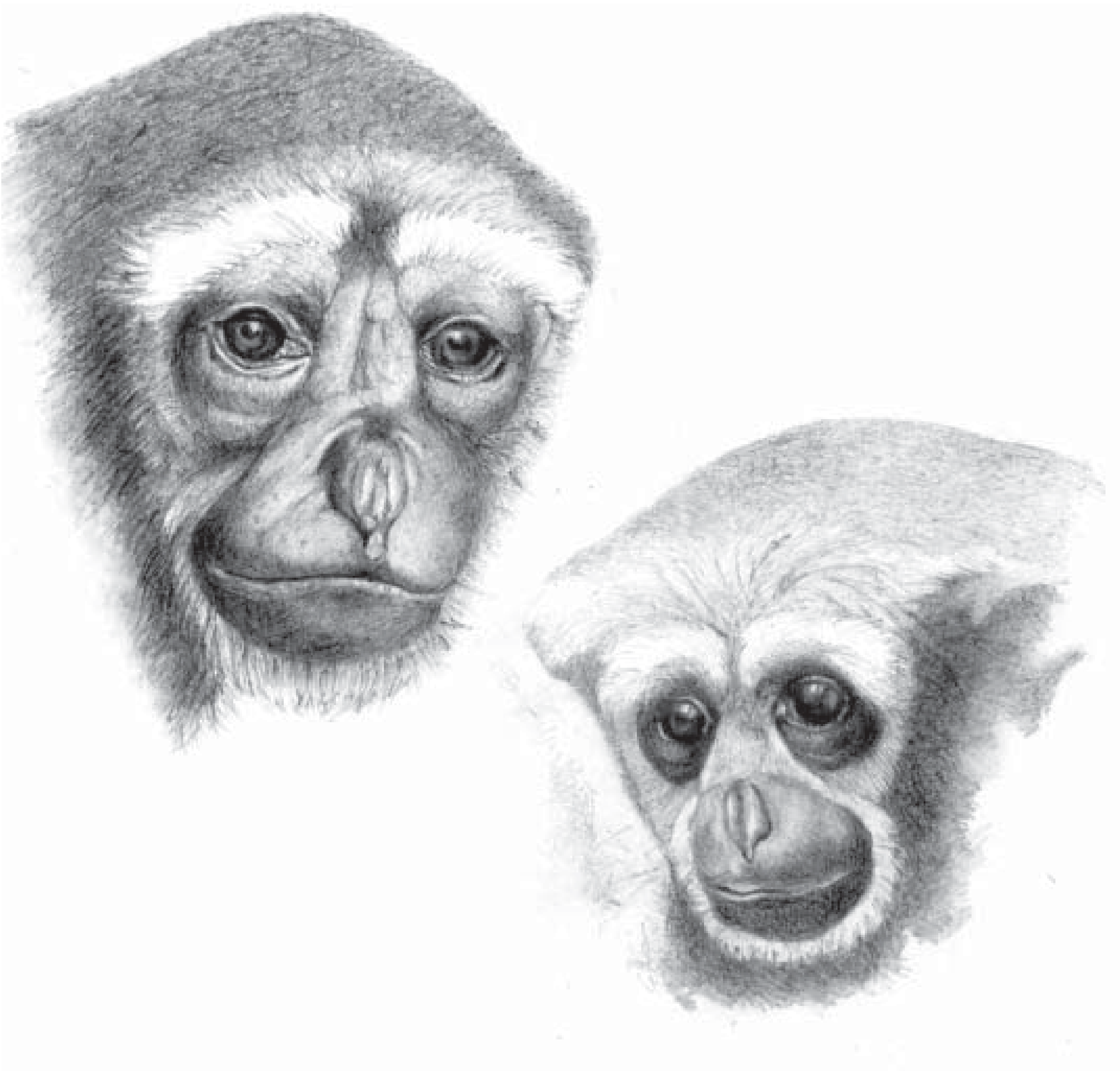
# Conservation of Western Hoolock Gibbon (*Hoolock hoolock hoolock*) in India and Bangladesh



**Population and Habitat Viability Assessment (P.H.V.A.)**
**Workshop Report, 2005**

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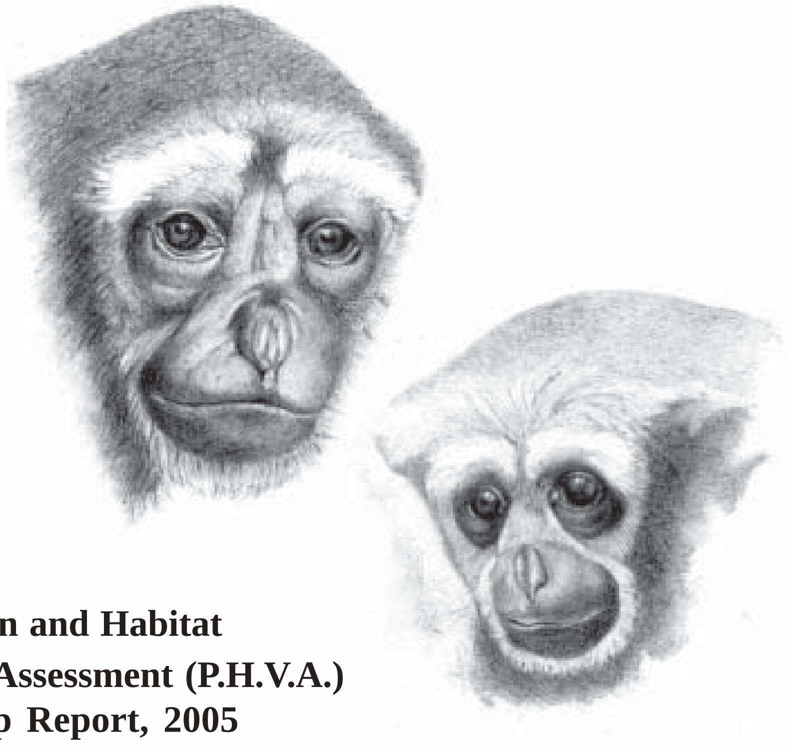

## Population and Habitat Viability Assessment (P.H.V.A.) Workshop Report, 2005

**Editors :**
**Sanjay Molur, Sally Walker, Anwarul Islam, Phil Miller, C. Srinivasulu, P.O. Nameer, B.A. Daniel and Latha Ravikumar**

**Authors :**
**Participants of the P.H.V.A. Workshop**

**Organisers :**
**Wildlife Trust of Bangladesh (WTB)**
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Ph. +91 422 2561087, 2561743; Fax: +91 422 2563269
Email: zooreach@vsnl.com / herpinvert@vsnl.com / zoocrew@vsnl.net
Website: www.zooreach.org; www.zoosprint.org

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# Population and Habitat Viability Assessment (PHVA) for Western Hoolock Gibbon

**Dhaka, Bangladesh 14-18 February 2005**

**Participants / Authors**


Dr. M. Farid Ahsan
Department of Zoology
University of Chittagong
Chittagong 4331, Bangladesh
Tel: +88-172-847356
Fax: +88-31-726310
E-mail: faridahsan@yahoo.com

Mr. Mohammad Ali, ACF
Wildlife Management and Nature Cons. Division, Solosahar BFRI Campus
Chittagong, Bangladesh
Tel: +88-31-684420 (O), 716637 (R)
+88-172-104664 (Mobile)
Fax: +88-31-684420
E-mail: mali@gononet.com

Dr. F.R. Al-Siddique
10, Shya Neer, 78/10 Pollobi Extension
Dhaka 1216, Bangladesh
Tel: +88 9003977, 9003749 (R)

Mr. Md. Abdul Aziz
C/o. Dr. M.M. Feeroz, Dept. of Zoology
Jahangirnagar University
Savar, Dhaka, Bangladesh
Tel: +88-176-256193
E-mail: azizzool@yahoo.com

Dr. N.C. Banik
Deputy Curator, Dhaka Zoo
Mirpur, Dhaka, Bangladesh
Tel: +88-171-689944
E-mail: ncbanik53@yahoo.com

Mr. Joyram Baruah
P.O. Banmukh, Kathpar, Dist. Sivasagar
785640, Assam, India
Tel: +91-3771-244125 (R)
+91-94350 95071 (Mobile)

Mr. Surajit Baruah
Research Scholar, Ecology & Wildlife Biology Lab, Department of Zoology, Gauhati University, Guwahati 781014, Assam, India
Tel: +91-361-2542711(R)
Fax: +91-361-2570647
E-mail: surajit2@sify.com

