Thai Gibbon
Population and Habitat Viability Analysis

Khao Yai, Thailand, 1994

The Asia Foundation

Population and Habitat Viability Analysis Report for Thai Gibbons: *Hylobates lar* and *H. pileatus*

Submitted to the

Royal Forest Department Kingdom of Thailand

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A contribution of the IUCN/SSC Conservation Breeding Specialist Group and the Gibbon Species Survival Plan (SSP) of the American Zoo and Aquarium Association (AZA), in cooperation with the Royal Forest Department of Thailand.

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Cover photo: A wild black-phase white-handed gibbon (*Hylobates lar*) in Khao Yai National Park, Thailand. Photo by Warren Brockelman, Center for Conservation Biology, Mahidol University, Bangkok, Thailand.

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1 December 1994

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No.0712.02/ /410

Royal Forest Department
Paholyothin Road, Jatujak
Bangkok 10900 Thailand.

January 17 , B.E. 2535 (1992)

Dear Dr. Tilson,

Further to your meeting with Dr. Schwann Tunhikorn , Head of Research at the Wildlife Conservation Division , I am happy to confirm that the Royal Forest Department very much like to host a workshop in Thailand next year to prepare a set of national guidelines governing the rehabitation of captive gibbons and their possible re-introduction to the wild or semi-wild state.

We are keen that this issue be addressed and properly placed in the context of a national conservation strategy before any attempts are made to release captive animals to the wild without due thought and preparation. We are also keen to explore ways in which the situation for wild animals held in captivity in Thailand , whether in public zoos and nature education centres or private hands , can be improved. We are aware that our record to date is not without fault and we appreciate your interest in lending a hand.

We would be grateful if you could arrange funding for such a workshop. Our own budget is already over-stretched. We would like to invite all interested parties to join from both the government and non-government sectors.

We look forward to hearing from you.

Yours Sincerely,

T. Prakobboon

(Mr. Thanimarong Prakobboon)
Deputy Director-General

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Khun Thammarong Prakobboon
Deputy Director-General
Royal Forest Department
Paholyothin Road, Jatujak
Bangkok 10900 Thailand

17 March 1992

Dear Khun Thammarong:

Your letter of January 17, 1992 regarding a workshop in Thailand next year to prepare a set of national guidelines governing the rehabilitation of captive gibbons and their possible reintroduction to the wild or semi-wild state has been received. I have copied this letter to the Office of the IUCN/SSC Captive Breeding Specialist Group and Dr. Seal, the Chair of that group, has agreed to help plan, coordinate and conduct a workshop to help resolve the Thai gibbon issue. The workshop should be scheduled within the next 12-16 months, to be held in Bangkok or an appropriate site within Thailand, and be attended by appropriate representatives of the Royal Forest Department, University Staff within Thailand, Siam Scientific Society, Thai Zoo Association Board Members and Directors, Wildlife Fund Thailand, individuals from the Gibbon Rescue Centers as well as input from the IUCN Primate and Reintroduction Specialist Groups.

The AAZPA/Gibbon Species Survival Plan (SSP) Committee is keen to be involved in all aspects of this significant workshop. Through the Gibbon SSP we will seek ways to fund the workshop and begin drafting a problem statement as well as a tentative workshop agenda for your approval. A list individuals from both the government and non-government sectors that you would like to see involved would be helpful in this initial planning stage.

This letter will serve as acknowledgement of your request and a willingness of the Gibbon SSP and Office of CBSG to help plan, coordinate and conduct the workshop.

Sincerely,

Ronald L. Tilson, Ph.D.
Director, Conservation Office
Co-Coordinator Gibbon SSP

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Population and Habitat Viability Analysis Report for Thai Gibbons: *Hylobates lar* and *H. pileatus*

Chapter 1:

PHVA Workshop Information

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Executive Summary

Schwann Tunhikorn and Ronald Tilson

In 1992 the Royal Thai Forest Department requested the American Zoo and Aquarium Association's (AZA) Gibbon Species Survival Plan (SSP) and subsequently the IUCN/SSC Conservation Breeding Specialist Group (CBSG) Office to prepare and conduct a Population and Habitat Viability Analysis (PHVA) Workshop to assess the risks of extinction in the wild populations and to resolve the growing crisis of too many captive gibbons in Thailand. The family *Hylobatidae* is represented in Thailand by three species: *Hylobates lar, H. pileatus* and *H. agilis*. A fourth species, *H. concolor*, living in countries east of Thailand, is commonly found in captive collections. All of these species are classified by the IUCN as threatened, *H. pileatus* and *H. concolor* are critically threatened, yet no captive program exists in Thailand for any of these species. This problem is further exacerbated by the fact that the ability of the existing Thai zoos to accommodate the continuing influx of captive gibbons is overwhelmed.

At the request of Khun Watana Kaeokamnerd, Deputy Director General of the Royal Forest Department, a Population and Habitat Viability Analysis (PHVA) Workshop for Thai gibbons was held at Khao Yai National Park on 26-29 April 1994. The workshop was organized and conducted by Schwann Tunhikorn (Royal Forest Department), Warren Brockelman (Mahidol University), Usum Nimmanheminda (Zoological Park Organization), Ronald Tilson (Minnesota Zoo), and Ulysses Seal (IUCN/SSC Conservation Breeding Specialist Group--CBSG). The Asia Foundation (Bangkok) sponsored all Thai NGO participants. Other supporting organizations include: the Calgary Zoological Society; Minnesota, Omaha and Milwaukee Zoos; and the European Endangered Species Program (EEP) -- London, Twycross, Paignton, Fota WP, Edinburgh & Duisburg Zoos.

The workshop at Khao Yai National Park was attended by over 90 participants, primarily members of the Royal Forest Department and Thai NGOs. Invited foundations included: Wildlife Fund Thailand; Wild Animal Rescue Foundation of Thailand; Gibbon Rehabilitation Project, Phuket; and the Seub Nakhasaphien Foundation. It was hoped that the results from the PHVA might provide the basis for an integrated *Thai Gibbon Action Plan.*

Thai scientists, conservation organizations, and wildlife authorities have struggled in the development of collaborative programs for the conservation of wild gibbon populations. The primary goal of the workshop was to develop a *Thai Gibbon Action Plan* which will serve as a guide to protect remaining gibbon habitat, eliminate human-caused mortality, and maintain genetically viable, self-sustaining, free-ranging populations of Thai gibbon species. In order to achieve this goal of recovery, it is necessary to understand the risk factors that affect survival of the wild gibbon populations.

Risk evaluation is a major concern in endangered species management and one goal is to reduce the risk of extinction to an acceptable level. A set of software tools to assist simulation and quantitative evaluation of risk of extinction is available and was used as part of the Population and Habitat Viability Analysis Workshop. This technique can improve identification and ranking of risks and can assist assessment of conservation management options for wild populations. Of critical importance to the success of these conservation management programs will be participation by appropriate organizations and individuals in Thailand to ensure the implementation of recommendations made at the workshop.

The first morning and afternoon consisted of a series of presentations summarizing information on the taxonomy, genetics, and status of gibbons in Southeast Asia, detailed field information on the status of *H. lar* and *H. pileatus* in Thailand, a summary of animals held in captivity in Thailand, the medical status of a sample of these animals, and a report on the rehabilitation project in Phuket. A brief presentation on population biology, the PHVA process, and the use of VORTEX was made. Preparation of a first version of a population model for the species based upon information from the participants was made in the plenary session. Stochastic population simulation models were initialized with ranges of values for the key variables to estimate the viability of the wild population using the VORTEX software modelling package.

At the meeting ten working groups were established: Thai Gibbon Habitat and Population Status; Life History and Vortex Analysis; Human Demography; Genetic Aspects; Estimates of Captive Gibbons; ZPO Thai Gibbon Program; Captive Management; Gibbon Diseases; Selection of Gibbon Reintroduction Areas; and Gibbon Rehabilitation and Release. Their charge was to review in detail current information, to develop values for use in the simulation models, and to develop conservation management scenarios and recommendations for the drafting of a *Thai Gibbon Action Plan.*

Estimates of habitat and population numbers for wild *H. lar* and *H. pileatus* gibbons were derived in the **Habitat and Population Status Working Group** through consensus of the workshop participants. The numbers were derived from estimating population numbers by measuring the size of the forest, then estimating the extent and type of available habitat within each forest, and multiplying that figure by estimated gibbon densities for different habitats (established earlier in the workshop for lowland, hill and submontane rain forest). These estimates resulted in a total population of approximately 110,000 *H. lar* gibbons living in 31 populations, and approximately 30,000 *H. pileatus* gibbons in eight separate populations. The working group finalized their information in two comprehensive tables, one for *H. lar* populations and one for *H. pileatus* populations, that integrated total habitat available, assumed density of gibbon groups in core areas, and estimated gibbon populations for each conservation area.

The working group also recommended that, since large populations of Thai gibbons are so highly vulnerable to poaching mortality and are probably still declining, that more surveys in core and peripheral areas need to be conducted, and that regular monitoring of the numbers of breeding groups in selected areas need to be carried out at regular intervals. In order to do this, protected area personnel need to be trained in simple methods of censusing gibbons.

The working group on **Life History and Vortex Analysis** used the base scenario developed in the plenary session from data provided by the participants. The total *H. lar* population of about 110,000 individuals is comprised of 31 separate populations. Sixteen (16) of these populations are estimated at 1000 or more individuals with estimated effective population sizes of 500 or larger. Five (5) populations have 200 or fewer individuals. Ten (10) populations fall between about 200 and 1000 individuals. Based upon loss of forest and habitat estimates and backward projections, the population may have declined from about 136,000 individuals over the past 10 years to the current estimate of 110,000 individuals solely on the basis of habitat loss. Removal of 3 or more animals (1 adult female, 1 adult male, and 1 young) per hundred of population per year will result in extinction of the population.

The total *H. pileatus* population of about 30,000 individuals is comprised of eight separate populations. Six (6) of these populations are estimated at 1000 or more individuals with estimated effective population sizes of 500 or larger. One (1) populations 200 or fewer individuals and one (1) population has between 500 and 600 individuals. Based upon loss of forest and habitat estimates and backward projections, the population may have declined from about 36,000 individuals over the past 10 years to the current estimate of 30,000 individuals solely on the basis of habitat loss. The following scenarios were developed:

- For both species, populations with 1000 or more individuals are at essentially zero risk of extinction over 100 years if their habitat remains intact and if losses due to hunting are less than 5 female adults and 2.5 female young per year per 1000 population. Populations of this size will not benefit, genetically or demographically, from the addition of individuals from captive populations or other wild populations over the next 100 years.

- Populations of 200-1000 individuals are essentially at zero risk of extinction over the next 100 years if their habitat remains intact and if losses are less than 1 adult female and 1 female infant per 200 individuals per year. These populations *might* benefit from the addition (by translocation) of 1 or 2 suitably chosen individuals from neighboring wild populations each 20-40 years.

- Populations (that are not disturbed and are not hunted) containing 100-200 animals have a probability of less than 1% of extinction over 100 years.

- Populations of about 100 individuals will lose about 6% of their heterozygosity in 100 years. These populations might benefit from periodic genetic supplementation (2-3 individuals at perhaps 20-40 year intervals) from other populations in the region as part of a regional metapopulation management strategy.

- Populations of less than 50 animals have a risk of extinction of up to 20% in 100 years particularly if the species is subject to inbreeding depression. These populations may require genetic supplementation every 20-30 years. If demographic extinction occurs, then the sites would be suitable for recolonization either by translocation or by reintroductions from a captive population.

The working group on **Human Demography and Community Conservation** examined past and future human population trends adjacent to gibbon protected areas, estimated the potential impact of these human populations on forest resources and gibbon habitat, and considered recommendations on how to minimize future negative impacts. Their recommendations focused primarily on ways to broaden community participation in managing each park's resources, encouraging NGOs to support these efforts, and training park staff in community planning exercises.

The working group on **Gibbon Genetics** considered issues of small populations, whether they are wild or in captivity, and how genetic management may help ensure their long-term survival. The development of the in-country capability for molecular genetic genotyping was recommended. Other recommendations stressed the value of knowing geographic providence of individual gibbons involved in reintroduction, translocation or captive management programs.

It was decided early on in the workshop that the **Captive Management Plan Working Group** should set guidelines for a captive management program for Thai gibbons regardless of their wild status because they are Thai species, are considered threatened by the IUCN/SSC Primate Specialist Group, and because there are no organized captive management programs in Thai zoos. Recommendations included establishing a Captive Management Program in Thailand, beginning with *H. pileatus* and possibly expanding to *H. concolor*, and further training of ZPO staff in gibbon health, husbandry and SPARKS studbook management. The working group on **Captive Management of Thai Gibbons** then developed a comprehensive set of gibbon management guidelines to serve as the basis for implementing the ZPO recommendations.

The working group on **Gibbon Diseases** acknowledged that infectious diseases pose a significant risk to gibbons, both for long-term maintenance of captive populations and for any suggested translocation or reintroduction program for wild populations. They provided general recommendations for disease control through quarantine procedures and disease testing, and identified diseases that pose unacceptable risks to wild populations. A comprehensive document on gibbon health issues was prepared and presented as part of this workshop.

The **Gibbon Rehabilitation Working Group** convened to discuss the mechanics of rehabilitation and release of gibbons. Three separate subjects were considered: release site selection; selection of animals and rehabilitation management; and release and post-release follow-up. Release site selection was addressed by the **Selection of Gibbon Reintroduction Areas Working Group**. A set of specific criteria guiding selection of appropriate gibbons for participation in reintroduction programs was generated, as well as a set of guidelines for rehabilitation, release and follow-up programs. Translocation of wild gibbons from one natural habitat to another was considered, but was deferred as a management option for future consideration.

On the last day of the workshop a comprehensive set of recommendations for the conservation management of gibbons was reviewed, intensively discussed, and consensus was reached. The Royal Forest Department requested the assistance of the IUCN/SSC Conservation Breeding Specialist Group to help develop a national conservation strategy for gibbons in Thailand. Recommendations from this PHVA report for Thai gibbons, which constitute the *Thai Gibbon Action Plan* submitted to the Royal Forest Department, will serve as a foundation for developing such a strategy. ■

Problem Statement

Ronald Tilson and Ulysses Seal

OVERVIEW

In 1992 the Royal Thai Forest Department requested the American Zoo and Aquarium Association's (AZA) Gibbon Species Survival Plan (SSP) and subsequently the IUCN/SSC Conservation Breeding Specialist Group (CBSG) Office to prepare and conduct a Population and Habitat Viability Analysis (PHVA) Workshop to resolve the growing crisis of too many captive gibbons in Thailand, the lack of a structured conservation program for the species, and the desire to have an integrated national conservation program for gibbons in place (see letters).

The family *Hylobatidae*, which is strongly represented in Thailand by three species, *Hylobates lar, H. pileatus* and *H. agilis* is an ideal candidate for a PHVA. A fourth species, *H. concolor*, because of its proximity to Thailand, is commonly found in captive collections. All of these species are threatened, *H. pileatus* and *H. concolor* are critically threatened, yet no captive program exists in Thailand for any of these species. This problem is further exacerbated by the fact that the ability of the existing Thai zoos to accommodate the continuing influx of captive gibbons is overwhelmed. This situation is a potential political nightmare.

The above program is in line with the AZA Gibbon SSP support of a proposal to develop a gibbon conservation and management center for Thailand, submitted by the Thai Royal Forest Department, the Zoological Park Organization, Mahidol University and Wildlife Fund Thailand. An abstract of the proposal is:

> *"Gibbons in protected areas in Thailand are gradually declining in number as poaching and a flourishing local pet trade take their toll. Enforcement of the ban on primate exports has caused an accumulation of unwanted animals in captivity in Thailand. The proposed center for gibbon conservation will help alleviate these problems by establishing a scientifically sound breeding program, promoting conservation-related research, implementing a reintroduction program in depleted protected areas and carrying out a public awareness program."*

Support for a gibbon PHVA was also recommended in the *Thai Zoo Masterplan for Conservation*, which has as its organizing principle, **"zoos within the Thai Zoological Parks Organization should commit their resources to the conservation of Southeast Asian species, specifically Thai species, that have high priorities for captive conservation action as**

recommended by the IUCN Specialist Group reports." The rationale behind this recommendation is derived from the Wildlife Fund Thailand's observation that identifies 33 species of mammals from 13 families, and 41 species of birds from 16 families, as threatened or endangered within Thailand. The process for identifying which species in Thailand have the highest priority is accomplished for some taxa through action plans of the IUCN Species Survival Commission Specialist Groups and CBSG workshops such as PHVAs and Conservation Assessment and Management Plans (CAMPs).

WHAT IS A POPULATION AND HABITAT VIABILITY ANALYSIS (PHVA) WORKSHOP?

An endangered species is, by definition, at risk of extinction. The goal in the recovery of such a species is to reduce this risk to some acceptable level, that is, as close as possible to the background or "normal" extinction risk all species face. To do this we need to improve our estimation of risk as a result of different management options, to improve objectivity in assessing risk, and to add quality control to the process (through internal consistency checks).

In the last several years the discipline of Conservation Biology has grown into some of the space between Wildlife Management and Population Biology. A set of principles loosely known as **"Population and Habitat Viability Analysis" (PHVA)** is powerful enough to improve the recognition of risk, rank relative risks and evaluate options. It has the further benefit of changing part of the decision making process from unchallengeable internal intuition to explicit (and hence challengeable) quantitative rationales. One consequence of a PHVA is that critical aspects of the biology of a species can be identified, indicating where further knowledge may substantially increase our ability to predict the fate of a population and where management actions to change population dynamics might be especially effective.

In widely distributed species, local populations may be lost, but are readily re-established from adjacent populations. A single or a few remnant populations isolated from any possible source of supplementation and recolonization typically will not survive indefinitely. Thus, it is not sufficient to protect a remnant population from those causes of decline that eliminated other populations. Rather, aggressive action must be taken to increase the population and to establish or re-establish additional populations. The goal of recovery is to extract a population out of the extinction vortex by returning its numbers, range and diversity to such levels that normal population dynamics, including temporary local extinctions, preclude the extinction process.

A population is considered to be those animals, perhaps further divided into smaller subpopulations, that exchange individuals sufficiently often so that each subpopulation exchanges, on average, at least one migrant per generation with other subpopulations. Simulation modelling of some of the known causes of variability in gibbon populations will be needed to estimate the size of wholly isolated populations needed for demographic stability. It is likely that populations containing less than 50 adults will not be stable over periods of 100-200 years. On the other hand, habitats unable to support 50 adults may be important to gibbon recovery. Natural or

managed migration can connect small remnant subpopulations to those in other such habitat patches, thereby constituting a larger, stable population (with a total of 50 or more adults).

Because every isolated population is vulnerable to extinction (for example, a disease epidemic can decimate even a large population), species viability requires at least three populations sufficiently discrete to be subject to independent fluctuations in numbers. If each population has a moderately low probability of extinction, and if the populations fluctuate independently of one another, then it is highly unlikely that species extinction will occur.

The rationale for demographic goals explained above applies equally to genetic goals set forth here. Populations of 50 breeding adults maintain sufficient genetic variation to minimize inbreeding (expected mean increase in the inbreeding coefficient less than 1%) and therefore this number has been recommended as a minimum size for isolated populations of domestic livestock, and for short-term minimum population sizes for wildlife. If subpopulations consist of fewer than 50 breeding adults, migration and immigration (one or more per generation) can genetically link these subpopulations, possibly leading to viable populations.

WHAT ARE THE PHVA WORKSHOP OBJECTIVES?

1) Estimate probable populations of gibbons in protected areas of Thailand, the degree of fragmentation of these populations, and their probabilities for long-term survival with no intervention;
2) Determine numbers of gibbons and subpopulations required for various probabilities of survival and preservation of genetic diversity for specified periods of time;
3) Project the potential expansion or decline of gibbon population numbers due to various environmental changes, habitat alteration and differing management plans;
4) Explore the role of exchanges among disjunct gibbon populations to maintain viable populations;
5) Formulate and evaluate possible role of captive propagation as a component of the above management options;
6) Identify reliable field methods for monitoring population status and assessing habitat quality;
7) Produce a Thai conservation strategy for gibbons that presents the results and recommendations of the PHVA workshop.

The combination of the above objectives form the basis of the national conservation management strategy for gibbons. This document will be prepared in draft form during the workshop, and will be reviewed and revised by all participants during the workshop to achieve agreement on its content before departure. It will include specific recommendations and priorities for management and research of both captive and wild populations. Once consensus is reached the document will be translated into Thai for distribution and implementation throughout Thailand. ■

Opening Address

Pramote Saiwichian

On behalf of the Royal Forest Department of Thailand I welcome everyone here to this workshop. Our goal in the next four days is to develop a Thai Conservation Policy that will guide us first in the protection of wild gibbon populations and their habitats, and second in the rehabilitation and reintroduction of captive gibbons back into our forests. It is a very big challenge and we are all grateful for your attending this meeting to help us with this issue.

This workshop would not have been possible without the help of the following organizations: the Government of Thailand; Royal Forest Department; the Center for Conservation Biology at Mahidol University; IUCN/SSC Conservation Breeding Specialist Group; and the Zoological Parks Organization of Thailand. We especially appreciate the support of The Asia Foundation for its generous funding of this workshop, and the other organizations who also provided support.

I would like to give everyone here some background information on how this workshop came to be. Early in 1992 the Royal Thai Forest Department requested the IUCN/SSC Conservation Breeding Specialist Group (CBSG) to prepare and conduct a Population and Habitat Viability Analysis (or PHVA as it is called) to resolve the growing crisis of too many captive gibbons in Thailand, the lack of a structured conservation program for the species, and the desire to have an integrated national conservation program of gibbons in place.

Gibbons are represented in Thailand by mainly two species, the white-handed gibbon and the pileated gibbon. A third species, the agile gibbon, is found in the far south of Thailand, and a fourth species, the white-cheeked gibbon, which lives in Laos and Vietnam but because of its proximity to Thailand, is commonly found in captivity here as a result of the pet trade. According to the IUCN Primate Specialist Group all of these species are threatened, and the pileated and white-cheeked gibbons are critically threatened, but we have no conservation programs in Thailand, either for wild gibbons or for captive gibbons. This problem is made worse by the fact that the existing Thai zoos, Royal Forest Department and NGO Foundations do not have adequate space or care for the growing number of captive gibbons. This situation has caused many problems for us in Thailand.

One way to solve the problem has been stated very well in a document that proposes to develop a gibbon conservation and management center for Thailand. Its purpose is:

> *"Gibbons in protected areas in Thailand were gradually declining in number as poaching and a flourishing local pet trade took their toll. Enforcement of the ban on primate exports has caused an accummulation of unwanted animals in captivity in Thailand. The proposed center for gibbon conservation will help alleviate these problems by establishing a scientifically sound breeding program, promoting conservation-related research, implementing a reintroduction program in depleted protected areas and carrying out a public awareness program."*

Support for a gibbon PHVA was also recommended in the *Thai Zoo Masterplan for Conservation*, completed in August 1993 which has as its organizing principle, **"zoos within the Thai Zoological Parks Organization should commit their resources to the conservation of Southeast Asian species, specifically Thai species, that have high priorities for captive conservation action as recommended by the IUCN Specialist Group reports."** The rationale behind this recommendation is derived from the Royal Forest Department's observation that identifies 33 species of mammals from 13 families, and 41 species of birds from 16 families, as threatened or endangered within Thailand. The process for identifying which species in Thailand have the highest priority is accomplished for some taxa through action plans of the IUCN Species Survival Commission and CBSG workshops such as this one.

