
# 2011 Sumatran Rhino
# Global Propagation & Management Board Meeting – Briefing Materials

## Kota Kinabalu, Sabah, Malaysia

## 8-9 February 2011

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## Table of Contents

Section 1. 2010 GMPB Meeting Minutes

Section 2. White Paper – Future Directions Towards the Persistence of the Captive Sumatran Rhino Population

Section 3. Miscellaneous GMPB Background Documents

Section 4. GMPB Membership

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## SECTION 1

## 2010 MEETING MINUTES

January 2010

Photo: S. Belcher

# SUMATRAN RHINO GLOBAL MANAGEMENT AND PROPAGATION BOARD (GMPB) MEETING

Bogor, Indonesia

# SUMATRAN RHINO
# GLOBAL MANAGEMENT AND PROPAGATION BOARD (GMPB)
# MEETING MINUTES
# 14-15 JANUARY 2010
# SANTIKA HOTEL- BOGOR, INDONESIA

## INTRODUCTION - Widodo Ramono

The vision of the Sumatran Rhino Global Management and Propagation Board (GMPB) is:

1. To develop and manage a Global Sumatran Rhino Propagation Program involving all countries and Institutions maintaining Sumatran Rhino in managed breeding centers and the major sponsors of the Centers and program.
2. To develop and manage a Global Sumatran Rhino Propagation program, involving all the countries and institutions maintaining Sumatran Rhino in Managed breeding centers through the support of the major sponsors of the centers and programs.

Task of the GMPB

1. To recommend and decide on the management of the global Sumatran Rhino (SR) captive population as a truly global population to maximize the options for reproduction and to improve its vitality in a global SR propagation program
2. To prepare and facilitate exchange of animal between all locations if indicated for the purpose of the program
3. To facilitate exchange of experience and transfer of knowledge and technology.

The composition of GMPB

1. The GMPB will consist of:
    - Representatives of the Countries or institutions holding SR in managed Breeding Centers
    - Representative of donor agencies
    - Sumatran rhino expert
2. The membership will be reviewed bi-annually and the GMPB will bi-annually elect a chairman from among the members
3. The SR expert members will form a Technical Committee (TC) that will function as the secretariat of the GMPB

**Summary of Primary 2009 GMPB Meeting Recommendations**

1. Individual animal recommendations as described in the detailed report from the March 2009 meeting.
2. Bank semen for all mature males.
3. Consult with geneticist to determine genetic diversity of current population and impact of specific pairings on the future of program.
4. Reproductive task force to conduct further assessments and germplasm rescue attempts from non-reproductive rhinos (Torgamba and possibly Gelogob)
5. Hold next GMPB meeting in 2 years in association with the SE Asia AsRSG meeting.

**Defining the need for a GMPB meeting in January 2010:**

Several important considerations have led to this meeting which is 1 year earlier than planned: (1) the loss of the only reproductive female Emi in Cincinnati, (2) Andalas is now successfully copulating, (3) there are increasing challenges such as global warming, earthquake and volcano.

## ANIMAL UPDATES

### Status Report on Loss of Emi and Cincinnati Zoo – Terri Roth

A brief history of Emi: she was collected and moved to the Los Angeles Zoo in 1991 and moved to the Cincinnati Zoo in 1995. She first became pregnant in 1997 but the pregnancy was lost. Her pregnancy in 2000 was maintained and Andalas was born in 2001. Suci was born in 2004 and Harapan was born in 2007. Emi died in September 2009. No symptoms were readily apparent before April 2009, when she began to show decreased appetite, lethargy, and she seemed depressed. Veterinarian Dr. Mark Campbell performed the following tests with no abnormal results:

- General exams: teeth, heart, overall physical
- Blood analyses (CBC and comprehensive chemistry) several times including aerobic and anaerobic blood culture
- Urinalysis 4 different samples over a couple months (results normal)
- Ultrasound exam of kidneys, repro tract, bladder, liver, spleen, thyroid (by us and an ultrasound expert from the medical school and an equine internal medicine expert) nothing abnormal identified
- Fecal ova and parasite exam (three times)---all negative
- Fecal culture (4 times)---all negative
- Fecal occult blood test (negative)
- Bile acid analysis (initially same results as back in 2001; subsequent tests demonstrated a marked and consistent elevation )
- Johne's stool culture (twice) - both negative
- Brucella (negative)
- Leptospirosis test (normal titers)
- TB test July (negative)---administered at base of ear with 0.1 PPD Bovis tuberculin
- MAPIA test two years ago (negative)
- Fungal panel tested (coccidiomycosis, aspergillosis, blastomycosis and Histoplasmosis) all negative---serology test
- Water deprivation test (for renal function – inconclusive)
- ACTH (normal)
- Comprehensive thyroid panel----unremarkable when compared to conspecifics (Ipuh and Suci) and domestic equids

The only abnormal findings were one or two very slightly elevated liver enzymes early on and the consistently elevated later bile acid tests. Emi was treated with:

- Tucoprim (antibiotic) treatment—Trimethoprim and Sulfadiazine
- H2 blocker Gastrogaurd prophylactic
- Sucralfate prophylactic
- Prednisolone

Post Mortem Gamete Rescue Attempt

- Both ovaries contained multiple follicles (5-12 mm)
- 30 oocytes recovered and matured *in vitro*
- 30 oocytes inseminated *in vitro* with frozen-thawed sperm
- No oocytes cleaved
- Staining revealed 2-3 mature oocytes but most were degenerate

Histopathology performed by two outside board certified veterinary pathologists showing significant hemosiderosis and hemochromatosis of the liver, moderate hemosiderosis in a few other organs and the cause of death was determined to be liver failure due to hemochromatosis. Hemochromatosis affects many wildlife species in captivity including black rhino, tapir, bats, many bird species, etc. Early testing of Ipuh, Emi and Rapunzel (and other SRs) suggested iron overload could be a problem in this species. Analyses were performed at Kansas State University.

Andalas' iron levels have been monitored from the beginning:

| Date/Age | Iron (ug/dL) | TIBC | Trans. Sat.(%) | Ferritin | Location |
|---|---|---|---|---|---|
| 9/14/2001 - 1 day | 173 | 291 | 59 | 226 | CZBG |
| 10/4/2001 - 3 wk | 119 | 316 | 37 | 72 | CZBG |
| 11/13/2001 - 2 mo | 71 | 306 | 23 | 33 | CZBG |
| 03/??/04 - 2.5 y | 144 | 159 | 91 | 1082 | LA |
| 2/23/2007 - 5.5 y | 203 | 216 | 94 | 3981 | LA |

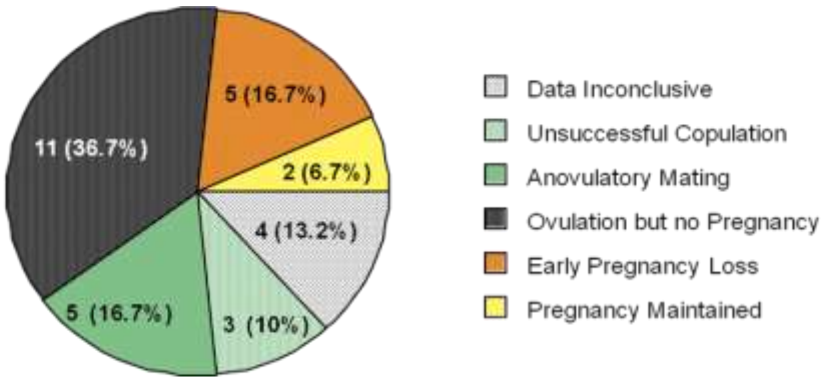
Diets from Cincinnati and Sabah have been published by Ellen Dierenfeld and Cincinnati diets contained lower levels of iron. The proposed follow up on the iron issue is to**:**

- Analyze serum for iron analytes from captive population
- Suggest quarterly samples from 2009 and collect quarterly in 2010
- Analyze all samples at Kansas State University

One of the most important issues we are dealing with now is whether Suci is sexually mature and what we do with her in terms of breeding. Suci currently weighs 688 kg. From follicle sizes on ultrasound as well as hormonal profile she appears to be mature.

Ipuh is now more than 28 years old. His health is good but his vision is impaired. Semen samples are stored at Cincinnati; seven ejaculates have been frozen in 260 ½ cc straws. Ipuh's sperm concentration is 17 to 55 million/ml and motility post-thaw is 30-45 percent.

We are confident that Andalas will be able to sire offspring soon and urge the group's patience with that process. Dr. Roth reminded the group that out of 30 attempted matings, data from Emi and Ipuh showed the following:




Suci needs to breed soon because she appears to be mature or very close to it. If we wait to breed her, she will start to lose her fertility, based on what we know about other rhino species. And we need to breed as many rhinos as possible as soon as possible to keep the program viable. At the last GMPB meeting, the recommendation was to AI Suci with sperm from Tam or Torgamba. The benefits of that recommendation are that (a) no rhinos need to move; (2) Tam or Torgamba are a good genetic match; (3) this technology could help other rhinos and reduce international rhino moves. The challenge is that Torgamba is no longer an option as he is not producing viable sperm, and government permission to use Tam's sperm has not been forthcoming. Dr. Roth requested the assistance of the GMPB to address this issue.

**Sumatran Rhino Sanctuary – Dedi Candra**

The goal of the SRS is to successfully breed Sumatran rhinos in sanctuaries for reintroduction purposes. The objective is to establish a centre for semi-in-situ conservation of the Sumatran rhinoceros, and the function of the SRS is as a center for breeding, research and conservation education of the Sumatran rhinoceros. The SRS:

- provides a natural environment with ~10 ha forest enclosure per rhino
- is within rhino habitat that provides natural food, topography and vegetation
- provides for less human interaction which allows rhinos to engage in natural behavioural repertoire (wallowing, exploring, forage for own food, etc)
- staff conduct intensive daily observation on all rhinos to monitor their behaviour pattern as important parameters for early detection of illness
- conducts research on food preferences, reproductive behaviour and hormones, habitat use, and study of Sumatran rhino ecology.

***Standard observation and monitoring of SRS animals includes:***

Husbandry

- Food intake - daily
- Behaviors monitoring - daily
- Body weight - weekly

Health

- Blood Analysis - monthly
- Mineral assays - Quarterly
- i-Stat testing - quarterly
- Urine and faecal analysis - weekly
- Physical inspection - daily
- Disease surveillance - annually

Reproduction

- Ultrasound 3x/week then daily near estrus
- Faecal sample collection (2-3 samples/week)
- Reproductive morphology and sexual behavioural changes daily

***The status of each rhino at the SRS was reviewed***:

Torgamba – male, age ~ 30 years.
Weight: 667 kg
Health status: overall good condition for an old male.

- Kidney problem - Low serum phosphorus and high Ureum-Creatinine in the blood observed since 2004
- Chronic Anemia – low hematology
- Less strong compared to females, he tires easily during courtship/
- Missing lower first molar causing history of dental disease (treated with power float)

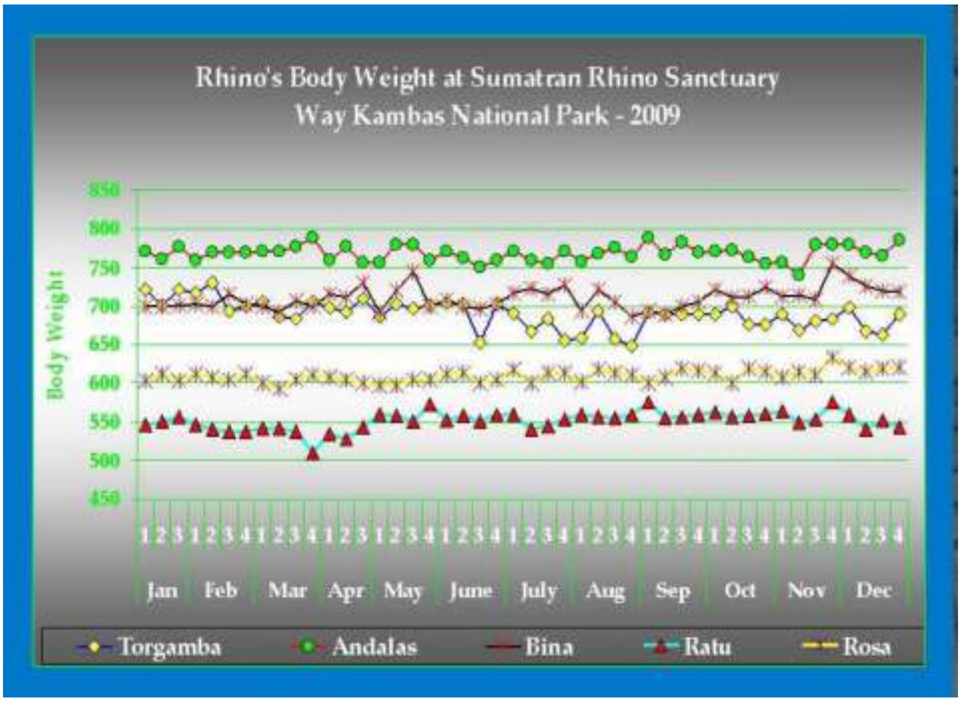
Reproductive status: oligospermic, infertile

Bina – female, age >25 years
Weight: 728 kg
Health status: good
Reproductive status: irregular estrus cycles
Ratu – female, age >8 years
Weight: 561 kg
Health status: good
Reproductive status: normal reproductive tract

- Clear behaviour of oestrous with approach to centre area, makes sign in the forest especially close the centre area (urine and faecal)
- Clear physical signs of oestrus like vulva redness, swollen
- She has regular cycle of oestrus since 2007 and potential female for breeding
- Many past breedings with Torgamba - no pregnancies
- Breeding with Andalas

Rosa– female, age >7 years
Weight: 622 kg
Health status: good. Monitoring for parasite infestation. Although Rosa shows no evidence of disease associated with these flukes, there may be concern because an elephant from the nearby sanctuary appears to have died from a severe fluke infestation.
Reproductive status: recently started cycling

Andalas – male, 8 years
Weight: 759 kg
Health status: good
Reproductive status: first copulation December 2009, mature male




Current Reproductive Strategy

Pair Andalas and Ratu in Center Breeding Area: Andalas as primary breeding animal at the SRS. Priority will be to mix Andalas with Ratu since she is an experienced breeder of presumed normal adult reproductive function.

Pair Andalas and Rosa/Bina in Center Breeding Area:
Even as we breed Andalas and Ratu, we will also breed other females.

Pairing Torgamba and Rosa in Second Breeding Area: Rosa is young and maturing inexperienced female and we believe that she may learn valuable courtship lessons by mixing with Torgamba.

Pairing Torgamba and Bina in Second Breeding Area: We need to pair Bina to induce regular cycle. Success is improbable, but we will continue to try to successfully breed Bina.

**Sabah Sumatran Rhinos – Junaidi Payne (BORA) and Petra Kretzmar (IZW)**

Two rhinos are present in captive conditions in Sabah:

- Kretam (Tam), male, captured August 2008, age roughly 20 years
- Gelogob, female, captured June 1994, exact age unknown, but aged

Reproductive assessments on both animals were performed in November 2009, a collaboration of the Leibnitz Institute for Zoo and Wildlife Research, Berlin / Research Institute for Wildlife Ecology, Vienna / Sabah Wildlife Department.

Tam's assessment results were:

- 21 ml ejaculate collected by electroejaculation; 1.5 x $10^6$ sperm / ml; 55% of sperm progressively motile; 8 % of cells morphologically intact
- 5 ml of semen in 10 straws were cryopreserved and retained by Sabah Wildlife Department
- Concentrations of viable sperm were judged too low for use via artificial insemination or *in vitro* fertilization
- Intra cytoplasmatic sperm injection (ICSI) into oocyte may be possible
- Very good prospects for better quality collection in the future

Gelogob was examined using trans-rectal ultrasound examination without chemical restraint.