Dr. Khudesta A. Begum
ULO, Deputation, Planning & Evaluation Cell, Department of Livestock Services Bangladesh, Dhaka, Bangladesh
Tel: +88-02-9110924, 9113395 (O)
+88-171-283169, 9667310 (R)
E-mail: khudesta_009@yahoo.com

Dr. Jihosuo Biswas, Field Biologist
Primate Research Centre, (NE India)
House No-4, Anandnagar, Bylane-3, P.O. Pandu, Guwahati 781012, Assam, India
Tel: +91-94351 20002 (Mobile)
Fax: +91-361-2570647
E-mail: jihosuo@yahoo.com

Mr. Joydeep Bose
Programme Officer (Wild Aid)
Wildlife Trust of India
A-220, New Friends Colony,
New Delhi 110065, India
Tel: +91-11-26326025/26
Fax: +91-11-26326027
E-mail: joydeep@wti.org.in, jbose100@hotmail.com

Mr. Suprio Chakma, Research Assistant
Encyclopedia of Flora & Fauna Project
Asiatic Society of Bangladesh
Old Secretary Road 5, Nimtali, Ramna, Dhaka 1000, Bangladesh
Tel: +88-0189-606087 (Mobile)
E-mail: supriochakma@yahoo.com
rongdng@yahoo.com

Dr. Dilip Chetry
Conservation Biologist, Primate Research Centre, (NE India), House No.4, Ananda Nagar, Bylane-3, Adabari Guwahati 781 012, Assam, India
Tel/Fax: +91-361-2570647
+91-94350 43892 (Mobile)
E-mail: chetryd@rediffmail.com, primateconservation@rediffmail.com

Dr. Tapan Kumar Dey
DFO, (Wildlife & Nature Conservation Division), Solasahar, Chittagong Bangladesh
Tel: +88 171-047966, 031-684420 (O)
E-mail: deytk@gononet.com

Dr. M.M. Feeroz
Department of Zoology
Jahangirnagar University
Savar, Dhaka, Bangladesh
Tel: +88-176-738795
E-mail: feeroz@juniv.edu

Dr. A.K. Gupta, CCF
Professor, Wildlife Institute of India
P.O. Box 18, Chandrabani
Dehradun 248 001, Uttaranchal, India
Tel: +91-135-2640111-115
Fax: +91-135-2640117
E-mail: akg@wii.gov.in, akphayre@yahoo.com

Mr. Md. Kamrul Hasan
C/o. Dr. M.M. Feeroz
Department of Zoology
Jahangirnagar University
Savar, Dhaka, Bangladesh
Tel: +88-171-235186, 0188-188554
E-mail: asan_wildlifeju@yahoo.com

Mr. Md. Hasanuzzaman
Assistant Professor, Dept. of Animal Science and Nutrition, Chittagong Govt. Veterinary College, Pahartoli, Chittagong 4202, Bangladesh
Tel: +88-171-204970
Fax: +88-31-659492
E-mail: anikzaman@yahoo.com

Mr. Asif Ahmed Hazarika
Director, Wild Survey North East
Seujpur, 4th Bylane, P.O. & Dist. Dibrugarh, Assam 786 001, India
Tel: +91-373-2300558
E-mail: asifhazarika@yahoo.com

Mr. Md. Akbar Hossain
DFO Mymensingh Forest Division
Mymensingh, Bangladesh
Tel: +88 171-543475

Dr. Md. Salim Iqbal
Veterinary Surgeon, Dhaka Zoo
Mirpur, Dhaka, Bangladesh
Tel: +88-175-026175
E-mail: salim87@bangla.net

Dr. Basit Khan
Environmental Advisor, Premier Oil
H/No 313, Hill Side Road, E-7, Islamabad 44000, Pakistan
Tel: +92-300-5011425
Fax: +92-51-2823718
E-mail: ar_basitkhan@yahoo.co.uk

Mr. Awadhesh Kumar
Wildlife Researcher, North Eastern Regional Institute of Science and Technology, Department of Forestry
Nirjuli, Itanagar 791 109,
Arunachal Pradesh, India
Tel: +91-360-2257402-8, Ext. 6454
Fax: +91-360-2257563
E-mail: reshi123in@yahoo.co.in, primates077@rediffmail.com

Mr. Chukhu Loma, Director
Biological Park, Itanagar
C/o Office of the Deputy Chief Wildlife Warden, Govt. of Arunachal Pradesh
G-Extention, PO- Naharlagun 791110, Arunachal Pradesh, India
Tel: +91-360-2244416 (O)
Mobil: +91-9436042049
Fax: +91-360-2214040
E-mail: loma_ap@yahoo.co.uk

Dr. Rekha Medhi
Lecturer, Department of Zoology
Jawaharlal Nehru College, Boko
781123, Assam, India
Tel: +91-361-2513133 (R), +91-98640 55896 (Mobile)
Fax: +91-361-2570647
E-mail: medhirekha@rediffmail.com

Dr. Sangita Mitra
Sr. Project Officer, WWF-India,WB State Office, Tata Centre, 1st Floor, 43
J.L. Nehru Road, Kolkata 700071, West Bengal, India
Tel: +91-33-2288-9530/3038 (O), 23532090 (R)
Fax: +91-33-22883761
E-mail: smitra@wwfindia.net, monkinct@rediffmail.com

Mr. Alan Mootnick
Director, Gibbon Conservation Center
P. Box 800249, Santa Clarita CA 91380, USA
Tel: +1-661-296-2737
Fax: +1-661-296-1237
E-mail: hoolock@earthlink.net

Mr. P. O. Nameer
Assistant Professor Dept. of WL Sciences, College of Forestry, Kerala Agrilcultural University, KAU (PO)
Thrissur 680 656, Kerala, India
Tel: +91-487-2370050, 2371018 (O), 2373106 (R), +91-9388556966 (Mobile);
Fax: +91-487-2371040
E-mail: trc_nameer@sancharnet.in

Mr. Md. Shamsur Rahman
CF (Wildlife & Nature Conservation Circle), Ban Bhaban, Mohakhali
Dhaka, Bangladesh
Tel: +88 8813820

Mr. Laskar Muqsudur Rahman, DFO
Wildlife Management and Nature Cons. Division, Sylhet, Bangladesh
Tel: +88-171-318935
E-mail: laskarmr@yahoo.com

Ms. Shimona A. Quazi
Lecturer, Dept. of Environmental Studies (Former), North South University
12 Kemal Ataturk Avenue, Banani Dhaka 1213, Bangladesh
Tel: +880-189 274321 (Mobile)
Email: shimona.quazi@gmail.com, shimonaq@yahoo.com

Mr. Amal Ch. Sarmah
Divisional Forest Office, Digboi Division, Itabhata, P.O. & P.S. Digboi Dist: Tinsukia 786171, Assam, India
Tel: +91-3751-264433 (O), 264839 (R); +91-94351 37918 (M)
Email: dfodigboi@sancharnet.in

Dr. G.S. Solanki
Senior Lecturer, North Eastern Regional Institute of Science & Technology, Dept. of Forestry, Nirjuli 791109, Arunachal Pradesh, India
Tel: +91-360-2257401(O) Ex. 6114, 2257749 (R); Fax: +91-360-2244307
E-mail: gssolanki02@yahoo.co.in

Dr. C. Srinivasulu
Research Associate, Department of Zoology, Osmania University, Hyderabad 500007, Andhra Pradesh, India
Tel: +91-40-27682218 (O), 55191981 (R); Fax: +91-9440571981 (Mobile)
E-mail: hyd2_masawa@sancharnet.in

**Resource Person**

Dr. Phil Miller, Sr. Program Officer
Conservation Breeding Specialist Group (SSC/IUCN), 12101 Johnny Cake Ridge Road, Apple Valley, MN 55124-8151, USA
Tel: +1-952-9979802
Fax: +1-952-9979803
E-mail: pmiller@cbsg.org

**Zoo Outreach Organisation**

Ms. Sally Walker, Founder/Hon. Director (zooreach@vsnl.com)
Mr. Sanjay Molur, Deputy Director (herpinvert@vsnl.net)
Dr. B.A. Daniel, Scientist (icinsa@vsnl.net)
Mr. R. Marimuthu, Education Officer (marimuthu@zooreach.org)
Ms. J. Sheela
Mr. Ravichandran
Zoo Outreach Organisation
No. 29/1, Bharathi Colony
P.Box 1683, Peelamedu
Coimbatore 641004, Tamil Nadu, India
Tel: +91-422-2561087, 2561743
Fax: +91-422-2563269
E-mail: zoocrew@vsnl.net