The workshop objectives will be:

> First, to estimate probable populations of gibbons in protected areas of Thailand, the degree of fragmentation of these populations, and their probabilities for long-term survival;
>
> Second, to determine the number of gibbon populations required for various probabilities of survival and preservation of genetic diversity for specified periods of time;
>
> Third, to project the potential expansion or decline of gibbon populations based on various threats such as habitat loss and poaching, and based on differing management plans;
>
> Fourth, to formulate and evaluate the possible role of captive propagation as a component of the above management options;
>
> Fifth, to design carefully thought out programs on how to rehabilitate and reintroduce gibbons back into the wild.

The combination of the above objectives will form the basis of the Thai national conservation management strategy for gibbons. This document will be prepared in draft form during the workshop, and will be reviewed and revised during the workshop to achieve agreement on its content before departure. It will include specific recommendations and priorities for management and research of both wild and captive populations. Once consensus is reached the document will be translated into Thai for distribution and implementation in Thailand.

I wish you all the very best success, request that all of work together as one group and always remember that no matter how different our views are, we are all here to do our best for the long-term conservation of gibbons for future generations of Thai people. I also hope that each of you can take a few minutes from your busy schedule, go out into the nearby forest, and if possible, view a gibbon high up in the trees. Maybe gibbons will sing a song in celebration of your work.

I now officially open this workshop. Thank you. ■

Workshop Agenda

Thai Gibbon PHVA Workshop
Khao Yai National Park, Thailand
25-29 April 1994

25 April — Workshop Coordinators meeting (PM) [Watana, Schwann, Manop, Preecha, Usum, Brockelman, Pisit, Seal & Tilson]

26 April — Workshop convenes (9:00 AM); Opening comments [Watana, Pramote & Seal]
Overview of gibbons in Southeast Asia [Tilson]
Overview of Thai gibbons--distribution, status, and threats [Brockelman]
PHVA overview and modelling of gibbon populations [Seal & Tilson]
Review of gibbon genetics and species/subspecies issues [Woodruff]

Working Groups:
Thailand Protected Areas and Gibbon Populations [Brockelman & RFD staff]
Population Biology and Vortex Models [Seal & RFD staff]
Status and Numbers of Confiscated Gibbons [Manop, Preecha, Pisit, Morin, Usum and others]
Captive Management [Castle, Christie, Usum and zoo staff]
Gibbon Diseases [Parntep, Cook, de Leeuw van Leween, and zoo vets]
Human Demography [Williams & RFD]
Discussion and data verification of working groups
Evening working groups

27 April — Status of working groups [Tilson and Seal]

Working Groups:
Habitat restoration, rehabilitation and reintroductions [Brockelman, Morin, Schwann, and others]
Genetic Aspects of Gibbon Management [Woodruff & Tilson]
Confiscation of gibbons and care [Manop, Preecha, Leonie, Morin, Pisit and zoo staff]
Public conservation/education [Pisit, Eudey, and others]
Evening working groups: Integration of reports

28 April — Development and review of Thai Gibbon Action Plan [Schwann & Tilson]
Consensus reached by all workshop participants

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Population and Habitat Viability Analysis Report for Thai Gibbons: *Hylobates lar* and *H. pileatus*

Chapter 2:

Working Group Reports

Working Group Report:
Thai Gibbon Habitat and Population Status

Working Group Members: Warren Brockelman, Yongyuth Trisurat (Facilitators), Samart Maungmaitong, Matana Srikachang, Siriporn Thon-Aree, Chumpol Suckaseam, Pongpan Laothong, Budsabong Kanchanasaka, Tunya Chang-arge, Piyaret Chimchom, Somboon Wongphakdi, Euayporn Sangtien, Siriphan Chamnankit, David Smith, Stephen Elliott & Ardith Eudey.

INTRODUCTION: HABITATS AND PROTECTED AREAS

The Center for Conservation Biology (CCB) at Mahidol University has maintained a database (MASS) for species habitats and protected areas since 1987. This is the only database in Thailand that attempts to store information of each forest type in Thailand for all protected area units, and the species (primarily birds and mammals) that live in each protected area. This information is also being developed by the Royal Forest Department, which manages the protected areas (PA), in the master plan for each protected area unit, but so far most units do not have complete management plans. Therefore, the gibbon PHVA project will rely on the habitat areas stored in the MASS database at Mahidol University.

The MASS database contains habitat areas calculated for the PA units established up to 1987. This includes 66 national parks, 32 wildlife sanctuaries and 41 non-hunting areas. Since then at least 49 new national parks and 7 new wildlife sanctuaries have been gazetted or are about to be, and several non-hunting areas are being upgraded to wildlife sanctuaries. The CCB has not yet included these new areas in its database, and probably will not do so until a new version of the MASS database linked to a GIS system is developed and installed, and the maps can be digitized. This will make little difference to the gibbon PHVA because all the best gibbon habitat had already been included in the PA system by 1987. Most new areas are in habitat marginal for large wildlife species, or in the drier forests in the North that have faced considerable hunting pressure from hill tribal people already. The conservation of these areas is intended to benefit mainly watershed and forest protection.

Thailand's protected area system is highly fragmented, but many PA units are contiguous with others and form, functionally, larger "effective conservation units" (ECU). These larger blocks of forest must be the basis for evaluating the effective population sizes of wildlife species. Some are divided by roads, but gibbons have been known to run across roads to disperse providing the distance is not so great. Therefore, it will be assumed that roads are not barriers to dispersal and gene flow. Reservoirs, however, are barriers and it is assumed that gibbons will not cross them.

The Wildlife Research Division of the Royal Forest Department, in association with the University of Minnesota, is initiating a project to map the distributions of 16 large mammal species in protected areas using GIS, global positioning system technology and field surveys by park rangers. It is planned to eventually coordinate with primate researchers and include some primate species, especially gibbons.

Brockelman and Baimai (1993) have recently carried out and analysis of effective conservation area forest units (ECU) in Thailand using the MASS database. This analysis lists the area of each forest type in each protected area, and the total forest area in each ECU in each part of the country. Not all of the forest types support gibbons. The types that do are as follows:

TE - Tropical Evergreen (broadleaved), foothills (200 m) to 1000 m elevation.
TE0 - Tropical Evergreen, lowlands.
TR - Tropical Rainforest, foothills to 1000 m; on peninsula.
TR0 - Tropical Rainforest, peninsular lowlands.

It has been observed that "mixed deciduous" (MD) forest in some parts of Thailand also supports gibbons. The areas of this forest type have not been included in the present analysis because such habitat would support a lower gibbon density than evergreen forest, and because gibbons using MD forest also appear to rely on nearby evergreen forest.

As implied above, it is assumed that all significant gibbon populations are within protected areas, although there is still some gibbon habitat and a few gibbons outside the protected area system. It is believed that there is little hope for gibbons outside patrolled parks and sanctuaries.

Areas of each forest type have been summed for all ECUs within the ranges of the two gibbon species common in Thailand, *Hylobates lar* and *H. pileatus*, in Tables 1 and 2. The third species, *H. agilis*, which occurs in a few insecure areas on the Malaysian border, will not be treated because it is much more abundant in Malaysia and Indonesia than in Thailand. Table 1 and 2 presents summaries of gibbon habitat areas for each of the six main regions of the country, for each species of gibbon.

ESTIMATION OF DENSITY

Estimates of habitat area must be multiplied by estimates of density to obtain population size estimates for each species in each ECU. Surveys for gibbons have been made in some of the most important PA units. In only a few cases have surveys covered the entire area with samples, in the range of the pileated gibbon. Some of these surveys are not very recent, but the estimates from such surveys are usually low - much lower than has been found in intensively studied long term study sites. Therefore, they will still be used for the core areas of the reserves.

Gibbons are surveyed by listening for their duetted songs from mapped "listening posts" (Brockelman and Ali, 1987; Brockelman and Srikosamatara, 1993). The duet indicates the presence of a territorial breeding group, and thus population estimates are made in terms of the number of breeding groups. Each group contains an adult male and one adult female, plus non-breeding or immature individuals which are assumed to be mostly the offspring of the breeding pair. The average total group size is 4. With a 1:1 breeding sex ratio, the effective genetic population size (Ne) is equal to the number of breeding adults, or exactly twice the number of groups. Factors that could reduce Ne still further include unequal breeding performance by males, population fluctuations, and inbreeding. At present, there is insufficient evidence on which to base the incorporation of these.

The auditory survey of gibbons requires prior knowledge of the diurnal pattern of singing and the probability that a given group will duet on an average day. Rainy or windy days are not used because it is known that singing is depressed in such weather. Groups vary in singing frequency, but it has been found in certain study populations that lar gibbons will duet, on average, on about 70% of days and pileated gibbons about 47%. For lar gibbons, 70% constitutes most of the groups present, and conservatively, one may take the number of groups heard during one or two days as the population estimate. For pileated gibbons, the average number of groups heard in a large number of 1-day samples should be multiplied by 2 to arrive at a population estimate.

POPULATION SURVEYS

Below are protected areas that have had at least a preliminary survey, with a brief statement of the results from each area. These surveys provide a basis for determining the average density of gibbons in the core areas to be used for population estimation. These estimates are used to determine average density in other areas with similar forest in the same regions.

Hylobates lar

North:

Doi Chiang Dao WS: Hill tribes present; gibbons virtually hunted out
Doi Suthep-Doi Pui NP: Hill tribes; gibbons extirpated
Doi Luang NP: Gibbons hunted, sparse
Mae Yom NP: Hill tribes; gibbons hunted, very rare

Northeast:

Phu Luang NP: Density low, ca. 1 group/km^2
Phu Phan NP: Gibbons hunted, very rare
Khao Yai NP: Density to 4 near headquarters, 3 farther away in wilderness core areas

West-Southwest:

Huai Kha Khaeng WS: Density 2 to 4 groups/km^2 in core areas
Kaeng Krachan NP: Density ca. 2.5 groups/km^2 in core areas

South:

Khlong Saeng WS: Density to at least 2 groups/km^2
Thale Ban NP: Gibbons rare; to 1 group/km^2
Ton Nga Chang WS: Gibbons sparse; ca. 1 group/km^2
Khao Phra Bang Kram WS: Gibbons nearly extirpated
Khao Banthad WS: Density ca. 1 group/km^2

Hylobates pileatus

Southeast:

Khao Khieo - Gibbons very sparse: ca. 0.5 group/km^2
Khao Ang Ru Nai - Density sparse, ca. 1 group/km^2
Khao Soi Dao - Density ca. 2 groups/km^2 in core
Khao Kitchakut - Similar to Khao Soi Dao
Khao Chamao - Density ca. 3 groups/km^2 in core
Khao Srabap - Gibbons nearly extirpated
Khao Yai - Density to 2 groups/km^2 in core

POPULATION ESTIMATES FOR EFFECTIVE CONSERVATION UNITS

Tables 1 & 2 give total habitat areas and assumed density of gibbon groups in the core area. The core area is assumed to approximately equal the total habitat area minus a 1km perimeter strip. The total perimeter area depends on the size and shape of the unit; it is assumed in most cases to be equal to 4 x square root of the total habitat area. In cases where this formula is believed to underestimate the perimeter, an adjustment is made by multiplying it by a perimeter multiplier.

It is assumed that perimeter areas have no gibbons, even though this is usually not true, for the following reasons: 1) such areas are subject to high poaching pressure, being located near villages; 2) perimeter areas are often damaged by past logging or present illegal cutting; and 3) perimeter areas are often drier suboptimal habitat and subject to adverse edge effects such as poorer dispersal and fire intrusion. In the case of the Huai Kha Khaeng - Thung Yai forest complex, the largest ECU in Thailand, the perimeter area has been doubled because of the complex configuration of the area and numerous roads of ingress.

An additional problem in incorporating human impacts on protected areas is the presence of villages--mainly tribal--located within the boundaries of some protected areas. Some of these were present long before the areas were declared protected areas by the RFD. After much discussion it was decided to assume that each village would, on average, negatively affect wildlife species within a 5-km radius from the center of the village, causing the depletion of primates in an area of about 80 km2. The analysis of core areas assumes that 7 villages exist within Thung Yai Naresuan WS and 2 within Kaeng Krachan NP.

This is a rather simple way of dealing with a very complex problem, but habitat areas and densities are not mapped sufficiently well to allow more refined estimation. It is believed that the overall average result provides an order-of-magnitude estimate of the real situation that is better than none. Since the assumptions are made explicit and clear, it will be possible to evaluate and correct them where appropriate. Estimates of gibbon populations are to be treated as very approximate - to within around $\pm$50% (plus or minus 50%) at best.

At present, the Royal Forest Department is in the process of preparing improved forest-type maps for the whole country on a scale of 1:250,000. Such maps now exist on a scale of 1:1,000,000, and are relatively crude. When the new maps are completed and digitized, they will greatly facilitate the analysis of wildlife populations. Protected area boundaries are also being digitized on a scale of 1:50,000, the basic topographic map scale for the country. The Wildlife Research Division/Univ. Minnesota project will automate the process of calculation of gibbon core areas and help provide improved estimates of effective gibbon populations. ■

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Table 1. White-handed gibbon habitat areas in effective conservation units in Thailand.

No.	Units	Habitat	Total area	Core density (gr./km^2)	Perimeter multiplier	Core area	No. of groups	Ne
North:								
	Lam Nam Pai WS	278						
37	Nam Tok Mae Surin NP	118	396	0.5	1	316	198	396
19	Doi Chiang Dao WS	113	113	0.5	1.5	49	25	50
44	Salawin WS	579	579	0.5	1	483	290	579
136	Om Koi WS	219						
133	Mae Tuen WS	209	428	1	1	345	345	690
35	Wiang Kosai NP	242	242	0.5	1	180	121	242
22	Phu Miang-Phu Thong WS	149	149	0.5	1	100	50	100
15	Lansang NP	109	109	0.5	1	67	34	67
138	Phu Luang WS	266	266	1	1	200	200	400
67	Sri Satchanalai NP	227	227	0.5	1	167	83	167
	Total, North		2509			1907		
	Northeast:							
5	Nam Nao NP	715						
137	Phu Khieo WS	1231	1946	1	1	1770	1770	3540
2	Phu Kradueng NP	189	189	1	1	134	134	268
1	Khao Yai NP	640	640	3	1.5	488	1465	2930
	Total, Northeast		2775			2392		
	West-Southwest:							
63	Khlong Wang Chao NP	500						
44	Khlong Lan NP	261						
54	Mae Wong NP	219						
31	Umphang WS	1387						
120	Huai Kha Khaeng WS	575						
146	Thung Yai Naresuan WS	1056						
67	Khao Laem NP	1000						
59	Sri Nakharin NP	479	5477	2.5	2	4325	10812	21625
9	Sai Yok	530	530	1	1	438	438	876
1	Salak Phra	427	427	1	1	344	344	688
17	Mae Nam Phachi WS	512						
28	Kaeng Krachan NP	2624	3136	2.5	1	2752	6880	13760
	Total, West-Southwest		9570			7859		
	South:							
30	Sadet Nykrom Maluang WS	274	274	1	1	208	208	416
2	Khlong Nakha WS	426						
69	Kaeng Krung NP	460						
56	Sri Phang Nga NP	255						
9	Khlong Saeng WS	814						
28	Khao Sok	476	2431	1	1.5	2135	2135	4300
35	Khlong Phraya WS	60						
30	Khao Panom Bencha NP	45	105	1	2	23	23	50
23	Khao Luang NP	407	407	1	1	326	326	650
42	Khao Pu-Khao Ya NP	479						
	Khao Banthad WS	1058	1537	1	1	1380	1380	2760
147	Ton Nga Chang WS	152	152	1	1	103	103	210
20	Thale Ban NP	200	200	1	1.5	115	115	230
	Tai Rom Yen NP	410	410	1	1	329	329	658
	Total, South		5516			4619		

Table 2. Pileated gibbon habitat areas in effective conservation units in Thailand.

No.	Units	Habitat	Total area	Core density (gr./km^2)	Perimeter multiplier	Core area	No. of groups	Ne
	Southeast:							
8	Khao Khieo-Khao Chomphu WS	118	118	0.5	1	75	37	75
4	Khao Soi Dao WS	626		2	1			
14	Khao Kitchakut NP	56	682	2	1	578	1156	2312
15	Khao Ang Ru Nai WS	1000	1000	1	1.5	810	810	3900
13	Khao Chamao NP	83	83	3	1	45	135	270
	Total, Southeast	1883			1508	2138		
	Northeast:							
1	Khao Yai NP	1280	1280	2	1.5	1065	2130	4300
39	Thap Lan NP	1326						
41	Phang Sida NP	409	1735	1.5	1.5	1485	2230	4500
33	Huai Sala WS	341						
21	Khao Phanom Dongrak WS	234	575	1	1.5	431	430	860
13	Yot Dom WS	161						
53	Phu Chong Na Yoi	624	785	1	1.5	617	620	1200
	Total, Northeast	4375				3598	5420	
	Total, pileated		6258			5106	7560	15000

Working Group Report:
Thai Gibbon Life History and Vortex Analysis

Working Group Members: Ulysses Seal (Facilitator), Pongpan Laothong, Preecha Kladkaew, Amon Achapet, Kumpol Meeswat, Wanchai Tunwattana, Stephen Elliott, Leslie Johnston, Mattana Srikrajang, Tanya Chan-ard, Budsabong Kanchanasalea, Warren Brockelman & Ronald Tilson.

INTRODUCTION

Populations separated by barriers that reduce or eliminate the opportunity for recolonization or occasional gene flow will each be subject to population fluctuations and at risk of extinction from local environmental hazards. Small populations are also subject to the potential risks of inbreeding depression. Thus, small and isolated gibbon populations are at risk of extinction from the interaction of random and deterministic processes (e.g., skewed sex ratio, failure to locate mates, disease, genetic drift, inbreeding depression, fighting, fluctuations in food resources, and poaching). These populations will require intensive management if the gibbons are to survive for even 50 or 100 years.

The need for and effects of intensive management strategies can be modelled to suggest which practices may be the most effective in preserving the individual gibbon populations. A simulation modeling package, VORTEX written by Robert Lacy and Kim Hughes was used as a tool to study the interaction of multiple variables treated stochastically to gain assist a better understanding of the effects of different management manipulations.

The VORTEX program is a Monte Carlo simulation of the effects of deterministic forces as well as demographic, environmental, and genetic stochastic events on wildlife populations. VORTEX models population dynamics as discrete, sequential events (e.g., births, deaths, catastrophes, etc.) that occur according to defined probabilities. The probabilities of events are modeled as constants or as random variables that follow specified distributions. VORTEX simulates a population by stepping through the series of events that describe the typical life cycle of sexually reproducing, diploid organisms.

VORTEX is not intended to give absolute answers, since it is projecting stochastically the interactions of the many parameters which enter into the model and because of the random processes involved in nature. Interpretation of the output depends upon your knowledge of the biology of the gibbon, the conditions affecting each of the individual populations, and possible changes in the future. The output is limited by the input. Where needed input data are questionable or questionable, data from other gibbon populations or best guesses by gibbon experts were provided as input. The results from the simulations can be used to suggest the most critically needed data to provide more reliable results and thus assist the design of needed research for management of the populations.

Application of these models to a release or reintroduction program would benefit from modelling and analysis of the results from the ongoing gibbon reintroduction program. An appreciation of the high frequency of random adverse events (stochasticity) and their impact on the perceptions of the success or failure of a program is essential to formulate expectations of probable outcomes. It is also useful to appreciate how many ideas fail even with the best possible advice. The importance of a continuing objective reporting process describing events and distributed to all interested parties cannot be over emphasized.

STARTING POPULATION

Carrying Capacity: K defines an upper limit for the population size, above which additional mortality is imposed in order to return the population to K. In other words, VORTEX uses K to impose a ceiling model of density-dependence on survival rates.

Habitat size, altitude, and forest type are indicators of carrying capacity of the respective Parks and Protected Areas and surrounding areas. Estimates of possible and probable gibbon carrying capacity in the respective protected areas fell between 50 and more than 20,000 animals (Table 1). Therefore, 4 carrying capacities of 50, 100, 300, and 600 gibbons to encompass the range of populations less than 1000 individuals were included in the sets of scenarios simulated.

We did not include any trends in carrying capacity over time since the range was encompassed by the K values used. We also did not include any annual variation in K since this tends to have minimal effects on large slow breeding populations (as opposed to sustained changes).

Age First Reproduction: VORTEX defines breeding as the time when young are born, not the age of sexual maturity. VORTEX also assumes discrete intervals of years in the case of gibbons. For gibbons on average the age of first reproduction for females appears to be 8 years although younger animals in captivity can breed and reproduction may be delayed in wild populations. For males in wild populations the age was set at 10 years based upon observations of Brockelman described in this report. These values were used in all of the simulation scenarios.

Litter Size: Environmental variation in reproduction is modelled by the user entering a standard deviation (SD) for the% females producing young each year. VORTEX then determines the% breeding each year of the simulation by sampling from a binomial distribution with the specified mean (e.g., 50%) and SD (e.g., 12.5%). Thus about 66% of the time, the% of females breeding will fall within ± 1 SD of the mean; about 95% of the time it will fall within ± 2 SD of the mean. The relative proportions of litters of each size (0 or 1) are kept constant; what is varied from year to year is the% breeding (litter size > 0) and the% not breeding (litter size = 0).

The proportion of females breeding each year determines the mean interbirth interval. This interval is reported to be 3 years in wild gibbons so that 67% of adult females, on average do not

produce litters each year. A modest amount of annual variation was included using a standard deviation of 12%. Sex ratio at birth is taken as equal or 0.500

Males Breeding: Gibbons are monogamous in a given season and breed with the same mate for several years. However, the breeding system modeled by VORTEX assumes that mates are randomly reshuffled each year and that all animals that can breed have an equal probability of breeding. Some animals may be excluded from the breeding pool in a given year if needed. Only one condition for male gibbons was modelled with all adult males in the breeding pool.

Age of Senescence: VORTEX assumes that animals can breed (at the species typical rates) throughout their adult lifespans. The maximum life expectancy is not used if the species does not reproduce throughout its entire life. This maximum age was estimated as 30 years for wild gibbons based upon known age animals in several studies and this value was used in all of the scenarios.

Mortalities: Mortality as a% (between 0.0 and 100.0) may be included for each age class of immature females and males. Once reproductive age (adult) is reached, the annual probability of mortality remains constant over the life of the animal and is entered only once. The mortality schedule used in all of the scenarios for the gibbons is drawn from studies by Brockelman. The estimate used was 5% per year for all age classes and both sexes. Mortality may be greater in the years of dispersal, ages 7-8 so that scenarios with 10% and 20% mortality in these age classes also were run.

Threats: Major potential threats for the populations of gibbons in Thailand include further fragmentation and loss of the remaining habitat and removal of animals by hunting or poaching. Gibbons are not known to have been affected by epidemic diseases, but this may be due a lack of data since unexplained disappearance of subpopulations has occurred.

The impact of habitat loss has been modelled by using different carrying capacities as a guide to the changing risk of extinction with decreasing population size. Removals, on a continuing basis were modelled as harvests split evenly between the sexes, removed annually or at less frequency intervals. Scenarios that included losses due to catastrophes did not include these systematic harvests or removals.