- Minor lesions were seen in reproductive organs; uterine cysts were present but had not progressed in size or number since 2005
- There was a small tumour mass in the cervix
- Both ovaries were small and inactive; no signs of larger follicles or corpora lutea were detected
- Gelogob is presumed acyclic and reproductively senescence; pregnancy from natural mating or artificial insemination is unlikely
- Hormone treatment to stimulate growth of follicular stock, oocyte production & in vitro fertilization was suggested

Other news from BORA is that Tam's weight now stable at around 600 kg. Tam's forest paddock has been divided into two (1.5 ha each) in preparation for receiving new rhino. After much deliberation, the size of the Borneo Rhino Sanctuary size will probably be reduced and developed/managed more along the lines of the SRS. Two rhinos are targeted for capture during 2010.

**White Oak Conservation Center – Steve Shurter**

White Oak is a 7,400-acre facility in north Florida and southeast Georgia. White Oak's species are linked with programs that improve the survivability of animals in the wild, with each species providing opportunities for training, research and breeding. Some of White Oak's programs provide animals for re-introduction (for ~30% of the species) and support is provided for field conservation programs in the range states, for example for rhinos in Indonesia.

White Oak presently holds black, white, Indian and Sumatran rhinos (Harapan), all in large, naturalistic enclosures. White Oak is a founding member of IRF, hosts IRF's program office and provides administrative support. Through its foundation, Gilman International Conservation, it directly funds efforts in protection and technical support for Indian, Sumatran and black rhinos.

Harapan's weight has been good since arriving at White Oak and he now weighs around 600 kg.


A number of browse items have been offered since his arrival:  12 native or species grown at White Oak or in Florida (FL) and 17 non-native species (grown in California – CA).

| Common name | Latin Name | Common name | Latin Name | Source |
|---|---|---|---|---|
| Sweet gum | *Liquidambar styracifula* | Ficus | *Ficus alii* | FL |
| Wax myrtle | *Myrica cerifera* | Ficus benjamina | *Ficus benjamina* | FL |
| Mulberry | *Morus alba* | Ficus | *Ficus nitida* | FL |
| Red bay | *Persea borbonia* | Ficus | *Ficus mysorensis* | CA |
| Loblolly bay | *Gordonia lasianthus* | Ficus | *Ficus lutea* | CA |
| Tupelo | *Nyssa sylvatica* | Ficus | *Ficus macrophylla* | CA |
| Elm, American | *Ulmus americana* | Ficus | *Ficus rubiginosa* | CA |
| Birch, river | *Betula, sp.* | Ficus "Florida" | *Ficus floribunda* | CA |
| Gallberry | *Ilex coriacea* | Pittisporum | *Pittisporum sp.* | WO |
| Hackberry | *Caeltis laevigata* | Bradford pear | *Pyrus sp.* | WO |
| Grape vine | *Vitis munsoniana* | Banana | *Musa sp.* | WO |
| Willow, coastal | *Salix nigra* | Bamboo, large leaf | *Phyllostachus sp.* | WO |
| | | Loquat | *Eribotrya japonica* | WO |
| | | Elm, Chinese | *Ulmus parvifolia* | WO |
| | | Photinia, red-tipped | *Photinia globra* | WO |
| | | Giant reed | *Arunda donax* | WO |
| | | Corn | *Zea mays* | WO |

Harapan is in good condition overall and his daily diet is now comprised of:

- Mixed ficus browse (CA) — 34 lbs/15 kg
- Mixed local browse — 70 lbs/31 kg
- Wild herbivore grain — 10 lbs/4.5 kg
- mixed fruit/veggies — 5  lbs/2.3
- Vitamin E supplement — 12 mls
- mixed hay:  timothy, coastal, alfalfa — 15  lbs/6.8 kg

**Los Angeles Zoo**
There was no report from Los Angeles, and Jeff Holland sent his regrets that they were unable to send a representative to the meeting. Los Angeles continues to be interested in participating in the program and in staying apprised of developments and opportunities for future re-engagement.

**UPDATE FROM THE IUCN ASIAN RHINO SPECIALIST GROUP MEETING IN BOGOR January 2009 – Bibhab Talukdar**

The purpose of the January AsRSG meeting was to:

- encourage networking among managers and researchers working in Rhino Bearing Protected Areas in South East Asia
- share experiences in current state of research on problems faced by small rhino populations, particularly with regard to in-breeding depression and scarcity of habitat
- assess current status threats and challenges in rhino conservation and explore trans-country cooperation on information sharing on rhino poaching as part of Crisis Management
- identify key resource personnel in the field of rhino research and conservation in South East Asia

Much of the meeting's discussions centered on 'doomed' or rhinos living in very fragmented habitats with no possibility of genetic exchange. It was agreed that every effort should be made to protect those wild rhinos that are breeding and not considered 'doomed.' Rhinos living in situations where no genetic exchange is possible should be captured and moved into a secure location (sanctuary or secured habitat). Additionally, it was agreed that all rhinos in "managed breeding programs" (i.e., zoos, sanctuary, breeding center, etc.,) should be managed under the umbrella of the GMPB. Finally, the AsRSG agreed that because of such small numbers, all Sumatran rhinos should be managed as a single population without concern for management at the subspecific level.

Sustainable funding for Asian rhino conservation was also discussed with the specific recommendations to:

- encourage governments to provide adequate budgets for wildlife law enforcement so that NGOs are not the sole source of support for rhino protection.
  - Vietnam: Forest Protection Department
  - Sabah: Director of Sabah Wildlife Department
  - Peninsular Malaysia: Department of Wildlife and National Parks
  - Indonesia: Director of Biodiversity Conservation, PHKA
- investigate the possibility that law enforcement might/should be eligible for support under carbon credit schemes
- determine who is setting up the mechanics of these schemes so that we know how best to influence the process

The AsRSG adopted the following resolution at the January meeting in Bogor:

> "We, the participants of the IUCN/SSC Asian Rhino Specialist Group, meeting in Bogor, Indonesia on 2-3 March 2009,
>
> *Recognizing* the need to strengthen adaptive conservation to further strengthen conservation,
>
> *Examining* the needs of on-the-ground, intensive management to save the remaining Sumatran and Javan rhino populations,
>
> *Recognizing* further that Sumatran and Javan rhinoceros are fully protected under national

and international laws and that actions damaging to rhino populations or their habitat are against these laws,

*Convinced* of the need to take urgent measures to prevent the continued fragmentation and eventual extinction of this Sumatran and Javan rhinoceros populations,

*Urge* range country government and non-governmental agencies and international donor to implement Sabah, Indonesia and Vietnam rhino action plans and to:

- Increase awareness efforts and resource allocation to protection efforts of all known populations of Javan and Sumatran rhinos in South East Asia
- to urgently set in motion the steps needed to create a second population of Javan rhinos in Indonesia
- to actively use relevant region cooperative initiatives (e.g., ASEAN Wildlife Enforcement Network (ASEAN-WEN) to strengthen information sharing and intelligence to close illegal cross border rhino horn trade,

*Recognizing* that where populations are seen to be declining, or there is an absence of breeding, that it is necessary to:

- consider all Sumatran rhinos as members of a single global population; individual animals and their germplasm may be exchanged between participating countries for breeding purposes
- consider a formal dialogue between the Governments of Indonesia and Malaysia (Federal and Sabah) and the United States on a possible Sumatran rhino exchange program to strengthen the Sumatran rhino populations
- consider a formal dialogue between the Governments of Indonesia and Vietnam on a possible Javan rhino exchange program to strengthen the Javan rhino populations.

*Invite* other members of the international community, including donor states, the private sector, the corporate sector, academic and scientific institutions, to provide effective and united support, including funding, to assist these efforts.

We, the participants of the Rhino Specialist Group meeting, pledge to do everything in our power to ensure the long-term viability of the Sumatran and Javan rhinoceros, and to encourage all sectors to assist and support these efforts."

* * *

**SETTING THE STAGE FOR THIS MEETING OF THE GMPB – Susie Ellis**

In addition to updating the GMPB on individual animal status, this meeting was designed to be a brainstorming session to develop a proactive strategy to address the recent population changes. The SR captive program originally was developed with the aim to contribute to the conservation of the wild population. We need a paradigm shift in order to work through the recent changes and to move the captive population towards optimally supporting the wild population. The main questions are: (1) How do we ensure that the captive population contributes to the wild population and what is needed to make that happen? (2) What are the steps needed to get to the point where we can manage SRs using a meta-population management strategy incorporating the captive and wild population? (3) What are the individual animal recommendations or population needs?

The group brainstormed a variety of ideas and topics:

***How do we ensure that the captive population optimally contributes to the wild population?***

- Propagate more rhinos – get more rhinos on the ground
- Achieve sustainable growth of population
- Analyze population demographics and genetics
- Technological support and exchange between institutional or countries
- Carry out research that enhances our ability to save the population
  - Monitoring technology (radio telemetry)
  - Fecal DNA analysis for genetic/demographic information
- Assess impact of SRS on surrounding area in Way Kambas
- Promote awareness to raise funds
- Make a realistic linkage between *ex situ* and *in situ* conservation
- Add more animals to captive population from wild population
- Maintain animals short-term in captivity to collect gametes
- Develop/contribute to a genome resource bank for Sumatran rhinos
- Understand genetic differences, if any, between the two subspecies – review/renew previous genetic work
- Understand the breeding situation in the wild
- Develop a material transfer agreement so that it is in place ahead of time when needed
- Obtain government approval/regulations to support these activities

A back-of-the-envelope analysis suggests that the current captive population could possibly expand to up to 17 rhino under optimal conditions with natural breeding (see next page).

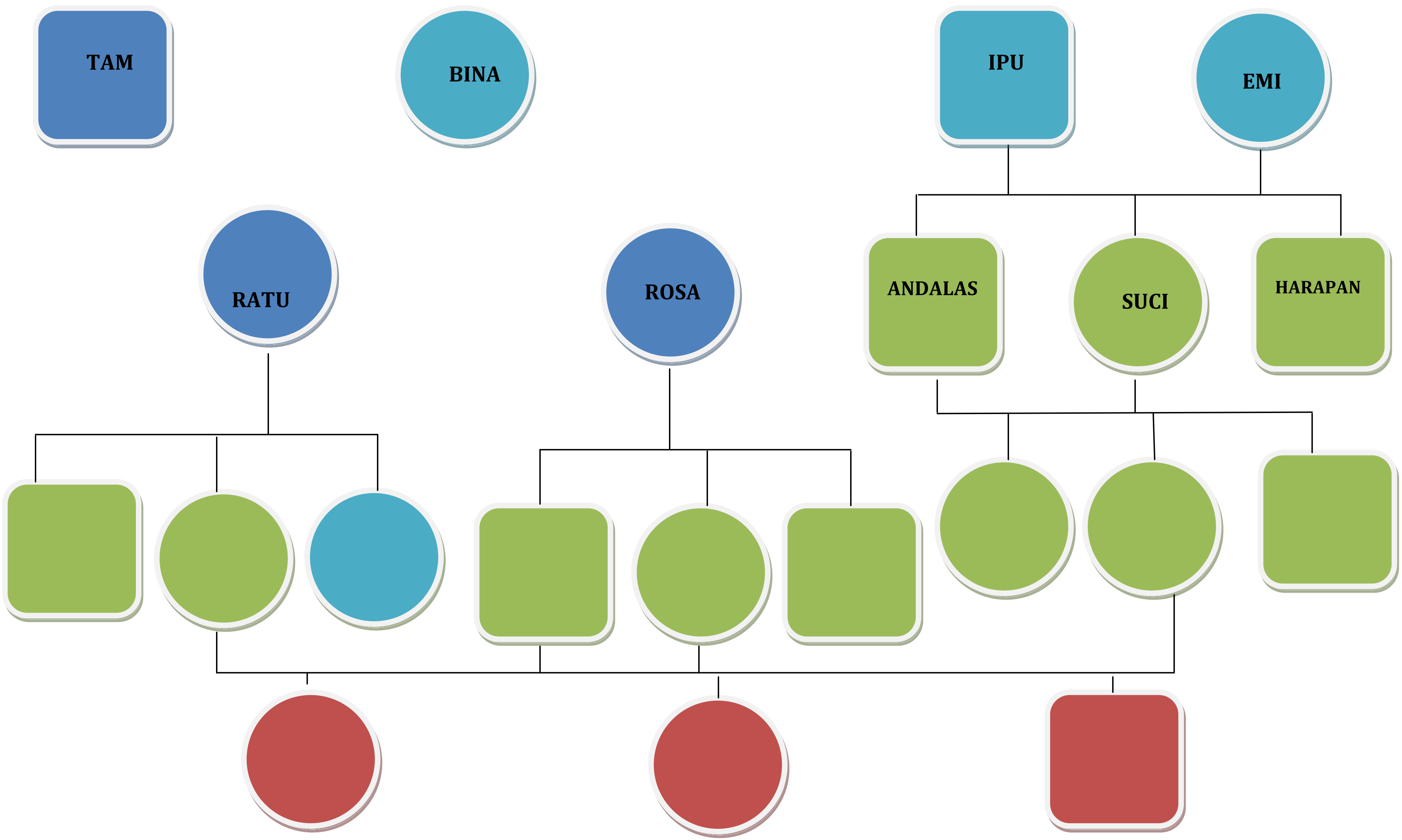
**How do we resolve the genetic issues?**

- There is concern from both the Indonesian and Malaysian governments about mixing the two subspecies.
- To address this, we need to pull together existing genetic information in a user-friendly manner and to identify what, if any, genetic differences are significant
- Address the political issues within and between the range countries particularly those pertaining to shipping of samples and/or animals.

**What are the steps towards developing and implementing a metapopulation strategy?**

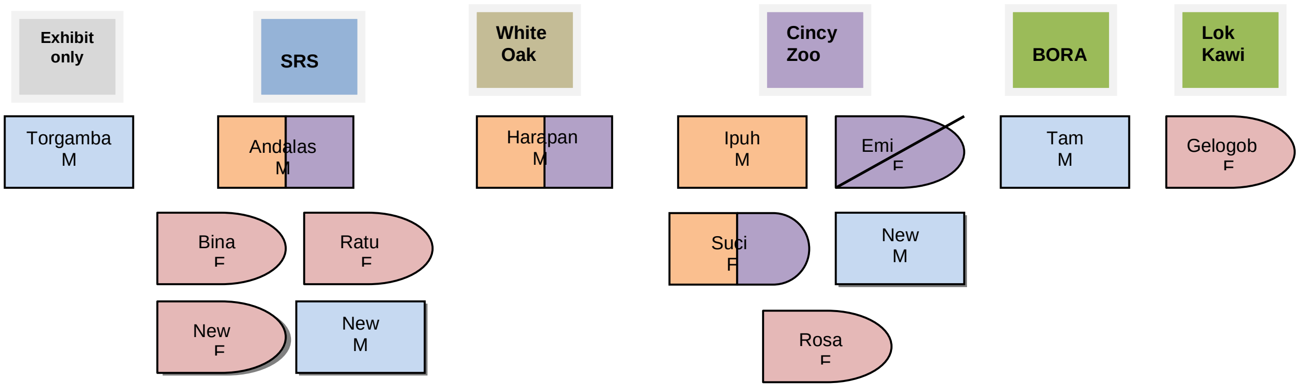
- Document whether SRS population is “safer” than the wild to garner government support.
- Emphasize the use of the SRS population as a genetic reservoir and as a physically “safer” population
- Develop a creative process for management, for example
  - Short-term captivity (bringing animals in from the wild for short-term gamete collection)
  - Short-term wild (temporarily releasing SRS animals into the wild for natural breeding while under close monitoring)
  - Preliminary feasibility studies are needed

# Sumatran Rhinos Potentially Involved in Reproduction 2020



At least two participants expressed concern that despite the fact that Andalas and Ratu mated in December, the progress with producing a calf is not moving ahead as quickly as desired.  (We had not confirmed at this time that Ratu was already pregnant.)  These participants desired to re-open the discussion to return Ipuh to Indonesia to breed with Ratu and Rosa.  The discussion was then moved to focus on the underlying need, rather than the position.  The position is that Ipuh should move; the underlying need is that we need to have a viable male at the SRS producing offspring.  With that, the group moved away from the position of moving Ipuh to examine what kinds of actions or strategies could address the need for a viable male.  The primary need is that we need more genetic diversity in the population.