**Wildlife Trust of Bangladesh**

Mr. Enayetullah Khan, Chairman
Dr. Md. Anwarul Islam, Chief Executive
Ms. Farhana Ruma, Programme Officer
Ms. Afroza Yasmin, Programme Officer
Ms. Gawsia Wahidunnessa Chowdhury, Programme Officer
Mr. Nurul Basar Sarker, Programme Officer
Mr. Md. Shahriar Mahmud, Research Assistant
Mr. Mahmudul Hassan, Research Assistant
Ms. Mehrab Chowdhury, Research Assistant
Ms. Israt Jahan, Research Assistant
Wildlife Trust of Bangladesh
COSMOS Centre, 69/1, New Circular Road Malibagh, Dhaka 1217
Bangladesh
Tel: 880-2-9336163, 8312014
Fax: 880-2-8314602, 9345540
E-mail: wildlife@citechco.net

# Conservation of Western Hoolock Gibbon
# *(Hoolock hoolock hoolock)* in India and Bangladesh

## Executive Summary

## EXECUTIVE SUMMARY

The Western Hoolock Gibbon *(Hoolock hoolock hoolock)* was assessed as Critically Endangered in Bangladesh and Endangered in India based on IUCN Red List Criteria, Regional Guidelines (IUCN 2003). Numbers are small (600-700) and they are further disadvantaged by their distribution in 126 localities in India and Bangladesh in populations ranging from 1 to 40. That they can be seen in so many localities imparts a false impression of status and security of the taxon. A Population & Habitat Viability Assessment (PHVA) Workshop was organized in Dhaka, Bangladesh from 14-18 February, 2005 initiated by Zoo Outreach Organisation and the South Asian Primate Networks of the IUCN SSC Primate Specialist Group and organised with collaborating organizations from both countries, particularly Wildlife Trust of Bangladesh (WTB), Forest Directorate, Government of the People's Republic of Bangladesh, Wildlife Information Liaison Development (WILD), CBSG, South Asia, and IUCN SSC Conservation Breeding Specialist Group (CBSG). The workshop, Report, and other material to generate public awareness was generously sponsored by the Great Ape Fund of the United States Fish and Wildlife Service, Margot Marsh Biodiversity Foundation Pimate Action Fund/ Conservation International, Twycross Zoo, Columbus Zoo and Appenheul Primate Park.

Hoolock Gibbon localities are situated in areas of high biodiversity, e.g. northeastern India and remaining forest areas of Bangladesh. Participants were invited from the forest and wildlife departments of both countries, local NGOs, field biologists of Bangladesh and India,who have had direct experience with Hoolock Gibbons and a few outside specialists.

The PHVA helps in understanding the implications of small population dynamics on the survival of threatened species. On the basis of deliberations of five Working Groups and frequent plenary discussions over a five-day period, a Draft Report was created and reviewed by participants to provide the basis for this Report. This Report will be used to address policy makers and politicians as well as the public to support recommendations for actions leading to long term survival of Western Hoolock Gibbon (WHG). An extensive education component will support circulation of the Report and a Summary, help participants and other educators carry out public awareness recommendations and drive home a message of need for intensive and immediate governmental intervention on behalf of this species.

### Working Groups

The **Simulation Modelling Group** ran population simulations using VORTEX with current information on WHG biology. The group modelled different variables around baseline data derived after sensitivity testing analysis. Some variables modelled included initial population sizes (ranging from 5-100 with intervals of 5), adult mortality rates (1%, 3% and 5%), inbreeding (0 and 3.14), age of first reproduction (8-14 years), female fertility rate (20-50%), catastrophes (0% - 5%), carrying capacity (no trend and negative trend), and hunting. The models generated a very high probability of extinction for populations of less than 15 individuals within twenty years, which applies to more than 80% of the existing population of WHG in India and Bangladesh. For populations larger than 15 individuals also, the probability of extinction increased with higher levels of adult mortalities, negative trend in carrying capacity and hunting, which are common factors affecting most wild WHG populations. The largest population in Bangladesh (Lawachara) with 37 individuals is very much prone to extinction within the next 25-30 years if hunting and habitat destruction continues at the present rate. In India, the largest population of 156 individuals is relatively safe, but only if habitat destruction and hunting are reduced.

The **Wild Population Management Working Group** discussed and prioritised problem areas for WHG population managment in the wild in both India and in Bangladesh by addressing them in two categories, under direct and indirect effects. The group identified problems under direct and indirect effects and deliberated on each of the identified issues, defining the facts, assumptions, justifications, and data availability. They then prioritised goals and actions for five main issues including 1. arresting habitat loss; 2. receiving legislative support for preventing illegal activities relative to conservation of WHG; 3. improving livlihoods of people living in and around WHG habitat; 4. setting up effective administration to support conservation programmes including periodic population monitoring; and 5. earning political will in favour of conservation.

The **Habitat and Distribution Working Group, Bangladesh** revisited data compiled at the 2002 Conservation Assessment and Management Plan (CAMP) Workshop for Primates held in Coimbatore, India. In the intervening three years, eight populations / locations of WGH have become extinct in Bangladesh due to combined effects of habitat loss, fragmentation, human interference and hunting: Horinchara in northeast; Chunati, Satghar, Padua, Bomarighona, Hinchari, Hnilla and Teknam in the southeast. The group also identified WHG in 23 other localities with 14 of those localities having less than ten individuals in the population. One location Lawachara has the largest population which consist of only 37 individuals. Priority problems identified are : habitat loss, human interference, agriculture, development, extraction, alien/exotic species. The Working Group based goals and action plans on these priorities.

The **Habitat and Distribution Working Group, India** also revisited the data from 2002 Primate CAMP exercise and noted that nine previously listed populations had not been recorded. The group recommends surveys to determine whether these localities have lost WHG or not. Hoolocks occur in all the seven states of NE India with Aranachal Pradesh having 168 individuals in 7 populations, Assam having 1985 in 94 populations, Meghalaya 236 individuals in 10 populations, Mizoram 128 individuals in 9 populations and Tripura 97 individuals in 3 populations. Population information from Manipur was not available due to difficulties in conducting field studies in the state. Of the total of 111 populations observed in the country, the number of population-size classes indicates that more than 55% of the populations of WHG in India have less than 15 individuals while only ten populations have more than 50 individuals. The goals identified by the group included the following six : arresting habitat loss, better understanding of WHG distribution, building political will, upgrading socio-economic as well as education status of people, increasing manpower for protection of WHG habitat, and increasing legislative support for preventing illegal activities.

The **Political and Public Awareness Working Group** felt that the socio-economic as well as educational status of the people living in WHG localities need improvement before they can participate in meaningful activity which would lead to WHG conservation, and recommended actions to bring this about. This included ways to strengthen the education system in general and as applied specifically to information pertaining to WHG as well as improving the socio-economic status, so that an attitudinal change towards conservation could evolve. The group also discussed legislaton, suggesting amendment of existing laws to reflect current values and emphasize species and habitat conservation. The group felt religious leaders could play an effective role in conservation education in Bangladesh if they were appropriately guided.

In the **Captive Management Group** it was noted with alarm that a large number of WHGs had been captured for exhibition and captive breeding over the years, and even very recently in Bangladesh, without appropriate exhibition or holding facilities, educational emphasis or expertise in husbandry. During that time only one infant was been born and survived and is currently living in Dhaka Zoo. The group discussed lacunaes in expertise in zoo conservation, management, administration, education and research and made recommendations for filling these gaps. A beginning was made on the formulation of a management plan for captive propagation utilising only currently held WHGs in India and in Bangladesh. In view of facts from the modelling and the habitat and distribution group, it was felt that no further WHG should be captured for captive breeding or exhibition in either country.

After the Working Groups completed their Reports recommendations were prioritised, read out at the Validictory function and distributed to the Press. The recommendation, after modification following Draft review are given below.

## Recommendations of the PHVA Workshop for Western Hoolock Gibbon

### *In situ* or field recommendations

1. In India the Western Hoolock Gibbon WHG is highly threatened due to habitat loss, but has been neglected compared to large mammals of the country. Considering the uniqueness of this species, the workshop recommends the development of a Ministry of Environment project dedicated to WHG for its long term conservation. A Memorandum should be submitted along these lines.