Catastrophes: Catastrophes can be thought of as the extreme of environmental variation. Catastrophes are events that impact either reproduction or survival or both. Catastrophes can be habitat destruction, floods, fire, disease, poaching, etc. Catastrophes do happen and are very real considerations when attempting to model the fate of small populations. The impact of these catastrophes is defined in terms of effects on reproduction and survival. A catastrophe may have

occurred when a rate is noted that is statistically higher than the normal variation. The reproduction and survival rates for catastrophe years are obtained by multiplying the (non-catastrophe) probability of reproduction or survival by a severity factor. The severity factor ranges from 0.0 to 1.0. Entering 0.0 indicates a total loss of reproduction or survival for the population and 1.0 indicates that the catastrophe, if it occurs, will have no effect.

Catastrophes in wild gibbon populations might include forest cutting, diseases, and illegal removals. Since resource shortage, disease, and poaching events might be episodic, occurring at uncertain intervals we modelled separately the impact of events occurring on the average either at approximately 10 or 20 (10% or 5% probability - catastrophe 2) or 10 (10% probability - catastrophe 1) year intervals. The event for type 1 (resource depletion or disease) was given a severity effect of either 0.90 on survival (about 10% additional loss of animals to the population and an 0.80 severity effect on reproduction of the remaining animals. The type 2 event (poaching or removal) was given no effect on reproduction and a 0.95 severity effect on survival reflecting the loss of and additional 5% of the animals. These may underestimate the negative effects on reproduction of the potential social disruptions that may occur.

Age Distribution: We initialized all of the models with a stable age distribution which distributes the total population among the various age classes. The initial population sizes used were 100, 200, 300, and 600. VORTEX automatically enters values for all age classes, proportionate to the stable age distribution.

Inbreeding: A population with the level of inbreeding depression of one lethal equivalent per diploid genome may have one recessive lethal allele per individual (as in the Recessive Lethals model in VORTEX); or it may have two recessive alleles per individual, each of which confers a 50% decrease in survival; or it may have some combination of recessive deleterious alleles which equate with one fully lethal allele per individual. Natural selection does not remove deleterious alleles at heterotic (or over-dominant) loci (because all alleles in this model are partly deleterious when homozygous), thus the effects of inbreeding are unchanged during repeated generations of inbreeding. The default number of lethal equivalents for the Heterosis model is 3.14 which is a median value obtained in a study of 40 mammalian species (Ralls et al. 1988).

Inbreeding depression has been observed in inbred lines of captive primates. To include this potential threat in these models the Heterosis model in VORTEX was used in which we entered the number of "lethal equivalents" as 3.4. The inclusion of inbreeding was varied systematically in the scenarios developed for the gibbon populations so that comparisons can be made under identical conditions with this factor present or absent.

RESULTS FROM SIMULATION MODELLING

The simulation scenarios were run 500 times (iterations) with projections for 100 years. Output results were summarized at 10 year intervals and used for the time series figures. Each individual scenario is identified with a file number in column 1 of the tables. The simulations were run using VORTEX version 6.2.

The base scenario was run under the conditions developed in the plenary session with the data provided by the participants. This included mortality rates of 5% for all age and sex classes, an interbirth interval of 3 years, maximum age of 30 years, equal sex ratio at birth, all males available for breeding, age of first reproduction for females = 8 years and for males = 10 years. There were no catastrophes or inbreeding depression effects included and no harvesting in this base scenario. The population size was started at 100 animals and the K was set at 200.

Deterministic Results

Growth rate - r: The deterministic growth rate calculated by a Leslie matrix algorithm is recorded in the tables. Positive values are necessary for a population to survive and in principle a zero value would characterize a population neither growing or declining. The deterministic growth rate is not sensitive to differences in carrying capacity. It also is not sensitive to the presence of environmental variance included as standard deviations in mortality and reproduction. The addition of catastrophes does reduce the deterministic r since their effects on reproduction and survival are averaged into the calculations of the Leslie matrix. It is also not affected by the inclusion of inbreeding,

Other Deterministic Values: The generation times in most of the scenarios were about 16-18 years for females and males. Thus a 100 year projection spans about 6 generations. The sex ratio of adult males to females in a stable population was equal. Lambda is calculated from r and can be used as an estimate of the % annual growth rate (i.e.: [lambda - 1.000] x 100 = annual % growth rate). A stable age distribution for each sex and age class is presented in Table ?. This will be the same regardless of K if the other values are the same. These are useful estimates for comparison with collected field data on population age structure as a check on census methods or detection of unusual events in the population.

The base scenario gibbon population had a deterministic r value = 0.026 which yields an annual growth rate of about 2.6% per year. The doubling time of this population would be about 25 years. The stable age distribution yields about 21% adult males and 26% adult females.

Stochastic Simulation Results

Carrying Capacity: The probability of extinction was sensitive to carrying capacity under all conditions tested, particularly in the range of 25 to 100 animals. The Pe for populations of 25 ranged from 0.3 to 1.0 at 100 years depending upon catastrophes, adult mortality, and the inclusion of inbreeding effects. Extinctions occurred beginning at 20 years and continued at an approximately linear rate during the 100 years of the projections.

The stochastic r values were also dependent upon carrying capacity with rates decreasing with decreasing carrying capacity, becoming negative under some conditions for K=25. The deterministic r values were positive under all of the conditions tested. A deterministic model would yield projections of growing populations under virtually all of the scenarios modelled here.

The proportion of starting genetic heterozygosity remaining in the surviving populations ranged from 30 to 80% depending upon the carrying capacity. It was only slightly affected by differences in adult mortality or the catastrophes or inbreeding.

Adult Mortality: Reduction of annual male and female adult mortality from 5 to 4% resulted in increased population growth rates. The effects of catastrophes and inbreeding were also reduced.

The mean surviving populations sizes were about the same at both levels of adult mortality but the standard deviation was less at the lower mortality rate. The mean proportion of heterozygosity remaining was not increased significantly.

Catastrophes: The effects of catastrophes are to increase the risk of extinction and decrease the population deterministic and average stochastic growth rates. The effects of periodic losses whether poaching, controlled removals, or disease are to increase the vulnerability of the population to other stochastic environmental events such as a rapid decline in the prey base. It is extremely important to include these possibilities in thinking about the hazards that small population may encounter. This has been illustrated in the events occurring with all reintroduction and recovery programs which have been described.

Inbreeding: The addition of a small amount of inbreeding to the scenarios resulted in an accelerated risk of extinction and a decrease in the stochastic r values that reflects the increased mortality imposed upon the populations by the inbreeding depression.

Harvest and Habitat Loss Effects

We examined the effects of removing 1 adult female every 2 years or every year, 1 adult female and 1 young male or 1 young female per year. Scenarios were run with and without inbreeding depression effects included. The results are summarized in Table 1 and Figures 1 and 2. Removal of 1 female a year produced a 21% Pe (probability of extinction) in 100 years. The loss of 1 adult female and 1 young male resulted in a Pe = 15%. The loss of 1 adult female and 1 young female per year resulted in an 86% Pe. If we started at a population of 200 animals and removed 2 females and 1 young male and 1 young female the Pe = 91%.

The rate of decline of these populations was very slow and would not be easily detected with routine surveys (Fig. 2). The effects of this rate of removal would be difficult to detect by surveys over a 10-20 year period.

Additional scenarios in Table 2 include catastrophes, 4, 5, and 6% rates of adult mortality, increased mortality in the dispersal age classes, female age of first reproduction of 8, 9, and 10 years, interbirth intervals of 3 and 4 years, and carrying capacities of 25, 50, 100, 200, and 500.

Table 1. Effects of removal of adult female and young gibbons from a population of 100 with a carrying capacity of 200. Inbreeding effects were also examined but had minimal effects in these scenarios. The deterministic rd = 0.026 for all scenarios.

File#	Harv	Inbrd	rs	Pe	N	Te
11	1/2	Yes	.018	0	190	-
12	1/1	Yes	.002	.21	166	83
13	2/1	Yes	-.046	1.00	-	-
14	1+1/1	Yes	-.0007	.18	150	73
15	1+1/1	No	.004	.15	177	72
16	1+1/1	Yes	-.025	.90	105	51
17	1+1/1	No	-.022	.86	116	53
19	2+1+1	No	-.030	.91	117	67

Definitions of Data Columns: Harv = harvest of animals from the population. These were done annually with removal of 1 adult female per 100 of starting population. Inbrd = inbreeding using the heterosis option with 3.14 lethal equivalents per individual; rd = the deterministic intrinsic rate of increase or growth rate; rs = the stochastic rate of increase; Pe = the probability of extinction in 100 years; N = the population size of the surviving populations at 100 years; Te = the mean or median time to extinction of populations that went extinct.

Table 2. Effects of female age of first reproduction, interbirth interval, and catastrophes on the growth rate and survival of gibbon populations. All populations starting at 100 animals and with K=100. AFR= age first reproduction, IBI= interbirth interval, other= special conditions, and the other column headings same as in Table 1.

File#	AFR	IBI	Other	rd	rs	Pe	N	Te
100	8	3	N	.026	.024	0	96	-
101	9	3	N	.020	.019	0	94	-
102	10	3	N	.015	.012	0	92	
103	8	4	N	.008	.007	0	84	-
104	8	3	2Cat	-.013	-.039	.71	24	66
105	8	3	4%Mort	.036	.034	0	97	-
106	8	3	6%Mort	.015	.013	0	91	-
107	8	3	10%7-8	.022	.020	0	94	-

Table 3. Effects of different rates of harvesting on the risk of extinction of gibbon populations under base conditions of AFR=8, IBI=3, and mortality=5% yielding a deterministic r = 0.026 (annual growth rate of 2.6%), no catastrophes, and no inbreeding.

File#	K	H Freq	H Yrs	rs	Pe	N	Te	
s101	300	1	100	-.185	1.00	-	25	
s102	300	2	100	-.126	.82	149	73	(.020)
s103	300	3	100	-.046	.03	228	88	(.024)
s104	300	4	100	-.038	0	280	-	(.026)
s105	300	1	100	-.185	1.00	-	25	
s106	300	2	100	-.126	.82	149	73	
s107	300	1	30	.009	.96	164	25	
s108	300	2	30	.026	0	295	-	
s109	600	1	100	-.061	.83	168	76	
s110	600	2	100	.026	0	581	-	
s111	600	1	30	.025	0	593	-	
s112	600	2	30	.026	0	594	-	

Population sizes and carrying capacity of 300 and 600 animals were used in these scenarios. Removals were done at 4 rates = annually, 2 year, 3 year, or 4 year intervals. Animals removed each time were 6 adult females, 3 one year females, 3 one year males, and 6 adult males. Thus 18 animals were removed which would be about 6% of the population. We would predict on the basis of the 2.6% annual growth rate potential of the base scenario that removals annually and every 2 years would result in extinction of all populations of size=300. Removals annually in the population of 600 would result in extinction.

We also examined the rate of recovery of populations subjected to removals annually and every 2 years for 30 years and then removals were stopped and the populations followed for another 70 years (scenarios 107 and 108 for K=300; scenarios 111 and 112 for K=600).

Table 4. Estimated size and decline in total population of *Hylobates lar* in Thailand from 1984 through 1993.

Year	Population	Production
1993	110,000	2,860
1992	112,160	2,915
1991	114,800	2,985
1990	117,500	3,055
1989	120,200	3,125
1988	123,100	3,200
1987	126,000	3,275
1986	128,560	3,350
1985	132,000	3,430
1984	136,000	3,530
Total		31,725

The number of animals produced each year in excess of the natural losses was calculated based upon a 2.6% annual growth rate in the base scenario of the simulation model. These data indicate that about 31,000 gibbons could have been removed form the total population with no effect on the population size. It should be emphasized that removals in individual subpopulations could easily result in a declining local subpopulation or even extinction but averaged over the entire country the population may have remained approximately stable. However since the estimated removals are very near this production level, the results are very sensitive to an increase or underestimate of the removal rate. The legal protection of these populations and their habitat could result in an increase in local populations that are below carrying capacity.

Table 5. Distribution of estimated groups and numbers of lar and pileated gibbons in the different geographic regions of Thailand.

Region	# Groups	# Animals
H. lar		
North	1346	5384
Northeast	3369	13476
West-Southwest	18474	73896
South	4619	18476
Total	27,808	11,232
H. pileatus		
Southeast	2138	8552
Northeast	5410	21640
Total	7548	30192

Table 6. Frequency distribution of population sizes of subpopulations of *H. lar* in Thailand.

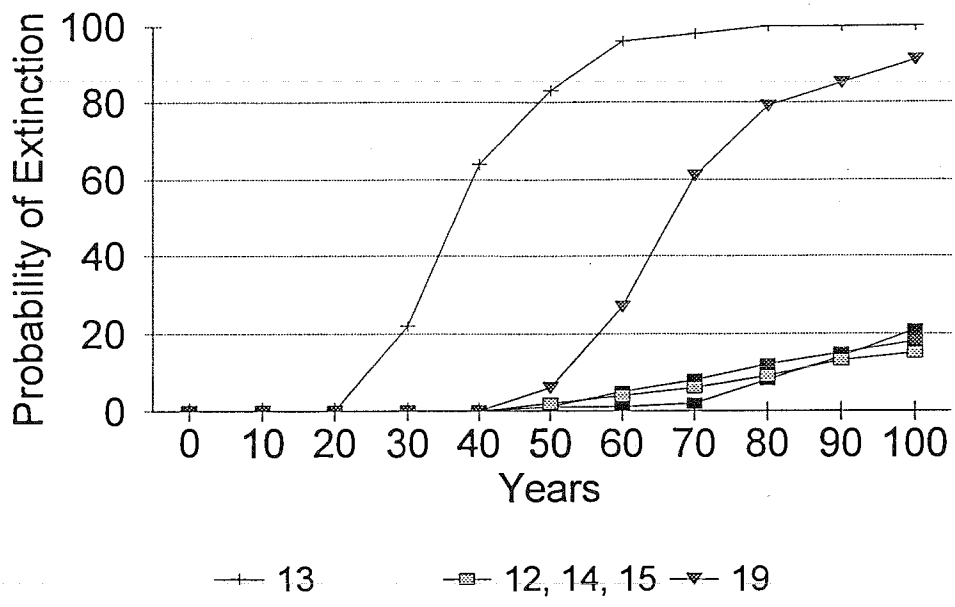
#Groups	N	#Populations
≤ 50	≤200	5
51 - 149	200 - 599	6
150 - 300	600 - 1200	4
301 - 500	1201 - 2000	5
>500	>2000	11
Total		31

Removal of 18 animals per year (6 adult females, 3 one year females, 3 one year males, and 3 adult males) from a population of 600 gibbons annually for 100 years (Fig. 3) resulted in an 83% probability of extinction in 100 years. The surviving populations also declined steadily in size over this time. If the harvest was stopped after 30 years the population recovered to original levels over the next 20 years (Fig. 3).

Removal of 18 animals in alternate years (6 adult females, 3 one year females, 3 one year males, and 3 adult males) from a population of 600 gibbons annually for 100 years (Fig. 4) resulted in a 0% probability of extinction in 100 years. The surviving populations showed no change in size over this time. If the harvest was stopped after 30 years the population was at the same levels as the population with a continuing harvest (Fig. 4).

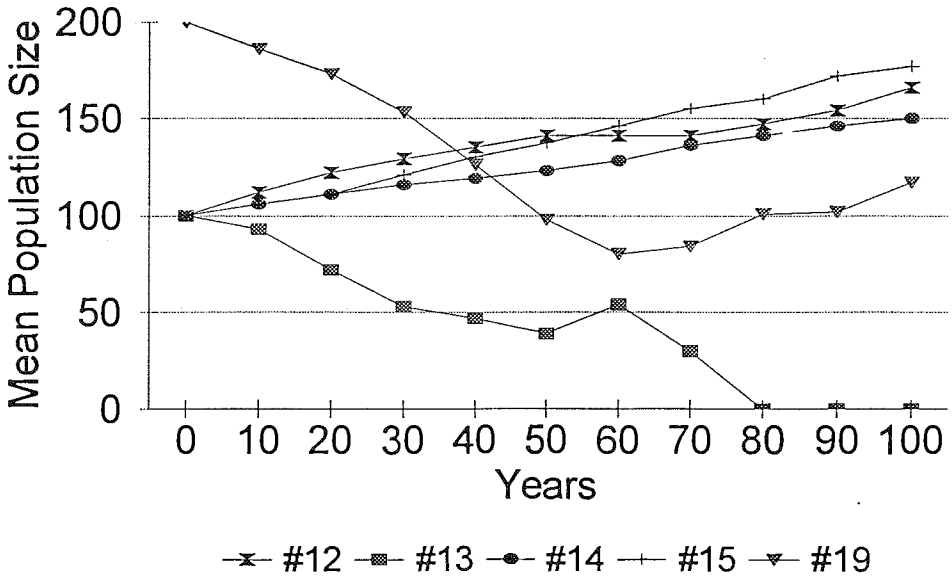
GIBBON DEMOGRAPHY

Effects of Harvest on Pe



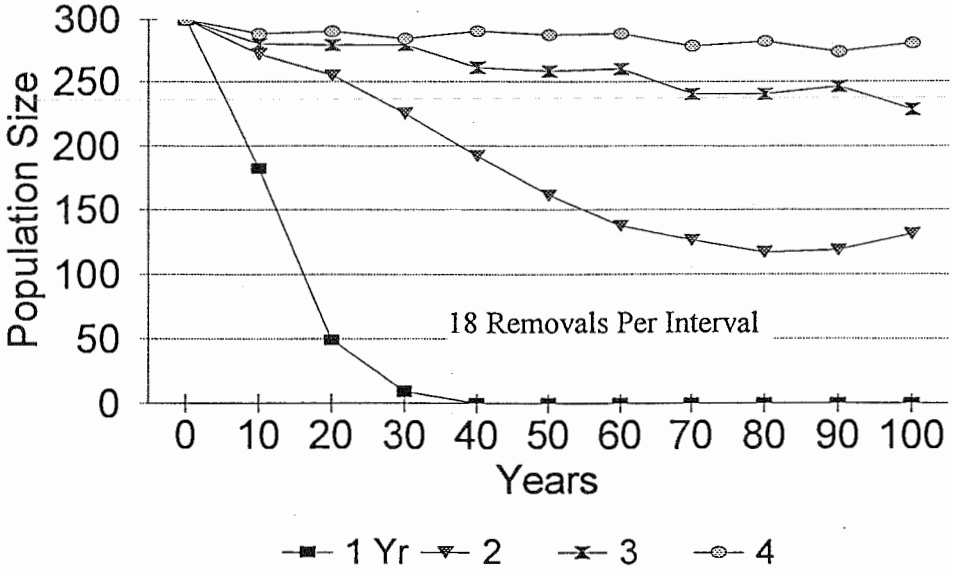
GIBBON DEMOGRAPHY

Effects of Harvest on N



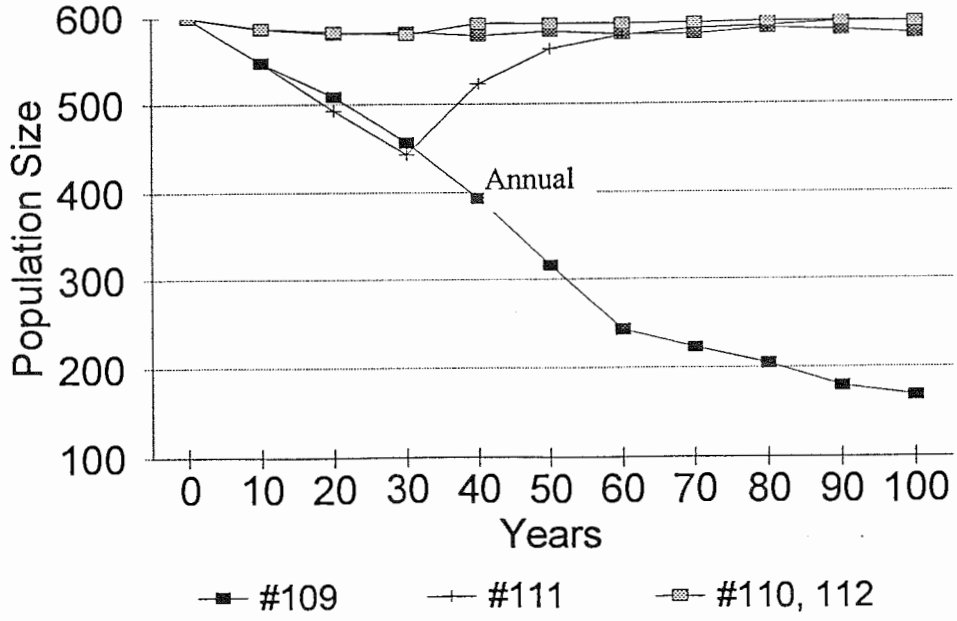
GIBBON DEMOGRAPHY

Harvest Rate Effects



GIBBON DEMOGRAPHY

Recovery from Harvests



WORKING GROUP SUMMARY AND RECOMMENDATIONS

Summary Points for *H. lar*

- The potential growth rate of wild populations of *H. lar* is estimated at a minimum of 2.6% per year. Populations with this growth rate can double in size in about 26 years. This minimum growth rate estimate is based upon an interbirth interval of 3 years, age of female first reproduction of 8 years, annual mortality in all age classes and both sexes of 5±1 %, age of senescence of 30 years, with no inbreeding effects or catastrophes included. Females might begin reproduction at an earlier age in harvested populations with a resultant increase in r.

- The total population in protected areas in Thailand is currently estimated at about 110,000 individuals. Thirty-one separate populations have been identified and tabulated. Sixteen (16) of these populations are estimated at 1000 or more individuals with estimated effective population sizes of 500 or larger. Five (5) populations have 200 or fewer individuals. Eleven (11) populations fall between about 200 and 1000 individuals.

- Based upon loss of forest and habitat estimates and backward projections, the population may have declined from about 136,000 individuals over the past 10 years to the current estimate of 110,000 individuals solely on the basis of habitat loss.

- Theoretically, given an annual growth rate of 2.6%, the total *H. lar* gibbon population could have sustained a maximum total loss of about 30,000 individuals (10,000 adult females, 5,000 young females, 5,000 young males, and 10,000 adult males). This rate of loss (about 2,500-3,000 individuals per year) would not result in a decline of the total population - if the losses were distributed over the total population or all of the subpopulations or if there were continuing demographic exchange between the subpopulations. However if the losses are concentrated in a few subpopulations and if all of the other subpopulations are at carrying capacity, then a net decline in the total population would occur.

- Removal (by hunting, poaching, disease, or other causes) of 3 or more animals (1 adult female, 1 adult male, and 1 young) per hundred of population per year will result in extinction of the population. The rate of extinction will depend on the number of animals removed, the frequency of removal, and the size of the population. Thus if 18 animals per year are removed from a population of 600 animals, there is an 83% probability of extinction in 100 years with a median time to extinction of 76 years. If this rate is reduced to 9 animals/100 years, the risk of extinction is about zero in 100 years. Removal of 18 animals/year from a population of 300 animals results in a median time to extinction of 25 years with all populations extinct in less than 40 years.

- Each of the 4 regions (North, Northeast, West-Southwest, and South) contain sufficient animals in protected area populations to be managed genetically and demographically as geographic units with no transfer of animals between the regions.