Even though under optimal conditions 17 animals could be on the ground by 2020 (see previous page), that still will not be enough to really make the captive population a substantial insurance population for the wild population.  The group then discussed what the minimum infusion of new genetic material might be in order to reach that goal.  A rough model using post-it notes (see below) was constructed on the wall with existing animals and locations, and then adding additional animals.  The group determined that adding two new males and one new female could substantially improve the breeding options for the captive population and likely would add significantly to genetic variability should breeding be successful.  [**This model assumes that Tam would not be included in the breeding population (until such time as the subspecies issue is sorted out).  Until/unless the subspecies issue is resolved, Sabah has very limited options.**]




Should the GMPB desire to pursue this option, we must make strong case to the Government of Indonesia for collection of new animals.

We then examined all the potential options for each animal currently in the population.

| *Animal* | *Option for Action* | *Note:* |
|---|---|---|
| ***Suci*** | 1. Find unrelated sperm<br>2. Breed with Ipuh<br>3. Find unrelated male for natural breeding<br>4. Breed with Harapan<br>5. Breed with Andalas<br>* Suci cant wait for 2 years<br>Plan A : find unrelated sperm | - Assume that we will need to justify to government of Indonesia (Indonesia does not allow parent-offspring matings)<br>- Time consideration; Suci may lose ability to breed if she is not bred soon<br>- There is a risk that mating Ipuh with Suci would present external credibility issues in terms of questions about sound management. |
| ***Rosa*** | 1. Change management, decrease intense keeper interaction - socialize with other rhino<br>2. Breed with Andalas<br>3. AI with unrelated sperm<br>4. Release short-term for mating with wild male<br>5. Breed with Ipuh<br>6. Get expertise on reversing imprinting | |
| ***Ipuh*** | 1. Mate with Rosa<br>2. Mate with Ratu<br>3. Bank sperm<br>4. Use sperm for Rosa<br>5. Use sperm for Ratu<br>6. Breed with Suci<br>7. Breed with new female | - Assume that we will need to justify to government of Indonesia (Indonesia does not allow parent-offspring matings)<br>- There is a risk that mating Ipuh with Suci would present external credibility issues in terms of questions about sound management. |
| ***Andalas*** | 1. Breed with Rosa<br>2. Breed with Ratu<br>3. Bank sperm<br>4. Breed with Bina<br>5. Breed with new female<br>6. Continue sperm assessment<br>7. Breed with Suci | |
| ***Harapan*** | No change because of age | |
| ***Ratu*** | 1. Breed with Andalas<br>2. Breed with new male<br>3. Breed with Ipuh<br>4. Use Ipuh's sperm | |

| *Animal* | *Option for Action* | *Note:* |
|---|---|---|
| ***Torgamba*** | 1. Use as ambassador animal<br>2. Compare data with Sabah Tanjung<br>3. Continue mating with Rosa, Ratu and Bina for behavioral experience.<br>4. Radio collar testing<br>5. Use for ecotourism | |
| ***Bina*** | 1. Breed with Andalas<br>2. Breed with Torgamba<br>3. Use as ambassador animal<br>4. Radio collar testing<br>5. Collect gametes<br>6. Share/compare post-mortem protocol (US and German) | |
| ***Tam*** | 1. Collect sperm<br>2. Find new female in Malaysia | Assumes for now that exchange not possible between Indonesia and Sabah |
| ***Gelogob*** | 1. Hormone stimulation<br>2. Move to Tabin to be placed into Tam<br>3. Enrich diet to gain weight<br>4. Regular health assessment to see if underlying cause for weight loss<br>5. Obtain organ samples post-mortem to study iron deficiency<br>6. Mate with Tam | |
| ***Note for ALL*** | **1.** Post-mortem frozen organ sample<br>**2.** Collect whole reproductive track<br>**3.** Collect eyes to evaluate cataract problems, blindness, etc.<br>**4.** Add Petra Kretchmar to Technical Committee | |

For all options above, there are some obvious decisions:

1. Harapan *status quo*
2. Keep Andalas and Ratu together
3. Suci : breed with new unrelated male or unrelated sperm (possibly Tam)
4. Rosa: change management to less intensive keeper interaction to minimize behavioral pathologies. Breed with unrelated male (Andalas or new male).

## 3. BENEFITS AND RISKS FOR THE VARIOUS SCENARIOS SUGGESTED FOR EACH RHINO:

### a. Move Rosa to Cincinnati Zoo

| Potential Benefits: | Potential Risks/Disadvantages: |
|---|---|
| 1. Security<br>2. Potential for generating more funding from zoos in the US<br>3. Genetic infusion<br>4. Conservation networking between countries<br>5. Could be used as an attention-getting promotion for the whole program<br>6. Increased capacity building<br>7. Increase capacity for fundraising from public<br>8. Space opened up at SRS for other animals<br>9. Good faith gesture between Cincinnati Zoo and Government of Indonesia<br>10. Allows addressing Rosa’s behavior issues<br>11. Increases biological information database with data from new animals<br>12. Increase awareness among government and NGOs<br>13. Demonstrates that we are managing Sumatran rhinos managing as one population (true metapopulation management) | 1. Transport loss<br>2. May not breed naturally<br>3. Reduces reproductive options for Andalas<br>4. Hemosiderosis<br>5. Local NGOs may express concern about export |

### b. Move Ipuh to Indonesia (SRS-YABI)

| Potential Benefits: | Potential Risks/Disadvantages: |
|---|---|
| 1. Proven breeder<br>2. High potential for breeding with Ratu and/or Rosa<br>3. Potential Indonesia donor could be persuaded to pay transport cost | 1. Transport loss<br>2. Older age and potentially blind<br>3. Genetic variation will be decreased as Ipuh will be over-represented<br>4. Creates need for new male for Cincinnati Zoo and at SRS.<br>5. Indonesia donor may only support move, not long-term care/maintenance at SRS.<br>6. Loss of animal will likely reduce funds from US zoos for Indonesia programs<br>7. May limit our ability to ability to bring in a new male |

**c. Bringing New Animals to SRS**

| Potential Benefits: | Potential Risks/Disadvantage: |
|---|---|
| 1. Demonstrates that we are managing Sumatran rhinos managing as one population (true metapopulation management)<br>2. Security<br>3. Infuses captive population with new genes<br>4. Could be used as an attention-getting promotion for the whole program<br>5. Increased capacity building<br>6. Increased capacity for fundraising<br>7. Good faith gesture among GMPB partners, especially Cincinnati Zoo/Government of Indonesia<br>8. Increases biological information database with data from new animals<br>9. Increased awareness among government and NGOs<br>10. Gets rid of need to inbreed to continue reproductive potential<br>11. Demonstrate that bilateral TFCA, REDD and DNS funding really contributes to Sumatran rhino conservation<br>12. Conservation forest ecosystem restoration (new approach in forestry that allows restoration)<br>13. Implementing the Government of Indonesia's rhino strategy<br>14. Could release animals back to wild if needed or hold at SRS short- term for breeding<br>15. Attractive to donors to move animals around<br>16. May allow rescuing at-risk rhinos from wild | 1. Capture or transport loss<br>2. May not breed<br>3. Hemosiderosis<br>4. Possible NGO criticism for capturing new animals<br>5. If isolated animals are collected and moved to the SRS, it could decrease the incentive for forest protection |

**d. Move Torgamba as Ambassador Animal**

| Potential Benefits: | Potential Risks/Disadvantages: |
|---|---|
| 1. Frees up space at SRS<br>2. Ambassador animal generates more funds for rhino conservation<br>3. Generating awareness about SRS<br>4. Reduce financial burden of keeping non-reproductive animal at SRS | 1. Zoos may not want older animal<br>2. Transport loss<br>3. Old age<br>4. Disease issues |

| | |
|---|---|
| 5. If moved to internationally, increased awareness about Sumatran rhinos and potential funding/support<br>6. Increases capacity building<br>**7.** Gesture of international goodwill if moved out of Indonesia | |

**4. ACTION ITEMS**

The following action items were developed **to be completed by July 2010**:

- **BORA** (Abdul Hamid, lead) to coordinate/lead analyses of subspecies genetics using samples currently in Malaysia (peninsular vs. Sabah Sumatran rhinos). Molecular genetic study to be carried out. The key issue is obtaining a list/inventory of samples.
- **White Oak** (Steve Shurter, lead) to work with Joe Christman and Jamie Ivey (AZA Rhino Advisory Group) to conduct an in-depth assessment of the global captive population and possible management scenarios.
- **IRF** (Susie Ellis, lead) to contact Bob Lacy (IUCN CBSG) for preliminary PMX and/or other pertinent analyses
- **YAB**I (Widodo Ramono, lead) will work with PHKA to facilitate government funding for national parks, including working with the Ministry of Forestry to access the German DNS funds for rhino conservation (available only to the parks, not NGOs)

**5. OTHER ISSUES (not in order of priority)**

**A number of other issues were discussed during the meeting, including:**

a) We need to work together to make a clear case to the governments of Indonesia and Malaysia about the subspecies issue, with a coherent argument for managing the species as one management unit.
b) More work needs to be done with iron storage issues, including absorption issues, serum analysis, source, indicators, and institutional comparisons. We need to continue to monitor iron load in all animals in the population as an ongoing management measure.
c) We need to remember that Andalas already represents two founders when making management decisions/breeding recommendations. Ipuh's genes are already well-represented.
d) One consideration when discussing the options mentioned previously is time, which is running short – is it going to be faster to move animals between countries or collect from wild in Indonesia?
e) The GMPB needs to work with and build relationships with local NGOs so that they understand the urgency of the problems facing Sumatran rhinos and our need to make rapid and agile decisions
f) Adding wild-caught animals to the US population would allow for another measure of genetic security in that a (hopefully) viable captive population would exist in two sites.
g) Animals held in isolation may not be able to breed or may have reproductive pathologies, and we need to continue to keep that in mind as management decisions are made
h) A strategy for dealing with isolated animals is covered in the Indonesian Rhino Strategy and we should consult the strategy before making recommendations/taking action

i) Removing isolated animals could have the unintended potential effect of decreasing forest protection
j) All GMPB members need to seek out additional funding alternatives
k) We need to determine scientifically the degree of risk between inter-breeding subspecies or allowing inbreeding in the captive population
l) We need to consider the acceptability of our actions/decisions within the conservation community, while at the same time acting in the best interest of the species. This should not change our recommendations or decisions, but we must be ready to defend them to the broader scientific community.

**6. COMPOSITION OF THE GMPB**

a) Chairman: Bpk. Widodo S. Ramono (Unanimous endorsement/approval from all members)
b) Members: No change, one representative from each holding institution
c) Technical Committee (experts invited for advice, as needed, based on program and expertise needs)

# Meeting Participants and Contact Information

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* Institutional Representative

# 2011 Sumatran Rhino
# Global Propagation & Management Board Meeting – Briefing Materials

## Kota Kinabalu, Sabah, Malaysia

## 8-9 February 2011

## SECTION 2

## White Paper – Future Directions Towards the Persistence of the Captive Sumatran Rhino Population

# Future Directions Towards the Persistence of the Captive Sumatran Rhino Population

**Discussion Paper**
**24 January 2011**


Susie Ellis, Ph.D.[1], Jamie Ivy, Ph.D.[2], and Widodo S. Ramono[3]
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## EXECUTIVE SUMMARY


No more than 200 Sumatran rhinos are thought to remain in fragmented populations on Sumatra and Borneo. In addition to the wild population, there are 10 Sumatran rhinos in captivity (five in Indonesia, two in Sabah, Malaysia, and three in the United States) for purposes of breeding, research and education. The captive Sumatran rhino population is overseen by the Sumatran Rhino Global Propagation and Management Board (GMPB), which was established in 2005. The GMPB is comprised of NGOs, governments, private donors, zoos and other international rhino conservation organizations. In February 2010 the GMPB met in Bogor, Indonesia to develop a proactive strategy to address the loss of the only breeding female and to move the captive population towards optimally supporting the wild population. Two main recommendations emerged from the meeting: (1) that the population needs to be managed under a truly global management system and (2) that new genetic material is needed to decrease its risk of extinction and enhance its viability.

As part of the research to substantiate these recommendations, a Population Viability Analysis (PVA) was carried out to analyze the potential persistence of the captive population of Sumatran rhinos. The software package VORTEX (v9.98; Lacy 1993) was used to develop a PVA for the global population of captive Sumatran rhinos. All modeled scenarios demonstrated that the global population of captive Sumatran rhinos has a moderate to high risk of extinction over the long-term, but that extinction risk declined if all captive animals could be managed as a single population rather than managed as regional subpopulations with limited transfers between geographic areas.

The present analyses suggest that the two most important management actions are (1) managing the captive Sumatran rhino population on a global basis and (2) adding animals to the global population to contribute to its long term persistence. The modeled scenario had the biggest positive impacts on the viability of the global population of captive Sumatran rhinos combined importing a pair of wild-caught rhinos into the Sumatran subpopulation, importing a wild-caught male into the US subpopulation, and transferring female #45 to the US. If all captive animals were managed as a single population (assuming 33% of females breeding; 15% first-year mortality), this combination of scenarios eliminated the risk of population extinction over the next 25 years and decreased

extinction risk by 20% over the next 100 years. There is an urgent need for decisive management action for the captive population of Sumatran rhinos. The authors urge the GMPB members, particularly the governments of Indonesia and Malaysia, to seriously consider these recommendations, and to act on them as soon as possible to strengthen the global captive Sumatran rhino population.

## BACKGROUND

### Sumatran Rhinos in Nature

No more than 200 Sumatran rhinos *(Dicerorhinos sumatrensis sumatrensis)* survive in fragmented populations on the islands of Sumatra and Borneo. Sumatran rhinos may well be the most endangered of all rhino species, due to their rapid rate of decline – more than 50% over the last decade. The species is listed as Critically Endangered on the IUCN Red List of Threatened Species (van Strien *et al*. 2008).

*Indonesia.* The Sumatran rhino population in Indonesia is spread across three major parks containing some of the most critical remaining tropical forest habitats in Indonesia. These parks are each home to numerous threatened species and provide critical ecosystem services for local human populations. There are between 50 and 70 animals in Sumatra's Bukit Barisan Selatan National Park and an estimated 27-35 rhinos in Way Kambas National Park (Yayasan Badak Indonesia, unpublished data). Surveys are planned in northern Sumatra's Gunung Leuser National Park – the other major Sumatran rhino site in Indonesia – in 2011. Previous estimates were that Gunung Leuser held between 60 and 80 individuals (Indonesia Ministry of Forestry 2007), but this has not been confirmed.

*Malaysia.* Sabah, Malaysia is believed to hold approximately 20-30 rhinos in fragmented populations of questionable viability. Rhino numbers and signs of breeding at Tabin Wildlife Reserve and Danum Valley Conservation Area (the sites which probably represent the last hopes for saving this rhino), seem not to have changed dramatically for the past 30 years (J. Payne *in litt*.). Peninsular Malaysia's rhino populations have experienced severe losses over the past few years; most Asian rhino experts concur that their continued existence is improbable.

### Sumatran Rhinos in Managed Breeding Centers and Programs

Because of the challenges and uncertainties of conserving the Sumatran rhino in the wild, in 1984 the IUCN/SSC Asian Rhino Specialist Group recommended and facilitated the development of a captive propagation program. This program was developed using rhinos living in extremely fragmented habitats and/or in isolated situations with no opportunity to breed. In the early 1990s, managed propagation centers known as "sanctuaries" were established in range states and some captive rhinos were repatriated to these locations.

Today, there are a total of 10 Sumatran rhinos in captivity (five in Indonesia, two in Sabah, Malaysia, and three in the United States) for purposes of breeding, research and education. These animals are tracked in the International Sumatran Rhinoceros Studbook. A number of NGOs, most notably the International Rhino Foundation and the Borneo Rhino Alliance (formerly SOS Rhino) have invested millions of dollars in Sumatran rhino propagation programs in range-countries, in collaboration with the governments of Indonesia and Malaysia.