2. Habitat loss is the primary reason for decline of WHG in Bangladesh with 8 populations becoming extinct in the last 15 years. This decline in habitat must be arrested both in quantity and quality through multi-species plantations, checking illegal felling and other measures.

3. Legislative support (currently being updated) is urgently required for preventing illegal activities such as poaching, encroachment, etc. Even existing legislation can be effectively implemented through a coordinated approach, nurturing working relationships with NGOs, academics, local communities, and policy makers, training and sensitization of legislators towards the need of WHG.

4. In Bangladesh, there are 22 known populations of WHG, of which 18 have less than 10 animals, isolated and fragmented small populations which cannot survive due to their size and pressure on their habitat. The workshop recommends translocation of the small populations to larger, viable habitats, taking advice and help from the IUCN SSC Reintroduction Specialist Group.

5. The Workshop recommends enhanced monitoring of habitat of WHG on priority basis including creation of more wildlife posts for patrolling, specific training for management in scientific monitoring methodology, improved infrastructure and peoples' participation.

6. As habitat loss and habitat destruction are the most important factor for decline of WHG in both countries, the workshop recommends a firm commitment from the two governments for wildlife habitat protection in localities associated with WHG and immediate follow up by the concerned departments.

7. The workshop recommends community-based eco-development programmes to be developed in order to generate alternate livelihood to check illegal activities in WHG habitat to minimize habitat loss.

8. The workshop recommends networking specialists, policymakers, law enforcement and celebrities popular with the general public to assist in producing an attitudinal change in politicians and general

public, particularly local stakeholders, about the need for overall protection of WHG.

9. The workshop recommends both countries to create a widely available database on WHG and its requirements for survival to encourage educational projects including educational programmes directed at laypersons in the localities of the species. Religious leaders/teachers could be particularly effective combining scientific facts with religious scriptures about wildlife conservation.

10. The workshop recommended a sytematic study of the eight localities in which WHG had become complete extinct in the last three years in Bangladesh should be undertaken to determine the reasons and causative factors so that the same could be recognised early in other localities.

11. Since translocation may be the only viable alternative to extinction of WHG which make up very small populations in several localities in both India and Bangladesh, the Working Group recommended that multidisciplinary teams for each country should be appointed consisting of experts from within the countries and external experts with experience in translocating similar species to assess proposed release sites for suitability, review socioecological and behavioural data on WHG to determine if these and legal requirements can be met, assess proposed individuals to be relocated keeping in mind genetic, demographic and health aspects, develop a strategy and timeframe for transport and release, establish and enact post-release monitoring and other follow up. The teams should also document project outcomes and keep the governments and conservation community fully informed.

### ***Ex situ* or zoo conservation**

12. As many WHGs have been taken from the wild in the past for exhibition in zoos and infructous captive breeding projects, and since the removal of even a very small number of animals can impact the future survival of the species, the workshop unanimously recommends that no further WHG should be captured from the wild for zoos or captive breeding centres. Zoos currently holding WHG should focus their conservation efforts on education, research and a regional cooperative breeding programme utilising currently held WHG taking advice and help from proven gibbon experts.

13. The workshop recommends that zoo education featuring WHG be given much more attention providing printed material, accurate, effective signage, trained educators and organized activities which to include outreach programmes to educate rural people in/near range of WHG.

14. The workshop recommends that the governments of both countries should insist that zoo staff and other researchers with training, experience, expertise and interest in the care and management of WHG and other threatened species remain in the zoo instead of being routinely transferred.

15. The workshop recommends that dramatic improvements be carried out in the areas of zoo husbandry, management and enclosures of WHG with advice from experts of international repute. This should include a Management Plan for daily care, a Cooperative Breeding Programme for WHG, and a detailed Husbandry Manual after assessment of current practices and enclosures of WHG by experts.

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## Modeling

## Population Modeling Working Group Report

***Working group participants:*** B.A. Daniel, Sanjay Molur, Phil Miller, P.O. Nameer and C. Srinivasulu

### Introduction

Western Hoolock Gibbon (WHG) is restricted to a very few viable forest habitats. These gibbons may be the most vulnerable to habitat destruction of all primate species of South Asia as they are strictly canopy dwellers. Their survival potential is further compromised by their biology and behaviour as they are late and monogamous breeders; they maintain a small group size and require long-term parental care as compared to other primates.

The Hoolock is distributed throughout its geographic range as a large number of isolated populations within a highly fragmented forest ecosystem. Because of this extensive degree of population fragmentation, many Hoolock populations are no doubt at significant risk of imminent extinction. It is important to determine the best possible management strategies for the security and viability of this species into the future. Perhaps the best tool at our disposal for accomplishing this task is an analytical technique known as population viability analysis, or PVA.

Specifically, we were interested in using this form of analysis to help us address the following questions:

- What is our depth of understanding of the population biology of the Hoolock?
- Based on this understanding, what do we see as the primary drivers of Hoolock population growth? To which parameters is our demographic model most sensitive?
- How vulnerable are small, fragmented Hoolock populations to local extinction in the absence of demographic interaction with other populations?
- What is the relative risk to Hoolock population viability posed by intrinsic biological processes such as inbreeding depression? Are there analogous risks to viability posed by extrinsic (anthropogenic) processes like poaching?
- Specifically with respect to the populations of Western Hoolock Gibbon which occur only in India and Bangladesh, what is the probability of the species' survival given its small size and great degree of fragmentation?.

The *VORTEX* computer model is a PVA simulation model of the effects of deterministic forces as well as demographic, environmental, and genetic stochastic events on wild populations. *VORTEX* models population dynamics as discrete sequential events (e.g., births, deaths, sex ratios among offspring, catastrophes, etc.) that occur according to defined probabilities. The probabilities of events are modeled as constants or random variables that follow specified distributions. The package simulates a population by stepping through the series of events that describe the typical life cycles of sexually reproducing, diploid organisms.

PVA methodologies such as the *VORTEX* system are not intended to give absolute and precise "answers", since they are projecting the interactions of many randomly-fluctuating parameters used as model input and because of considerable measurement uncertainty we observe in typical wildlife population demography datasets. Because of these limitations, many researchers have cautioned against the sole use of PVA results to promote specific management actions for threatened populations (e.g., Ludwig, 1999; Beissinger & McCullough, 2002; Reed *et al*., 2002; Ellner *et al*., 2002; Lotts *et al*., 2004). Instead, the true value of an analysis of this type lies in the assembly and critical analysis of the available information on the species and its ecology, and in the ability to compare the quantitative metrics of population performance that emerge from a suite of simulations, with each simulation representing a specific scenario and its inherent assumptions about the available data and a proposed method of population and/or landscape management. Interpretation of the output depends upon our knowledge of the biology of the Hoolock in its habitat, the environmental conditions affecting the species, and possible future changes in these conditions. For a more detailed explanation of *VORTEX* and its use in population viability analysis, refer to Appendix I, Lacy (2000) and Miller and Lacy (2003).

The *VORTEX* system for conducting population viability analysis is a flexible and accessible tool that can be adapted to a wide variety of species types and life histories as the situation warrants. The program has been used around the world for both teaching and research applications and is an accepted method for assisting in the definition of practical wildlife management methodologies.

**Baseline Input Parameters for Stochastic Population Viability Simulations**

Much of the demographic data used as input to our Hoolock population dynamics models is derived from the information presented in Das *et al.* (2005). Where appropriate, information presented by Brockelman (1994a,b) was also used to substantiate that which was presented during the PHVA discussions.

**Baseline population model**

Breeding System: Based on the Hoolock data we assume that they display a long-term monogamous breeding system. Under this condition, a mated pair will stay together until one member of the pair dies. Furthermore, a system based on long-term monogamy may result in male gibbon numbers playing a role in limiting female breeding success.

Age of First Reproduction: *VORTEX* considers the age of first reproduction as the age at which first offsprings are produced, not simply the onset of sexual maturity. Observations from Hoolock and other gibbons indicate that the minimum age of first breeding is 8 years for females and 10 years for males. This age may perhaps be as high as 10 for females and 14 for males, so we elected to include this parameter in our sensitivity analysis (see below)

Age of Reproductive Senescence: In its simplest form, *VORTEX* assumes that animals can reproduce (at the normal rate) throughout their adult life. Specific data on this parameter are scarce for wild populations of Hoolock; data from both wild and captive Hoolock populations suggests that the typical reproductive lifespan may be about 20 years. Das *et al.* (2005) report that a mated pair produces an average of 5-6 offspring in their reproductive life of 10-20 years. We therefore set the maximum age of breeding at 30 years. Uncertainty in this parameter, however, prompted us to include this in our sensitivity analysis (see below).

