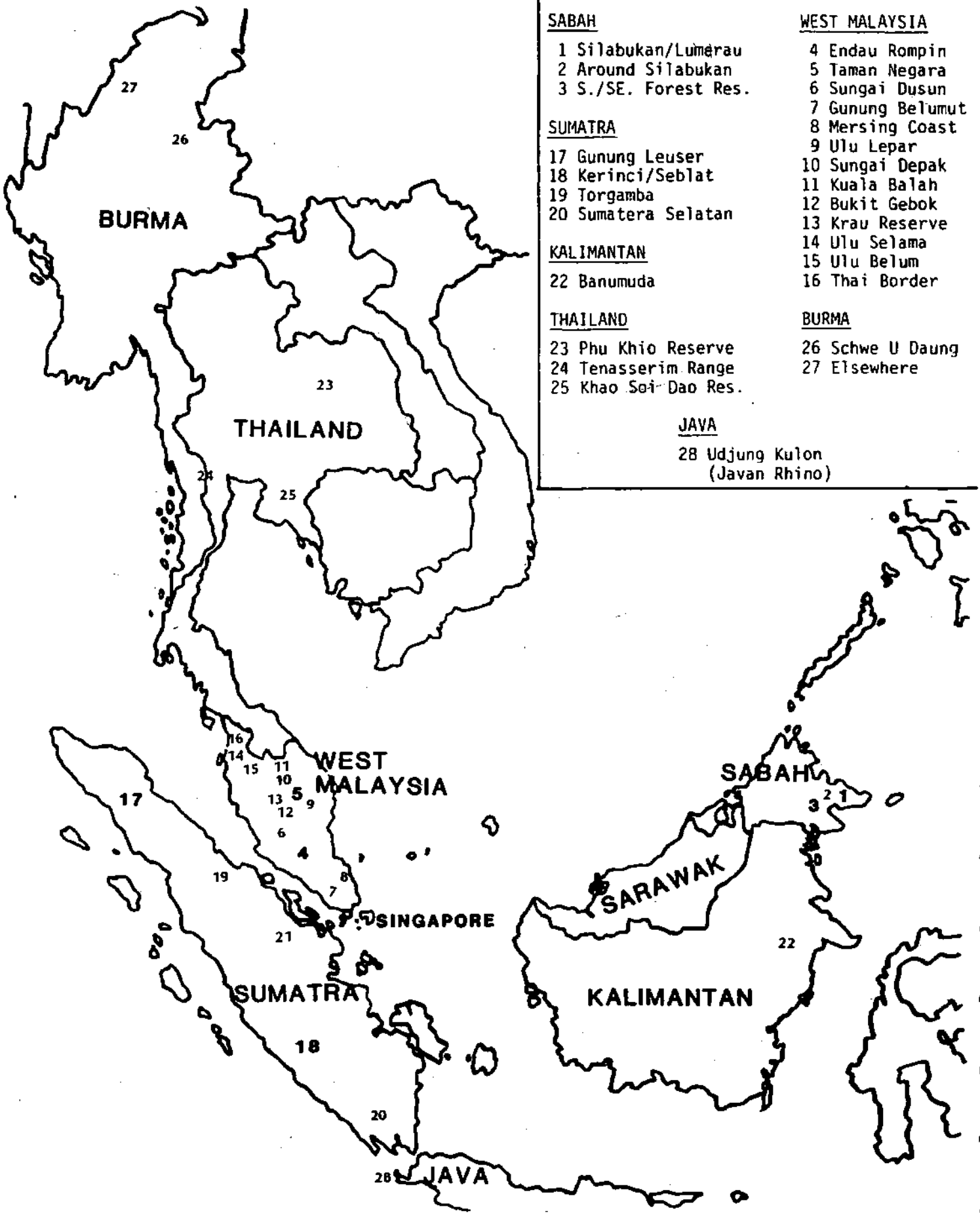
* Predicated on maximum density 1 rhino/40 km^2 suggested by Flynn (1982).
** Populations possibly preservable in wild if interactively managed.

TABLE 3

SUMMARY OF ASIAN TWO-HORNED RHINO POPULATIONS

AREA	TOTAL ESTIMATED POPULATION	TOTAL WITHIN PROBABLY PRESERVABLE POPULATIONS	TOTAL OUTSIDE PROBABLY PRESERVABLE POPULATIONS
Sabah	~~15-30~~ 28-38	~~7-12~~ 20+	8-18
West Malaysia (Peninsular Malaysia)	50-75	28-37	12-38
Sumatra	43-130	25-100	18-30
Kalimantan (Indonesian Borneo)	0	0	0
Thailand	6-15	?	?
Burma	4+	?	?
Indochina	?	?	?
TOTAL	118-254	75-169	43-85

FIGURE 1



SABAH

1 Silabukan/Lumerau
2 Around Silabukan
3 S./SE. Forest Res.

SUMATRA

17 Gunung Leuser
18 Kerinci/Seblat
19 Torgamba
20 Sumatera Selatan

KALIMANTAN

22 Banumuda

THAILAND

23 Phu Khio Reserve
24 Tenasserim Range
25 Khao Soi Dao Res.

WEST MALAYSIA

4 Endau Rompin
5 Taman Negara
6 Sungai Dusun
7 Gunung Belumut
8 Mersing Coast
9 Ulu Lepar
10 Sungai Depak
11 Kuala Balah
12 Bukit Gebok
13 Krau Reserve
14 Ulu Selama
15 Ulu Belum
16 Thai Border