***United States.*** In 1997, seven imported rhinos were held in US zoos. In a true spirit of cooperation, the Bronx and Los Angeles Zoos sent their female rhinos to live with the only male rhino (Ipuh - Studbook [SB]# 28) at the Cincinnati Zoo & Botanical Garden for one last effort to breed this species. After years of extensive research, the first Sumatran rhino calf was bred and born in captivity (Andalas – male, SB # 42). This birth, from sire Ipuh and dam Emi (SB # 29), was the first captive Sumatran rhino birth in 112 years. A second birth quickly followed (Suci – female, SB # 43) in 2004. Male offspring Harapan (SB # 44) was born in 2007. Unfortunately, in 2009, breeding female Emi died from liver failure due to hemacrhomatosis (GMPB 2010). Suci and Ipuh remain at the Cincinnati Zoo & Botanical Garden.

Male offspring Harapan is housed at White Oak Conservation Center, a 7,400-acre facility in north Florida and southeast Georgia. White Oak presently holds four of the five rhino species (black, white, Indian and Sumatran) in large, naturalistic enclosures. White Oak is a founding member of the International Rhino Foundation (IRF), hosts the IRF's program office and provides administrative support.

***Indonesia.*** The Sumatran Rhino Sanctuary (SRS) in Way Kambas National Park, Sumatra encloses 100 hectares (247 acres) of native rainforest habitat for propagation, research and education purposes. The SRS was developed in 1998. Facilities include a large, fenced enclosure of native forest for each of five rhinos; a large, fenced central breeding area with observation posts; a guard post; a small visitor and education center; and very basic barracks, meeting rooms, and veterinary facilities.

For many years the SRS held only non-reproductive rhinos, but today three of the five rhinos in the SRS are reproductively viable. With the advent of the methodologies developed by the Cincinnati Zoo facilitating reliable reproduction, the addition of two rescued, young, healthy females into the SRS population, and the transfer of Cincinnati Zoo-born male Andalas to the SRS in February 2007, the Sanctuary is poised for successful rhino breeding. Late last year Andalas and Ratu (SB # 46), a young, healthy female who was rescued in 2005, bred for the first time and Ratu eventually became pregnant after their third mating. Unfortunately she later miscarried, but this first pregnancy is still considered a major success. Ratu and Andalas have resumed breeding, and the SRS is continuing with efforts to achieve another pregnancy. Andalas' mother Emi (SB #29), who died in 2009, lost a number of pregnancies early in gestation before successfully carrying a pregnancy to term, and extensive reproductive research carried out in Cincinnati will be used to help Ratu sustain her next pregnancy. A second female, Rosa (SB # 45), was also rescued in 2005, but has a number of behavioral idiosynchrasies which have prevented her from successfully breeding with the resident SRS males.

***Malaysia*.** Two rhinos are held at a facility in Tabin Wildlife Reserve in Sabah, Malaysia: Tam (SB # 47), an adult male (~21 years old) who wandered out of the forest in April 2008, and a post-reproductive female of unknown age, Gelogob (SB #40, who was captured in 1994. Reproductive assessments on both animals were performed in November 2009 through a collaboration of the Leibnitz Institute for Zoo and Wildlife Research (Berlin), Research Institute for Wildlife Ecology (Vienna), and Sabah Wildlife Department.

A small amount of sperm (21 ml) was collected from Tam, cryopreserved and retained by Sabah Wildlife Department. Concentrations of viable sperm were judged too low for use via artificial insemination or *in vitro* fertilization. There appear to be good prospects for better quality sperm collection in the future. Gelogob was examined using trans-rectal ultrasound without chemical restraint. She is presumed acyclic and reproductively senescent; pregnancy from natural mating or artificial insemination is highly unlikely.

The Malaysian government has committed to a Rhino Rescue Program in Sabah, with the intention that any remaining scattered and isolated rhinos that can be located and caught from outside Tabin and Danum will be translocated to a fenced sanctuary inside Tabin. Two rhinos are targeted for capture within the next year.

**Sumatran Rhino Global Propagation and Management Board**

The current captive Sumatran rhino population is overseen by the Sumatran Rhino Global Propagation and Management Board (GMPB), which was established in 2005. The GMPB is comprised of NGOs, governments, private donors, zoos and other international rhino conservation organizations like the International Rhino Foundation, the Borneo Rhino Alliance and the Asian Rhino Project of Australia, all of which have invested enormous resources and effort into saving this species. This group includes representatives from range-states, rhino experts, key supporters, and technical advisors who can be called in to assist with specific issues.

The mission of the GMPB is to make management recommendations that will optimize the chances for successful propagation from all Sumatran rhinos in captivity. The tasks of the GMPB are: (1) to recommend and decide on the management of the global Sumatran rhino captive population as a truly global population to maximize the options for reproduction and to improve its vitality in a global Sumatran rhino propagation program; (2) to prepare and facilitate exchange of animals between all locations if indicated for the purpose of the program; and (3) to facilitate exchange of experience and transfer of knowledge and technology for the benefit of the species.

***2010 GMPB Meeting Summary.*** In February 2010 the GMPB met in Bogor, Indonesia to develop a proactive strategy to address recent changes in the captive population (i.e., the loss of the only breeding female) and to move the captive population towards optimally supporting the wild population. The main questions discussed were: (1) How does the GMPB ensure that the captive population contributes to the wild population and what is needed to make that happen? (2) What are the steps needed to get to the point where the Sumatran rhino can be managed using a meta-population management strategy incorporating the captive and wild population? (3) What are the individual animal recommendations or population needs?

This paper focuses on the third point, and in particular, whether the population in captivity can persist without two important changes: (a) a shift to a truly global management system and (2) the importation of new genetic material to decrease its risk of extinction and enhance its viability.

Two major issues emerged during the population discussions at the 2010 GMPB meeting: (1) whether it would be deleterious to breed the two subspecies together (*Dicerorhinus sumatrensis sumatrensis* [Sumatra] and *Dicerorhinos sumatrensis harrisoni* [Sabah])[1]; and (2) that progress with producing a calf is not moving ahead as quickly as hoped in Indonesia. At the meeting, the discussion to return Ipuh to Indonesia to breed with Ratu and Rosa was re-opened. The discussion was then moved to focus on the underlying need, rather than the position. The position is that Ipuh (whose genes are already represented in his male offspring Andalas), should be moved from Cincinnati Zoo to the SRS; the underlying need is that the SRS needs a viable male to produce offspring. With that, the discussions moved away from the position of moving Ipuh to examine what kinds of actions or strategies could address the need for the broader question: what will it take to ensure that the captive population is viable long-term? The group agreed that the primary need is that more genetic diversity in the population, accompanied by a better understanding of population dynamics, is needed.

An informal analysis suggested that if all of the animals capable of reproduction bred under optimal (and hypothetical) conditions, 17 animals could be "on the ground" by 2020. However, this scenario would still not be enough to make the captive population a substantial insurance population for the wild population nor reduce its risk of extinction.

With that goal in mind, the GMPB constructed a hypothetical model including existing animals and locations, and then adding additional animals to the global population (Figure 1). The group agreed that the best option would be adding two new males and one new female to the global population. This scenario had the potential to substantially improve the breeding options for the captive population and likely would add significantly to population persistence should breeding be successful. Optimally, "Tam" from Sabah would also be used as a reproductive male, but the model at that time assumed that he would not be included in the breeding population. Until the subspecies issue is resolved, Sabah has very limited options. Females Bina and Gelogob are thought to be non-reproductive. Since the January 2010 meeting, the Sabah GMPB representatives have used molecular genetics techniques to sort out the subspecies issue. Their conclusion was that there is not enough genetic separation between the two subspecies to merit keeping the captive populations as distinct breeding units, especially given the very low population numbers. These results will be discussed at the February 2011 GMPB meeting in Kota Kinabalu, Sabah.

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[1] The IUCN Asian Rhino Specialist Group recommended at its January 2009 meeting that: (1) where populations are seen to be declining, or there is an absence of breeding, that it is necessary to consider all Sumatran rhinos as members of a single global population; and (2) individual animals and their germplasm may be exchanged between participating countries for breeding purposes consider a formal dialogue between the Governments of Indonesia and Malaysia (Federal and Sabah) and the United States on a possible Sumatran rhino exchange program to strengthen the Sumatran rhino populations.

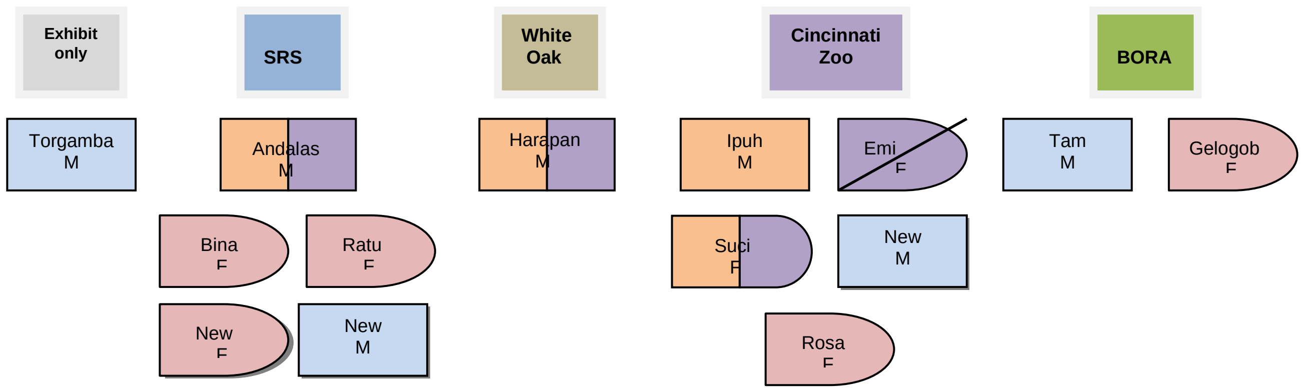


Figure 1. Hypothetical captive Sumatran rhino population with the addition of a new wild-caught male and female in Sumatra and one new wild-caught male, plus moving Rosa to Cincinnati to address behavioral issues (GMPB 2010).

The purpose of this paper is to present an analysis of a range of scenarios for the captive population, as recommended by the GMPB, and in support of the recommendation to add more wild-caught animals to the population. Appendix I shows the available options for each animal in the captive population as discussed at the January 2010 GMPB meeting. The benefits and risks of those options are included as Appendix 2.

## ANALYSIS

### Population Viability Analysis

As part of the research to substantiate this recommendation, a Population Viability Analysis (PVA) was carried out to analyze the potential persistence of the captive population of Sumatran rhinos. PVA is a computer modeling tool that can be used to assess the current and future risk of population decline and extinction. Many factors and processes affect population persistence: variation in the environment (such as weather, food supplies, and predation), genetic changes in the population (such as genetic drift, inbreeding, and response to natural selection), catastrophic effects (such as disease epidemics, floods, and droughts), the chance results of the probabilistic events in the lives of individuals (such as breeding success and survival), and the interactions among these factors (Gilpin and Soulé 1986). All of these factors and processes, as well as others, are often considered for PVAs on wild populations. However, the two factors that are often of the most interest for PVAs on captive populations are stochasticity in the lives of individuals and genetic changes in the population, because the influence of environmental variation and catastrophes are often thought to be reduced in a captive setting. Exploring the impact of these factors on a population though PVA modeling can help us understand and predict the probability of population persistence.

The software package VORTEX (v9.98; Lacy 1993) was used to develop a PVA for the global population of captive Sumatran rhinos. VORTEX simulates the effects of deterministic forces on a population as well as demographic, environmental, and genetic stochastic events. The VORTEX model is individual-based and simulates a population by stepping through a series of discrete events that describe the typical life cycle of sexually reproducing, diploid organisms. Model events, or parameters, occur according to defined probabilities (constant or random variables that follow specified distributions). Thus, each run (iteration) of the model provides a unique result. By running the model hundreds of times, it is possible to describe the range of probable outcomes of a particular parameter set. For a more detailed explanation of VORTEX and its use in PVAs, see Lacy (1993, 2000) and Miller and Lacy (2003).

**Model Input Parameters**
The International Sumatran Rhinoceros Studbook provides little data to inform model parameters because only a small number of Sumatran rhinos have been held in captivity (n = 47). Thus, parameters have been based on Sumatran rhino information provided by the IRF, previous PVA work on wild Sumatran rhinos, and analyses of other rhino studbooks.

Global Population Overview:
The International Sumatran Rhinoceros Studbook currently tracks 10 living animals (five males and five females) distributed across Sumatra, Malaysia, and the US. Two animals (Studbook [SB] #4 and 32) are considered post-reproductive and were effectively removed from the potential breeding population. After those exclusions, eight animals (four males, four females) remained in the population that was used for PVA modeling (male Ipuh - SB# 28, female Gelogob – SB# 40, male Andalas - SB#42, female Suci – SB # 43, male Harapan – SB #44, female Rosa – SB #45, female Ratu – SB #46, and Tam – SB #47).

**Settings**
Number of Populations:
Two population management scenarios were considered. For the first scenario, the global population of captive Sumatran rhinos was considered to be a single population. This scenario predicted the effects of intensely managing the population on a global scale, with unrestricted transfers among regional subpopulations. For the second scenario, the global population was divided into three regional groups: three animals (male Ipuh - SB# 28, female Suci – SB #43, male Harapan – SB #44) currently living in the United States were included in Population 1, three animals (male Andalas - SB#42, female Rosa – SB #45, and female Ratu – SB #46) currently living in the SRS were included in Population 2, and two animals (female Gelogob - SB# 40 and male Tam – SB #47) housed singly in Malaysia were included in Population 3. This scenario predicted the effects of intensely managing subpopulations on a regional scale, with reduced transfers among regional subpopulations.

Definition of extinction:
Extinction was defined as only one sex remaining in the population.

Number of Years and Iterations:
All scenarios were simulated 1000 times; the reported results were averaged across all iterations. Each model projection extended to 100 years, with demographic and genetic summaries reported at 25, 50, and 100 year intervals. Given that Sumatran rhinos can live

up to ~40 years of age, a projection out to 100 years was necessary to capture results across multiple generations. Although current conservation management will likely be concerned with shorter time frames, for long-lived species like the Sumatran rhino the impacts of population processes may not be evident until many years after the onset of effect. Thus, modeling population trends several generations into the future provided valuable information about the long-term impacts of current population parameters and proposed conservation efforts.

**Species Description**

Inbreeding depression:

VORTEX allows the detrimental effects of inbreeding to be modeled by reducing the survival of offspring through their first year. Although no inbreeding depression studies have been conducted on rhinos, a survey of 40 other mammal taxa in captivity found that inbreeding depressed juvenile survival by a median effect of 3.14 "lethal equivalents" (Ralls et al. 1988). Until recently, Sumatran rhinos lived in large continuous tracts of forest. Given the species' historic population size and range, there is no reason to suspect that Sumatran rhinos have evolved an unusual tolerance of inbreeding. Thus, inbreeding depression was incorporated into the model and the effect on infant survival was assumed to be equivalent to that observed in other captive mammal populations; 3.14 lethal equivalents per individual, with 50% of the total genetic load derived from lethal alleles (the default values provided by VORTEX).

**Reproductive System**

Breeding System:

The breeding system was specified as polygamous, with each male being able to breed multiple females within a single year.

Age of first reproduction:

VORTEX precisely defines reproduction as the time at which offspring are born, not simply the age of sexual maturity. Female Sumatran rhinos are thought to sexually mature between 6-7 years of age and males are thought to sexually mature at ~10 years of age. Sumatran rhino gestation is ~15-16 months. Thus, to conform to the manner in which VORTEX defines reproduction, the age of first reproduction for females was set to 7 and the age of first reproduction for males was set to 11.

Maximum age of reproduction:

VORTEX assumes that animals can reproduce throughout their entire adult lives and does not model reproductive senescence. Individuals are culled from the model once they surpass the specified maximum age. The maximum age of reproduction for both sexes was set at 40 years.

Offspring production:

Females produce only one calf per parturition, with a birth sex ratio of 50% each sex.

Percent females breeding:

The shortest inter-birth interval for a female Sumatran rhino that produces surviving offspring is approximately 3 years. Thus, under an optimistic model, ~33% of adult females can breed each year. This proportion of breeding females is likely to be unrealistically high for the global population of captive Sumatran rhinos, as the studbook indicates that only four captive-born calves have ever been produced. Still, three of those calves were produced in 2001, 2004, and 2007 (i.e., 3 years apart) by a single female. Additionally, when captive reproduction does occur some females could lose their offspring within 3 years of birth, coming into estrus soon afterwards and subsequently increasing the yearly percent of females breeding. Two values for percent females breeding were modeled: 33% and 20%.