- The 16 populations with 1000 or more individuals are at essentially zero risk of extinction over 100 years if their habitat remains intact and if losses due to hunting are less than 5 female adults and 2.5 female young per year per 1000 population.

- Populations of 1000 or more individuals will lose less than 0.5% of their heterozygosity in 100 years. Populations of this size will not benefit, genetically or demographically, from the addition of individuals from captive populations or other wild populations over the next 100 years.

- The 10 populations of 200 to 1000 individuals are at essentially zero risk of extinction over the next 100 years if their habitat remains intact and if their losses due to hunting are less than 1 adult female and 1 female infant per 200 individuals per year. The loss of genetic heterozygosity in these populations will range from 3% to 0.6% over 100 years or 0.5% or less per generation. These populations *might* benefit from the addition (by translocation) of 1 or 2 suitably chosen individuals from neighboring wild populations every 20-40 years.

- Populations, (that are not disturbed and are not hunted) containing about 100 animals (about 25 average groups of 4 animals) have a low probability of extinction over 100 years of less than 1%. The generation time is about 16-17 years or 5.9 generations per 100 years.

- Populations of about 100 individuals will lose about 6% of their heterozygosity in 100 years. These populations might benefit from periodic genetic supplementation (2-3 individuals at perhaps 20-40 year intervals) from other populations in the region as part of a regional meta-population management strategy.

- Populations of less than 50 animals have a risk of extinction of up to 20% in 100 years particularly if the species is subject to inbreeding depression. These populations may require genetic supplementation every 20-30 years. This could be accomplished by the addition of 2-3 individuals or of their genetic material at this interval. If the population is below carrying capacity the population has the potential to double in size in about 25 years by natural reproduction depending upon local threats and chance events. If demographic extinction occurs, then the sites would be suitable for recolonization either by translocation or by reintroductions from a captive population.

Summary Points for *H. pileatus*

- The potential growth rate of wild populations of *H. pileatus* is estimated at a minimum of 2.6% per year. Populations with this growth rate can double in size in about 26 years. This minimum growth rate estimate is based upon an interbirth interval of 3 years, age of female first reproduction of 8 years, annual mortality in all age classes and both sexes of 5 ± 1 %, age of senescence of 30 years, with no inbreeding effects or catastrophes included. Females might begin reproduction at an earlier age in harvested populations with a resultant increase in r.

- The total population in protected areas in Thailand is currently estimated at about 30,000 individuals. Eight separate populations have been identified and tabulated. Six (6) of these populations are estimated at 1000 or more individuals with estimated effective population sizes of 500 or larger. One (1) populations 200 or fewer individuals and one (1) population has between 500 and 600 individuals.

- Based upon loss of forest and habitat estimates and backward projections, the population may have declined from about 36,000 individuals over the past 10 years to the current estimate of 30,000 individuals solely on the basis of habitat loss.

- Theoretically, given an annual growth rate of 2.6%, the total *H. pileatus* gibbon population could have sustained a maximum total loss of about 7,000 individuals (2,200 adult females, 1,100 young females, 1,100 young males, and 2,200 adult males) over the past 10 years without declining. This rate of loss (about 500-800 individuals per year) would not result in a decline of the total population - if the losses were distributed over the total population or all of the subpopulations or if there were demographic exchange between the subpopulations. However if the losses are concentrated in a few subpopulations and if all of the other subpopulations are at carrying capacity, then a net decline in the total population would occur.

- Each of the 2 regions (Southeast and Northeast) contain sufficient animals in protected area populations to be managed genetically and demographically as geographic units with no transfer of animals between the regions.

- The 6 populations with 1000 or more individuals are at essentially zero risk of extinction over 100 years if their habitat remains intact and if losses due to hunting are less than 5 female adults and 2.5 female young per year per 1000 population.

- Populations of 1000 or more individuals will lose less than 0.5% of their heterozygosity in 100 years. Populations of this size will not benefit, genetically or demographically, from the addition of individuals from captive populations or other wild populations over the next 100 years.

- Populations, (that are not disturbed and are not hunted) containing 100-200 animals (about 25-50 average groups of 4 animals) have a low probability of extinction over 100 years of less than 1%. The generation time is about 16-17 years or 5.9 generations per 100 years.
- Populations of about 100 individuals will lose about 6% of their heterozygosity in 100 years. These populations might benefit from periodic genetic supplementation (2-3 individuals at perhaps 20-40 year intervals) from other populations in the region as part of a regional meta-population management strategy.

Working Group Summary Recommendations

All of the following recommendations depend upon the no loss of protected habitat and protection of the populations from hunting and poaching.

1) The current combined subpopulations of *Hylobates lar* in each of the 4 regions of Thailand are sufficiently large to not require exchange of individuals between the regions or the addition of captive bred individuals for either genetic or demographic support or augmentation of the populations over the next 100 years.

2) The current combined subpopulations of *Hylobates pileatus* in each of the 2 regions are sufficiently large to not require exchange of individuals between the regions or the addition of captive bred individuals for either genetic or demographic support or augmentation of the populations over the next 100 years.

3) Subpopulations of 1000 or more individuals within the regions will not benefit genetically or demographically by the addition of individuals from any source over the next 100 years unless a local extinction or decline in numbers (that is not a result of habitat loss) into one of the lower population size categories occurs.

4) Subpopulations of 200-1000 individuals, in habitat capable of sustaining larger populations, should simply be protected and allowed to expand in numbers by natural reproduction with no additions of individuals from other sources.

5) Subpopulations of 200-1000 individuals, near maximum densities in the occupied habitat, may benefit genetically by the periodic exchange of individuals from other populations. The addition or exchange of about 1-5 individuals, who reproduce in the population, per 20-40 years would be sufficient.

6) Stable populations of 200 or more individuals (considered to at or near maximum densities) can sustain losses of about 5 adult females with young per year per 1000 population without declining or increasing the risk of extinction. Management of hunting or other removals or losses above the natural mortality rate should use this as an average upper limit.

7) Populations of 200 or fewer individuals, in habitat that will not support a larger population, will require continuing monitoring and will benefit genetically by periodic supplementation with 2-5 individuals of known provenance at about 20 year intervals. These small populations should be evaluated individually and suitable conservation management plans developed for their particular needs. ■

Working Group Report: Human Demography and Community Participation

Working Group Members: Samboon Wongpakdee, John Williams (Facilitators), Auayporn Sangtian, Ardith Eudey, Schwann Tunhikorn & Ronald Tilson.

INTRODUCTION

The group met to consider issues of human populations that concern the long-term management of the gibbon population in Thailand. In essence, the effective management of wildlife populations in Thailand is focused on the better management of protected areas. The requirements concern the maintenance of high quality habitat (against encroachments and degradation from non-sustainable human use) and the reduction of poaching pressure on the wild animal species themselves. Of concern are forest areas, national parks, and wildlife preserves.

OBJECTIVES

- To maintain the extent and the quality of habitat.
- To reduce the hunting and poaching pressure of people on wildlife.
- To gain the support and cooperation of local people in the sustainable management of protected area and wildlife resources, and to reduce conflicts with local people.
- To support programs for the sustainable development of protected areas by local people and their economic welfare.

POPULATION ISSUES

Over the last four decades the growth of human populations into areas around protected areas and their poverty and dependence on forest resources, has resulted in increasing pressure on forest products of all kinds and hunting pressure on wildlife. Some of these pressures are:

- Migration into the areas surrounding many protected areas since 1950 has resulted in settlements of people in and around protected area areas. Some of the settlements within protected areas have been forced to relocate outside the boundary of the protected areas. Many of the migrants came from lowland rice growing villages and arrived with little knowledge of local agricultural practices or sustainable uses of local resources.

- Many of these communities are very poor and highly dependent on the local resources of the forest. Resources are used for both subsistence and income. Collection of forest products and hunting have been the major activities.

- In recent years, there has been a considerable reduction of migration into the villages along most protected area boundaries. In fact, there is evidence of some migration, particularly with young people leaving school, out of the villages seeking employment and wider opportunities in towns and cities away from the protected area.

- Population growth in the immediate vicinity of protected areas is not generally a problem, though there are some areas along highways near protected areas, such as Muak Lak District not far from Khao Yai National Park, which are undergoing very rapid population growth.

LOCAL COMMUNITY ISSUES

- There is conflict between local villages and protected area managers in many locations. Rangers act as policemen responding to hunting and collection of forest products from protected area lands. Further, the forced removal of people from their homes within protected areas, or the taking of land formerly cultivated back into protected areas, has resulted in considerable conflict.

- The long term management of protected areas requires a major change in the way that protected area managers work with surrounding communities.

HUMAN DEMOGRAPHIC SITUATION AT KHAO YAI NATIONAL PARK

While Khao Yai National Park is only one of a number of parks and protected areas that support gibbons, the human demographic trends of the park are illustrative of a number of demographic trends that are taking place around protected areas.

Mortality

Over the last fifty years, improved general health technology and services has led to reductions of mortality. The life expectancy in Thailand today is close to 70 years. This very positive development, combined until recently with high fertility, resulted in rapid population growth, and increased movement of people from rice growing villages into unsettled areas, particularly those areas surrounding what are now national parks and wildlife sanctuaries.

Fertility

The fertility of Thailand has fallen from very high levels in 1970 to near or slightly below replacement levels in 1994. This has been one of the most rapid transitions from high to low fertility of any country in the world.

Migration

Data from the Thailand Census of Population for 1980 and 1990 provide extensive data for estimating patterns of migration in those districts that surround the parks. For most of the districts, household migration is at a low level, but there is extensive migration of young people (particularly those age 15-20) out of these areas and into larger towns and cities. There are some exceptions. Muak Lak District in Saraburi Province shows a very rapid rate of in-migration.

Population Growth

Despite the low level of fertility, the population of Thailand is growing at the rate of 1.3 or 1.4%. This is due to the momentum of population growth, which results in an uneven age distribution with very few old people and very few deaths. If the current rate of fertility persists, the growth rate will gradually decline to near zero. Local population changes will continue to be affected by migration patterns.

Population Dependence on Natural Resources

Poor rural communities near parks and protected areas are frequently dependent upon the resources of the natural areas in the park for both subsistence and forest products to be used as income. This dependence creates a problem for forest managers, who attempt to prevent local villagers from entering and taking resources from the park. Such issues are resolved through a variety of techniques, including participatory community development techniques, conflict resolution, and joint management approaches.

Khao Yai National Park is located 100-150 km north of Bangkok, a city with a population of 7,000,000 people, which over the last decade has experienced striking economic growth. One can reach the park within a two-hour drive of the Bangkok Airport, and the park environs is a tourist destination for the residents of the metropolitan area. The park is greatly influenced and will continue to be influenced by Bangkok, and by the relationship of the city to the rest of the nation.

The areas around the park have increased in population during the last twelve years. That increase in population has been particularly marked in the Muak Lak District of Saraburi Province on the northwest border of the Park. The completion of the improved and expanded highway from Bangkok to the northeast of the country, which passes within a dozen kilometers of the park, opens the park to access by thousands of people, and opens communities near the highway to settlement and development.

It should be noted that population change is a function of three factors: migration, fertility, and mortality. Most of the recent population growth in Muak Lak District has been directly attributable to in-migration. Only about 1.4% of the growth is attributable to natural increase.

The fertility rate of the entire area has declined sharply over the last 20 years. The total fertility rate in the districts around the park is 2.3-2.5, little higher than replacement level. The natural increase of the population will continue to exceed 1% for another two decades, a consequence of the population momentum that comes from a relatively young population. The age groups from 10-14 and 14-19 are considerably larger in number than those younger or older, and these children will be forming new households over the next 10-20 years.

Table 1. Population in selected districts around Khao Yai National Park.

	1980	1990	Rate of Change %
Saraburi Province			
Muak Lak District	26,145	49,556	8.9%
Radchasima Province			
Pak Thong Chai	119,235	to be	
Pak Chong	73,721	filled in	
Nakhon Nayok			
Ban Na	49,378	54,252	0.95%
Nakhon Nayok	67,909	69,556	0.24%
Pak Phli	22,798	23,067	0.12%
Prachin Buri			
Prachin Buri	53,536	67,152	2.3%

Source: Census of Population, 1980, 1990. 1990 data from Ratchasima Province not available.

Improving health facilities and public health measures continue to reduce mortality to low levels; the life expectancy of women in the area approaches 70 years.

Migration is often a key factor affecting communities and districts that surround national parks. The patterns of migration affecting local communities around Khao Yai are quite distinctive.

WORKING GROUP SUMMARY RECOMMENDATIONS

1) Training of protected area personnel: Protected area personnel who interact with local communities and visitors to the protected area need to be better trained, to more professionally administer their duties, to be more effective in educating people on the values of the protected area, and to better gain the confidence and trust of local people. Protected area supervisors and staff need to be provided with training in conflict resolution procedures and participatory exercises with the local communities.

2) Benefits of protected areas to local people: In general, every effort should be made to enhance the value of protected areas to the communities that are adjacent to it. This is best done in a participatory manner with local people, who best know their particular needs and interests. This could be accomplished in the following ways:

- Options in protected area use for local people. A number of activities can be undertaken to make the protected area benefits more accessible to local people: free entrance fees, better access to camping areas, informal understandings with regard to what the protected area managers see as really serious infractions (hunting) and what may be tolerated that benefits local people and does no damage to protected area resources (picking up dead wood, mushrooms, bamboo shoots).

- Providing jobs to local communities. These jobs may be temporary jobs, such as planting trees, protected area clean-up activities, or construction projects, or they may be full-time staff positions within the protected area.

- Provision for enhancing tourism income. If local people are prevented from some of their traditional uses of protected area resources, some compensation is appropriate. A recommended approach is to set aside a significant portion of park entrance fees for the benefit of local communities. Such benefits need to be provided to the communities for community development activities decided upon individually by the communities.

- A special eco-development fund needs to be established and administered to provide community development benefits to local communities on the periphery of the protected area. Development activities need to be established to reduce the dependence of people on such activities as poaching gibbon. The eco-development funds need to be developed in participatory development projects with the local people. Non-governmental agencies may prove useful in participatory work with the communities.

- Greater efforts could be made to provide local people with benefits from proximity to wildlife reserves. As appropriate, residents could provide guide and other supportive services for research projects and educational visitors. Some of these areas could further be opened up for limited tourism use. ■

Working Group Report: Genetic Aspects of Gibbon Management in Thailand

Working Group Members: David Woodruff and Ronald Tilson.

INTRODUCTION

Small populations of gibbons, both in the wild and in captivity, require genetic management to ensure their long-term survival. Left alone, small populations will inevitably go extinct as a result of demographic and genetic processes. Genetic management of gibbon populations is in its infancy but a number of principles should be incorporated into management policy and guidelines. Failure to consider genetic aspects of species management planning now will make it harder and more expensive to achieve conservation goals in the future.

In captive populations geneticists can provide managers with answers to questions regarding species and subspecies identification and pedigree relationships. Such information is important in the management of most species to avoid inbreeding depression and outbreeding depression associated with hybridization. It is also possible to monitor a population's overall genetic variability and mitigate the inevitable genetic erosion that occurs in small populations. Individual animals can be genotyped at selected loci and the data used in intensively managed breeding programs, the identification of carriers of genetic diseases, and the selection of animals for reintroduction programs.

In the wild, geneticists can currently contribute little to gibbon population management. If non-invasive genotyping based on DNA extracted from feces ever becomes feasible, genetic monitoring and management of free-ranging populations will also become practical. In the meantime the principles of theoretical population genetics can be applied to the management of small wild populations.

Some of the following recommendations require molecular genetic laboratory resources and expertise not yet available in Thailand. The establishment of in-country capabilities in molecular genetic genotyping and conservation genetics at the Dept. of Biology, Chulalongkorn University, will meet this need. The development of active collaborations between ZPO/RFD and such a university-based laboratory is to be encouraged. All tissues samples should be archived at such a central laboratory.

GENOTYPING METHODS

Until recently, the analytical techniques used to determine genetic relationships all required fresh or frozen blood or tissue samples. There were several problems in applying these techniques to gibbons. First, they required that animals be trapped, restrained, or anesthetized for removal of blood or tissue samples. Such procedures are inherently stressful to the animals and may require

the services of trained veterinary personnel. Second, such tissues required immediate cryogenic or cold ethanol storage until they could be properly treated in the laboratory for cell culture or purified DNA extraction. Traditional tissue acquisition procedures were thus risky, expensive, and often logistically difficult. Many of these problems can be avoided with the recent development of non-invasive genotyping methods based on DNA amplified from the roots of shed or plucked hair.

We use the following protocol for gibbon genotyping. Plucked or shed hair of an individual gibbon should be collected opportunistically and stored in fully labelled paper envelopes. About 6-10 hairs per individual are sufficient if care is taken to collect the hair with the bulb or root attached. We strongly recommend that hairs be handled with forceps or hemostats to avoid contamination with human DNA. Envelopes should be stored in a cool dry place and, for long-term storage, freezing is recommended. Plastic bags and other containers in which humidity can build up should be avoided. Great care should be taken with the labelling of each sample. Hair samples that are not unambiguously derived from a single individual should be clearly identified as such. Labels should include full data on the specimen's I.D. (name, tattoo no., ZPO no., owner's name and address in the case of privately held animals), sex, age, species/subspecies designation, and all available information on the geographic source of the animal (where was it originally captured). In the case of captive-born gibbons the identities of the parents should also be recorded whenever possible. Genotyping individual gibbons is still very expensive -- such costs are justified only if hair collection records are accurate.

WORKING GROUP SUMMARY RECOMMENDATIONS

*The following recommendations are concerned with the management of healthy populations. No genetic disease issues were considered in these recommendations (see **Gibbon Diseases Working Group Report**).*

- *Hylobates concolor*: All confiscated concolor gibbons should be genotyped as it is now clear there are 3-5 species currently confused under this name. Correctly identified individuals should be incorporated into a formally planned Thai captive breeding program. Thai participation in international cooperative breeding programs is to be encouraged.

- *Hylobates hoolock*: Any confiscated animals should be genotyped as there are two recognized geographic subspecies of hoolock gibbon. Every effort should be made to place such animals into the international cooperative breeding program.

- *Hylobates lar*: More attention should be paid to possible geographic differentiation within the **lar** populations of Thailand. If on-going DNA studies (University of California, San Diego and University of Munich) show that the animals from northern, western and southern populations are well-differentiated, then such evolutionary significant units should be the focus of management efforts. Although there are no data on the relative fitness of inter-regional hybrids the possibility of out-breeding depression cannot be ruled out. In the interim, whenever possible, animals should be managed in groups of common geographic origin.

- *Hylobates lar*: Currently less than 5% of the animals held by ZPO are of known geographic provenance. When it becomes possible to identify the region of origin of the remaining animals, every effort should be made to obtain this information and incorporate it into all management decisions. If, for example, animals are to be selected for rehabilitation and reintroduction in the south, every effort should be made to use animals of clear southern origin. Conversely, interregional hybrids and northern *lar* would be avoided for such an experiment.

- *Hylobates lar*: Newly confiscated lar should be genotyped so as to provide managers and law-enforcement officials with data on areas where poaching is occurring. If captive breeding programs are initiated for Thai *lar*, then other captive animals should also be genotyped to provide basic data on variation as it may affect reproductive performance. This might involve genotyping for variation at several microsatellite and MHC loci.

- *Hylobates pileatus*: Currently the 8 Thai populations of *pileatus* are treated as a single management unit and there are no genetic data to test this assumption. All gibbons should therefore be genotyped opportunistically and the genetic information should be in incorporated into their future management.

- If intensive captive breeding programs are to be conducted then genetic variation and relationships should be taken into account. *Pileatus* x *lar* hybrids should be excluded from *pileatus* breeding programs. The Thai captive breeding efforts should be integrated into the international cooperative breeding program to the extent possible. ■

REFERENCES

Three recent papers describe the principles of conservation genetics as they apply to Thai gibbon conservation efforts. The reader is referred to these for background information and examples of methods and their application to Thai mammals and birds.

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Working Group Report: Estimates of Captive Gibbons in Thailand

Working Group Members: Preecha Ratanaporn, Tim Redford (Facilitators), Surapon Duangkhae, Tanya Chan-ard, Steve Elliott Somchai Dangsee, Sompong Boonsanong, Panit Sanpote, Yongyut Trisuret, Sudsabong Kanchanasaka, Piyarat Chimchom, Avayporn Sangtian, Songkran Meewadsana, Ronglarp Sukmasuang, Mattana Srikrajang, Danny Morris, Ardith Eudey, T. D. Morin, Reg Gates, Dianne Gates, Lex de Leeuw van Weenen, Sarah Christie & Kathy Castle.

ZOOS, FOUNDATIONS AND LARGER PRIVATE COLLECTIONS

During 1993-1994, 79 from 120 known animal collections were visited through a survey funded by an non-governmental organization; the remaining 40 collections are known or believed to have no or very few gibbons. From this survey, 377 gibbons are enumerated to be in such collections. This figure is believed to be accurate within 5%.

REGISTRATION

Current Thai law (since 1992) requires the registration of all gibbons, and there are approximately 1,800 registered, with almost one-third (553 animals) in Bangkok. These are the only data on the number of animals that are held in private hands, mostly as pets. These data are the basis of developing estimates of the present captive population outside of the larger collections of the ZPO and other zoos in Thailand.

ACCURACY OF REGISTRATION FIGURES

The Royal Forest Department suggests that the registration figures are accurate, particularly within the Bangkok area. Compliance with registration in Bangkok is about 90%. Compliance in areas outside of Bangkok is less than 90%; therefore registration numbers were adjusted in the working group to estimate the number of animals.

For Bangkok animals, an additional 60 animals were added to those registered. Local estimates for Chiang Mai were 100 non-registered animals, a figure based upon local knowledge of gibbons within that area. Registered gibbons in the remaining 68 provinces of Thailand are about 1,100. The Royal Forest Department representatives believed compliance to be in excess of 75%; working group members believed compliance to be substantially lower than 50%. The RFD Wildlife Conservation Division stated that it was their best belief that the compliance rate outside of Bangkok was 85%, or about 215 gibbons.

Table 1. Total captive gibbons in Thailand.

Zoos, Foundations, and Larger Private Collections	
Agile Gibbons	2
Concolor Gibbons	34
Lar Gibbons	300
Pileated Gibbons	41
Subtotal	377
Private Registrations with Royal Forest Department (see note below)	
Gibbons in Bangkok	553
Gibbons in Chiang Mai (est)	145
Gibbons in remaining provinces	1100
Subtotal	1798
Adjustments for non-registered gibbons	
Bangkok	60
Chiang Mai	100
Other Provinces (15% under reporting)	215
Subtotal	375
Total Estimated	2550

Note: These numbers reflect records of gibbons registered with the Royal Forest Department of Thailand after the Wild Animals Reservation and Protection Act took effect on 29 February 1992; Manop Lauprasert, Chief, CITES Office, RFD.

AGE DISTRIBUTION

Zoos and Larger Private Collections

Within this group, most of the population is comprised of adults. Acquisition of new gibbons are primarily from private owners; the majority are adolescents or young adults. New acquisitions during the last year included 10 young (less than three years old) out of 76 new gibbons. From these data, we estimate that there are approximately 40-50 juvenile gibbons in these collections. The sources for these estimates came from representatives of the Zoological Parks Organization, Royal Forestry Department, the Gibbon Rehabilitation Project (Phuket), Wild Animal Rescue Foundation (Bangkok), and Chuma Primate Rescue Centre (Bangkok).