Offspring Production: Data from wild populations of Hoolock and other gibbons indicates that an inter-birth interval of three years is common. This would translate into about 33% of adult females breeding per year, on average. Atul Gupta (pers. comm.) notes that the interbirth interval could vary from 2-5 years. We therefore decided to include this variable in our demographic sensitivity analysis.

Annual environmental variation in female reproductive success is modeled in *VORTEX* by specifying a standard deviation (SD) for the proportion of adult females that successfully produce young within a given year. While very little data are available for this parameter, we propose that annual variance would be relatively low. We therefore set the standard deviation in the percentage of adult females breeding at 4%.

The overall population-level sex ratio among juveniles is assumed to be 50%.

Male Breeding Pool: In many species, some adult males may be socially restricted from breeding despite being physiologically capable. This can be modeled in *VORTEX* by specifying a portion of the total pool of adult males that may be considered "available" for breeding each year. Observations of Hoolock and other gibbons suggest that all adult males are equally capable of pairing with an adult female when necessary. We therefore set the probability of an adult male entering the breeding pool as 100%.

Mortality: Detailed age- and sex-specific mortality rates are scarce for populations of Western Hoolock gibbon. Jihosuo Biswas (pers. comm.) provided mortality data in the intervals 0 – 3 years of age, 3 – 6 years of age, and 6 + years of age. In particular, field data indicates that the cumulative mortality rate for 0 – 3 years of age is 52%, or a cumulative survival rate of 48%. Therefore, the annual rate of survival within this time interval is $(0.48)^{1/3} = 0.783$. This gives an annual mortality rate within this time interval of 0.217. Using this same logic for cumulative

| Age (years) | Mean rate (SD) |
|---|---|
| 0 – 1 | 18.0 (3.0) |
| 1 – 2 | 18.0 (3.0) |
| 2 – 3 | 18.0 (3.0) |
| 3 – 4 | 9.0 (2.0) |
| 4 – 5 | 9.0 (2.0) |
| 5 – 6 | 9.0 (2.0) |
| 6 + | 1.0 (0.5) |

survival rates for the remaining age classes, we derived annual mortality rates of 0.108 and 0.009 for the 3 – 6 and 6+ age classes, respectively. After additional discussion, we came up with the following baseline mortality schedule for both males and females:

Note that the standard deviations around the mean mortality values, representing the annual variability in demographic rates brought about by environmental variation, has been assumed to be relatively small in this type of stable environment.

Catastrophes: Catastrophes are singular environmental events that are outside the bounds of normal environmental variation affecting reproduction and/or survival. Natural catastrophes can be tornadoes, floods, droughts, disease, or similar events. These events are modeled in *Vortex* by assigning an annual probability of occurrence and a pair of severity factors describing their impact on mortality (across all age-sex classes) and the proportion of females successfully breeding in a given year. These factors range from 0.0 (maximum or absolute effect) to 1.0 (no effect), and are imposed during the single year of the catastrophe, after which time the demographic rates rebound to their baseline values.

Historically, Hoolock populations appear to be largely free of effects from major catastrophic events. Specifically, disease epidemics have not been identified, nor have other environmental events such as droughts, monsoons, or fires been shown to significantly impact Hoolock populations in Bangladesh or India. An inability to observe such phenomena in the recent past, however, does not mean that such events could not happen in the future. Therefore, we decided to include a "generic" type of catastrophic event that would occur, on average, once every 20 years. When the event occurs, we assumed that the population would suffer from a 25% decrease in both reproductive success and annual rates of survival across all age classes.

Inbreeding Depression: *Vortex* includes the ability to model the detrimental effects of inbreeding, most directly through reduced survival of offspring through their first year. Our baseline model does not include inbreeding depression, but some risk assessment models are constructed that include this process. Specifically, we are using the basic captive mammal population data of Ralls *et al.* (1988) to characterize inbreeding depression in our system. Therefore, we are assuming that selected Hoolock populations have an average of 3.14 lethal equivalents per genome, with 50% of the total genetic load due to lethal alleles.

Initial Population Size: Our baseline model is initialized with 50 individuals, spread across all age and sex classes according to a stable age distribution calculated from the life table of fecundity and mortality rates. This is an arbitrary population size, chosen primarily so that the population would be large enough to be free of excessive stochastic instability. Additional models will be developed that are designed to explicitly investigate the relationship between population size and persistence probability.

Carrying Capacity: The carrying capacity, K, for a given habitat patch defines an upper limit for the population size, above which additional mortality is imposed randomly across all age classes in order to return the population to the value set for K.

Carrying capacity is typically very difficult to estimate in the field for any species. Our baseline model is designed to allow growth of the population beyond its initial size. Therefore, we set K in our baseline model equal to 100. In subsequent risk assessment models, we assume that severe habitat fragmentation and loss of forest habitat has resulted in populations that are at the limit of the habitat capacity. Therefore, we initialize all risk models with carrying capacity equal to initial population size.

Iterations and Years of Projection: All population projections (scenarios) were simulated 500 times. Each projection extends to 100 years, with demographic information obtained at annual intervals. All simulations were conducted using *Vortex* version 9.45 (June 2004).

**Table 1: Demographic input parameters for the baseline *VORTEX* model for the Western Hoolock Gibbon in South Asia. See accompanying text for more information.**

| Model Input Parameter | Baseline value |
|---|---|
| Breeding System | Long-term monogamy |
| Age of first reproduction (@& / B&) | 8 / 10 yr |
| Maximum age of reproduction | 30 yr |
| Inbreeding depression? | No |
| Annual % adult females reproducing (SD) | 33 (4) |
| Overall offspring sex ratio | 0.5 |
| Adult males in breeding pool | 100% |
| % annual mortality (SD)[‡] | |
| 0 – 3 | 18.0 (3.0) |
| 3 – 6 | 9.0 (2.0) |
| 6 + | 1.0 (0.5) |
| Catastrophe? | Unspecified |
| Annual frequency of occurrence | 5% |
| Severity: Reproduction | 0.75 |
| Severity: Survival | 0.75 |
| Initial population size | 50 |
| Carrying Capacity (K) | 100 |

No sex-based differences in annual mortality rates.

Table 1 summarizes the baseline input dataset upon which all subsequent *VORTEX* models are based.

### Demographic sensitivity analysis

During the development of the baseline input dataset, it quickly became apparent that a number of demographic characteristics of Western Hoolock Gibbon populations were being estimated with varying levels of uncertainty. This type of measurement uncertainty, which is distinctly different from the annual variability in demographic rates due to extrinsic environmental stochasticity and other factors, impairs our ability to generate precise predictions of population dynamics with any degree of confidence. Nevertheless, an analysis of the sensitivity of our models to this measurement uncertainty can be an invaluable aid in identifying priorities for detailed research and/or management projects targeting specific elements of the species' population biology and ecology.

To conduct this demographic sensitivity analysis, we identify a selected set of parameters from Table 1 whose estimate we see as considerably uncertain. We then develop biologically plausible minimum and maximum values for these parameters (see Table 2).

For each of the parameters listed above we construct multiple simulations, with a given parameter set at its prescribed minimum and/or maximum value, with all other parameters remaining at their baseline value. With the nine parameters identified above, and recognizing that the aggregate set of baseline values constitute our single baseline model, the table above allows us to construct a total of 11 alternative models whose performance (defined, for example, in terms of average population growth rate) can be compared to that of our starting baseline model. For the entire suite of sensitivity analysis models, we will consider a population whose initial size and carrying capacity is equal to that of the original baseline model, i.e., 50 and 100 individuals, respectively.