Percent males in breeding pool:

All adult males were available for breeding each year. In other words, it was assumed that there were no social or behavioral constraints that would restrict a male from breeding when he was physiologically capable.

**Mortality Rates**

There are few data on the mortality rates observed in captive Sumatran rhinos. The data that are available suggest adults experience very low rates of mortality, which are likely comparable to mortality rates observed in other captive rhino populations. Yearly adult mortality ranges from 1-7% for captive southern white rhinos (*Ceratotherium simum simum*), 3-7% for captive Indian rhinos (*Rhinoceros unicornis*), 1-14% for captive eastern black rhinos (*Diceros bicornis michaeli*), and 1-17% for captive southern black rhinos (*Diceros bicornis minor*). Based on this information, yearly adult mortality for Sumatran rhinos was set at 5%.

Predicting mortality during the first year of life is difficult for Sumatran rhinos, because only four rhinos in the International Studbook have been born and all lived through their first year of life. First-year mortality is 17% for captive southern white rhinos (*Ceratotherium simum simum*), 28% for captive Indian rhinos (*Rhinoceros unicornis*), 27% for captive eastern black rhinos (*Diceros bicornis michaeli*), and 16% for captive southern black rhinos (*Diceros bicornis minor*). Two values for first year mortality were modeled: 15% and 25%.

| | Low First Year Morality | High First Year Mortality |
|---|---|---|
| Morality from Age 0 to 1 | 15% | 25% |
| Mortality from Age 1 to 40 | 5% | 5% |
| % Surviving to Age 40 | 11% | 10% |

**Carrying Capacity**

A carrying capacity of 300 animals (100 per geographic region) was imposed on the model. Future carrying capacities for the captive population are currently unclear, but given current population parameters a capacity of 300 animals was unlikely to significantly impact general projection results. Dramatically smaller capacities could greatly influence projections, however, and models should be re-run if future capacities are determined to be small.

**Transfer Rates**

Transfer rates were specified for scenarios that modeled the global population of captive Sumatran rhinos as three regional subpopulations. Although VORTEX models transfers (dispersals, migrations, etc.) on a yearly basis, it is unlikely that regional subpopulations would exchange animals annually. Still, to model low levels of exchange between subpopulations, three yearly transfer rates between all combinations of subpopulations were modeled: 0%, 1%, and 3%. The model restricted transfers to younger, reproductive animals 10-30 years of age, and assumed that no animals suffered mortality during transfer.

**Genetic Management and Breeding Pair Selection**

Although VORTEX can model the genetic management of a captive population by applying a breeding pair selection scheme that minimizes average kinship, genetic management was not applied to the global population of captive Sumatran rhinos. Genetic management is often relaxed at the onset of captive breeding programs, while the population is still growing and demographically unstable due to small population size. During this stage of captive breeding, any successful breeding pairs are encouraged to help bolster the chances of population persistence. Thus, given the current status of the global population of captive Sumatran rhinos, breeding pairs were selected at random for the purposes of these analyses. Although breeding was at random, close inbreeding was avoided by disallowing breeding between first-order relatives; breeding between individuals with a kinship coefficient of 0.25 or higher was rejected.

**Summary of Scenario Parameters**

| Model Input Parameter | Baseline Value |
|---|---|
| # of populations | 1; 3 |
| inbreeding depression included? | yes |
| environmental variation included? | no |
| breeding system | polygamous |
| age of first reproduction (♂ / ♀) | 11 / 7 |
| maximum age of reproduction | 40 |
| annual % adult females breeding | 33; 20 |
| % males in breeding pool | 100 |
| litter size | 1 |
| offspring sex ratio | 0.5 |
| % annual mortality | |
| 0-1 years | 15; 25 |
| 1-40 years | 5 |
| initial population size | 8 breeding animals |
| carrying capacity | 300 total (100 per subpopulation) |
| % transfer rates | 0; 1; 3 |
| breeding pair selection | random |
| genetic management | avoid close inbreeding |

Four additional scenarios of interest also were modeled: 1) importing an additional pair of wild-caught rhinos (one male and one female) into the captive subpopulation in Sumatra, 2) importing one additional wild-caught male into the captive subpopulation in the US, 3) moving Rosa (SB#45) from Sumatra to the US, and 4) the combination of scenarios 1,2, and 3. The transfer of additional rhinos to the US is of interest because three of the four captive births recorded in the International Sumatran Rhinoceros Studbook occurred in the US, but the US does not currently have a viable breeding pair of rhinos (the only US female is closely related to both US males and one of the males in Sumatra). The four additional scenarios of interest were modeled under only two of the 16 possible parameter sets described in the previous paragraph. The additional scenarios were modeled under the most optimistic parameter sets for the two management strategies investigated: managing the global population of captive Sumatran rhinos as a single population vs. managing subpopulations on a regional scale with reduced transfers among regional subpopulations.

## Results

<u>Effects of Management Structure:</u>

Results suggested that managing captive Sumatran rhinos as a single population greatly increased the probability of population persistence, when compared to scenarios for which captive animals were managed on a regional scale with reduced transfers among regional subpopulations. When managed as a single population, the probabilities of extinction within the next 25 years for captive Sumatran rhinos ranged from 6-17% (Table 1). When managed as separate regional subpopulations, the probabilities of extinction of all subpopulations within the next 25 years ranged from 26-41% (Table 2). Probabilities of extinction for a given subpopulation ranged from 57-93% over the same time frame (Table 2), with the subpopulations in the US and Malaysia at the highest risks of extinction. Long-term projections further highlighted the benefit of managing captive Sumatran rhinos as a single population: over the next 100 years extinction probabilities for a single population ranged from 31-95%, while extinction probabilities for separately managed subpopulations ranged from 93-100% (Tables 1 and 2). These results are consistent with what is known and expected about the effects of small population size. As population size declines, extinction risk increases due to demographic instability and the deleterious effects of inbreeding on reproduction and survival (Gilpin and Soulé 1986; Caughley 1994). Thus, a single, larger population will have a lower risk of extinction when compared to several smaller, fragmented populations with reduced migration (or transfer) rates.

<u>Effects of Biological Variables:</u>

Due to the paucity of biological data on Sumatran rhinos, ranges of reproductive success and mortality were tested to determine how sensitive the probability of population persistence was to these factors. As expected, lower rates of reproductive success (measured as the % of females breeding in a given year) and higher rates of first-year mortality resulted in higher probabilities of extinction (Tables 1 and 2). However, decreasing reproductive success had a noticeably greater impact on probability of extinction than increasing mortality. For example, if captive Sumatran rhinos were managed as a single population, the impact of increasing first-year mortality from 15% to

25% increased extinction risk over the next 100 years by 9-15%, while decreasing the % females breeding from 33% to 20% increased extinction risk over the same time frame by 49-55% (Table 1).

Effects of Transfer Rate Among Subpopulations:
If the global population of captive Sumatran rhinos is managed as separate subpopulations, a restricted rate of animal transfers between subpopulations is expected. VORTEX models transfers (dispersals, migrations, etc.) on a yearly basis, but it is unlikely that regional subpopulations would exchange animals annually due to the logistics and costs associated with moving rhinos long distances. Still, to model low levels of exchange between subpopulations, three yearly transfer rates between all combinations of subpopulations were modeled: 0%, 1%, and 3%. When single subpopulations were considered, increasing the transfer rate among subpopulations had small, varying impacts on subpopulation extinction probabilities (Table 2): in some cases extinction probability decreased slightly, in other cases it increased slightly. In general, increasing transfers among subpopulations slightly decreased the extinction risks of the US and Malaysian subpopulations while slightly increasing the extinction risk of the Sumatran subpopulation. All three transfer rates produced very similar results when the extinction risk of the total population was considered (Table 2), indicating that transfer rates up to 3% do not notably decrease the probability of the entire captive population becoming extinct. However, it is important to note that because the US subpopulation does not currently have a viable breeding pair of rhinos, that subpopulation will ultimately go extinct without additional imports.

Impact of Importing an Additional Pair of Wild-Caught Rhinos into the Captive Subpopulation in Sumatra:
Given the demographic instability of the small, global population of captive Sumatran rhinos, the impact of importing an additional pair of wild-caught rhinos (one male and one female) into the population is of interest. For the most optimistic scenario in which all captive animals were managed as a single population (33% of females breeding; 15% first-year mortality), importing two additional wild-caught rhinos decreased the extinction probability of the population from 6% to 1% over the next 25 years (Tables 1 and 3). Over the next 100 years, the extinction probability dropped from 31% to 12% (Tables 1 and 3). If regional subpopulations were managed with no transfers, importing two additional wild-caught rhinos into the Sumatran subpopulation decreased the extinction risk of that subpopulation from 57% to 15% over the next 25 years (Tables 2 and 4). Over the next 100 years, the extinction risk of the Sumatran subpopulation dropped from 94% to 54% (Tables 2 and 4).

Impact of Importing an Additional Wild-Caught Male Rhino into the Captive Subpopulation in the US:
The import of an additional wild-caught male into the US subpopulation is of interest given that three of the four captive births recorded in the International Sumatran Rhinoceros Studbook have occurred in the US, but the US does not currently have a viable breeding pair of rhinos (the only US female is closely related to both US males). For the most optimistic scenario in which all captive animals were managed as a single population (33% of females breeding; 15% first-year mortality), importing an additional wild-caught male

decreased the extinction probability of the population from 6% to 2% over the next 25 years (Tables 1 and 5). Over the next 100 years, the extinction probability dropped from 31% to 22% (Tables 1 and 5). If regional subpopulations were managed with no transfers, importing an additional wild-caught male into the US subpopulation decreased the extinction risk of that subpopulation from 89% to 55% over the next 25 years (Tables 2 and 6). Over the next 100 years, the extinction risk of the US subpopulation stayed nearly the same, dropping only from 100% to 99% (Tables 2 and 6).

<u>Impact of Transferring Female Rosa (SB #45) from Sumatra to the US:</u>
The transfer of female Rosa (SB #45) from Sumatra to the US if of interest given that three of the four captive births recorded in the International Sumatran Rhinoceros Studbook have occurred in the US. Thus, it is possible that transferring female Rosa (SB#45) to the US could help to address her behavioral issues, thereby increasing her chances of successfully reproducing. For the most optimistic scenario in which all captive animals were managed as a single population (33% of females breeding; 15% first-year mortality), moving Rosa from Sumatra to the US had essentially no impact on overall extinction risk (Tables 1 and 7). Because all animals were being managed together in that scenario, the regional location of animals effectively made no difference. If regional subpopulations were managed with no transfers, transferring Rosa from Sumatra to the US decreased the 25-year extinction risk of the US subpopulation from 89% to 65% and increased the 25-year extinction risk of the Sumatran subpopulation from 57% to 76% (Tables 2 and 8). Thus, the increase in the probability that the US subpopulation persisted for the next 25 years was greater than the increase in the extinction risk experienced by the Sumatran subpopulation (difference of 24% vs. 19%). Over the long-term, however, the risk of extinction for the US subpopulation remained nearly unchanged while a noticeable increase in the extinction risk of the Sumatran subpopulation persisted (100-year extinction risk increased from 94% to 100% with the transfer of Rosa).

<u>Impact of Combing All Previous Scenarios:</u>
The final modeled scenario combined all previous scenarios: importing an additional pair of wild-caught rhinos into the captive Sumatran subpopulation, importing an additional wild-caught male into the captive US subpopulation, and moving Rosa (SB #45) from Sumatra to the US. For the most optimistic scenario in which all captive animals were managed as a single population (33% of females breeding; 15% first-year mortality), combining all previous scenarios decreased the extinction probability of the population from 6% to 0% over the next 25 years (Tables 1 and 9). Over the next 100 years, the extinction probability dropped from 31% to 11% (Tables 1 and 9). If regional subpopulations were managed with no transfers, combining all previous scenarios decreased the extinction risk of all subpopulations except the one in Malaysia over the next 25 years: the extinction risk of the US subpopulation decreased from 89% to 28%, the extinction risk of the Sumatran subpopulation decreased from 57% to 30%, and the extinction risk of the Malaysian subpopulation remained at approximately 80% (Tables 2 and 10). A similar trend was observed over the next 100 years: the extinction risk of the US subpopulation decreased from 100% to 80%, the extinction risk of the Sumatran subpopulation decreased from 94% to 79%, and the extinction risk of the Malaysian subpopulation remained at 100% (Tables 2 and 10).

## Discussion

The VORTEX modeling and projections presented here are based on biological parameters that are very poorly defined for the Sumatran rhino. Thus, a series of scenarios was designed to predict the future persistence of the global population of captive Sumatran rhinos across a range of plausible parameters. Although care was taken to incorporate the information that is available on Sumatran rhino biology, as well as previous PVA work on wild Sumatran rhinos and information gleaned from other rhino species, projections should be considered to be approximate guidelines of future population persistence.

Both demography and genetics play a role in population viability. However, for the current captive population of Sumatran rhinos, the gene diversity retained by the population experienced smaller fluctuations across modeled scenarios than did extinction risk. In other words, while the modeled scenarios demonstrated a range in extinction risks for the population, the gene diversity retained by populations that managed to persist remained more constant. This indicates that, unless the demographic outlook of the captive population can be significantly improved in terms of population size and growth rate, a focus should be placed on improving extinction risk over gene diversity retention.

The two biological parameters that were varied across scenarios were reproductive success, measured as the % of females breeding in a given year, and first-year mortality. As expected, lower rates of reproductive success and higher rates of first-year mortality resulted in higher probabilities of extinction (Tables 1 and 2). However, results also suggested that extinction risk was more sensitive to reproductive success than the first-year mortality of offspring. All four of the captive-born Sumatran rhinos in the International Studbook lived through their first year of life, which makes the estimation of first-year mortality difficult. However, other rhino studbooks suggest that first-year mortalities for other captive species range from 16% to 28%. Thus, the range of first-year mortalities modeled here, 15% to 25%, adequately covers the range exhibited across other species. Unless first-year mortality is found to be significantly higher for the Sumatran rhino, the extinction risk of the population can be more effectively decreased by focusing on increasing the number of breeding females.

All modeled scenarios demonstrated that the global population of captive Sumatran rhinos has a moderate to high risk of extinction over the long-term (Tables 1 and 2). Extinction risk notably declined if all captive animals could be managed as a single population vs. managed as regional subpopulations with limited transfers between geographic areas. This result was primarily driven by the low numbers of captive Sumatran rhinos that currently exist. The smaller a population, the more demographically unstable that population is due to both chance events that impact the survival and reproduction of individual animals and random fluctuations in the sex ratio of the population. By managing all captive Sumatran rhinos as a single population, the increase in population size compared to the sizes of regional subpopulations reduced the impact of these processes which decreased extinction risk. However, given the costs and risks associated with moving rhinos long distances, it is important to note that it would be extremely difficult, if not impossible, to effectively manage these widely distributed captive animals as a single population. Furthermore, results indicate that low rates of transfer among subpopulations

(1-3% per year) do not improve the extinction risk of the metapopulation over either the short or long-term. This suggests that the current location of animals and the possibility of future transfers among geographic regions should be carefully evaluated.

Results suggested that importing an additional pair of wild-caught rhinos into the captive Sumatran subpopulation would have a greater impact on extinction risk than on gene diversity retention (Tables 3 and 4). Again, this result was primarily driven by population size. The current size of both the entire captive population and the Sumatran subpopulation is so small, adding only two additional individuals notably impacts the degree to which chance events affect population demography and extinction risk. Although the effect was not as great, importing two additional wild-caught rhinos did also improve both short and long-term gene diversity retention. Projected gene diversity retention over the next 25 years increased from an average of 82% to 86% if all captive animals were managed as a single population (33% of females breeding; 15% first-year mortality). If regional subpopulations were managed with no transfers, gene diversity in the Sumatran subpopulation increased over the same time frame from an average of 73% to 79%. Over the next 100 years, gene diversity retention increased from 75 to 79% if all captive animals were managed as a single population and gene diversity retention in the Sumatran subpopulation increased from 61% to 72% if regional subpopulations were managed with no transfers.