Private (Registered and Unregistered)

At least half of the registered and unregistered gibbons in private hands are believed to be juveniles. Adult gibbons are difficult to maintain within a residential setting. If 60% of these animals are juveniles, then the number of juveniles is estimated to be about 1,275 animals.

Total Juveniles in the Captive Population

The total number of juvenile gibbons within the captive population, including the zoos, collections, and pets (ages 0-7), is estimated to be about 1,325.

Mortality within the Captive Population

Mortality within the captive gibbon population is here estimated to be 10% per year. Mortality in excess of 10% in the first year is attributable to loss during capture by poachers (see section below on poaching). Data on infant mortality are not available.

Trends in Number of Captured Animals

Since the passing of the Wild Animal Preservation and Protection Act of 1992 of Thailand, it is believed that the number of animals entering the captive population is declining, and that there were more animals entering the captive population five years ago than at present. All agencies involved were in agreement that this trend is probably accurate.

Age Distribution Among Juveniles

No data are available on the age distribution of the captive population within the age groups under 7 years. If the same number came into the captive population every year, with 10% mortality for each age group, then the age distribution would be as follows:

Table 2. Age distribution given equal recruitment each year and 10% mortality per year.

age <2	24.4%
age 3	22.0%
age 4	19.8%
age 5	17.8%
age 6	16.1%
Total	100%

Approximately one-quarter of the population would enter the captive population each year. However, since this number is believed to be declining, we estimate that there is a more even age distribution by age group, and that about one-fifth of the total juveniles have entered the captive population during the last year. This is clearly a rough estimate.

POACHING

It is estimated that a proportion of the captive gibbon population is smuggled into Thailand, and that this proportion is probably increasing. Within the zoo and larger private collections, approximately 10% of the gibbons are *H. concolor*, which are native to Vietnam. In addition, additional reports from CITES indicate cross-border traffic of gibbons into Thailand. Anecdotal information from Chiang Mai and Phuket indicate some *H. lar* gibbons are entering Thailand from Myanmar due to extensive logging operations in the south and subsequent hunting of gibbons and capture of juveniles. Gibbons have declined within more accessible areas of Thailand, while patrolling in protected areas deters some poaching.

Information from the Wildlife Fund of Thailand obtained from interviews with poachers indicates that for every animal that enters the market alive and is sold and survives the trauma of the first year, 6 to 8 animals may die. Any time a infant gibbon enters the market it is the result of its mother being killed. Additional adult females may be shot and wounded, resulting in death to her and her infant, but no capture. Additionally, many infants are killed by bullets; fatally injured by falling; die as a result of trauma or improper care given by the poacher; or die from neglect by the owner or by other causes within the first year of captivity. It is estimated that these deaths normally comprise of 3 or 4 female adults and 2 or 3 infants for every recruitment into the captive population.

The addition of 260 gibbons into the captive population each year suggests that about 1,600 to 2,000 gibbons die in the process, over half of which are adult females.

The problem of illegal hunting by both military and civilians continues and needs attention. In addition, villagers around some protected areas hunt gibbons for subsistence. This problem is best addressed with community development and outreach activities that focus on these villages. ■

Working Group Report:
Captive Management Plan for Gibbons in Thailand

Working Group Members: Usum Nimmanheminda (Facilitator), Sophon Dumnui, Supoj Methaphivat, Sumate Kamolnorranath, Visit Arsaithamkul, Kathy Castle, Sarah Christie, Reg Gates & Dianne Gates.

The possibilities of initiating a captive management program for gibbons in Thailand were discussed. It was suggested, working from information compiled during the Thai Gibbon PHVA (April 1994), that the species most in need of conservation action, both in the wild and in captivity, is *H. pileatus*. This is based upon the fact that it is the most threatened gibbon species native to Thailand.

The other critically endangered gibbon species held in Thai zoos is *H. concolor*; however these gibbons are not native to Thailand. Despite this, the Thai Zoological Parks Organization, working with reference to the *Thai Zoo Masterplan for Conservation*, may decide in the future to initiate a program for *H. concolor* as part of international efforts to protect this taxon.

Both Khao Kheow and Dusit Zoos have the Single Population Analysis and Record Keeping System (SPARKS) studbook management program. The staff have received training in the use of the program during the 1992-93 IUCN/SSC Masterplanning workshops, but further input would be useful in expanding their capabilities. It was agreed that it would be most useful for the American Zoo and Aquarium Association (AZA) and European Endangered Species Program (EEP) representatives to the gibbon workshop to meet with staff from both zoos at Dusit on 30 April and hold a SPARKS training session (see **Post-Conference Working Group Report**).

No recent and comprehensive official SPARKS manual is yet available, but the United Kingdom region has produced a manual. This was designed primarily for use in a training course for UK and European species managers, but should also be useful in other regions. A copy will be left with the relevant personnel and will be translated into Thai for future use.

WORKING GROUP RECOMMENDATIONS

1) Based upon the fact that a significant number of gibbons representing *H. lar, H. pileatus* and *H. concolor* are already in ZPO zoos; and based upon the fact that *H. pileatus* and probably *H. concolor* are relative rare in the wild, the ZPO should develop a captive management plan for gibbons in Thailand. This program should be linked with other global gibbon regional programs, particularly Southeast Asia Zoo Association (SEAZA), as outlined in the *Thai Zoo Masterplan for Conservation.* It was suggested that the species most in need of conservation action, both in the wild and in captivity, is *H. pileatus.*■

Working Group Report:
Captive Management of Thai Gibbons

Working Group Members: Visit Arsaithamkul, Kathy Castle, Reg Gates, Dan Morris (Facilitators), Jeanette de Leeuw van Weever, Diane Gates, Sarah Christie, Naida Loskutoff, Sophon Dumnui, Supoj Methaphivat & Usum Nimmanheminda.

MANAGEMENT GUIDELINES FOR CAPTIVE GIBBONS

The suggestions, minimum requirements and recommendations for short-term and long-term management for gibbons in captivity are summarized, and in some cases expanded upon, in this working group report. Aspects of captive management are also covered in the ***Gibbon Disease Working Group Report.***

Criteria for Transporting Gibbons

Criteria for transportation of gibbons include the following:

- Shipping container criteria include strength, safety, size and ventilation.
- Container options include: a) sky kennels with locks, heavy-duty hardware, smaller mesh size over doors and windows; or b) wooden crates.
- Bedding and food should be provided in the crate during transit. A source of moisture also needs to be provided to the gibbon using water or succulent fruit.
- The animal should be familiarized with the crate prior to shipment by giving it access for several days. Staff may be able to trap the gibbon on the day of shipment in crate, eliminating the need for immobilization.
- If the scheduled transit is long in time or involves multiple plane changes, it is advisable to have an attendant accompany the shipment.

Quarantine Criteria

When a gibbon is accepted into a facility, it should be kept under quarantine (see **Gibbon Disease Working Group Report**). The animals should be permanently identified with an implant and tattoo (right leg tattoo males, left leg tattoo females, implant between shoulder blades). Refer to **Gibbon Disease Working Group Report** for recommended medical tests.

Quarantine holding areas should have the following components:

- shifting capability between stalls
- ability to completely separate two animals in adjacent stalls
- stalls, feed/water dishes should be cleaned/disinfected daily; stalls should have concrete floors sloped to front drains located outside stalls

Cage Design Options

Ideally, all animals in quarantine should be isolated from each other until quarantine is completed. Animals arriving simultaneously from the same source can be quarantined together. Specifications are as follows:

- A row of cages with interconnecting shifts can be used for quarantine. Dividing walls between cages need to be constructed of material that prevents physical contact between cages. Small mesh fencing can be installed on top of solid walls approximately .5m in height. Minimal dimensions for each individual cage are 3 m depth x 1.5 m width x 2 m height. Several conveniently located cages within each row should have front squeeze panels that can be moved to various positions down the length of the cage to create smaller units for small gibbons or to be used for physical restraint, facilitating medical procedures. In this example animals are shifted to adjoining cages to facilitate cleaning and feeding. However, they must be isolated from other gibbons housed along the row. The keeper service area should be enclosed with fencing to eliminate the possibility of escapes.

- This second option is as in above except that each cage has a shifting unit within it. A nest box or smaller inner cage can be located in the rear of each stall to serve as a shifting unit.

- All quarantine caging should have concrete floors that slope towards the service area. Drain troughs can extend along the full length of the row outside the cages to prevent fecal contamination between separately quarantined animals.

- Stalls should be equipped with lix-its or metal water bowls for a source of fresh water, nonabsorbent benches and removable synthetic ropes for brachiation, branches, etc.

- All animals must have protection from direct sun, rain and other elements. This can be provided by either roofing material on part of cage roof or suspended nest boxes.

- Food should be placed in containers or on benches so that it is not contaminated by feces.

Policy Recommendation

Since Thai zoos have limited space for quarantine, long-term holding facilities should be located outside of the zoo facilities. Zoos can be used to evaluate incoming gibbons on a medical and behavioral basis. Zoos should only be used to evaluate these animals and not hold them for long periods of time unless individual gibbons would benefit breeding programs.

Manual Restraint

- Preferable methods of restraint include netting or squeezing animals up to four years of age and squeeze units for animals four years and older.

- Staff should not have direct contact with any gibbon until medical evaluations have been completed.

- For a short-term physical transfer while a gibbon is immobilized, the handler should restrain the animal's upper arms behind its back (one arm in each of the handler's hands) and carry it pointed away from the handler and other assistants.

Exhibit and Holding Facilities

Exhibits, for the public display of gibbons, should be designed and propped to allow natural behaviors and breeding. Each exhibit should have holding areas available for shifting gibbons during cleaning, medical procedures, etc. Off-display holding is of two types for either short-term/quarantine purposes or long-term holding.

Exhibit/Holding Facilities

- The minimum exhibit size is 7m x 4m x 4m or approx 30 m2. The public should not have access for viewing on more than two sides of a rectangular-shaped exhibit. It is necessary to have exhibits larger in size than holding areas in order to provide the animals adequate flight distance from public observers.

- For indoor exhibits, public viewing should be through 1.9 cm thick glass which is tempered and laminated.

- Wire caging material recommended is chain-link or welded wire with openings 5cm x 5cm or 5cm x 2.5cm in size.

- Each exhibit should have three shifts areas approximately 1.5m x 1.5m x 2m in size.

- Each exhibit should also include shade, feeding stations, water source for drinking, propping arranged to create arboreal pathways and wider props for sitting.

- Outdoor moated exhibits can be designed with an animal bridge to mainland holding. The holding building should have a brick face to prevent escapes. The minimum distance recommended for water moats is 5m.

- If not viewing through glass, the public should be separated from the exhibit by a minimum of 2m to reduce public feeding and physical contact with the animals.

- Moated exhibits should include modifications to the island edges that facilitate gibbons climbing back onto the island after falling into water. A simple means of accomplishing this is with branches that extend into the water.

Permanent Off-Exhibit Facilities

- Holding cages should be at least 2m apart. If cages are directly adjacent to each other, either solid walls should be installed between cages or the separating mesh should be small enough to prevent direct contact yet still permit adequate ventilation of the area.

- If the holding cages are separated from each other, tunnels can be used to connect the cages. If the cages are directly adjacent, shift doors can be used to connect the cages.

- Another option for a holding area (or exhibit area) is to split area with a panel that pivots on a center pole. The panel can be left parallel to the longer sides of holding to allow animals use of the entire area or it can be positioned to divide the total area into half.

- Keeper/attendant access doors to each cage should swing inside when opened and should be locked at all times.

- Water and food provisions are the same as for holding/quarantine areas.

- Props should be included for brachiation, shade and rest as described in quarantine facilities.

- Nest boxes can be designed for daily animal use as well as a squeeze restraint unit. Nest boxes should be approximately 0.75m x 0.75m x 1.0m.

- Family or breeding groups should be separated from each other by at least 50m or with a visual barrier.

Introduction of Gibbons - General Principles

- Both juvenile or adult animals should be familiar with the introduction site by having the individual animals use the intro area for at least one full day prior to introduction. Adults can be maintained in pairs (one male, one female). Immature animals can possibly be managed in larger groups depending on the cage size. Mature gibbons should not be managed with same sexed animals.

- Animals should be placed in adjacent stalls and given olfactory, visual and limited tactile contact until behavioral signs of compatibility are noted.

- Animals should be given physical access to each other initially with staff supervision. As signs of compatibility are noted, staff can decrease the amount of time in attendance.

- When adult gibbons exhibit signs of incompatibility during introductions, two options exist: if multiple animals are available, try different pairings; if limited animals are available, attempt to introduce the gibbons when the female is in estrus.

- Immature gibbons have successfully been housed in multiple animal groups. Animals are introduced when they are young and then separated as they approach reproductive maturity. Caution should be used to reduce competition over food by dispersing food.

Zoonotic Disease Precautions for Staff

- Staff working with gibbons should protect themselves from being carriers or recipients of zoonotic diseases.

- In order to protect staff and animals from zoonotic diseases, masks and latex gloves should be worn when servicing gibbons, especially animals in quarantine. If this equipment is not available, hands should be washed before and after preparing diets or servicing gibbons.

- Disinfection foot baths should be used between quarantine areas.

Nutrition or Diets

Gibbons should be fed according to the National Research Council (NRC) requirements for old world monkeys. These are:

Nutrient	Quantity/Day	Nutrient	Quantity/Day
crude protein (%)	16.7	biotin (mg/kg)	0.1
linoleic acid	1.0	vitamin C (mg/kg)	11.0
vitamin A (IU/g)	14	calcium (%)	0.6
vitamin E (mg/kg)	56	phosphorous (%)	0.4
vitamin D (IU/g)	2.2	magnesium (%)	0.2
thiamin (mg/kg)	5.6	potassium (%)	0.9
riboflavin (mg/kg)	5.6	sodium (%)	0.3
niacin (mg/kg)	55.6	iron (mg/kg)	200
pyridoxine (mg/kg)	2.8	zinc (mg/kg)	11.1
folacin (mg/kg)	0.2	copper (mg/kg)	1.5
vitamin B12 (mg/kg)	0.6	manganese (mg/kg)	44.4
pantothenic acid (mg/kg)	16.7		

Fresh Produce Diets

Two diets were obtained from the Dusit Zoo (Bangkok) and Gibbon Rehabilitation Project (Phuket). They are:

Dusit Zoo Diet
green beans (leaves and vegie)
banana (lots)
guava (lots)
papaya
ramputan in season
long bean (leaf and vegie)
lucerne
eggs (1 every 2-3 days per animal)

Gibbon Rehabilitation Project diet
AM/PM divided into 2 feedings for 27 H. lar
28 bunches of morning glory locally known as pak bung
2 kg cabbage
2 kg green beans
4 kg cucumber
2 kg tomatoes
2 kg eggplant
1 kg sweet corn
3.5 kg sweet potatoes
3 kg Mexican turnip (mang kaew)
2 kg aubergine like local fruit
6 strains bananas
15 eggs

PM
"gibbon balls" originally
3 kg sweet potato
350 gm steamed rice
500 gm boiled corn
500 gm boiled soya-beans
12 boiled eggs
200 gm oatmeal
20 gm vitamin and mineral powder (manufactured for dogs, Beapharm, Holland)
6 bananas

Water Equipment and Sources
Dispensing equipment includes automatic waterers (lix-its) or elevated containers. Water suitable for human consumption should be used for gibbons. Fresh water should be available at all times.

Other Considerations

Fibrous foods such as vegetable materials will decrease loose stools. Feeding gibbons several times per day increases activity options for animals and can be used as a tool for shifting animals as needed.

To avoid development of stereotypic behaviors, food can be presented in a manner that increases time spent eating, such as:

- Provide foods that are not cut into bite-sized pieces.
- Disperse food throughout holding area.
- Present food in a manner that requires manipulation to obtain and eat (ie., place on top of chain-link caging).

Record Keeping

Each gibbon entering captivity should be assigned an accession number as soon as it enters a facility. This number is used for the inner thigh tattoos and permanent records. Codes should be assigned to each zoo in the ZPO that can be used to identify the first captive facility to manage a particular individual. This code will precede the individuals accession number and included in the permanent tattoo. An example is: DU1234 = #1234 at the Dusit Zoo.

Other components of a facility's record keeping system include:

- Zoos and long-term holding facilities should participate in the International Species Inventory System (ISIS) and information exchanged between facilities.

- Animal Record Keeping System (ARKS) is available through ISIS for local record management.

- Rehabilitation facilities with short-term captive goals and more restricted budgets can utilize widely available computer databases for maintaining inventory records or consider ISIS programs.

- Permanent behavioral, medical and nutritional records should be kept for individual gibbons. Ideally this should be computerized to maximize the benefit of this data for addressing management problems.

- Currently Thai zoos utilize veterinarian staff to keep animal management records but have plans to incorporate curatorial positions to be responsible for more of the animal management responsibilities. Registrar type positions are also a goal for Thai zoos.

WORKING GROUP SUMMARY RECOMMENDATIONS

1) All domestic and international shipments of gibbons must follow IATA/CITES recommendations. Additional guidelines for transporting gibbons and gibbon quarantine are presented in the working group report.

2) There are three types of gibbon enclosures which vary in design and dimension based on their function. Specific recommendations are made in the working group report.

3) Recommendations for the introduction of unfamiliar gibbons to each other for the purpose of breeding, holding or rehabilitation are presented in the working group report.

4) Zoonotic disease precautions for staff are presented in the working group report. Additional considerations are presented in the working group on **Gibbon Diseases**.

5) Specific nutritional recommendations cannot be made at this time. General recommendations for diets are presented in the working group report.

6) Recommendations for record-keeping include assigning an accession number to each gibbon which is used for tattoos and all records, participation in the International Species Information System (ISIS), and the keeping of permanent behavioral, medical and nutritional records in a computerized database. ■

Working Group Report: Gibbon Diseases

Working Group Members: Parntep Ratanakorn, Sumate Kamolnorranath, Robert Cook, Andrew Teare (Facilitators), Lex de Leeuw van Weenen, Visit Arsaithamkul, Melissa Forberg, Chisanu Tiyacharoensri, Wanchai Tunwattana, & Preecha Kladkaew.

INTRODUCTION

The gibbon disease working group was charged with developing disease testing and control protocols for captive and wild gibbons in Thailand. Initial discussions amongst the participants produced agreement that disease problems for rescued and zoo animals were indistinguishable. Consensus on a working approach for producing the required protocols was reached. The initial effort was focused on defining a list of important diseases which impact captive gibbons based on a disease risk assessment model for captive populations (Munson and Cook). The factors considered included infectivity, disease prevalence, outcome of infection, availability of prevention, diagnostic testing capabilities and public health concerns. In producing this list of important diseases for captive gibbons in Thailand, all of these factors were weighed in combination with the clinical experiences of the veterinarians present from Thailand and North America along with information from the published literature. This list of diseases was prioritized based on the threat to captive and wild populations and formed the basis for recommendations regarding disease testing and control protocols for captive gibbons in Thailand. Based on these models further protocols and recommendations were created encompassing gibbon reintroduction and disease assessment of wild gibbon populations.

In addition the group generated a cost analysis for disease testing of gibbons in captivity as well as in preparation for reintroduction. Statements were drafted on contraception, animal handling, zoonotic disease concerns, humane euthanasia and gibbon health research priorities.

Above all the group believed most strongly that the maintenance of gibbon health in captive management, rehabilitation and reintroduction is in great part dependent on the increased availability of laboratory facilities with expertise in the diagnosis of gibbon diseases.

EXAMINATION AND TESTING OF CAPTIVE GIBBONS

Necropsy

Based on a rough survey of deaths per year in a number of holding institutions it is estimated that mortalities in the captive gibbon population range from 5% to 10% per year. With an overall captive population in institutions of 377 the estimated number of deaths per year ranges between 18 and 37 gibbons.

The working group suggested that there should be a central veterinary coordinator of all necropsy reports, that all gibbons are necropsied by a veterinarian, and, if possible, the freshly dead animal should go to a central laboratory which is set-up to do gross examinations, histopathology, serological testing, and microbiological testing. There are five veterinary schools in Thailand (two government and one private in Bangkok, one in Khon Khaen, and one in Chiang Mai). These could act as centralized laboratories for gross and histopathology exam of gibbons which arrive within 24 hours of death and are kept refrigerated or moved on ice. Microbiological and serological testing could be performed. Another alternative is at the Department of Livestock Development Diagnostic Centers, where deceased gibbons could be examined or microbiological and serological testing could be performed. A third alternative is to create a centralized wildlife disease laboratory to perform gross and histopathological exams of deceased gibbons and support captive gibbon health programs through microbiological and serological testing.

The working group recommended that cooperative agreements be established between the Ministry of Universities, the Royal Forestry Department, Ministry of Agriculture, the Zoological Parks Organization and all non governmental agencies of Thailand holding gibbon. This agreement should delineate the establishment of a CENTRALIZED WILDLIFE DISEASE LABORATORY or regional facilities which can thoroughly access the death of wildlife including gibbons and support diagnostic testing through microbiological and serological analyses. If no diagnostic laboratory is nearby, the attending veterinarian should perform the necropsy exam and send formalin fixed tissues and microbiological cultures to the laboratory.

The working group also recommended that a standard protocol be adapted for all gibbon necropsies. The protocol which follows is based upon the recommendations of the working group report: Monitoring, investigation, and surveillance of disease in captive wildlife at the International Conference on Implications of Infectious Disease for Captive Propagation and Reintroduction of Threatened Species, Oakland, California, 1992 (*Journal of Zoo and Wild Animal Medicine* 24[3]:1993).

GIBBON NECROPSY PROTOCOL

WORKSHEET

Common Name:

Genus\Species:

Isis #: Studbook #:
Permanent ID:

Date of Birth / / Age Weight Kg
dd/mm/yy

Date of Death / / Date of Necropsy / /
dd/mm/yy dd/mm/yy

Gross Exam Performed By:

Histopathology Performed By:

Institution:

Address:

Copy of Report Sent To Gibbon Veterinary Advisor? Yes

HISTORY (Include clinical signs, treatments, antemortem test results, diet, circumstances of death and quarantine status):PLEASE ATTACH COPY OF MEDICAL RECORD

GROSS EXAMINATION WORKSHEET
General Condition: (Nutritional condition, physical condition)
Musculoskeletal System: (Bone, joints, muscles)
Body Cavities: (Fat stores, abnormal fluids)
Hemolymphatic: (Spleen, lymph nodes, thymus)
Respiratory System: (Nasal cavity, larynx, trachea, lungs, regional lymph nodes, air sacs)
Cardiovascular System: (Heart, pericardium, great vessels)
Digestive System: (Mouth, teeth, esophagus, stomach, intestines, liver, pancreas, mesenteric lymph nodes)
Urinary System: (Kidneys, ureters, urinary bladder, urethra)

Reproductive System: (Testis/ovary, uterus, vagina, penis, prepuce, accessory glands, mammary glands, placenta)
Endocrine System: (Adrenals, thyroid, parathyroids, pituitary)
Nervous And Sensory Systems: (Brain, spinal cord, peripheral nerves, eyes, ears)
GROSS DIAGNOSIS: (List each lesion separately. Include organ, lesion type, distribution, severity, etc.)
LABORATORY STUDIES:(List bacterial and viral cultures submitted and attach results, if available)

Proper Tissue Preservation

Preserve the tissues listed below in 10% buffered formalin at a ratio of 1 part tissue to 10 parts formalin. Tissues should be no thicker than 1 cm except where indicated. Include sections of all lesions and samples from all tissues listed. For embryos or neonates, also include the information in the neonatal protocol.