**Table 2: Uncertain input parameters and their stated ranges for use in demographic sensitivity analysis of simulated Western Hoolock Gibbon populations in South Asia. Values in bold are those used in the baseline model. See accompanying text for more information.**

| | | **Estimate** | |
|---|---|---|---|
| **Model Parameter** | Minimum | Midpoint | Maximum |
| Age of First Reproduction (AFR) (@& / B&) | 8/8 | **8/10** | 10/14 |
| Maximum Age of Reproduction | 25 | **30** | 30 |
| % Adult Females Reproducing | 20 | **33** | 50 |
| % Juvenile Mortality | 12.6 | **18.0** | 27.0 |
| % Adult Mortality | 0.7 | **1.0** | 1.5 |
| Inbreeding Depression (# Lethal Equivalents) | 0.0 | **0.0** | 3.14 |
| Catastrophe Frequency | None | **None** | 0.05 |

## Results of Simulation Modeling

### Baseline simulation

Where appropriate, the results that are reported here for each modeling scenario include:

**$r_s$ (SD)** – The mean rate of stochastic population growth or decline (standard deviation) demonstrated by the simulated populations, averaged across years and iterations, for all simulated populations that are not extinct. This population growth rate is calculated each year of the simulation, prior to any truncation of the population size due to the population exceeding the carrying capacity.

**$P(E)_{50/100}$** – Probability of population extinction after the specified time interval (in years), determined by the proportion of 500 iterations within that given scenario that have gone extinct within the given time frame. "Extinction" is defined in the *VORTEX* model as the absence of either sex.

**$N_{50/100}$** – Mean population size after the specified time interval (in years), averaged across all simulated populations, including those that are extinct.

**T(E)** – The average time to population extinction, in years.

The set of demographic, genetic, and ecological input data that represents our best understanding of the life history of Hoolock populations in South Asia is hereafter referred to as our *baseline model*. In this case, our baseline model simulates the predicted trajectory of a relatively large population of Hoolocks that is free of the impacts of catastrophe and genetic sources of mortality (i.e., inbreeding depression). The results of this analysis are presented in Figure 1. The average population growth rate is 0.013, and the extinction probability over 100 years is 0.0%.

Our group thought that the simulation of Hoolock population dynamics was acceptably accurate, both in its mean trajectory and in its manifestation of annual variability in demography and subsequent population growth. We therefore felt comfortable with proceeding into the demographic sensitivity analysis phase of our work with the baseline model unchanged. It is

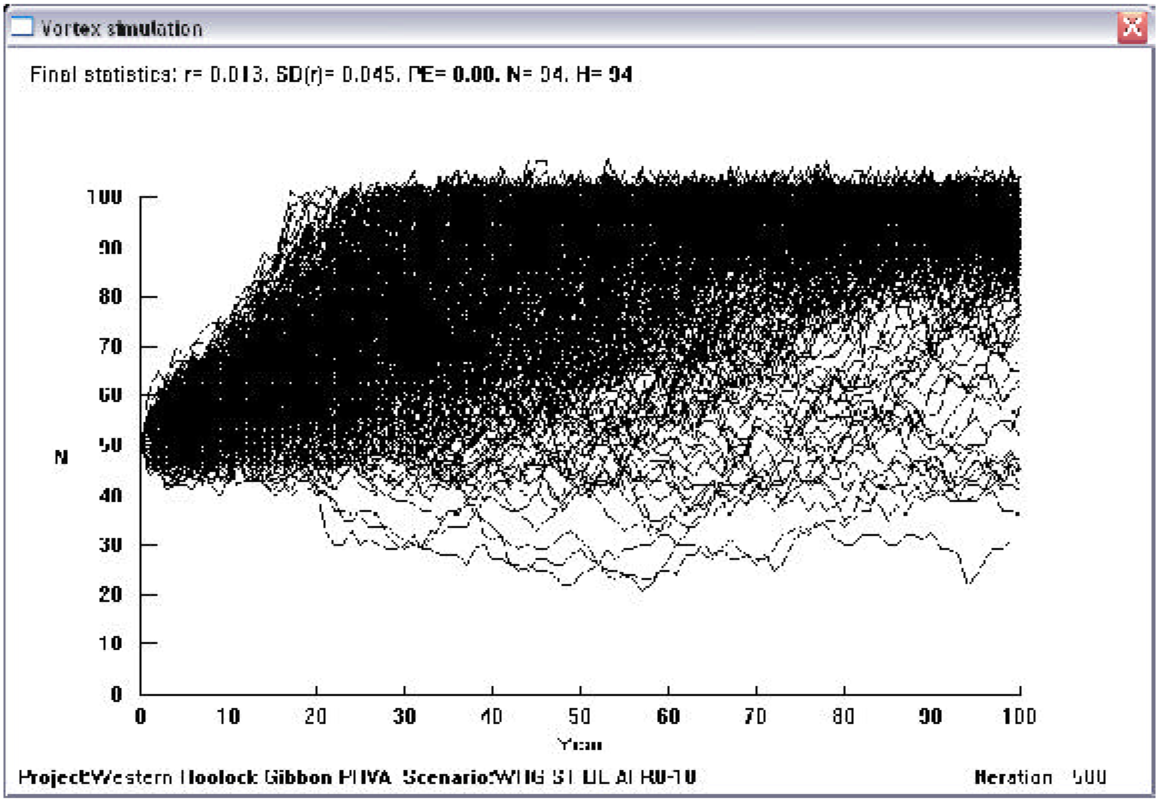



**Figure 1: Plot of 500 individual iterations of the baseline *VORTEX* simulation model of Hoolock population dynamics. The average rate of population growth across these iterations is 0.013. See text for accompanying details.**

important to note that, despite our sense of comfort with this model, we see this baseline projection as merely a starting point for deeper analysis of Hoolock population viability. In other words, we do not see this single model as precisely descriptive of the predicted fate of any one population or class of populations currently known to exist in South Asia.

### Generalized demographic sensitivity analysis

The results of our initial demographic sensitivity analysis are shown graphically in Figure 2. Our initial analysis indicates that our model is highly sensitive to uncertainty in the degree of female reproductive success, adult mortality, and the presence of catastrophic reduction in fecundity and survival. Note that while the total range in population growth rates observed from the models is approximately the same when analyzing both adult and juvenile mortality, the range of growth spans just 1% – 5% in adults but a much larger 13% – 27% in adults. This smaller range of adult mortality values indicates the greater degree of model sensitivity.

### Risk analysis I: Population size, inbreeding depression, catastrophe, and extinction risk

We were interested in looking at relative extinction risk as a function of population size, with and without the impact of inbreeding and catastrophe. This analysis may help us to identify a sort of population size threshold, below which the risk of extinction is likely to be unacceptably high.

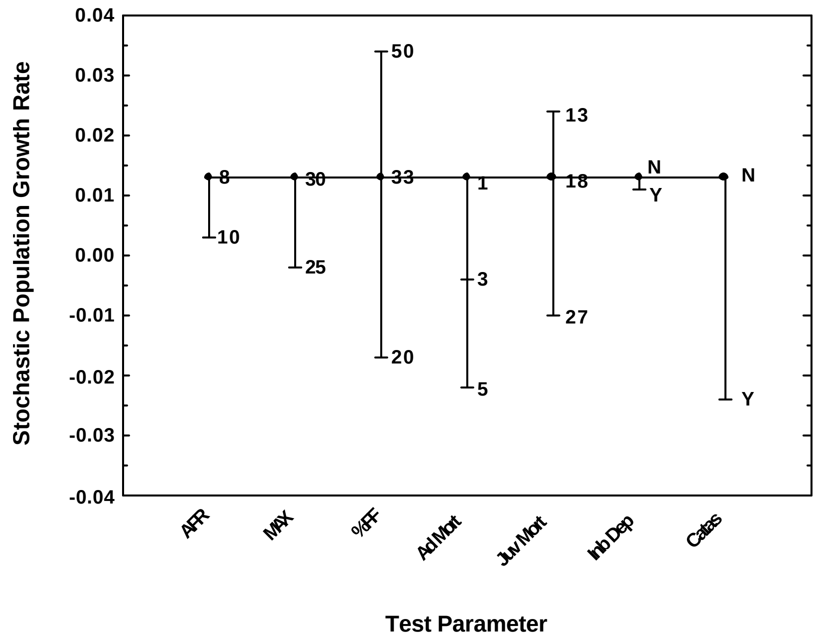



**Figure 2: Generalized demographic sensitivity analysis of a simulated Hoolock population. Stochastic population growth rate for a set of models in which the specific parameter is varied across a range of biologically plausible values. The baseline model growth rate of 0.013 is given by the central data point for each parameter. The general model of Hoolock population dynamics is most sensitive to uncertainty in those parameters giving the widest range in simulated population growth rates. See Table 2 for additional details.**

To conduct this analysis, we developed a suite of models in which the baseline demographic parameters were employed, and then increased the initial population size from 5 to 100 in defined increments (5, 10, 15, 20, 25, 30, 35, 40, 50, 75, 100). Our first set of eleven models did not include inbreeding or catastrophe. The second and third sets of models included the standard description of inbreeding depression (3.14 lethal equivalents, 50% lethal load) and then the additional inclusion of the genetic catastrophe, respectively.