Conservation breeding programs often aim to retain 90% of initial gene diversity, to maintain the potential for adaptation and minimize the deleterious consequences of inbreeding (Soulé 1986). Gene diversity across the entire captive population is currently only ~90%, and gene diversity is predicted to further decline across all tested scenarios. In general, more gene diversity was retained across scenarios that exhibited lower extinction probabilities. The most gene diversity was retained if three additional wild-caught animals were imported, all captive animals could be managed as a single population, reproduction was maximized, and first-year mortality was minimized.

The transfer of female Rosa (SB #45) from Sumatra to the US was considered because three of the four captive births recorded in the International Sumatran Rhinoceros Studbook have occurred in the US and it is possible that transferring female #45 to the US could address her behavioral pathologies and increase her chances of successfully reproducing, while giving the US subpopulation a viable pair of breeding rhinos. If regional subpopulations are separately managed with no transfers, transferring Rosa from Sumatra to the US was projected to provide an overall advantage in terms of extinction risk over the short-term: the increase in the probability that the US subpopulation persisted for the next 25 years was greater than the increase in the extinction risk experienced by the Sumatran subpopulation (Table 6; difference of 24% vs. 19%). Over the long-term, however, the risk of extinction for the US subpopulation remained nearly unchanged while a noticeable increase in the extinction risk of the Sumatran subpopulation persisted; the 100-year extinction risk increased from 94% to 100% with the transfer of Rosa (Table 6). Still, one could argue that a 94% extinction risk is already prohibitively high and increasing that risk further over the next 100 years might be justifiable given the potential for shorter-term gains in terms of decreasing the extinction risk of the US subpopulation and increasing the potential for reproduction.

Finally, a scenario that combined all previously discussed scenarios was considered. This scenario had the biggest positive impacts on the viability of the global population of captive Sumatran rhinos, as it combined importing a pair of wild-caught rhinos into the Sumatran subpopulation, importing a wild-caught male into the US subpopulation, and transferring female #45 to the US. If all captive animals were managed as a single population (33% of females breeding; 15% first-year mortality), this combination of scenarios eliminated the risk of population extinction over the next 25 years and decreased extinction risk by 20% over the next 100 years (Tables 1 and 9). If regional subpopulations were managed with no transfers, this combination of scenarios decreased the extinction risks for the Sumatran and US subpopulations by 61% and 27%, respectively (Tables 2 and 10). The extinction risk for the Malaysian subpopulation effectively remained unchanged, because that subpopulation did not benefit from additional imports.

**CONCLUSION**

The management of the captive Sumatran rhino population is scientifically and politically challenging, involving governments of Indonesia, Malaysia, the US, as well as a host of international stakeholders, including permitting authorities. The analyses presented in this paper suggest that if the captive population is truly to be part of a holistic strategy for the conservation of the Sumatran rhino, <u>the most important issue at hand is preventing the extinction of the captive population and that maintaining genetic diversity of that population, which was originally the focus when this analysis was begun, is actually secondary</u>.

<u>The most important need is to manage captive Sumatran rhinos as one global population,</u> which has been the mandate of the GMPB and, more recently, the recommendation of the IUCN Asian Rhino Specialist Group. While this strategy also presents many hurdles - in particular, the costs and risks associated with moving rhinos long distances - it nevertheless needs to be immediately implemented to prevent the population's drift towards extinction. Analyses contained in this paper also demonstrate the need to increase the population size as expeditiously as possible.

In January 2010, the GMPB agreed that adding two new wild-caught females and one new wild-caught male had the potential to substantially improve the breeding options for the captive population and likely would add significantly to genetic variability should breeding be successful. The present analyses suggest that, more importantly, <u>adding animals to the global population is essential for its long term persistence</u>. For the global population, adding a new male and female to the Sumatra subpopulation lowers the 100-year probability of extinction from 31%to 12%. Under a global management scenario, importing an additional wild-caught male into the US subpopulation decreases the probability of extinction of the entire population to 2% over the next 25 years, and to 22% over the next 100 years. Of note, because the US subpopulation does not currently have a viable breeding pair, without additional imports that subpopulation will ultimately go extinct. This has additional ramifications - the largest supporters of the Sumatra program are US zoos and the loss of Sumatran rhino ambassadors will likely affect funding for that program. The US subpopulation also provides a small measure of genetic insurance for the Indonesian and Malaysian subpopulations.

<u>The management option with the most potential positive impact combines adding new wild-caught animals to both the Sumatra and the US subpopulations and transferring female Rosa to the US</u>. This option has the potential to eliminate the risk of population extinction over the next 25 years, and by 20% over the next 100 years[2]. In combination with other methods, such as successfully developing artificial insemination and other artificial reproductive technologies, the case can be made that this strategy buys much-needed time for the captive population, with minimal impact on the wild population. Additionally, transferring Rosa (SB #45) from Sumatra to the US could allow her behavioral pathologies to be addressed under a different husbandry regime and could increase chances of this founder female successfully reproducing. This transfer has no impact on overall population extinction risk and also frees up space for a new female at the SRS.

There is an urgent need for decisive management action for the captive population of Sumatran rhinos. Acting on this last management recommendation as soon as possible will 'buy' important time for the captive population. Concurrently, other methodologies to improve management need to be immediately developed, which may include artificial reproduction techniques. Other creative management strategies discussed by the GMPB should also begin testing immediately, including temporarily bringing wild rhinos into captivity for gamete collection and releasing captive animals into the wild short-term for natural breeding while under close monitoring.

The authors have conducted these analyses with the objective of acting in the best interest of the species and in consideration of the the acceptability of these recommendations within the conservation community. We urge the governments of Indonesia and Malaysia to seriously consider these recommendations, and that those governments begin a formal dialogue on a possible Sumatran rhino exchange program, along with the US government, to strengthen the global Sumatran rhino population. We also invite other members of the international community, including donor states, the private sector, the corporate sector, academic and scientific institutions, to provide effective and united support, including funding, to assist these efforts.

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[2] The extinction risk for the Malaysian subpopulation effectively remains unchanged, because that subpopulation did not benefit from additional imports.

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## **Table Legend**

| | |
|---|---|
| PE | Probability of extinction, assessed as the percent of simulated populations to go extinct by a given year. |
| N ± SD | Mean size of the simulated populations still extant at a given year, ± standard deviation. |
| GD ± SD | Gene diversity (expected heterozygosity) of extant populations at a given year calculated as a percent of the initial gene diversity, ± standard deviation. |

Table 1: VORTEX results for managing the global population of Sumatran rhinos as a single population

| % females breeding | % first-year mortality | 25 Years | | | 50 Years | | | 100 Years | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | PE | N ± SD | GD ± SD | PE | N ± SD | GD ± SD | PE | N ± SD | GD ± SD |
| 33 | 15 | 0.06 | 17 ± 8 | 82 ± 6 | 0.15 | 29 ± 19 | 78 ± 7 | 0.31 | 78 ± 64 | 75 ± 10 |
| 33 | 25 | 0.06 | 14 ± 7 | 82 ± 5 | 0.20 | 20 ± 14 | 77 ± 8 | 0.46 | 41 ± 36 | 72 ± 11 |
| 20 | 15 | 0.14 | 9 ± 4 | 80 ± 6 | 0.44 | 9 ± 6 | 73 ± 10 | 0.86 | 10 ± 8 | 64 ± 15 |
| 20 | 25 | 0.17 | 8 ± 4 | 79 ± 6 | 0.55 | 7 ± 5 | 70 ± 11 | 0.95 | 6 ± 4 | 62 ± 16 |

Table 2: VORTEX results for managing the global population of Sumatran rhinos as regional subpopulations

| % transfer rate | % females breeding | % first-year mortality | | 25 Years | | | 50 Years | | | 100 Years | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | PE | N ± SD | GD ± SD | PE | N ± SD | GD ± SD | PE | N ± SD | GD ± SD |
| 0 | 33 | 15 | US | 0.89 | 2 ± 1 | 63 ± 7 | 1.00 | - | - | 1.00 | - | - |
| | | | SRS | 0.57 | 7 ± 4 | 73 ± 7 | 0.82 | 10 ± 7 | 68 ± 10 | 0.94 | 19 ± 19 | 61 ± 16 |
| | | | Malaysia | 0.80 | 3 ± 1 | 65 ± 8 | 0.99 | 2 ± 0 | 61 ± 7 | 1.00 | - | - |
| | | | Total | 0.27 | 7 ± 4 | 79 ± 7 | 0.80 | 9 ± 7 | 68 ± 10 | 0.94 | 19 ± 19 | 61 ± 16 |
| 0 | 33 | 25 | US | 0.88 | 2 ± 1 | 64 ± 6 | 1.00 | - | - | 1.00 | - | - |
| | | | SRS | 0.57 | 6 ± 3 | 72 ± 6 | 0.85 | 10 ± 7 | 69 ± 8 | 0.97 | 15 ± 18 | 61 ± 14 |
| | | | Malaysia | 0.83 | 3 ± 1 | 65 ± 8 | 0.99 | 2 ± 1 | 61 ± 13 | 1.00 | na | na |
| | | | Total | 0.28 | 6 ± 3 | 79 ± 7 | 0.84 | 9 ± 7 | 69 ± 8 | 0.97 | 15 ± 18 | 61 ± 14 |
| 0 | 20 | 15 | US | 0.86 | 2 ± 1 | 63 ± 6 | 1.00 | - | - | 1.00 | - | - |
| | | | SRS | 0.67 | 5 ± 2 | 72 ± 7 | 0.94 | 6 ± 3 | 67 ± 12 | 1.00 | - | - |
| | | | Malaysia | 0.91 | 3 ± 1 | 66 ± 8 | 1.00 | - | - | 1.00 | - | - |
| | | | Total | 0.36 | 5 ± 3 | 78 ± 7 | 0.93 | 5 ± 3 | 68 ± 12 | 1.00 | - | - |
| 0 | 20 | 25 | US | 0.88 | 2 ± 1 | 63 ± 6 | 1.00 | - | - | 1.00 | - | - |
| | | | SRS | 0.68 | 4 ± 2 | 72 ± 6 | 0.95 | 4 ± 2 | 64 ± 11 | 1.00 | - | - |
| | | | Malaysia | 0.93 | 3 ± 1 | 65 ± 9 | 1.00 | - | - | 1.00 | - | - |
| | | | Total | 0.41 | 5 ± 2 | 78 ± 7 | 0.95 | 4 ± 2 | 65 ± 12 | 1.00 | - | - |
| 1 | 33 | 15 | US | 0.87 | 3 ± 2 | 65 ± 8 | 0.99 | 4 ± 3 | 69 ± 8 | 1.00 | - | - |
| | | | SRS | 0.58 | 6 ± 4 | 73 ± 7 | 0.83 | 10 ± 9 | 68 ± 12 | 0.95 | 29 ± 31 | 67 ± 14 |
| | | | Malaysia | 0.81 | 4 ± 2 | 70 ± 8 | 0.94 | 6 ± 4 | 70 ± 8 | 0.99 | 11 ± 8 | 67 ± 10 |
| | | | Total | 0.26 | 7 ± 4 | 79 ± 6 | 0.75 | 10 ± 9 | 70 ± 11 | 0.94 | 27 ± 31 | 67 ± 12 |
| 1 | 33 | 25 | US | 0.86 | 3 ± 1 | 66 ± 8 | 0.99 | 5 ± 3 | 62 ± 14 | 1.00 | - | - |
| | | | SRS | 0.61 | 5 ± 3 | 73 ± 7 | 0.87 | 8 ± 6 | 68 ± 11 | 0.97 | 22 ± 26 | 66 ± 12 |
| | | | Malaysia | 0.83 | 4 ± 2 | 70 ± 8 | 0.96 | 7 ± 6 | 65 ± 12 | 0.99 | 24 ± 19 | 70 ± 12 |
| | | | Total | 0.28 | 6 ± 4 | 78 ± 7 | 0.82 | 9 ± 7 | 70 ± 10 | 0.97 | 23 ± 25 | 67 ± 11 |
| 1 | 20 | 15 | US | 0.89 | 3 ± 1 | 66 ± 8 | 1.00 | - | - | 1.00 | - | - |
| | | | SRS | 0.67 | 4 ± 2 | 73 ± 7 | 0.94 | 5 ± 3 | 66 ± 11 | 1.00 | - | - |
| | | | Malaysia | 0.91 | 3 ± 1 | 68 ± 9 | 0.99 | 4 ± 2 | 64 ± 10 | 1.00 | - | - |
| | | | Total | 0.36 | 5 ± 3 | 78 ± 6 | 0.91 | 4 ± 3 | 67 ± 10 | 1.00 | - | - |
| 1 | 20 | 25 | US | 0.89 | 2 ± 1 | 64 ± 7 | 1.00 | - | - | 1.00 | - | - |
| | | | SRS | 0.70 | 4 ± 2 | 72 ± 7 | 0.97 | 3 ± 1 | 65 ± 10 | 1.00 | - | - |

| % transfer rate | % females breeding | % first-year mortality | | 25 Years | | | 50 Years | | | 100 Years | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | PE | N ± SD | GD ± SD | PE | N ± SD | GD ± SD | PE | N ± SD | GD ± SD |
| | | | Malaysia | 0.91 | 3 ± 1 | 69 ± 8 | 0.99 | 3 ± 1 | 68 ± 5 | 1.00 | - | - |
| | | | Total | 0.40 | 4 ± 2 | 77 ± 7 | 0.95 | 3 ± 1 | 67 ± 8 | 1.00 | - | - |
| 3 | 33 | 15 | US | 0.83 | 3 ± 2 | 68 ± 8 | 0.96 | 6 ± 4 | 65 ± 11 | 1.00 | - | - |
| | | | SRS | 0.58 | 6 ± 4 | 75 ± 7 | 0.81 | 10 ± 8 | 70 ± 9 | 0.94 | 33 ± 28 | 70 ± 10 |
| | | | Malaysia | 0.78 | 4 ± 2 | 71 ± 8 | 0.91 | 7 ± 6 | 69 ± 10 | 0.98 | 19 ± 21 | 65 ± 14 |
| | | | Total | 0.27 | 7 ± 5 | 79 ± 7 | 0.70 | 11 ± 10 | 72 ± 9 | 0.93 | 35 ± 35 | 69 ± 11 |
| 3 | 33 | 25 | US | 0.86 | 3 ± 1 | 66 ± 8 | 0.98 | 4 ± 3 | 64 ± 12 | 1.00 | - | - |
| | | | SRS | 0.59 | 6 ± 3 | 74 ± 7 | 0.86 | 8 ± 6 | 68 ± 11 | 0.98 | 28 ± 26 | 62 ± 18 |
| | | | Malaysia | 0.81 | 4 ± 2 | 71 ± 7 | 0.94 | 7 ± 5 | 69 ± 10 | 0.99 | 15 ± 17 | 70 ± 8 |
| | | | Total | 0.29 | 6 ± 4 | 78 ± 7 | 0.77 | 8 ± 7 | 70 ± 11 | 0.96 | 23 ± 26 | 66 ± 15 |
| 3 | 20 | 15 | US | 0.88 | 3 ± 1 | 67 ± 7 | 0.99 | 3 ± 1 | 63 ± 8 | 1.00 | - | - |
| | | | SRS | 0.70 | 4 ± 2 | 73 ± 7 | 0.95 | 4 ± 3 | 66 ± 9 | 1.00 | - | - |
| | | | Malaysia | 0.88 | 3 ± 1 | 70 ± 7 | 0.98 | 5 ± 3 | 71 ± 8 | 1.00 | - | - |
| | | | Total | 0.36 | 5 ± 3 | 77 ± 7 | 0.90 | 5 ± 3 | 69 ± 10 | 1.00 | - | - |
| 3 | 20 | 25 | US | 0.88 | 3 ± 1 | 67 ± 8 | 0.99 | 3 ± 2 | 62 ± 12 | 1.00 | - | - |
| | | | SRS | 0.71 | 4 ± 2 | 73 ± 7 | 0.96 | 4 ± 2 | 69 ± 8 | 1.00 | - | - |
| | | | Malaysia | 0.89 | 3 ± 1 | 70 ± 7 | 0.98 | 3 ± 2 | 61 ± 12 | 1.00 | - | - |
| | | | Total | 0.40 | 5 ± 3 | 77 ± 7 | 0.91 | 4 ± 3 | 68 ± 10 | 1.00 | - | - |