Recommended Tissue Sampling Procedures:

- Adrenal glands: Entire gland with transverse incision.
- Brain/pituitary gland: Sliced longitudinally along the midline.
- Gastrointestinal tract: 3-cm-long section of esophagus, stomach (cardia, antrum, pylorus), duodenum, jejunum, ileum, cecum, and colon. Open carefully along the long axis. Cross section of tongue.
- Heart: Section including atrium, ventricle, and right and left AV valves.
- Kidneys: Section from both kidneys (cortex, medulla and pelvis).
- Liver: Sections from three lobes including capsule and gallbladder.
- Long bone: Submit 1/2 femur including growth plate.
- Lungs: Sections from several lobes including a major bronchus.
- Lymph nodes: Cervical, anterior mediastinal, bronchial, mesenteric, and lumbar with a transverse cut.
- Pancreas: Representative sections from two areas
- Reproductive tract: Entire testis with transverse cut; entire prostate with transverse cut.
- Skeletal muscle: Cross section of thigh muscles
- Skin: Full thickness of dorsal skin
- Spleen: Cross sections including capsule
- Thymus: Representative section
- Thyroid/parathyroid/adrenals: Leave glands intact, but make a cut in the capsule.
- Urinary bladder/ureter/urethra: Cross section of bladder and 2-cm sections of tubular structures
- Brain: Cut in half along anterior to posterior midline.

Neonatal or Fetal Necropsy Protocol

Follow the adult protocol for tissue sampling and include the following:

- Fix umbilical stump and surrounding tissues.
- Examine for malformations (cleft palate, deformed limbs).
- Assess hydration (tissue moistness) and evidence of nursing/eating (food or milk in stomach).
- Determine if breathing occurred (do the lungs float in formalin?).
- Placenta.

Shipping Tissues

After at least 72 hours in fixative, ship tissues in a leakproof container with enough formalin to keep tissues moist. Tissues can be shipped by mail or other carrier to the pathology laboratory.

Cost Analysis

The cost of performing necropsies is dependant on the method chosen to address the requirement of complete necropsies. Two different approaches are proposed:

Item	Cost (Baht)
Gross and histopathologic exam +cultures	2,500
Advanced analysis	1,000
Shipment of carcass	500
TOTAL COST(with shipment)	**4,000**
National Diagnostic Laboratory	
Pathology Building	500,000
Equipment	1,500,000
Histopathology Lab	360,000
Equipment	1,400,000
Tissue Library	600,000
Microbiology Laboratory Equip & Building	3,500,000
Serology Laboratory Equip & Building	1,000,000
Staff	
Pathologist	100,000
Histotech	78,000
Path technician/secretary	70,000
2 Virologists	200,000
Bacteriologist	100,000
3 LAB technicians 3 x 70,000	210,000
1 Secretary	70,000

Permanent Identification

The group recommends that every gibbon be permanently and individually identified. This system should be coordinated between all holding facilities to prevent duplication. Further it is recommended that each facility select a unique letter to precede the number. Number tattoo of inner thigh, right on male and left on female (tattoo machine = 17,000 Baht). Transponder placed subcutaneously between scapulae (cost = 150 Baht, reader = 16,000 Baht).

MINIMUM QUARANTINE PROTOCOL FOR CAPTIVE GIBBONS

Date: \ \
dd\mm\yy

Animal Identification
accession #: transponder #:

tattoo #:

genetic I.D.:

Current Drug Exposure(*Including Contraceptives*):

Recommendations for Facility Standards

Length of quarantine: MINIMUM 31 DAYS

Sanitation and Hygiene Requirements: Enclosures should provide physical separation from other animals. Disinfectant boot baths should be placed outside each enclosure. Cages should have floors which are completely disinfectable with shift capability. Animals should be shifted and the cage cleaned each day with disinfectant. When handling animals latex gloves and masks should be worn by keepers and veterinarians.

Environmental Standards: (water, food, etc.) are detailed in the report of the Captive Husbandry Group. Waste water, feed dishes and other fomites should not be carried between quarantine areas and other holding.

Required testing/biomaterials collection for species:

Serology: Hepatitis B titers checked just prior to end of quarantine,
Fecal: 3 negative fecal flotations, 3 negative direct fecal smears, 3 negative Baermann analyses.
Culture: 3 negative fecal cultures (especially salmonella and shigella).
Biomaterials: Freeze serum samples for later analysis (when possible -30C). Plucked hair samples into paper bag, labeled, dry at room temperature.
TB testing : Minimum of one test. Mammalian Old Tuberculin in eyelid. Positive test should be followed by comparative tuberculin test on chest with ppd bovis, ppd avian, and ppd human. Chest radiographs are recommended following a positive TB test.

Baseline Physiological Data

Temp
Pulse/H.R.(BPM)
Respiration (RPM)

Weight (kg)

Physical Examination

Oral exam (Dental): Check for oral ulcers and cut canines

Ears/Eyes/Nose/Throat:

Heart/Lungs:

Abdomen:

Musculoskeletal:

Urogenital:

Dermatologic:

Other:

Clinical Laboratory Tests Performed:

CBC Biochemistry

Malaria

Vaccine/MLV/Killed	Name Brand	Date Received	Serial #:
Tetanus Toxoid			
Rabies Vaccine (killed)	----------	----------	----------
	----------	----------	----------

Additional Recommended Tests:
Radiographs
Heavy Metal Analysis
Serology for influenza, Hepatitis A, Parainfluenza, HSV1&2
HIV, SIV, Leptospirosis,

Pre-Release Standards-The following tests must be negative or within acceptable limits for this species to be released (For example):

Negative TB Test

WBC no greater than 20,000 if all other parameters are normal
WBC no less than 4,000 if all other parameters are normal

3 Negative Fecal checks
3 Negative Fecal Culture
Negative Blood Parasites

Costs of Captive Gibbon Quarantine Evaluation

Estimated Supply & Lab Costs per Gibbon	3,947 Baht
Transponder 150 B & Tattoo 5 B	155
Hepatitis B Serology	600
Fecal Culture & Sensitivity- 400 B x 3	1200
Fecal= 60 B x 3	180
Shipping Costs& Report	400
Immobilization= 100mg ketamine	200
gloves & masks & scrub	15
syringe & needle	10
Blood tubes & Cryotube	22
TB test, syringe & antigen	15
CBC	70
Malaria	50
Biochemistry	1000
Tetanus Toxoid & Rabies Vacc	30
Recommended tests costs	4,150
Parainfluenza	350
HSV 1&2	800
Influenza serology	300
HIV	600
Leptospirosis	400
Hepatitis A	1200
Heavy Metals	500

BASIC MEDICAL EQUIPMENT FOR MEDICAL FACILITY

The following is a list of basic medical equipment to meet medical needs at a facility: Stethoscope, exam table, surgery light, ophthalmoscope/otoscope, centrifuge, refrigerator, freezer, penlight, tattoo machine, surgery set, dental instruments, thermometer, running hot and cold water, sink, climate control, immobilizing equipment (blowpipe, CO2 pistol [Telinject], darts), squeeze cage, bite gloves, gas anesthesia machine (isoflurane), computer (486AT, 33MHz, 240MB, 8 MB RAM), medical database program, binocular microscope, binoculars, clippers, x-ray machine, and EKG.

TESTING PROTOCOLS FOR CAPTIVE GIBBONS

This prioritized list is based in part on the Disease Risk Assessment Criteria delineated by the working group report: Monitoring, Investigation, and Surveillance of Disease in Captive Wildlife at the International Conference on Implications of Infectious Disease For Captive Propagation and

Reintroduction of Threatened Species, Oakland California, 1992 (*Journal of Zoo and Wild Animal Medicine* 24(3):1993). These criteria include: the infectivity of the agent (high, low, carrier); prevalence of disease in donor/recipient animals; outcome of disease (morbidity, mortality); availability of therapeutics or preventatives; diagnostic tests; and public health concerns.

High Risk

Shigella and Salmonella - Diagnosed by culture if possible by a human medical laboratory (due to familiarity with special culture requirements for isolation in humans). The highest yield is with fresh fecal samples sent the same day to the laboratory. The lab must be given a special request to isolate these organisms specifically along with other enteric bacteria. Three cultures are recommended since the gibbon may harbor the organism yet it is difficult to culture.

Hepatitis B- Hepatitis B surface antigen and Hepatitis B antibody serology on serum samples. Surface antigen will become positive early in exposure to the virus prior to changes in the animals condition or changes in the serum biochemistry. Antibody conversion will follow antigen recognition. Clearance of antigen with persistent antibody titers implies clearance of the virus in humans. Persistence of antigen titers implies a carrier state in humans. It is recommended that positive antigen animals be tested every 3 months to determine if the antigen has cleared. Little research work has been done specifically on gibbons. Antigen positive animals should be treated as potential sources of spread to other gibbons and human handlers.

GI Protozoa- Giardia, Amoeba, Balantidium- Diagnosed by direct fecal examination. Simple smear diluted with physiological saline. Recommend 3 negative tests during the quarantine period.

Tetanus- Diagnosed by clinical signs and response treatment.

Tuberculosis- Screening tests should be performed using 0.1ml of mammalian old tuberculin administered intradermally in the eyelid. The test must be read at 24, 48 and 72 hours. Swelling at 48 hrs which increases or stays the same at 72 hours is read as positive. A swelling at 24 hours which is less at 48 hrs, and less or gone at 72 hours is either a negative or suspicious and may warrant a repeat test in two weeks. If positive, do a comparative test using 0.1ml each of purified protein derivative (ppd) avian, ppd bovis, ppd human, and mammalian old tuberculin administered intradermally in a clipped area of the chest just below the nipple. A gibbon coming into a zoo collection should be required to have 1 negative TB test during quarantine with yearly rechecks.

Rabies- Diagnosed by clinical signs. At death the head should be submitted fresh to the laboratory for Florescent Antibody examination.

Trauma- Diagnosed by clinical signs.

Nutritional Disease- Metabolic bone disease is diagnosed based on clinical signs and dietary history. Other vitamin or mineral deficiencies are similarly diagnosed with the support of serum or plasma vitamin and mineral analyses.

Dental Disease- Diagnosis is based on clinical examination or corresponding visual exam and dietary history.

Vibrio Cholerae- Diagnosed by culture.

Moderate Risk

Hepatitis A- Serum analysis for Hepatitis A antibody will reveal exposure and possible disease.

Strongyloides- diagnosed by fecal floatation and/or baermann test. Repeat as part of 3 negative fecal checks.

Influenza- Serum analysis for influenza antibody.

Parainfluenza- Serum analysis for parainfluenza antibody.

Pseudomonas pseudomallei- Diagnosis by culture and sensitivity.

Coccidia- Diagnosis by fecal floatation. Recommend 3 negative fecal checks.

Heavy Metals- (Lead, Zinc, Mercury, etc.) Heparinized whole blood samples are submitted for analysis via atomic absorption spectrophotometry.

Low Risk

Other nematodes- Diagnosed by fecal flotation.

Leptospirosis- Diagnosed by culture for organism, fluorescent antibody testing of affected tissues or serum titers which are the most reliable.

Toxoplasmosis- Diagnosed by fecal flotation for the coccidian or in cases of systemic disease, serum titers.

Vibrio sp.- Diagnosed by culture of affected organ system.

Yersinia enterocolitica- Diagnosed by culture of affected organ system

Gibbon Leukemia Virus- Serum analyzed for titers.

HIV and SIV- Serum analyzed for titers.

Polio- Serum analyzed for titers or virus isolated.

Microsporum canis- Diagnosed by clinical signs, skin scraping and fungal culture.

Sarcoptic mites- Diagnosed by skin scraping.

Airsacculitis- Diagnosed by clinical signs and culture for infecting organism.

Malaria- Diagnosed by identification of organism on thick blood smear.

Simian Hemorrhagic Fever- Diagnosed by clinical signs and serum titers or virus isolation.

Anthrax- Diagnosed by identification of organism on blood smear.

Japanese B Encephalitis- Analysis of serum titers.

Streptococcal encephalitis- Diagnosed by clinical signs with culture of oral cavity or CNS.

Echinococcosis- Diagnosed by clinical signs and necropsy findings.

STATEMENT ON TREATMENT

Listing treatments for each disease is beyond the scope of this group. The group recommends that the veterinarians from Thailand zoos, rehabilitation centers, wildlife department, universities and private practice continue to build cooperative programs of data exchange. A regular meeting of this group to discuss advances in medical diagnostics and therapy will greatly advance the care of gibbons in Thailand.

DISEASES OF SPECIAL CONCERN

HEPATITIS B antigen positive animals which are persistently antigen positive after 3 tests 3 months apart must be handled with special considerations. Such animals possess a zoonotic disease potential as well as being potentially infective to other gibbons. The animal must either remain isolated, remain only with other persistently positive animals or be euthanized. It is the recommendation of this group that such animals pose an unacceptable risk to humans and conspecifics and should be euthanized.

TUBERCULOSIS- animals which are positive on intradermal skin test with Mammalian Old Tuberculin, are positive for *M. tuberculosis* or *M. bovis* on comparative skin testing, have clinical signs consistent with active tuberculosis, and or are culture positive on gastric lavage or tracheal wash, and/or are radiographically positive for chest lesions are considered to be actively positive for tuberculosis. The animal must either remain isolated under treatment, remain only with other positive animals under treatment or be euthanized. The animal can never be considered negative for disease. It is the recommendation of this group that such animals pose an unacceptable risk to humans and conspecifics and should be euthanized.

MINIMUM QUARANTINE PROTOCOL FOR REINTRODUCTION GIBBONS

Date: \ \
dd\mm\yy

Animal Identification
accession #: transponder #:

Permanent ID:

genetic I.D.:

Current Drug Exposure (*Including Contraceptives*):

Facility Standards

Length of quarantine: MINIMUM OF 90 DAYS DIAGNOSTIC TEST NEGATIVE

Sanitation and Hygiene requirements: Enclosure physically separate from other animals. Disinfectant boot bath. Cages should have concrete floors with shift capability. Animals should be shifted and the cage cleaned each day with disinfectant. When handling animals latex gloves and masks should be worn by keepers and veterinarians. The animals should not be in contact with any other animals except those which are to be released into the same area.

Required testing/biomaterials collection for species:

Serology :Hepatitis B antigen and antibody titers negative checked just prior to end of quarantine period. HIV, SIV, HSV-1 & 2, Herpes B, Influenza, Parainfluenza, Hepatitis A and Leptospirosis Negative.

Fecal 3 negative fecal flotations, 3 negative direct fecal smears, 3 negative Baermann analyses.
Culture : 3 negative fecal cultures (especially salmonella and shigella).

Biomaterials: Store serum samples for later analysis. Plucked hair samples into paper bag, labeled, dry at room temperature.
TB testing Negative intradermal skin test using Mammalian Old Tuberculin in eyelid.

Baseline Physiological Data

Temp
Pulse/H.R.(BPM)

Weight (kg)

Respiration (RPM)

Physical Examination

Oral exam (Dental): oral ulcers and dental disease

Ears/Eyes/Nose/Throat:

Heart/Lungs:

Abdomen:

Musculoskeletal:

Urogenital:

Dermatologic:

Other:

Clincal Laboratory Tests Performed:

CBC Biochemistry

Malaria

Vaccine/MLV/Killed	Name Brand	Date Received	Serial #:
Tetanus Toxoid			
Rabies Vaccine (killed)	----------	----------	----------
	----------	----------	----------

Additional Required Tests:
Radiographs
Heavy Metal Analysis

Additional Pre-release Standards-The following tests must be negative or within acceptable limits for this species to be released (For example):

WBC no greater than 20,000 if all other parameters are normal
WBC no less than 4,000 if all other parameters are normal

Blood Parasite Negative

COST ESTIMATE FOR GIBBON REINTRODUCTION QUARANTINE

Transponder 150 B & Tattoo 5 B	155
Hepatitis B Serology	600
Fecal Culture & Sensitivity- 400 B x 3	1200
Fecal= 60 B x 3	180
Shipping Costs& Report	400
Immobilization= 100mg ketamine	200
gloves & masks & scrub	15
syringe & needle	10
Blood tubes & Cryotube	22
TB test, syringe & antigen	15
CBC	70
Malaria	50
Biochemistry	1000
Tetanus Toxoid & Rabies Vacc	30
Heavy metal	500
Influenza serology	300
Hepatitis A	1200
Parainfluenza	350
Herpes Simplex I & II	800
HIV (SIV not available)	600
Leptospirosis	400
Herpes B	1000
ESTIMATED SUPPLY & LAB COSTS PER GIBBON	9,097
Pre-Release Quarantine Enclosure for 1 gibbon 6 m^2 per gibbon	150,000

MEDICAL CONSIDERATIONS FOR REINTRODUCTION

Due to the lack of information on the incidence of disease in wild gibbons the group recommended that the most conservative criteria be adopted regarding gibbons scheduled for reintroduction. Every effort should be made to eliminate any risk of introducing diseases into the wild population. To that end the following points are suggested:

- To qualify for release, all gibbons scheduled for reintroduction must complete a prerelease quarantine following the protocol advocated in this working group report.
- Necropsy protocols must be strictly adhered to in order for gibbons in contact with deceased gibbons to qualify for release.
- Gibbons which are Hepatitis B positive (antigen or antibody) and/or Hepatitis A positive should not be released.
- No gibbon with 2 positive intradermal skin tests two months apart using Mammalian Old Tuberculin in the eyelid should be released.
- Gibbons with cut canines that have exposed pulp cavities should have the pulp cavity filled or the tooth removed to prevent later abscess and infection. Only gibbons with intact canines should be released.

DEFINING DISEASES OF WILD GIBBONS

It is difficult to recommend disease testing criteria for reintroduction without knowledge of disease incidence in free-ranging gibbons. The working group therefore strongly recommended that every effort be made to further define the incidence of diseases in free ranging gibbons both through fortuitous collection of biomaterials (fecal) as well as post-mortem necropsy evaluation of freshly dead individuals. If gibbons are being captured for translocation or other research projects it is imperative that complete medical examination, disease testing and biomaterials collection be performed on each individual.

RESEARCH PRIORITIES

- Further definition of the implications of Hepatitis B positive gibbons. Do they harbor the virus, does it cause clinical disease, can it spread to other gibbons or humans ?
- Further definition of the status and implications to gibbons of HIV, SIV, Malaria, HSV-1, SHF. Do they harbor the virus, do they cause clinical disease, can they spread to other gibbons or humans?

- Further definition of public health concerns and zoonoses of gibbons.

- It is difficult to recommend disease testing criteria for reintroduction without knowledge of disease incidence in free-ranging gibbons. The group therefore strongly recommends that every effort be made to further define the incidence of diseases in free ranging gibbons both through fortuitous collection of biomaterials (fecal) as well as post-mortem necropsy evaluation of freshly dead individuals. If animals are being captured for translocation or other research projects it is imperative that complete medical examination, disease testing and biomaterials collection be performed on each individual.

STATEMENT ON CONTRACEPTION

Should large numbers of rehabilitated gibbons prove unreleaseable it may be necessary to provide long term maintenance. If breeding of these individuals is deemed non-desirable, methods of contraception should be considered. The following techniques are currently available and include:

- Vasectomizing males: A non-reversible surgical method which maintains male behavior while eliminating the possibility of impregnation. This method should be considered non-reversible (US$15/surgery).

- Melengestrol Acetate Implant: Potentially reversible long term contraceptive technique for females. Implant is based on body size and is surgically implanted. It is uncertain whether this method is truly reversible. The animals must be caught up for reimplantation and implants are known to fail (US$25/implant).

- Contraception vaccination: Less proven method. A contraceptive vaccine prepared from Porcine Zona Pellucida injected multiple times to raise antibody levels against the zona pellucida of the gibbon egg. Would require regular revaccination. This may not be reversible. Not commercially available.

- Daily administration of progestogen via oral form. Missing treatment would subject the female to pregnancy, high labor intensive (US$25/month).

- Norplant implantation: easily administered but not proven in gibbons. Lasts up to 5 years in humans. May have a longer half life than MGA implants (US$300/implant).

- Depo-vera injection. Given every 2 months. Labor intensive, relatively expensive (US$10/injection; six injections per year).

For permanent contraception the group recommends vasectomy due to cost and lack of failure. If reversibility is desired, depo provera is recommended.

ANIMAL HANDLING PROTOCOLS

The group recommends that any healthy gibbons greater than 2 kg be chemically restrained in order to perform a complete physical examination. Initial manual restrain may be required in order to deliver the anesthetic dose.

In many instances the animals health status is unknown at the time of restraint. It is therefore the responsibility of the attending veterinarian to assess the visual status of the animal and determine the appropriate dose of anesthetic for that individual. The drugs Ketamine HCl, Teletamine Zolazepam, and Acepromazine have all been used alone or in combination for various length procedures.

ZOONOTIC DISEASE CONSIDERATION

In order to protect humans from contracting gibbon carried diseases or gibbons contracting human carried diseases the following special efforts are required. All personnel involved with the care and handling of gibbons must be aware of the potential for disease spread between gibbons and humans. Every effort should be made to protect oneself via the use of latex gloves, eye protection good sanitation and hygiene. People handling gibbons should undergo a yearly physical exam, be tested yearly for tuberculosis, and if possible inoculated against polio, tetanus, rabies, measles and hepatitis B. In addition gibbon keeper staff should have a complete fecal exam including culture once yearly or more frequently if symptomatic.

Gibbons which are herpes B positive, hepatitis B positive, hepatitis A positive, or HSV 1 & 2 positive all provide a special challenge. The implications of a positive test still have yet to be defined for the health of the gibbon. The ability of gibbons to transmit such diseases to humans has not yet been defined. The group recommends that these animals be kept isolated and that special precautions are taken to protect animal care staff.

STATEMENT ON EUTHANASIA

The working group recommended that gibbons that are suffering from incurable conditions or those confirmed as TB positive be humanely euthanized. A lethal injection should be administered intravenously using an approved animal euthanasia agent while it is anethesized.

WORKING GROUP SUMMARY RECOMMENDATIONS

Captive Management

1) Every facility holding gibbons should have an attending veterinarian with expertise in gibbon diseases.

2) All gibbons that die should receive a complete necropsy (gross and histopathological examinations, and serological and microbiological testing) performed by a veterinarian following the necropsy protocol advocated in this working group report, and that there should be a central veterinary coordinator for all gibbon necropsy reports.

3) A cooperative agreement should be established between the Ministry of Universities, the Royal Forestry Department, Ministry of Agriculture, the Zoological Parks Organization and all Non Governmental Agencies of Thailand holding gibbons to establish a national wildlife disease laboratory.

4) Every gibbon should be permanently and individually identified through tattoos and transponder chips that are nationally coordinated to avoid duplication.

5) All gibbon transfers between facilities should follow quarantine protocold advocated in this working group report.

6) Thai veterinarians from zoos, gibbon rehabilitation centers, the wildlife department, universities and private practice should develop cooperative programs for exchanged of medical data.

7) All gibbons that are Hepatitis B antigen positive (and are persistently antigen positive after three tests at three-month intervals) pose an unacceptable risk to humans and conspecifics and should be euthanized. Similarly, all Tuberculosis positive gibbons also pose an unacceptable risk to humans and conspecifics and should be euthanized.