The results of our risk analysis are presented graphically in Figures 3 and 4, in which the risk of population extinction is presented over the entire 100-year timeframe of the PVA simulation. In the absence of inbreeding depression and catastrophe, we can draw the following conclusion from these results:

· Immediately clear from these graphical results is the very high probability of extinction in the smallest populations (e.g., $N_0$ d" 15 individuals), and the relative stability exhibited by populations starting with 30 or more individuals.

When inbreeding depression is included in the model, nearly all populations are significantly affected. Only the largest populations show little effect of this additional destabilizing force. This analysis demonstrates the common but complicated ways in which different processes can interact to put small populations of threatened wildlife at risk.

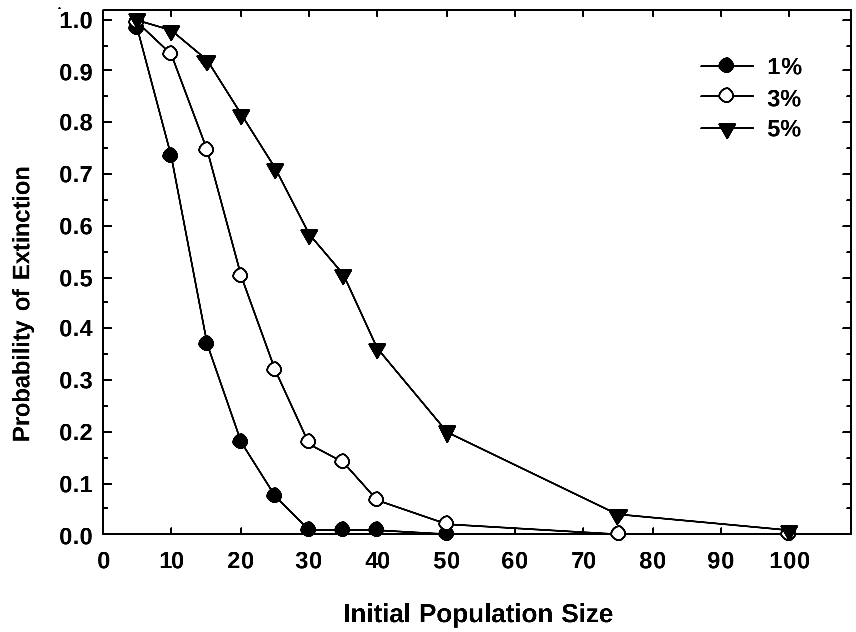



**Figure 3: Adult mortality influences the survival of Hoolocks in the wild with significant increase in extinction risk with increase in mortality of 2%.**

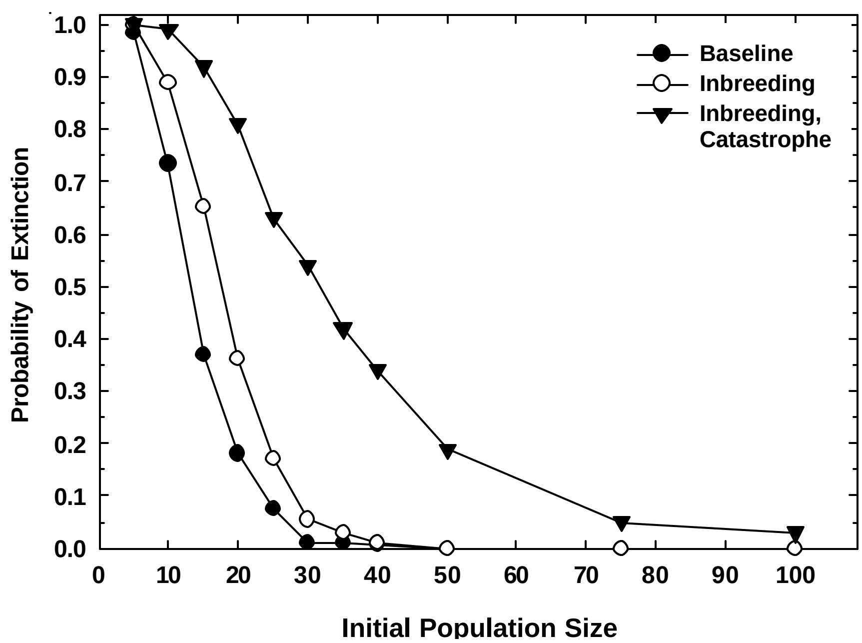
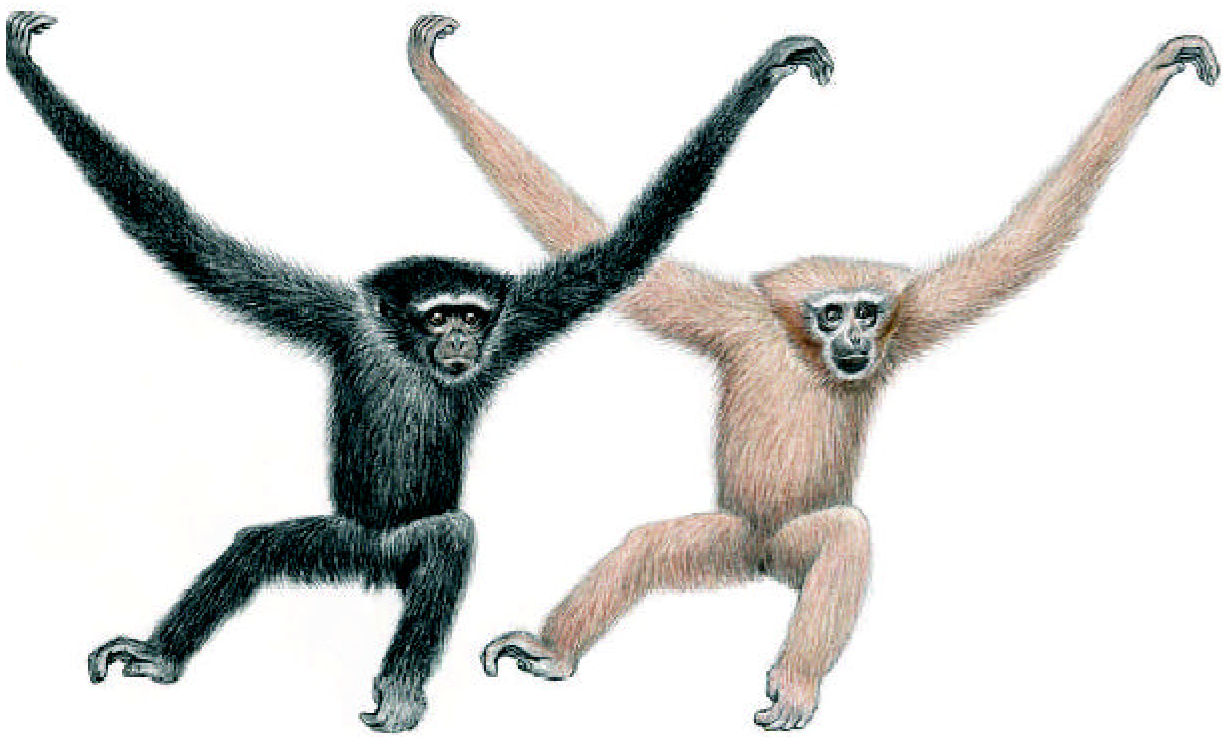



**Figure 4: Inbreeding depression and catastrophe increase extinction risk in wild Hoolock populations as compared to just inbreeding or the baseline model.**

Of course, we have no data on the mode of action of inbreeding depression in wild Hoolock populations, or even if inbreeding depression exists at all. Therefore, we are unable to make specific predictions about the role this process plays in Hoolock populations that exist currently. However, these analyses clearly demonstrate the additional risk that detrimental genetic processes can impose on small populations, and the sometimes subtle ways in which different processes whose individual impacts are relatively mild can interact to greatly increase extinction risk. Because of this, additional study of Hoolock population genetics may be warranted so that greater confidence can be placed on the inclusion of such factors into future PVA models.