BURMA

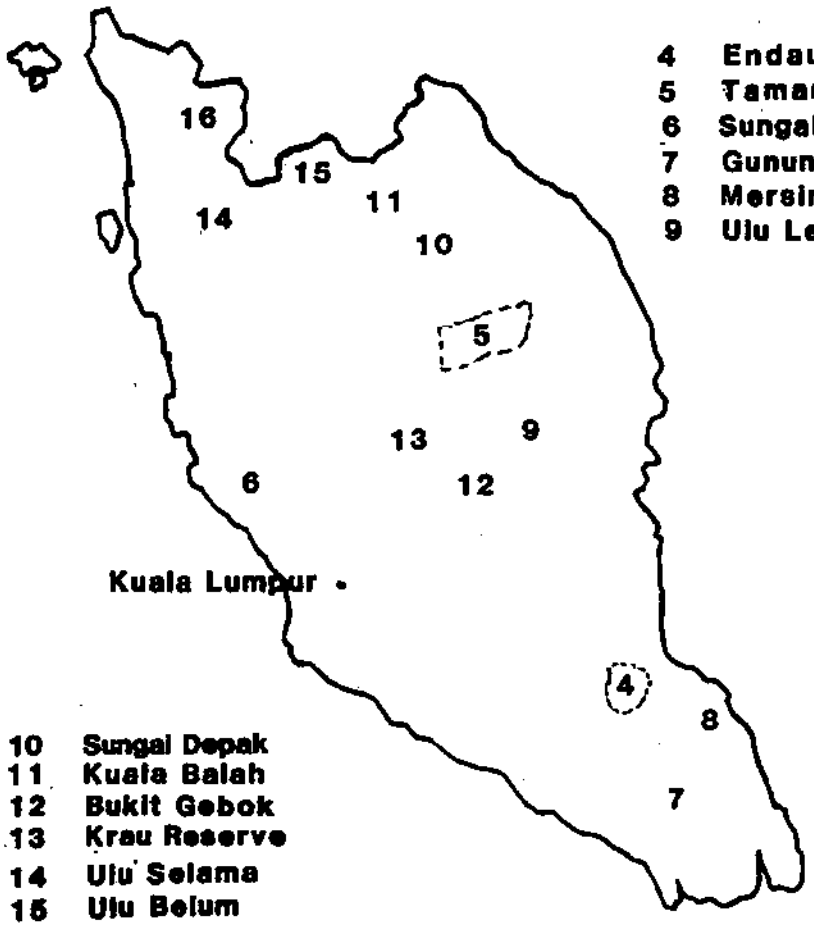
26 Schwe U Daung
27 Elsewhere

JAVA

28 Udjung Kulon
(Javan Rhino)

FIGURE 2

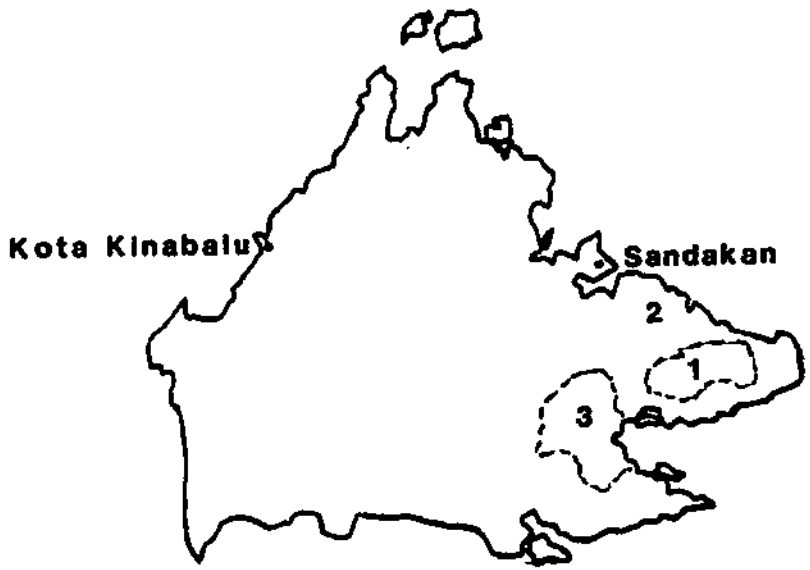
WEST MALAYSIA



4 Endau Rompin
5 Taman Negara
6 Sungai Dusun
7 Gunung Belmut
8 Mersing Coast
9 Ulu Lepar

10 Sungai Depak
11 Kuala Balah
12 Bukit Gebok
13 Krau Reserve
14 Ulu Selama
15 Ulu Belum
16 Thai Border

SABAH



1 Silabukan/Lumerau Forest Reserves

2 Areas being converted to agriculture

3 South/Southeast Forest Reserves