Table 3: VORTEX results for importing 1.1 wild-caught animals into the Sumatran subpopulation; managing the global population of Sumatran rhinos as a single population

| % females breeding | % first-year mortality | 25 Years | | | 50 Years | | | 100 Years | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | PE | N ± SD | GD ± SD | PE | N ± SD | GD ± SD | PE | N ± SD | GD ± SD |
| 33 | 15 | 0.01 | 23 ± 10 | 86 ± 4 | 0.05 | 40 ± 24 | 83 ± 7 | 0.12 | 113 ± 81 | 79 ± 8 |

Table 4: VORTEX results for importing 1.1 wild-caught animals into the Sumatran subpopulation; managing the global population of Sumatran rhinos as regional subpopulations

| % transfer rate | % females breeding | % first-year mortality | | 25 Years | | | 50 Years | | | 100 Years | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | PE | N ± SD | GD ± SD | PE | N ± SD | GD ± SD | PE | N ± SD | GD ± SD |
| 0 | 33 | 15 | US | 0.85 | 2 ± 1 | 63 ± 6 | 1.00 | - | - | 1.00 | - | - |
| | | | SRS | 0.15 | 12 ± 7 | 79 ± 6 | 0.32 | 22 ± 17 | 75 ± 8 | 0.54 | 51 ± 35 | 72 ± 11 |
| | | | Malaysia | 0.81 | 3 ± 1 | 65 ± 8 | 0.99 | 2 ± 0 | 67 ± 7 | 1.00 | - | - |
| | | | Total | 0.06 | 13 ± 7 | 84 ± 5 | 0.31 | 22 ± 17 | 76 ± 8 | 0.54 | 51 ± 35 | 72 ± 11 |

Table 5: VORTEX results for importing 1.0 wild-caught animal into the US subpopulation; managing the global population of Sumatran rhinos as a single population

| % females breeding | % first-year mortality | 25 Years | | | 50 Years | | | 100 Years | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | PE | N ± SD | GD ± SD | PE | N ± SD | GD ± SD | PE | N ± SD | GD ± SD |
| 33 | 15 | 0.02 | 18 ± 9 | 84 ± 4 | 0.09 | 31 ± 21 | 80 ± 7 | 0.22 | 86 ± 67 | 77 ± 10 |

Table 6: VORTEX results for importing 1.0 wild-caught animal into the US subpopulation; managing the global population of Sumatran rhinos as regional subpopulations

| % transfer rate | % females breeding | % first-year mortality | | 25 Years | | | 50 Years | | | 100 Years | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | PE | N ± SD | GD ± SD | PE | N ± SD | GD ± SD | PE | N ± SD | GD ± SD |
| 0 | 33 | 15 | US | 0.55 | 5 ± 3 | 70 ± 7 | 0.86 | 7 ± 6 | 63 ± 13 | 0.99 | 15 ± 17 | 65 ± 12 |
| | | | SRS | 0.58 | 6 ± 3 | 72 ± 6 | 0.84 | 10 ± 7 | 68 ± 10 | 0.96 | 18 ± 20 | 67 ± 9 |
| | | | Malaysia | 0.83 | 3 ± 1 | 67 ± 7 | 0.99 | 2 ± 0 | 66 ± 9 | 1.00 | - | - |
| | | | Total | 0.17 | 8 ± 4 | 81 ± 6 | 0.71 | 9 ± 7 | 69 ± 11 | 0.95 | 17 ± 19 | 66 ± 10 |

Table 7: VORTEX results for importing moving female #45 from Sumatra to the US; managing the global population of Sumatran rhinos as a single population

| % females breeding | % first-year mortality | 25 Years | | | 50 Years | | | 100 Years | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | PE | N ± SD | GD ± SD | PE | N ± SD | GD ± SD | PE | N ± SD | GD ± SD |
| 33 | 15 | 0.05 | 17 ± 8 | 82 ± 5 | 0.15 | 29 ± 19 | 78 ± 8 | 0.31 | 80 ± 66 | 75 ± 10 |

Table 8: VORTEX results for importing moving female #45 from Sumatra to the US; managing the global population of Sumatran rhinos as regional subpopulations

| % transfer rate | % females breeding | % first-year mortality | | 25 Years | | | 50 Years | | | 100 Years | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | PE | N ± SD | GD ± SD | PE | N ± SD | GD ± SD | PE | N ± SD | GD ± SD |
| 0 | 33 | 15 | US | 0.65 | 5 ± 2 | 70 ± 7 | 0.91 | 6 ± 5 | 66 ± 11 | 0.99 | 9 ± 6 | 67 ± 10 |
| | | | SRS | 0.76 | 4 ± 2 | 68 ± 6 | 0.97 | 2 ± 1 | 63 ± 8 | 1.00 | - | - |
| | | | Malaysia | 0.82 | 3 ± 1 | 66 ± 8 | 1.00 | - | - | 1.00 | - | - |
| | | | Total | 0.28 | 6 ± 3 | 79 ± 7 | 0.87 | 5 ± 5 | 68 ± 11 | 0.99 | 9 ± 6 | 67 ± 10 |

Table 9: VORTEX results for combing all previous scenarios; managing the global population of Sumatran rhinos as a single population

| % females breeding | % first-year mortality | 25 Years | | | 50 Years | | | 100 Years | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | PE | N ± SD | GD ± SD | PE | N ± SD | GD ± SD | PE | N ± SD | GD ± SD |
| 33 | 15 | 0.00 | 24 ± 10 | 88 ± 4 | 0.03 | 41 ± 24 | 84 ± 6 | 0.11 | 121 ± 80 | 81 ± 8 |

Table 10: VORTEX results for combing all previous scenarios; managing the global population of Sumatran rhinos as regional subpopulations

| % transfer rate | % females breeding | % first-year mortality | | 25 Years | | | 50 Years | | | 100 Years | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | PE | N ± SD | GD ± SD | PE | N ± SD | GD ± SD | PE | N ± SD | GD ± SD |
| 0 | 33 | 15 | US | 0.28 | 9 ± 5 | 75 ± 7 | 0.56 | 15 ± 11 | 71 ± 10 | 0.80 | 38 ± 31 | 69 ± 10 |
| 0 | 33 | 15 | SRS | 0.30 | 9 ± 5 | 76 ± 7 | 0.57 | 16 ± 13 | 72 ± 10 | 0.79 | 45 ± 32 | 72 ± 10 |
| 0 | 33 | 15 | Malaysia | 0.81 | 3 ± 1 | 67 ± 7 | 1.00 | - | - | 1.00 | - | - |
| 0 | 33 | 15 | Total | 0.04 | 15 ± 7 | 86 ± 4 | 0.29 | 19 ± 15 | 76 ± 9 | 0.63 | 46 ± 36 | 72 ± 10 |

Appendix I. Potential options for each animal currently in the captive population as of January 2010.

| Animal | Option for Action | Notes/Concerns: |
|---|---|---|
| ***Suci*** | 1. Find unrelated sperm<br>2. Breed with Ipuh<br>3. Find unrelated male for natural breeding<br>4. Breed with Harapan<br>5. Breed with Andalas<br>* Suci can't wait for 2 years<br>Plan A : find unrelated sperm<br>Plan B: breed with Ipuh to prevent loss of reproductive capacity | - Assume that we will need to justify parent-offspring mating to government of Indonesia<br>- Time consideration; Suci may lose ability to breed altogether if she is not bred soon<br>- There is a risk that mating Ipuh with Suci would present external credibility issues in terms of questions about sound management. |
| ***Rosa*** | 1. Change management, decrease intense keeper interaction - socialize with other rhino<br>2. Breed with Andalas<br>3. AI with unrelated sperm<br>4. Release short-term for mating with wild male<br>5. Breed with Ipuh<br>6. Get expertise on reversing imprinting | |
| ***Ipuh*** | 1. Mate with Rosa<br>2. Mate with Ratu<br>3. Bank sperm<br>4. Use sperm for Rosa<br>5. Use sperm for Ratu<br>6. Breed with Suci<br>7. Breed with new female | - Assume that we will need to justify parent-offspring mating to government of Indonesia<br>- There is a risk that mating Ipuh with Suci would present external credibility issues in terms of questions about sound management. |
| ***Andalas*** | 1. Breed with Rosa<br>2. Breed with Ratu<br>3. Bank sperm<br>4. Breed with Bina<br>5. Breed with new female<br>6. Continue sperm assessment<br>7. Breed with Suci | |

| *Animal* | *Option for Action* | *Notes/Concerns:* |
|---|---|---|
| ***Harapan*** | No change because of age | |
| ***Ratu*** | 1. Breed with Andalas<br>2. Breed with new male<br>3. Breed with Ipuh<br>4. Use Ipuh's sperm | |
| ***Torgamba*** | 1. Use as ambassador animal<br>2. Compare data with Sabah Tanjung<br>3. Continue mating with Rosa, Ratu and Bina for behavioral experience.<br>4. Radio collar testing<br>5. Use for ecotourism | |
| ***Bina*** | 1. Breed with Andalas<br>2. Breed with Torgamba<br>3. Use as ambassador animal<br>4. Radio collar testing<br>5. Collect gametes<br>6. Share/compare post-mortem protocol (US and German) | |
| ***Tam*** | 1. Collect sperm<br>2. Find new female in Malaysia | Assumes as of January 2010 that exchange is not possible between Indonesia and Sabah |
| ***Gelogob*** | 1. Hormone stimulation<br>2. Move to Tabin to be placed into Tam<br>3. Enrich diet to gain weight<br>4. Regular health assessment to see if underlying cause for weight loss<br>5. Obtain organ samples post-mortem to study iron deficiency<br>6. Mate with Tam | |

For all options above, there are some <u>obvious decisions</u>:

1. Harapan should remain *status quo* because of his age
2. Andalas and Ratu should be kept together
3. Optimally, Suci should be breed with a new unrelated male or unrelated sperm (possibly Tam)
4. Rosa needs to have management for less intensive keeper interaction to minimize behavioral pathologies. She should be bred with an unrelated male (Andalas or new male) or artificial insemination developed.

**APPENDIX II. BENEFITS AND RISKS FOR THE VARIOUS SCENARIOS SUGGESTED FOR EACH RHINO.**

### a. Move Rosa to Cincinnati Zoo

| Potential Benefits: | Potential Risks/Disadvantages: |
| --- | --- |
| 1. Security | 1. Transport loss |
| 2. Potential for generating more funding from zoos in the US | 2. May not breed naturally |
| 3. Genetic infusion | 3. Reduces reproductive options for Andalas |
| 4. Conservation networking between countries | 4. Hemosiderosis |
| 5. Could be used as an attention-getting promotion for the whole program | 5. Local NGOs may express concern about export |
| 6. Increased capacity building | |
| 7. Increase capacity for fundraising from public | |
| 8. Space opened up at SRS for other animals | |
| 9. Good faith gesture between Cincinnati Zoo and Government of Indonesia | |
| 10. Allows addressing Rosa's behavior issues | |
| 11. Increases biological information database with data from new animals | |
| 12. Increase awareness among government and NGOs | |
| 13. Demonstrates that we are managing Sumatran rhinos managing as one population (true metapopulation management) | |

### b. Move Ipuh to Indonesia (SRS-YABI)

| Potential Benefits: | Potential Risks/Disadvantages: |
| --- | --- |
| 1. Proven breeder | 1. Transport loss |
| 2. High potential for breeding with Ratu and/or Rosa | 2. Older age and potentially blind |
| 3. Potential Indonesia donor could be persuaded to pay transport cost | 3. Genetic variation will be decreased as Ipuh will be over-represented |
| | 4. Creates need for new male for Cincinnati Zoo and at SRS. |
| | 5. Indonesia donor may only support move, not long-term care/maintenance at SRS. |
| | 6. Loss of animal will likely reduce funds from US zoos for Indonesia |

| | |
|---|---|
| | programs<br>7. May limit ability to ability to bring in a new male |

### c. Bringing New Animals to SRS

| **Potential Benefits:** | **Potential Risks/Disadvantage:** |
|---|---|
| 1. Demonstrates that we are managing Sumatran rhinos managing as one population (true metapopulation management)<br>2. Security<br>3. Infuses captive population with new genes<br>4. Could be used as an attention-getting promotion for the whole program<br>5. Increased capacity building<br>6. Increased capacity for fundraising<br>7. Good faith gesture among GMPB partners, especially Cincinnati Zoo/Government of Indonesia<br>8. Increases biological information database with data from new animals<br>9. Increased awareness among government and NGOs<br>10. Gets rid of need to inbreed to continue reproductive potential<br>11. Demonstrate that bilateral TFCA, REDD and DNS funding really contributes to Sumatran rhino conservation<br>12. Conservation forest ecosystem restoration (new approach in forestry that allows restoration)<br>13. Implementing the Government of Indonesia's rhino strategy<br>14. Could release animals back to wild if needed or hold at SRS short- term for breeding<br>15. Attractive to donors to move animals around<br>16. May allow rescuing at-risk rhinos from wild | 1. Capture or transport loss<br>2. May not breed<br>3. Hemosiderosis<br>4. Possible NGO criticism for capturing new animals<br>5. If isolated animals are collected and moved to the SRS, it could decrease the incentive for forest protection |

**d. Move Torgamba as Ambassador Animal**

| **Potential Benefits:** | **Potential Risks/Disadvantages:** |
| --- | --- |
| 1. Frees up space at SRS<br>2. Ambassador animal generates more funds for rhino conservation<br>3. Generating awareness about SRS<br>4. Reduce financial burden of keeping non-reproductive animal at SRS<br>5. If moved to internationally, increased awareness about Sumatran rhinos and potential funding/support<br>6. Increases capacity building<br>**7.** Gesture of international goodwill if moved out of Indonesia | 1. Zoos may not want older animal<br>2. Transport loss<br>3. Old age<br>4. Disease issues |

# 2011 Sumatran Rhino
# Global Propagation & Management Board Meeting – Briefing Materials

## Kota Kinabalu, Sabah, Malaysia

## 8-9 February 2011

## SECTION 3

## Miscellaneous GMPB Background Documents

# DRAFT OUTLINE

## Sumatran Rhino

# GLOBAL MANAGEMENT & PROPAGATION BOARD (GMPB)

## Tasks

1 To recommend and decide on the management of the Global Sumatran Rhino Captive Population as a truly global population to maximize the options for reproduction and to improve its vitality and viability in a **Global Sumatran Rhino Propagation Program**.
2 To prepare and facilitate exchange of animals between all locations if indicated for the purpose of the Program.
3 To facilitate exchange of experience and transfer of knowledge.

## Composition of the GMPB

The GMPB will consist of:
1 Representatives of the Countries or Institutions holding Sumatran Rhino in Managed Breeding Centers;
2 Representatives of Donor Agencies; and
3 Sumatran Rhino Experts.

The membership will be reviewed bi-annually and the GMPB will bi-annually elect a chairman from among the members

The Sumatran Rhino Expert members will form a Technical Committee (TC) that will function as the secretariat of the GMPB

## Operation of the GMPB

The GMPB will meet bi-annually to review the membership, elect a chairman and discuss current issues.

Normal operations will be conducted by electronic correspondence, but members may request a special meeting if urgent and crucial matters arise.

All members can request the GMPB to review issues relating to the Global Sumatran Rhino Propagation Program.

On all issues placed before the GMPB the TC will produce an Opinion Paper for review by the members.

If the issue(s) require a decision to be made by the GMPB the TC will prepare a Resolution Paper for approval by the GMPB.