8) All personnel involved with the care and handling of gibbons must be aware of the potential for disease spread between gibbons and humans, protect from zoonotic diseases by appropriate vaccinations, and regularly tested for zoonotic diseases as listed in this working group report.

9) Gibbons suffering from incurable conditions (and diseases listed above) should be humanely euthanized.

Reintroduction of Captive Gibbons

Due to the lack of information on the incidence of disease in wild gibbons the group recommends that the most conservative criteria be adopted regarding gibbons scheduled for reintroduction. Every effort should be made to eliminate any risk of introducing diseases into the wild population. To that end the following recommendations are listed:

10) To qualify for release, all gibbons scheduled for reintroduction programs must complete a prerelease quarantine following the protocol advocated in this working group report.

11) Gibbons which are Hepatitis B positive (antigen or antibody), Hepatitis A positive, and/or Tuberculin positive should not be considered for reintroduction programs (see recommendation #7 above).

12) Gibbons with damaged or cut canines should be medically treated and should not be considered for reintroduction programs.

13) Every effort be made to further define the incidence of diseases in free ranging gibbons both through fortuitous collection of biomaterials as well as post-mortem necropsy evaluation of freshly dead individuals. ■

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Working Group Report: Selection of Gibbon Reintroduction Areas

Working Group Members: Warren Brockelman, Yongyuth Trisurat (Facilitators), Matana Srikachang, Samart Maungmaitong, Siriporn Thon-Aree, Chumpol Suckaseam, Pongpan Laothong, Budsabong Kanchanasaka, Tunya Chang-arge, Piyaret Chimchom, Somboon Wongphakdi, Euayporn Sangtien, Siriphan Chamnankit, David Smith, Stephen Elliott, & Ardith Eudey.

Editors' note: The reintroduction of gibbons was not officially considered during the workshop until discussions of recommendations which occurred on the last day of the workshop. However, if the Royal Forest Department decides to interactively manage the gibbon metapopulation in Thailand, it may need to reintroduce captive gibbons or translocate gibbons from fragmented forests to larger contiguous forests. The following suggestions may be of use in developing reintroduction techniques if such programs are deemed prudent.

SELECTION OF GIBBON REINTRODUCTION SITES

Criteria for Selection of Sites

- Area: The site should contain, ideally, at least 100 km^2 of viable habitat. Areas with less than 10 km^2 are unacceptable, as it would not be possible to establish a viable population over the long-term.

- Habitat: The area should contain tropical evergreen forest.

- Human habitation: The release forest area should contain no human habitations within 5 km of the release site(s). Further, there should be no tourist facilities or other human work areas in the vicinity.

- Protection/education: The area should be protected against poaching and deforestation. Sites with educational program opportunities are most desirable.

- Resident gibbon population: The site should not contain a resident gibbon population, and it should not be contiguous with larger forest areas with resident gibbon populations or other important conservation species.

Table 1. Evaluation of potential reintroduction sites for gibbons in Thailand.

	CRITERIA					
SITE	**1**	2	3	4	5	Total
***lar*;**						
Doi Chang Dao WS	1	2	3	2	2	10
Doi Suthep NP	2	1	3	2	1	9
Doi Inthanon NP	1	1	3	2	2	9
Doi Luang NP	1	2	1	3	1?	8
Doi Luang WS	1	3	2	3	1?	10
Om Koi WS	1	2	3	2	2?	10
Khlong Lan NP	1	2	1	2	3	9
Jaesorn NP	1	3	1	2	2?	9
Thung Salang Luang NP	1	1	1	1	1-2?	5-6
Khao Pra Taeo WS	3	1	2	2	1	8
Ko Tarutao NP	1	2	1	1	1	6
Ko Lanta NP	2	1	2	2	1	8
Khao Phra Bang Khram WS	1	1	3	2	2	9
agilis						
Pa Pru swamp	2	1?	1	2	1	7
pileatus						
Khao Khieo WS	2	1	2	1	2	8
Nam Tok Priew NP	1	1	1	2	1	6
Ko Chang NP	1	2?	2	2	1	8

Comments on Favorable Reintroduction Sites for Gibbons

Table 1 indicates the scoring for each protected area that was suggested by a member of the working group as a candidate site. The sites with the lowest total number of points are the most desirable. Scoring of sites was based upon: 1=good; 2=moderately good to acceptable; 3=marginal to barely acceptable; and 4=unacceptable. From these scores it is possible to select one or more sites for northern *lar*, central *lar*, southern *lar*, *pileatus*, and *agilis*. Brief comments on some of these potentially favorable sites follow.

- For northern Thailand, a number of sites are about equally favorable. Doi Luang National Park has the lowest score. Doi Suthep has many advantages, but the local human villages and other facilities are a negative factor. If this problem can be dealt with through proper education and public relations, Doi Suthep might have great potential.

- In central Thailand, Thung Salang Luang has the most favorable attributes.

- In south Thailand there are few optimal sites because most gibbons have been depleted by hunting. Some large islands, particularly Ko Tarutao NP, have the most potential.

- For the pileated gibbon, three sites were considered as possibilities and Nam Tok Priew (Khao Srabap) was selected because of its relative isolation and lack of resident gibbons at present.

- It is essential that gibbons selected for reintroduction programs be of the same species and subspecies (insofar as known) as former resident gibbon populations.

Tasks of High Priority (and Urgent Need) for Reintroduction Sites

- All protected areas selected as gibbon release sites must be surveyed in detail to determine:
  - The precise extent of suitable evergreen habitat.
  - The existence and location of any resident gibbon groups.
  - The locations of all roads, trails, human habitations and other facilities.
  - The locations of all potential release points and access trails.

- RFD staff working in the protected areas should be informed of and involved in these preliminary surveys. All findings and recommendations should be reported back to the protected area chief as well as to reintroduction project personnel.

- Specific needs for gibbon reintroduction sites are as follows:
  - Doi Luang NP: Location and extent of suitable evergreen habitat.
  - Doi Suthep NP: Location of suitable and accessible evergreen habitat.
  - Thung Salang Luang NP: Location of suitable evergreen forest.
  - Ko Tarutao NP: Location of suitable habitat away from park headquarters.

- Nam Tok Priew NP: Location of suitable habitat away from villages and tourists.
- Chalerm Prakiet Somdej Prathep Ratana Ratchasuda WS (peat swamp forest): Location of accessible but remote tall forest, probably by boat.

Tasks of High Priority (but of less Urgent Need) for Reintroduction Sites

- Gibbon surveyors should resurvey pileated gibbon populations that were surveyed in the 1970s and 1980s to estimate long term trends in abundance for this species.
- More surveys should be carried out in the core areas of large protected area blocks to obtain better estimates of core density.
- Surveys should be carried out in peripheral areas of important conservation areas to determine the effects of human disturbance and edge effects on gibbon populations.

WORKING GROUP SUMMARY RECOMMENDATIONS

Site Selection for Reintroduction Programs

The following protected areas are suggested as reintroduction or translocation sites for such programs. Four suitable sites have been selected for lar, one for pileatus and one for agilis in the far south.

1) For *H. lar* in north Thailand: Doi Luang NP, Chiang Rai (habitat area 100 km^2); and Doi Suthep NP, Chiang Mai (habitat area about 80 km^2). Gibbons in Doi Suthep have been extirpated within the last 15-20 years. The site would be optimal for reintroduction except for the large number of humans living and working on the mountain. Reintroduction may be done providing that very aggressive animals are excluded and the local residents are educated and allowed to participate in the project. Translocated wild gibbons would be preferred, as these would not harass humans.

2) For *H. lar* in north central Thailand: Thung Salang Luang NP, Pitsanulok.

3) For *H. lar* in south Thailand: Ko Tarutao NP, Satun (habitat area about 150 km^2).

4) For *H. pileatus* in south east Thailand: Nam Tok Priew NP, Chanthaburi (habitat area 130 km^2).

5) For *H. agilis* in far south Thailand: Chalerm Prakiet Somdet Prathep Ratana Ratchasuda (Pa Pru swamp forest), Narathiwat (habitat area 50 km^2). ■

Working Group Report: Gibbon Rehabilitation and Release

Working Group Members: Warren Brockelman, Preecha Ratanaporn, Tim Redford, T.D. Morin (Facilitators), Surapon Duangkhae, Tanya Chan-ard, Steve Elliott Somchai Dangsee, Sompong Boonsanong, Panit Sanpote, Yongyut Trisuret, Sudsabong Kanchanasaka, Piyarat Chimchom, Avayporn Sangtian, Songkran Meewadsana, Ronglarp Sukmasuang, Mattana Srikrajang, Danny Morris, Ardith Eudey, Reg Gates, Dianne Gates, Lex and Jeanette de Leeuw van Weenen, Sarah Christie, Ronald Tilson & Kathy Castle.

Editors' note: The reintroduction of gibbons was not officially considered during the workshop until discussions of recommendations which occurred on the last day of the workshop. However, if the Royal Forest Department decides to interactively manage the gibbon metapopulation in Thailand, it may need to reintroduce captive gibbons or translocate gibbons from fragmented forests to larger contiguous forests. The following suggestions may be of use in developing reintroduction techniques if such programs are deemed prudent.

REHABILITATION AND REINTRODUCTION JUSTIFICATION

While it does not appear that any significant immediate genetic or demographic conservation value will be realized, research methods employed in this process will be of value long-term in answering questions on behavior, diseases and the role of the gibbon in the preservation of current and future forest ecology.

These answers would serve as models for species like the pileated gibbon or in the event of a catastrophic occurrence, providing the basis for future restoration.

A very large captive population exists with the majority still being kept in private hands (legally and illegally) that in time must be dealt with. It is the public perception in Thailand that something must be done with them and this should not be ignored as this emotion has led to heightened concern in Thailand about gibbons in the wild as well. Publicity generated by a rehabilitation and release program may further increase this feeling of ownership in the future of gibbon as well as offer excellent opportunities to expand educational programs. The increased awareness generated would make the gibbon a flagship species for whole reserves and the biodiversity within them.

Export is illegal under Thai law and the amount of space available in Zoological Parks Organization facilities is insufficient to handle these numbers of gibbons. The existing space in the Zoological Parks Organization facilities would be better utilized in long term conservation of critically endangered species. Although no cost figures are available yet it could possibly be

less expensive to rehabilitate and release gibbons, even with monitoring, than to maintain in captivity.

Selection of Gibbons for Rehabilitation and Reintroduction Programs

This process will be based on a continuing assessment of the animals progression through the stages of rehabilitation. The following conditions seen in animals would preclude suitability for rehabilitation and release:

- Missing limb or limbs
- Canine teeth clipped or diseased
- Blind animals or partially sighted animals
- Castrated or sterilized animals
- Low reproductive potential
- Cut vocal cords
- Any retarded growth or bone deformity
- Diseased animals, refer to Disease Working Group Report
- Hybrid animals
- Animals exhibiting persistent sign of neurosis
- Animals of unknown geographic origin/subspecies

Animals selected for inclusion in the rehabilitation program may or may not graduate to the release program. Additional considerations include:

- Only adults that have formed bonded pairs are suitable for release.
- Sub-adult and adolescent animals could be established in small mixed groups.
- Small groups of sub-adults (up to 4 in number) can also be considered for release. An older sub-adult animal (6-8 years of age) as a leader could be released with this group. Release of juveniles has been tried but not enough time has yet passed to know if reproductive success will occur. Oldest animal in group was only six months older than the rest. If animals separate they can be re-captured and brought back into captivity.

Diet

As the animals progress through the rehab process and are close to release, more variety of wild fruits, and natural vegetation and natural foodstuffs should be incorporated into the diet offered.

Locomotion

Minimum enclosure requirements are covered in the captive management recommendations. However natural branches and ropes should be added to encourage exercise and strengthening of the animals locomotion abilities.

Socialization

Adequate natural abilities need to be demonstrated by individuals before they can be considered for release candidates. Grooming and dueting together are signs that pairing is successful. Playing and brachiating behaviors are desirable. The pair must be compatible before release; if the first pairing is not successful, a different mate should be offered. Presence of neurotic behavior is a contra-indicator for release.

Reintroduction

The gibbons are placed in an acclimation cage at the release site for at least 5 days. This period of acclimation is very important in reducing stress by allowing the apes to adjust to their new environment and to teach them that they will be fed twice a day. If the animals are not acclimated, but released immediately, they may separate, wander off, never find their feeding station and may perish. The diet for the acclimation period should be the same as their diet at the rehabilitation center with the addition, if feasible, of local leaves, shoots and fruits when possible. The same person (or animal keeper) should accompany the animals to the release site and maintain the feedings and observations, this procedure helps to reduce stress.

On the day of release the cage door is opened and should remain open. The cage becomes the first feeding station. After the first week of release the feeding station may be moved farther into the forest. Daily observations are made of foraging behavior. As the gibbons begin to learn their new food source, the supplementary feeding may be reduced and eventually terminated after four to five weeks. This allows a gradual transition to a natural diet.

Follow-Up

Follow up studies are necessary to evaluate the success of rehabilitation and to study the behavior of previously captive gibbons in the wild. It is necessary to establish and note location of the range. During the first year, they should be observed for a minimum of several days each month. Observation should include the behaviors of grooming behaviors, dueting, group change, general appearance and vigor. Monitoring of ranging as well as height reached in the canopy are important to monitor and care should be taken to mark trees, for identification by humans, that the gibbons are foraging in to aid in the collection of data.

Public Relations

Public relations concerning reintroduction involved both problems and opportunities. It is essential that the purpose and the target audience be carefully identified initially. PR efforts are involved in distinct ways in two phases of the overall process.

Tourism promotion and education could be carried out at the rehabilitation site providing it does not interfere with operations. This would provide the opportunity for some fund-raising. Local officials and religious leaders should be targeted as these people have educational roles themselves. Schoolchildren could benefit by learning more about animals and their conservation. Finally, potential donors and fund raisers should also be given tours of the site.

An initial effort should be made to survey the local households (if present) near the release site to obtain information about the local forest and wildlife and to determine their attitudes toward the project. To the fullest extent possible, local residents should be hired to participate in such work as building facilities, caring for the animals and follow-up observations. Without local support and participation, release efforts are probably doomed to failure. Finally, local residents must be educated about the project. They should be taught to defend themselves from possible attacks by gibbons, and what to do if gibbons leave the forest and show up on their doorsteps.

WORKING GROUP SUMMARY RECOMMENDATION:

1) A long-term rehabilitation and release program should be considered in Thailand. The first phase of this program should be a series of test release programs to establish feasibility and level of support required for the long term program. This work should be carried out on low risk, relatively abundant populations such as *H. lar* to serve as a model for more endangered species. ■

Post-Workshop Working Group Report: SPARKS Training and Data Entry Assumptions

Working Group Members: Sarah Christie, Kathy Castle, Andrew Teare, Reg Gates (Facilitators), Visit Arsaithamkul, Jumpon Khotchasit, Wanchai Tunwattana, Suphaphan Hirunro & Danny Morris.

Staff from Dusit Zoo and Khao Kheow Open Zoo met with staff from Henry Doorly, Perth and Minnesota Zoos to install and begin using the Single Population and Analysis Records Keeping System (SPARKS) software program. Practice regional studbooks were set up for several gibbon species found in Dusit and Khao Kheow Zoos using data from the immobilization of these gibbons in April 1993 by several Thai zoo veterinarians and Dr. Robert Cook, Wildlife Conservation Society (formerly the New York Zoological Society). Extremely helpful was the SPARKS Training Course Manual sent by Sarah Christie, London Zoo, who was unable to attend the training session.

Several assumptions were made as these databases were established. These include:

1) If a date is estimated to the year, assume that day and month is 1 January. Example, if a gibbon of unknown origin was acquired sometime in 1992, enter 01 January 1992.

2) To estimate the age at acquisition, the following categories were established:
   - if adult when acquired, assume 10 years
   - if older juvenile when acquired, assume 5 years old
   - if juvenile when acquired, assume 2 years old
   - if infant when acquired, assume $\leq$ 1 year old

3) If the date of birth is unknown, assume that the year of acquisition minus the assumed age in years is the birth year. For example, if an adult wild-caught gibbon was acquired from a private individual in 1990, its estimated birth date would be 01 January 1980.

4) When entering data on a wild-caught gibbon with an unknown capture date, assume that the gibbon was captured at one year of age. For example, a pileated gibbon entering the captive population by donation from a private individual in 1991 would have an estimated birth date of 01 January 1989 and an estimated capture date of 01 January 1990.

5) If a gibbon was collected from a known province, enter province in the institution list using the first nine letters. ■

Population and Habitat Viability Analysis Report for Thai Gibbons: *Hylobates lar* and *H. pileatus*

Chapter 3:

Royal Forest Department Action Plan

Thai Gibbon Action Plan

Hylobates lar & H. pileatus

Schwann Tunhikorn, Ronald Tilson and Workshop Participants

RECOMMENDATIONS FOR WILD THAI GIBBON POPULATIONS

The following recommendations for conservation management focus primarily on wild populations of lar and pileatus gibbons in Thailand, which were derived from the results of Vortex modelling simulations based upon current knowledge of wild gibbons. The simulations for gibbon populations assumed that there would be no future loss of protected habitat and considered varying levels of removal.

1) The current combined subpopulations of *Hylobates lar* in each of the 4 regions of Thailand are sufficiently large to not require exchange of individuals between the regions or the addition of captive bred individuals for either genetic or demographic support or augmentation of the populations over the next 100 years.

2) The current combined subpopulations of *Hylobates pileatus* in each of the 2 regions are sufficiently large to not require exchange of individuals between the regions or the addition of captive bred individuals for either genetic or demographic support or augmentation of the populations over the next 100 years.

3) Subpopulations of 1000 or more individuals within the regions will not benefit genetically or demographically by the addition of individuals from any source over the next 100 years unless a local extinction or decline in numbers (that is not a result of habitat loss) into one of the lower population size categories occurs.

4) Subpopulations of 200-1000 individuals, in habitat capable of sustaining larger populations, should simply be protected and allowed to expand in numbers by natural reproduction with no additions of individuals from other sources.

5) Subpopulations of 200-1000 individuals, near maximum densities in the occupied habitat, may benefit genetically by the periodic exchange of individuals from other populations. The addition or exchange of about 1-5 individuals, who reproduce in the population, per 20-40 years would be sufficient. *This type of translocation was not considered as a management option during the workshop. The feasibility of such translocations is questionable.*

6) Stable populations of 200 or more individuals (considered to at or near maximum densities) cannot sustain losses exceeding about 5 adult females with young per year per

1000 population without declining or increasing the risk of extinction. The effects of removal are so severe that losses should be eliminated as much as possible.

7) Populations of 200 or fewer individuals, in habitat that will not support a larger population, will require continuing monitoring and will benefit genetically by periodic supplementation with 2-5 individuals of known provenance at about 20 year intervals. These small populations should be evaluated individually and suitable conservation management plans developed for their particular needs. *Again, it is questionable whether such translocations are feasible.*

8) The **Gibbon Disease** working group recommended that complete medical examination, disease testing and biomaterials collection be performed on every gibbon captured from the wild or involved in translocation programs.

RECOMMENDATIONS FOR GIBBON MONITORING AND HABITAT PROTECTION

9) Natural gibbon populations must be regularly monitored to evaluate the effectiveness of existing protection methods. A simple monitoring program using protected area personnel should be implemented in selected key gibbon population areas, under the supervision of wildlife technical officials and resident biologists.

10) Royal Forest Department protected area personnel should be provided with training to more professionally administer their duties, to be more effective in educating people on the values of the protected area, and to better gain the confidence and trust of local people.

11) In general, every effort should be made to enhance the value of protected areas to adjacent human communities through easier access to self-sustaining resources (picking up dead wood, mushrooms, bamboo shoots), informal understandings with regard to what constitutes serious infractions (hunting), and providing jobs to members of local communities such as planting trees, clean-up activities, or construction projects.

12) In general, every effort should be made to enhance ecotourism income for members of local communities. An eco-development fund should be established to support local community projects that will benefit protected areas.

RECOMMENDATIONS FOR THAI GIBBON CAPTIVE MANAGEMENT

13) It is recommended that a captive management program for gibbons in Thailand be initiated for gibbons and linked with other global gibbon regional programs, particularly the Southeast Asia Zoo Association (SEAZA), as outlined in the *Thai Zoo Masterplan for*

Conservation. It was suggested that the species most in need of conservation action, both in the wild and in captivity, is *H. pileatus*.

14) This captive management program should be under the direction of the Zoological Parks Organization of Thailand (ZPO), and should have the participation of gibbons being held by the RFD at long-term holding facilities or sites.

15) The other critically endangered gibbon species held in ZPO zoos is *H. concolor*; however these gibbons are not native to Thailand. Despite this, the ZPO, working with reference to the *Thai Zoo Masterplan for Conservation*, may decide in the future to initiate a program for *H. concolor* as part of its international efforts to protect this taxon.

16) The ZPO captive management program for gibbons should be based on founders already in captivity, and not extracted from wild populations.

17) Specific recommendations for ZPO gibbon management protocols were established by the **Thai Gibbon Captive Management Working Group.**

18) Specific recommendations for ZPO gibbon medical management protocols were established by the **Gibbon Diseases Working Group**.

19) Specific recommendations for diseases of captive gibbons, particularly hepatitis B and tuberculosis, and the need to establish a regional or national wildlife disease and diagnostic laboratory in Thailand to support gibbon conservation efforts, were made by the **Gibbon Diseases Working Group.**

20) It was recommended by the **Genetic Management Working Group** that all gibbons in managed ZPO programs be genotyped, breeding combinations attempt to match gibbons of known geographic providence, interregional and interspecific hybridization be avoided, and additional characterization of wild populations of known providence be undertaken, particularly populations of *H. pileatus*.

RECOMMENDATIONS FOR GIBBON REINTRODUCTION PROGRAMS

21) It is recommended that a long-term rehabilitation and release program should be considered for gibbons held in captivity in Thailand. Protocols for such programs need to be developed at a future workshop.

22) If the Royal Forest Department decides to reintroduce gibbons, a possible list of protected areas of Thailand that could be considered as suitable sites for gibbon reintroduction or translocation programs was suggested by the working group on **Gibbon Rehabilitation and Release**.

23) If the Royal Forest Department decides to reintroduce gibbons, a preliminary set of guidelines regarding information needs for each gibbon reintroduction site and program was made by the working group on **Selection of Reintroduction Areas** as a basis for consideration at a future workshop.

24) If the Royal Forest Department decides to reintroduce gibbons, the **Gibbon Diseases Working Group** recommended a series of protocols regarding pre-lease quarantine, physical examination, and disease testing to eliminate any risk of introducing diseases or abnormal animals into wild populations.

DEVELOPMENT OF A GIBBON CONSERVATION STRATEGY FOR THAILAND

25) The Royal Forest Department requested the assistance of the IUCN/SSC Conservation Breeding Specialist Group to help develop a national conservation strategy for gibbons in Thailand. Recommendations from this PHVA report for Thai gibbons will provide a foundation for such a strategy. ■

Population and Habitat Viability Analysis Report for Thai Gibbons: *Hylobates lar* and *H. pileatus*

Chapter 4:

Supporting Reports and Articles

Factors to Consider in a Gibbon Reintroduction Program

W.Y. Brockelman

As young gibbons are captured from the wild and bought by pet lovers, large numbers are accumulating in captivity. While many of these receive loving care while young, they become dangerous and difficult to manage when they mature. They are usually kept on chains so they are not free to develop their legendary locomotor abilities. They are not given the food that gibbons are adapted to finding and eating in the forest. They have no chance to find a proper mate and enjoy a normal family life. They contribute nothing to the propagation of their own kind. Their songs go unanswered.