Further details on the procedures and formats will be made by the TC for approval by the GMPB

## Initial Members of the Global Management &Propagation Board (GMPB):

**Country Representatives (Voting members)**

1 Representative of Indonesia
1 Representative of Sabah
1 Representative of Peninsula Malaysia

**Institution Representatives (Voting members)**

1 Representative of the US zoos
1 Representative of YSRS
1 Representative of MRF
1 Representative of the SOS Rhino Sabah Program
2 Representatives of the Donor Community (IRF, AsRP, SOSRhino etc)

**Technical Committee (Non- voting members)**

First meeting Organizing Committee

Ir. Juss Rustandi, YSRS Head Secretariat
Mr. Sectionov, S. Hut. YMR
Dr. Nico van Strien, IRF Coordinator
Dr. Marcellus Adi, SRS Site Manager
Dr. Tom Foose, International Studbook Keeper

*The Technical Committee will be formed by the voting members on the first meeting. Potential candidates for the TC will be invited at the discretion of the organizing committee.*

**First meeting:**

Date: Sunday/Monday 20/21 March 2005
Venue: Jakarta
Provisional Agenda: Tasks of GMPB
Composition of GMPB
Operation and Procedures of GMPB
Tecnical Committee
Budget for GMPB

# Global Management and Propagation Board Technical Committee
# Opinion Paper 11/15/05
# for consideration by the GMPB

**Subject**: Indonesian Sumatran rhino captive breeding program three-year action plan that maximizes the potential for reproductive success

This document is drafted in response to the letter of request issued on October 6, 2005 by Koes Saparjadi, Director General of Forest Protection and Nature Conservation, to Dr. Widodo S. Ramono, Chair of the GMPB and Dr. Nico van Strien, Chair of the GMPB Technical Committee.

## Background:

The Sumatran rhino captive breeding program was initiated in 1985. A total of 18 Indonesian rhinos were acquired for the program with the last one captured in 1991. Of these rhinos, seven were sent to the US, three to the UK, one to Thailand and seven remained in Indonesia. Due to husbandry and reproductive challenges, there were numerous mortalities in the first decade and no reproductive success.

In 1997, an intensive research and management effort was initiated at the Cinicnnati Zoo & Botanical Garden, with the last three Sumatran rhinos (Ipuh, Emi and Rapunzel) in the US in an effort to learn about the reproductive physiology of the species so that it could be bred successfully in captivity. In 2001, a male Sumatran rhino calf (Andalas) was produced at the Cincinnati Zoo after five previous confirmed pregnancies all ending in early pregnancy loss. This was the first time a Sumatran rhino had been successfully bred and born in captivity since 1889, and the event provided a spark of hope for the Sumatran rhino captive breeding program. The Cincinnati Zoo repeated its success with the same male/female pair (Ipuh and Emi) in 2004, this time producing a female calf (Suci). This second birth proved the repeatability of the intensive management strategy that had been developed and implemented by the Cincinnati Zoo staff. These births brought the total number of captive Indonesian Sumatran rhinos up to seven.

From 2000 until now, a pair of rhinos (Torgamba and Bina) at the Sumatran Rhino Sanctuary (SRS) in Way Kambas, Indonesia, has mated on numerous occasions but, to date, no pregnancies have been diagnosed. The rhino pair initially encountered challenges that appeared physical in nature (male could not orient appropriately or achieve full intromission), but these challenges eventually were overcome and successful matings have been occurring for years, albeit at somewhat irregular intervals. In Spring 2005, an intensive management protocol similar to that used in Cincinnati was attempted during a 4-month period. This effort confirmed that the female's cycle was somewhat irregular but that she did ovulate after mating as expected. Unfortunately, she failed to conceive despite several matings during this interval. Furthermore, attempts to collect semen over the years by manual stimulation, electroejaculation and post-coital sampling have produced mixed results with many samples appearing aspermic or containing largely abnormally shaped sperm cells. Currently, the fertility of both animals is in question.

Recently, some very exciting opportunistic developments have occurred in Sumatra. First, a female rhino (Ratu) wandered outside the Way Kambas National Park into the local villages and could not be persuaded back into the forest. She was finally captured and moved to the SRS. Additionally, a second female rhino (Rosa) in Bukit Barisan Selatan National Park had, for over a year, frequently been found outside of the park boundaries, on roads and in villages.

Of further concern was her unusual friendliness with people. Because it was impossible to continue to justify expending resources in support of constant RPU monitoring for one animal, she was recently captured and soon will be moved to the SRS to join the captive breeding program. The rescue of these two female rhinos brings the total number of Indonesian Sumatran rhinos in captivity up to nine.

Given the reproductive success in Cincinnati and the addition of two new young female rhinos to the SRS, a thorough evaluation of the population and the recommendation of appropriate next steps (including management strategies and animal transfers) are certainly warranted to ensure that the captive breeding program succeeds. Success in the short-term would be the production of more calves by the proven breeding pair in Cincinnati, their offspring and new founder animals that have yet to contribute to the captive population's gene pool. In the long-term, success would be a self-sustaining, genetically-robust, captive population from which animals could be extracted for reintroduction back into their native habitat.

## Reproductive Status of Animals (by location)

**Bronx Zoo**

Rapunzel - >25 yrs old; ovaries have been quiescent since 1997 and severe pathology exists in her reproductive tract; despite over a year of intensive monitoring and hormone treatments in the late 1990's, reproductive cyclicity did not resume; female considered post-reproductive, very old and almost blind; current general health is good

**Cincinnati Zoo & Botanical Garden**

Emi – ~17 yrs old; Currently the only successfully reproducing female Sumatran rhino in captivity; has two surviving calves; is currently being mated with Ipuh to produce a third pregnancy; current health excellent

Ipuh - >25 yrs old; Currently the only proven male Sumatran rhino in captivity; has sired two surviving calves; is currently being mated with Emi to produce a third pregnancy; current health excellent but corneal scarring is apparent

Suci – 16 mo.; female offspring of Emi and Ipuh; should reach reproductive maturity in ~2-3 yrs; current health is excellent

**Los Angeles Zoo & Botanical Garden**

Andalas – 4 yrs old; male offspring of Emi and Ipuh; should reach reproductive maturity in 1-2 yrs; monthly fecal samples are being collected for testosterone evaluation and determination of puberty; current health is excellent

**Sumatran Rhino Sanctuary, Way Kambas**

Bina – ~20+ yrs old; has been at SRS 7 yrs; has mated with Torgamba numerous times since 2000; no confirmed pregnancies; cycle is often irregular but she does cycle and does ovulate after mating; no significant pathology detected by ultrasound; fertility is questionable; current health is excellent

Torgamba - >25 yrs old; has been at SRS 7 yrs; has mated with Bina numerous times since 2000 without producing a pregnancy; semen quality from post-coital collection, manual stimulation and electroejaculation has been variable; fertility is questionable; bloodwork in Spring of 2005 suggested early signs of renal disease

Ratu - ~6-7 yrs old; has been at SRS ~2 mo; appears to be nulliparous; currently not pregnant; ultrasound exam revealed active ovaries and no pathology; currently recovering well from acute myopathy
Rosa - ~6 yrs old; will move to SRS in November; nulliparous; currently not pregnant; being treated for worms otherwise, current health is excellent

## Important Considerations in the Development of the GMPB Goals

1) The current reproductive potential of each individual rhino in captivity
2) The need to maximize genetic diversity and number of contributing founders
3) The costs and logistical challenges to moving rhinos (especially internationally)
4) The challenge of obtaining import/export permits to and from the US
5) The need to produce pregnancies in all young females before pathologies develop

## Three-year Goals of the GMPB with Supporting Rationale and Recommended Action Steps

Note: These action steps have been developed based on the assumption that pregnancies are not established in any rhinos other than the proven pair (Emi and Ipuh). If pregnancies are diagnosed at some point in this plan, subsequent action steps are likely to change.

**1) Produce a third pregnancy by Emi and Ipuh at the Cincinnati Zoo**

Rationale: As the only successfully reproducing pair of Sumatran rhinos in captivity, nothing should be done to disrupt this pairing and the management system that has proven successful.

Action: Now that Suci has been weaned, intensive ultrasound monitoring and management should resume and the pair should be introduced for breeding as soon as possible

**2) Determine the fertility status of Bina**

Rationale: Bina has been in captivity for many years (n=14) without being pregnant, a condition that often leads to pathology and infertility. However, she exhibits no obvious pathology in her reproductive tract and continues to cycle. Since she has only mated with Torgamba in captivity, and his fertility is questionable, Bina should be bred repeatedly by a proven male in an attempt to produce a pregnancy and to better understand her unusual cyclist, or to determine conclusively that she is no longer fertile.

Action: Move Bina to the Cincinnati Zoo for intensive monitoring and pairing with proven male rhino Ipuh as soon as permits can be acquired and logistics put in place. Bina should be monitored intensively at Cincinnati to better understand her unusual reproductive pattern and possibly alter it through hormonal therapies that might improve her chances of becoming pregnant. She should be mated with Ipuh on every consecutive estrus for 24 months, or until pregnant. If still not pregnant after 24 months of natural matings with a proven male, gamete rescue should be considered so her genetic potential is not lost forever.

**3) Determine the fertility status of Torgamba**

Rationale: Torgamba has mated with Bina, a cycling female with no apparent reproductive pathologies since 2000, but no embryos have been observed by ultrasound following matings. Given these poor post-copulatory results and the occasional aspermic or abnormal sperm sample collected from this male, his fertility is in question. However, he obviously does not lack libido, his testicles are normal size and without any gross abnormalities, and an occasional evaluation of post-coital samples has revealed normally shaped, motile sperm. Because Torgamba has only been mated with Bina, a female of questionable fertility herself, he should be paired with one or more fertile females and mated continuously over numerous consecutive cycles. If the female(s) cycle, mate with Torgamba, and ovulate but never conceive, it may be concluded that Torgamba is subfertile and perhaps infertile.

Action: Torgamba should be given ample opportunity (~12 mo) to breed with the two new, young and presumably fertile female rhinos at the SRS. Torgamba and the females should be intensively managed in 2006 so that cycles are not missed and Torgamba has as many opportunities as possible to produce a pregnancy. During these matings, every effort should be made to collect additional post-coital semen samples from Torgamba to evaluate sperm quality. If no pregnancies result after Torgamba has had ample opportunity with fertile females, he should be sent to Los Angeles in exchange for Andalas. At LA Zoo, Torgamba should be evaluated more extensively for reproductive deficiencies and, if at all possible, restored to better fertility. Concurrently, every effort should be made to collect and bank sperm samples from him if any good quality semen can be obtained so that his genes may one day contribute to the captive population. If any good sperm samples can be obtained from him suggesting he may still be fertile, he should be considered a match for Suci when she reaches maturity.

**4) Produce pregnancies in Ratu and Rosa as soon as possible with appropriate genetic match**

Rationale: Ratu and Rosa are two new prime breeding-age female rhinos in the program. Every effort must be made to produce pregnancies in these two females as soon as possible both to enhance the captive population and to ensure that they do not develop reproductive pathologies.

Action: Intensive ultrasound monitoring of the females should commence as soon as they have settled in at the SRS and have been conditioned to allow the rectal exams without objection. The females should be paired with Torgamba when ultrasound data suggest they are in estrus. Every effort should be made to breed the females with Torgamba on every cycle until they become pregnant. If neither female is pregnant within 12 mo of initiating this intensive management/breeding regime, Andalas should be moved from the LA Zoo to the SRS in exchange for Torgamba. Andalas would become the breeding male at the SRS, and the intensive monitoring and breeding program should continue with introductions between the females and Andalas.

**5) Produce pregnancies by Andalas with appropriate genetic match as soon as he is mature**

Rationale: Andalas, the first product of this captive breeding effort, represents an extremely valuable first generation offspring. This male is expected to be fertile and should be paired with a female for breeding as soon as he is sexually mature. Because Emi, the only reproductively active female rhino in the US, is his mother, Bina may be infertile and Suci is his sister, Ratu and Rosa are much better prospects as mates for Andalas.

Action: Monitor Andalas through fecal testosterone concentrations to determine when he becomes sexually mature. Exchange Andalas for Torgamba early in 2007 if: 1) Torgamba has not produced a pregnancy yet at the SRS, and 2) Andalas appears to be sexually mature (or close to it). Andalas will then become the breeding male at the SRS. Both females will be monitored intensively by ultrasound and paired with Andalas when in estrus throughout the year. No cycles should be missed and every effort needs to be made to optimize the chance of a successful copulation and subsequent conception in both females. Additionally, post-coital semen samples will need to be obtained to confirm that Andalas is producing sperm and to attempt to evaluate the quality of his semen.

**6) Produce a pregnancy in Suci with appropriate genetic match as soon as she is mature**

Rationale: Suci also represents an extremely valuable first generation offspring. Because females typically reach maturity before males, Suci is expected to reach sexual maturity and begin cycling at three to four years of age (2007 or 2008). Soon after Suci begins cycling regularly, she should be bred with an appropriate genetic match until she becomes pregnant. Such a strategy is important for producing more calves and for preventing the development of reproductive pathology. Currently, the only appropriate genetic match for Suci is Torgamba.

Action: Suci should be monitored through serum hormone analysis and monthly ultrasound exams from the age of two until she initiates reproductive cyclicity. Once Suci is sexually mature, Torgamba should be moved from the LA Zoo to Cincinnati in exchange for another rhino at Cincinnati (most likely Emi's third calf) so that he can be paired with Suci for mating. Suci should be intensively monitored by ultrasound and paired with Torgamba for breeding on every cycle until she conceives.

**Additional GMPB recommended action steps that need to be implemented concurrent with above action steps to ensure the success of the program**

1) A second, full-time, trained, practicing, clinical veterinarian is required at the SRS due to the additional work-load with new animals, the intensity of the program and necessary coverage every day of the year by someone with the proper skills. This

individual needs to be trained in all aspects of rhino preventative medicine, emergency care and ultrasound monitoring.

2) Permit applications for animal exchanges need to be initiated as soon as possible, especially for animals potentially imported to or exported from the US considering regulations have become stricter and time required to get approval has lengthened.
3) At the SRS, technology transfer, knowledge sharing and staff training in the areas of veterinary medicine and reproduction should occur to the extent resources allow using skilled personnel from SRS partners (US Zoos, IRF, Asian Rhino Project)
4) The GMPB Technical Committee should draft additional opinion papers for presentation and acceptance by the entire GMPB on the subjects of: 1) preventative medicine and disease assessment; 2) breeding facility requirements; and 3) animal translocation protocols.
5) If the program continues to succeed in producing Sumatran rhino calves, by 2008, there should be a plan in place for establishing a second breeding center both in the US and in Indonesia. Additional breeding centers will provide space for an expanding population of captive Sumatran rhinos and are necessary to reduce the risk of losing entire populations from localized natural disasters or disease outbreaks.

# 2011 Sumatran Rhino Global Propagation & Management Board Meeting – Briefing Materials

## Kota Kinabalu, Sabah, Malaysia

## 8-9 February 2011

## SECTION 4

## GMPB Membership

# MEMBERS OF THE SUMATRAN RHINO GMPB 2010-2011

**Chairman:** Mr. Widodo Ramono

**Range State Representatives (voting members):**

| | |
|---|---|
| Indonesia: | PHKA Director of Biodiversity Conservation and ex-officio Rhino Conservation Officer (Mr. Novianto Bambang Wawandono) |
| Peninsula Malaysia: | Director of Dept. of Wildlife and National Parks (Mr. Abd. Rasid bin Samsudin) |
| Sabah: | Director of Wildlife Department (Mr. Laurentius Yambu) |

**Institutional Representatives (voting members):**

| | |
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| Yaysan Badak Indonesia | Mr. Widodo Ramono |
| U.S. Zoos | Dr. Terri Roth |
| Asian Rhino Specialist Group Chair | Mr. Bibhab Talukdar |
| International Rhino Foundation | Mr. John Lukas |
| Asian Rhino Project | Ms. Kerry Crosbie |
| Borneo Rhino Alliance | Dr. John Payne |

**GMPB Technical Committee (non-voting members):**

Dr. Muhamad Agil
Dr. Hadi Alikodra
Mr. Dedi Candra
Dr. Susie Ellis
Ms. Siti Hawa
Dr. Abdul Hamid Ahmad
Mr. Jeff Holland
Dr. Petra Kretchmar
Dr. Sen Nathan
Mr. Tim Portas
Dr. Robin Radcliffe
Mr. Steve Shurter
Mr. Bibhab Talukdar
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