Clearly, the capture of gibbons for the pet market must be stopped and the raising of pets should be discouraged. It decimates natural populations and gibbons are not easily bred in captivity. Some of the gibbons now in captivity might be returned to the wild, but successful reintroduction is difficult. One cannot just turn a pet loose in the forest and expect it to survive. Many people have tried this. If these animals do not soon die of starvation, they usually follow humans around if they find them, beg for food and become a great nuisance.

Some studies have shown that with proper selection, preparation and supervision, some captive gibbons may be able to adjust to the wild and even reproduce. Many captives, however, cannot make the adjustment. More research needs to be carried out to find ways to improve the chances of successful reintroduction. A reintroduction project should involve close cooperation between pet owners, veterinarians, Forestry Department personnel and primatologists who study behavior and ecology.

The procedures involved in reintroduction of gibbons (and most other animals as well) fall under the following headings: selection, medical examination, rehabilitation, release site selection, public relations, release and follow-up observations. Clearly, the process is not rapid or simple, and requires careful preparation and attention to detail.

1. Selection of animals

Most gibbons in captivity are probably not suitable for release into the forest, for a variety of reasons. First of all, they must be strong and healthy, with no injuries that might impair their locomotor abilities, and their teeth should be intact. Second, they should be at home in the trees. Many gibbons raised in cages or around houses prefer to run on the ground, and therefore cannot adapt to forest life. Others may have been fed only a human diet and would not find natural foods to their liking.

Thirdly, the animals should be reintroduced into the same geographic range from which they originated, and animals should not be paired or bred with individuals of different races. This creates a problem, because we usually do not know where animals originated many years after their capture. At present, research is being carried out on techniques of genetically "typing" gibbons and other animals from their DNA.

2. Medical examination

All gibbons must be examined by a competent veterinarian to be sure that they are disease-free. Having been raised around humans, they can easily pick up human diseases and transmit them to other gibbons.

Adult gibbons must also be in good reproductive condition if they are to be paired and released.

3. Rehabilitation

"Rehabilitation" is the conditioning of captive animals to behave in a more natural-like manner so that they have a greater chance of successful adjustment to the wild. It is teaching them to behave more like gibbons again instead of like humans. This is a difficult process, and we cannot predict very well whether any given animal will succeed. There are several aspects of rehabilitation:

a. Locomotion - A gibbon must be given a spatious cage or other open area where it can practice brachiation and jumping. It should not be allowed to follow humans around on the ground.

b. Diet - Gibbons should be given a diet more resembling a natural diet, consisting of a wide variety of leaves, shoots, fruits and insects.

c. Socialization - Gibbons released as adults should be given compatible mates. This may require some experimentation - not all pairs will get along well, just as is true in humans. Grooming and duetting together are signs that pairing is successful.

A gibbon management facility should also attempt to socialize juvenile gibbons, by putting them together so they will play, groom and sleep together. Human contact must be minimized and they must be allowed to seek other gibbons for companionship, not humans. Unfortunately, most gibbons in captivity were captured as infants while clinging to their mothers, and later learned to depend on human substitutes for their mothers. It is not fully understood if this damages their chances for later mating or reproduction appreciably, but baby gibbons must receive warmth and motherly love from somewhere.

4. Release site selection

The release area should satisfy several criteria:

a. It should be natural habitat for the species being released - that is the species must have once lived there. Preferably, it should be in the same part of the country from which the gibbon originated; that is, a northern Thai gibbon should not be released on the peninsula. There may be important genetic differences between the populations in widely different parts of the country, as implied above.

b. The forest area should not have many wild gibbons remaining, or they will probably drive out the released animals. The territory of a single group may be as large as 30 hectares.

c. The site should be part of a large forest area, not isolated patch, so that it may be able to hold a viable population, not just a few animals. There should be space for at least 100 group territories, as a general rule.

d. The site should be away from human activity: not near houses, roads or places visited often by humans, or the gibbons may leave the forest and follow them. Adult gibbons raised with humans also readily attack humans and can cause serious injury with their canines.

e. The site should be in a park or wildlife sanctuary and actively protected by guards.

5. Public relations

If any villagers or other people live near the area they should be informed about the reintroduction so that they will not be surprised or puzzled to see the gibbons. They should be instructed about what to do if the gibbons approach or attack anyone. If possible, local people should be hired to help observe or protect the animals.

6. Release

The animals to be released, usually a mated pair, should be kept temporarily in a cage or enclosure at the release site to become accustomed to the area and local foods. This may induce them to stay around after release and not wander far away. They should continue to be offered food after release until they learn to rely on natural foods. They should not be allowed to follow humans. This may be considered to be the final - and most important - stage of rehabilitation.

Release sites must not be within the territory of any other group, wild or reintroduced. Mature males will fight over their territories - they will not share them. Release sites for different groups should be at least 500 meters part.

7. Follow-up observations

After release, the gibbons must be carefully observed to determine how well they adjust to the wild. Notes should be taken on their movements, ability to move through the trees, natural foods eaten and singing behavior. If they fail to behave like normal gibbons or if they follow people out of the forest, they may have to be returned to captivity. During the first year, they should be checked for several days each month. Local persons near the release site may be hired to regularly report on the animals. It is crucial that we observe whether each reintroduction was successful or not in order to be able to improve chances for future animals released.

MEDICAL EVALUATION OF RESCUED HYLOBATES SP.
CBSG/Thai Zoo

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INTRODUCTION

On 12 through 17 April 1993, a total of 52 *Hylobates sp.* were examined at the Khao Kheow Open Zoo and the Dusit Zoo. Animals were anesthetized and examined. Collection information included age, sex, weight, and location. Each animal received a physical exam and blood samples were collected for analysis. TB tests were administered, hair samples taken and vaccinations and therapeutics were administered. Blood samples were analyzed for CBC, biochemistry, and virology.

MATERIALS AND METHODS

Each animal received ketamine HCL (Ketaset, Fort Dodge Laboratories, Inc. Fort Dodge, Iowa 50501 USA) at a total dose of 35 to 80 mg (7 to 10 mg/kg). Dose was dependant upon animals location (tree tops versus enclosure) and visual assessment. Animals were weighed, age assessed as immature or adult and sex determined by the appearance of external genitalia. Physical exams were performed and venipuncture followed using the femoral vein. Tuberculin tests were administered using Mammalian Human Isolates (Tuberculin Intradermic, Coopers Animal Health Inc., Kansas City, KS 66103 USA) 0.1cc intradermally in the skin of the eyelid. Results were read by the zoo staff at 24, 48 and 72 hours. Hair was retrieved for genetic analysis. A doseage of 0.3cc tetanus toxoid adsorbed USP vaccine (Connaught Laboratories, Inc. Swiftwater, Pennsylvania 18370, USA) was administered into the hind limb musculature, and oxytetracycline (Liquamycin, LA-200, Pfizer Animal Health, New York, N.Y. 10017 USA) at a dose of 9 mg/kg IM was given to those animals which presented with health problems believed to be bacterial in origin. Rectal temperature was noted and ivermectin (Ivomec 1% Sterile Solution, MSDAGVET, Merck & Co., Inc. Rahway, New Jersey 07065, USA) at a dose rate of 200 mcg/kg was given to each individual.

Blood samples were placed in a cooler with ice packs or in a refrigerator. At intervals during the course of the day, serum samples were centrifuged, aliquoted into cryotubes and placed into a liquid nitrogen transport container. Following completion of the days activities, the samples were transported to Dr. Parntep Ratanakorn for further analysis.

RESULTS

Physical Exam - Physical exams were performed under ketamine anesthesia on 52 *hylobates* of three species (*Hylobates lar, hylobates concolor, and hylobates pileatus*) at two different sites (26 at Khao Kheow Open Zoo and 26 at Dusit Zoo). See Table 1. Eighteen of 52 animals (35%) had their canines blunted or cut. The most severely affected animals had exposed pulp cavities, some of which were visibly infected. In these cases the affected canines were removed. One individual had bilaterally curved metatarsi suggestive of secondary nutritional hyperparathyroidism. Two animals were difficult to definitely sex. One appeared mature based on the size of its canine teeth while the other was immature. The mature animal may be bilaterally cryptorchid or suffering from some other developmental anomaly. Further medical work-up of this individual would be revealing. A few of the animals had abscesses secondary to puncture wounds, most likely due to bites from conspecifics. One animal had a very firm subcutaneous abdominal mass approximately 3mm in diameter, round and smooth, possibly due to small gauge shot. One animal had an abscess penetrating into the larynx. This animal did not survive the procedure and was the only one to die during the course of the evaluations. A post-mortem necropsy was not performed.

Blood counts and biochemical profiles - Complete blood counts were performed on 30 of the 52 animals. See table 2. Biochemical profiles were determined for 48 of 52 animals. See table 3. Minimums, maximums, means, and standard deviations were calculated.

Virology - Viral testing was performed on a subset of the total group examined. Titers were examined for exposure to Hepatitis B antigen (HBsAg), Hepatitis B antibody (AntiHBs), Human Immunodeficiency Virus (AntiHIV), and Hepatitis A (HAV). Table 4 lists the virology results compared to the results of liver function tests in these gibbons and the data available through ISIS for normal liver function tests.

DISCUSSION

Fifty-two gibbons of three species were anesthetized and examined at the Khao Kheow Open Zoo and the Dusit Zoo. Approximately 35% of the examined animals had cut canines, some of which presented with an active pulpitis. A few of the animals had wire neck collars. One animal died following examination and on visual exam was found to have a penetrating laryngeal abscess secondary to a wire collar which was removed. Fifty-three percent (8/15) of the animals tested had titers to Hepatitis B antigen suggesting active viremia. Eight percent (1/12) of the animals tested had titers to Hepatitis B antibody suggesting these animals had mounted a response to the virus. Repeat analyses would need to be performed to determine whether the virus cleared from the systems of the antigen positive animals. No animals had titers to HIV and 27% (3/11) demonstrated exposure to Hepatitis A.

The data collected will serve as a starting point for health assessments during the PHVA.

HYLOBATES EVALUATION IN THAILAND ZOOS
KHAO KHEOW OPEN ZOO (KKOZ)
DUZIT ZOO (DZ)

COMPLETED BLOOD COUNTS

TABLE I

ACC	RBC	HCT	HB	WBC	PMN	MONO	EOS	BAND	LYM		MORPHOLOGY
L35	8.55	45.00	15.30	5200.00	56.00	1.00	1.00		42.00		NORMAL
L42	8.90	52.00	17.30	5950.00	70.00	4.00	1.00		25.00		NORMAL
L46	6.60	32.00	10.90	4950.00	69.00	1.00			30.00		ANISO, POIKILO
L47	4.38	29.00	8.90	4900.00	83.00	1.00		1.00	15.00		ANISO, POIKILO
R37	9.11	50.00	17.30	7550.00	60.00	4.00		2.00	34.00		NORMAL
R38	7.81	38.00	12.10	6750.00	54.00	1.00	1.00		44.00		NORMAL
R44	8.23	44.00	14.90	8450.00	67.00	3.00	3.00		37.00		NORMAL
R45	6.78	35.00	12.30	6950.00	56.00	2.00			42.00		ANISO, POIKILO
R50	8.90	54.00	18.30	6450.00	58.00	1.00	1.00		40.00		NORMAL
R51	7.10	39.00	13.80	5950.00	52.00	3.00			45.00		NORMAL
R52	7.98	43.00	14.80	6100.00	64.00	3.00	1.00	1.00	31.00		NORMAL
R15	9.40	55.00	16.60	22800.00	40.00	1.00	3.00		56.00		NORMAL
R17					12.00	4.00	10.00		74.00		ANISO
R18	7.78	48.00	15.20	9600.00	4.00	2.00	12.00		82.00		ANISO
R19	7.70	54.00	18.00	6600.00	13.00	4.00	20.00		63.00		ANISO
R20	8.24	59.00	18.20	11200.00	38.00	3.00	13.00		46.00		ANISO
R23	7.48	43.00	14.00	19600.00	22.00	2.00	11.00		65.00		ANISO, POIKILO
R26					48.00	5.00	16.00		31.00		ANISO, POIKILO
R25	8.26	62.00	18.40	15600.00	76.00	4.00	1.00		19.00		ANISO
L21	7.90	45.00	13.80	9400.00	37.00	4.00	8.00		51.00		ANISO, POIKILO
R24					44.00	1.00	2.00		53.00		ANISO
L11					8.00	2.00	30.00		59.00		ANISO
L13	7.26	48.00	14.20	10400.00	21.00	7.00	9.00		63.00		ANISO
L14	7.64	55.00	15.80	17200.00	49.00	1.00			50.00		ANISO
L16					45.00	3.00			52.00		NORMAL
L12					6.00	5.00	7.00		81.00		NORMAL
L22	6.98	44.00	14.60	15000.00	38.00	3.00	5.00		54.00		ANISO
R27					10.00	1.00			89.00		NORMAL
R29					1.00	1.00	2.00		96.00		ANISO
LAR30	5.96	40.00	12.40	6800.00	12.00	4.00	4.00		80.00		ANISO

MIN	4.38	29.00	8.90	4900.00	1.00	1.00	1.00	0.00	15.00
MAX	9.40	62.00	18.40	22800.00	83.00	7.00	30.00	2.00	96.00
MEAN	7.68	46.09	14.87	9700.00	40.43	2.70	7.32	0.80	51.63
STD DEV	1.10	8.41	2.49	4998.09	23.69	1.55	7.32	0.75	20.32

HYBLOBATES BIOCHEMICAL PROFILES

TABLE II

ACC #	BUN	CREAT	URIC	NA	K	CL	CO	CA	PO	PROT	ALB	GLOB	SGOT	SGPT	AP	TB	DB	CHOL	TG
# 1	4	0.2	2.5	144	6.5	117	16.0	6.6	1.23	5.1	3.8	2.3	30	84	1981	0.99	0.05	191	87
# 2	5	0.8	3.1	150	5.6	108	27.0	5.9	2.99	5.6	3.5	2.1	17	27	565	0.37	0.05	155	47
L3	4	0.9	2.5	151	5.7	110	23.0	6.0	2.10	6.4	3.6	2.8	16	51	680	0.56	0.03	169	100
R4	7	1.0	2.5	151	5.7	114	19.0	5.5	3.75	6.0	3.1	2.9	17	23	1396	0.16	0.01	122	81
R5	5	1.2	2.7	142	4.7	112	15.0	5.3	3.22	5.9	3.3	2.6	14	14	1191	0.28	0.07	124	89
R6	3	1.3	2.5	152	5.7	118	30.0	5.2	1.96	6.6	3.4	3.2	15	14	205	0.41	0.10	109	75
R7	3	1.3	2.7	152	5.1	112	20.0	6.6	1.71	6.2	3.7	2.5	21	29	373	0.27	0.05	112	105
R8	11	1.0	1.6	138	4.4	110	19.0	5.6	4.13	6.3	3.7	2.6	11	12	1428	0.22	0.10	126	191
L9	4	1.0	2.5	142	4.0	110	20.0	6.5	1.68	7.0	3.6	3.4	53	91	313	0.62	0.14	176	226
L10	5	1.5	1.5	138	4.2	110	22.0	5.2	2.17	6.1	3.3	2.8	10	25	546	0.11	0.04	163	103
L11	5	0.8	3.3	146	5.2	115	23.0	5.5	3.36	6.6	3.3	3.3	21	29	244	0.42	0.09	183	130
L14	4	0.5	1.7	137	5.9	107	21.0	6.6	1.78	6.9	3.4	3.5	16	9	277	0.69	0.01	124	64
R15	6	0.0	2.8	148	9.8	114	13.0	8.1	2.89	7.2	4.0	3.2	47	32	3382	1.87	0.16	134	133
L16	6	1.2	2.9	136	4.9	108	23.0	6.4	1.41	6.6	4.5	2.1	18	20	186	0.64	0.05	122	52
R17	0	1.4	2.2	148	5.7	111	24.0	6.1	0.85	6.7	4.1	2.6	30	26	163	0.61	0.04	132	70
R18	1	0.7	1.9	136	4.9	114	23.0	5.5	4.82	5.5	3.1	2.4	21	27	1344	0.10	0.04	128	71
R19	4	1.5	3.1	157	5.8	114	25.0	5.9	2.04	5.9	4.0	2.9	47	33	237	0.28	0.04	118	73
L21	4	0.8	1.4	151	5.0	121	24.0	5.5	2.91	5.5	3.6	1.9	14	19	523	0.17	0.04	118	86
L22	5	0.9	1.1	165	4.9	111	20.0	6.0	5.08	5.1	9.5	2.0	103	26	1638	0.18	0.07	114	69
R23	8	1.6	3.4	148	5.0	105	18.0	5.2	3.23	6.1	3.1	3.0	36	29	295	0.15	0.08	86	149
R24	2	1.0	2.1	157	6.0	114	21.0	5.8	3.23	6.7	4.1	2.6	43	23	297	0.22	0.11	143	163
R25	2	0.8	3.3	148	4.1	108	26.0	5.1	4.07	5.6	3.0	2.6	61	22	849	0.38	0.23	124	108
R26	8	1.0	2.2	152	5.4	107	21.0	5.4	5.71	4.6	2.0	2.6	39	23	895	0.16	0.03	147	214
# 27	3	1.5	5.1	149	5.8	101	6.0	6.7	0.54	7.8	4.4	3.4	21	16	458	0.38	0.10	107	133
# 28	1	0.8	4.6	148	5.7	106	21.0	6.5	1.50	6.6	3.7	2.9	24	38	561	0.51	0.08	127	111
# 29	15	1.2	6.0	153	5.8	107	23.0	6.0	2.01	5.6	3.6	2.0	40	31	1244	0.47	0.03	147	102
# 30	5	1.0	3.0	150	5.7	108	18.0	5.6	2.81	7.1	2.7	3.4	18	20	1275	0.20	0.05	149	103
# 32	4	1.2	1.7	158	6.2	111	6.0	6.4	4.30	8.0	4.4	3.6	14	15	360	0.33	0.10	174	159
# 33	10	1.8	2.4	155	6.7	105	10.0	4.7	7.43	7.4	3.8	3.6	25	18	2859	0.13	0.07	233	113
R34	6	1.3	5.3	155	6.2	104	19.0	6.0	3.94	6.0	3.8	2.2	29	24	510	0.11	0.07	104	271
L35	4	1.0	4.3	153	5.4	106	11.0	5.8	2.55	6.8	3.9	2.9	24	33	758	0.38	0.05	154	165
R36	8	1.3	3.6	145	4.0	111	23.0	5.4	3.64	7.3	4.1	3.2	14	13	594	0.32	0.12	101	123
R37	16	1.2	6.0	140	6.1	97	17.0	6.1	0.48	6.3	4.0	2.3	22	11	563	0.68	0.03	137	104
R38	5	1.5	5.2	143	5.5	98	5.3	5.5	4.93	6.7	4.6	2.1	29	36	465	0.33	0.10	105	169
R39	22	1.5	6.2	142	4.0	104	13.0	5.8	3.71	6.8	4.0	2.8	14	11	339	0.22	0.12	229	216
R40	3	1.0	3.7	140	4.0	106	13.0	5.4	2.73	6.4	4.0	2.4	16	15	1092	0.25	0.03	130	71
R41	2	1.2	3.3	141	5.0	107	15.0	5.4	4.00	6.6	3.8	2.8	20	18	787	0.12	0.07	124	118
R42	6	1.4	3.1	124	4.3	88	8.2	5.5	2.38	6.4	3.8	2.6	20	33	199	0.10	0.04	110	67
R43	2	1.4	1.8	153	5.6	117	9.0	6.1	3.87	6.3	4.4	1.9	24	32	913	0.16	0.08	93	64
R44	5	1.0	4.1	124	6.4	99	17.0	8.0	2.51	6.4	3.9	2.5	52	23	1057	2.00	0.09	99	47
R45	12	1.0	2.1	155	5.8	110	7.0	6.6	4.74	7.1	3.8	3.3	145	453	666	0.41	0.04	154	137
L46	5	0.3	4.1	151	8.3	110	12.0	8.3	2.71	7.1	4.1	3.0	70	18	162	2.12	0.11	117	143
L47	2	0.9	3.9	156	4.7	105	19.0	6.4	3.03	7.3	4.4	2.9	18	14	970	0.44	0.06	167	137
L48	15	1.9	3.0	154	6.5	108	19.0	6.6	3.52	7.2	4.1	3.1	16	13	245	0.50	0.18	154	327
R49	3	1.6	2.9	145	4.3	99	5.2	6.9	0.22	7.1	4.5	2.6	53	19	174	0.64	0.08	146	154
R50	3	1.4	3.8	154	6.1	111	14.0	6.3	1.38	6.6	3.9	2.7	30	20	227	0.24	0.10	121	101
R51	2	0.7	2.5	151	5.4	109	17.0	6.0	4.93	6.1	3.5	2.6	17	25	1650	0.81	0.01	167	109
R52	4	0.7	0.6	149	5.7	104	21.0	5.2	5.50	6.3	4.1	2.2	15	30	7505	0.35	0.09	154	69
MIN	0	0.0	0.6	124	4.0	88	5.2	4.7	0.22	4.6	2.0	1.9	10	9	162	0.10	0.01	86	47
MAX	22	1.9	6.2	165	9.8	121	30.0	22.0	7.43	8.0	9.5	3.6	145	453	7505	2.12	0.23	233	327
MEAN	6	1.0875	3.079	147.4	5.487	108	17.5	6.014	3.035	6.447	3.875	2.727	30.62	34.72	930.0	0.459	0.073	138	120.
STD	4	0.3865	1.283	1.283	8.043	5.914	6.1	0.747	1.484	0.692	0.957	0.462	24.38	62.90	1169	0.445	0.043	31.23	58

TABLE III

HYLOBATES SPP. VIROLOGY RESULTS

ID	HBsAg	AntiHBs	AntiHIV	AntiHAV	SGOT	SGPT	AP	TB	DB
R37	+	-	-	-	22	11	563	0.68	.03
R38	+	-	-	NA	29	36	465	0.33	0.10
R39	+	-	-	+	14	11	339	0.22	0.12
R40	+	-	-	+	16	15	1092	0.25	0.03
R41	+	-	-	-	20	18	787	0.12	0.07
R42	-	+	-	+	20	33	199	0.10	0.04
R43	-	-	-	-	24	32	913	0.16	0.08
R44	+	NA	-	-	52	23	1057	2.00	0.09
R45	+	NA	-	NA	145	453	666	0.41	0.04
L46	-	-	-	-	70	18	162	2.12	0.11
L47	+	NA	-	-	18	14	970	0.44	0.06
L48	-	-	-	-	16	13	245	0.50	0.18
R49	-	-	-	NA	53	19	174	0.64	0.08
R50	-	-	-	-	30	20	227	0.24	0.10
R51	-	-	-	NA	17	25	1650	0.81	0.01
+/TOT	8/15	1/12	0/15	3/11					
%POS	53%	8%	0%	27%					
ISIS					32	27	406	0.30	