Tables 3 and 4 provide a more detailed look at the time course of extinction. These data are important as they help to evaluate the relative risk of extinction over a shorter time frame – in this case, we look at 50 years in addition to the standard 100-year timeframe. Note that the extinction risk increases over time, and the population size typically decreases as more extinctions occur over the time course of the computer simulation – even in the presence of a positive long-term stochastic growth rate. For example, a population initialized with 40 individuals in the absence of drought has only a 2.2% probability of extinction in 15 years, but this risk increases to 9.6% in 50 years and 21.6% in 100 years. The operation of stochastic demographic fluctuations serves to destabilize populations over time and therefore increases their risk of significant decline and possible extinction. When evaluating the results of population viability analyses, it is important to project far enough into the future so that processes with longer time horizons have a chance to influence the course of the projection. This is particularly important in this Hoolock analysis, where a generation lasts 30 years. A time horizon for analysis that is significantly shorter than this



***Drawing by Stephen Nash***

**Table 3: Results of Western Hoolock Gibbon population size risk analysis models under different scenarios of baseline (see Table 2), inbreeding, catastrophe, adult mortalities of 1%, and decreasing carrying capacity. Extinction risk and population size estimates are given for 50 and 100-year time periods.**

| $N_0$ | Inbreeding | Catastrophe | rs (SD) | P(E) 50 / 100 | N 50 / 100 | T(E) |
|---|---|---|---|---|---|---|
| 5 | None | None | 0.003 (0.168) | 0.876 / 0.984 | 0.87 / 0.08 | 28.4 |
| 10 | None | None | -0.003 (0.135) | 0.354 / 0.734 | 4.61 / 1.8 | 54 |
| 15 | None | None | -0.001 (0.112) | 0.078 / 0.37 | 9.75 / 5.95 | 68.7 |
| 20 | None | None | 0.001 (0.096) | 0. 030 / 0.18 | 14.4 / 10.88 | 69.3 |
| 25 | None | None | 0.004 (0.083) | 0. 008 / 0.074 | 19.57 / 16.66 | 78.7 |
| 30 | None | None | 0.007 (0.073) | 0.00 / 0.01 | 25.53 / 23.17 | 85.2 |
| 35 | None | None | 0.008 (0.067) | 0.00 / 0.01 | 30.30 / 28.72 | 75.4 |
| 40 | None | None | 0.009 (0.063) | 0.004 / 0.008 | 35.33 / 34.01 | 66.3 |
| 50 | None | None | 0.011 (0.056) | 0 / 0 | 45.68 / 45.44 | 0 |
| 75 | None | None | 0.013 (0.047) | 0 / 0 | 71.31 / 70.89 | 0 |
| 100 | None | None | 0.014 (0.042) | 0 / 0 | 96.17 / 96.1 | 0 |
| 5 | 3.14 | None | -0.002 (0.167) | 0.878 / 0.998 | 0.74 / 0.01 | 28.5 |
| 10 | 3.14 | None | -0.007 (0.135) | 0.420 / 0.89 | 4.05 / 0.79 | 54.5 |
| 15 | 3.14 | None | -0.008 (0.115) | 0.138 / 0.652 | 8.43 / 2.9 | 68.9 |
| 20 | 3.14 | None | -0.006 (0.101) | 0.042 / 0.36 | 13.19 / 6.68 | 76.5 |
| 25 | 3.14 | None | -0.002 (0.088) | 0.012 / 0.172 | 18.59 / 11.77 | 77.7 |
| 30 | 3.14 | None | 0.001 (0.077) | 0.002 / 0.054 | 24.13 / 17.86 | 81.5 |
| 35 | 3.14 | None | 0.003 (0.07) | 0.004 / 0.028 | 29.06 / 23.75 | 80.9 |
| 40 | 3.14 | None | 0.005 (0.064) | 0.00 / 0.01 | 34.53 / 29.91 | 82 |
| 50 | 3.14 | None | 0.008 (0.056) | 0 / 0 | 45.46 / 42.47 | 0 |
| 75 | 3.14 | None | 0.011 (0.046) | 0 / 0 | 70.98 / 69.55 | 0 |
| 100 | 3.14 | None | 0.012 (0.041) | 0 / 0 | 96.10 / 95.53 | 0 |
| 5 | 3.14 | 5% | -0.006 (0.175) | 0.948 / 1 | 0.38 / 0 | 23.5 |
| 10 | 3.14 | 5% | -0.018 (0.163) | 0.692 / 0.99 | 1.98 / 0.09 | 41 |
| 15 | 3.14 | 5% | -0.018 (0.145) | 0.406 / 0.916 | 4.93 / 0.64 | 56.2 |
| 20 | 3.14 | 5% | -0.019 (0.137) | 0.234 / 0.814 | 7.84 / 1.5 | 62.5 |
| 25 | 3.14 | 5% | -0.017 (0.127) | 0.126 / 0.63 | 11.76 / 3.17 | 68.7 |
| 30 | 3.14 | 5% | -0.016 (0.122) | 0.084 / 0.538 | 14.75 / 5.14 | 72 |
| 35 | 3.14 | 5% | -0.015 (0.116) | 0.040 / 0.42 | 18.59 / 7.52 | 74.8 |
| 40 | 3.14 | 5% | -0.013 (0.112) | 0.034 / 0.344 | 22.96 / 10.34 | 76.8 |
| 50 | 3.14 | 5% | -0.011 (0.105) | 0.008/ 0.194 | 29.65 / 15.63 | 78.8 |
| 75 | 3.14 | 5% | -0.007 (0.092) | 0.002 / 0.054 | 50.99 / 33.46 | 87.6 |
| 100 | 3.14 | 5% | -0.005 (0.087) | 0.00 / 0.034 | 68.87 / 49.42 | 84.1 |
| 5 | None | 5% | -0.004 (0.177) | 0.918 / 0.992 | 0.53 / 0.04 | 23.6 |
| 10 | None | 5% | -0.013(0.158) | 0.602 / 0.916 | 2.59 / 0.54 | 43.5 |
| 15 | None | 5% | -0.014(0.145) | 0.348 / 0.802 | 5.59 / 1.57 | 55.4 |
| 20 | None | 5% | -0.014(0.135) | 0.218 / 0.664 | 8.50 / 2.99 | 61.1 |
| 25 | None | 5% | -0.012(0.126) | 0.128 / 0.484 | 12.24 / 5.65 | 64.7 |
| 30 | None | 5% | -0.013(0.122) | 0.090 / 0.446 | 15.31 / 7.24 | 69.2 |
| 35 | None | 5% | -0.01(0.116) | 0.042 / 0.314 | 19.56 / 10.61 | 73.2 |
| 40 | None | 5% | -0.01(0.111) | 0.022 / 0.254 | 23.50 / 13.31 | 75 |
| 50 | None | 5% | -0.008(0.105) | 0.004 / 0.152 | 29.93 / 20.29 | 78.2 |
| 75 | None | 5% | -0.005(0.092) | 0.000 / 0.042 | 49.99 / 36.38 | 84.8 |
| 100 | None | 5% | -0.003(0.086) | 0.000 / 0.024 | 69.77 / 54.72 | 92.2 |

**Table 4: Results of Western Hoolock Gibbon population size risk analysis models under no inbreeding and catastrophe, but increased adult mortalities of 3% and 5%, and decreasing carrying capacity. Extinction risk and population size estimates are given for 50 and 100-year time periods.**

| $N_0$ | Inbreeding | Catastrophe | Adult Mortality | $r_s$ (SD) 50 / 100 | P(E) 50 / 100 | N | T(E) |
|---|---|---|---|---|---|---|---|
| 5 | None | None | 3% | -0.007 (0.175) | 0.936 / 0.994 | 0.45 / 0.03 | 23.2 |
| 10 | None | None | 3% | -0.012 (0.144) | 0.554 / 0.934 | 2.95 / 0.44 | 47.3 |
| 15 | None | None | 3% | -0.013 (0.126) | 0.256 / 0.746 | 6.39 / 2.14 | 59.3 |
| 20 | None | None | 3% | -0.011 (0.113) | 0.106 / 0.502 | 10.55 / 4.85 | 68.2 |
| 25 | None | None | 3% | -0.009 (0.101) | 0. 038 / 0.32 | 14.77 /8.09 | 71.6 |
| 30 | None | None | 3% | -0.006 (0.09) | 0.018 / 0.178 | 18.99 /13.2 | 78 |
| 35 | None | None | 3% | -0.006 (0.082) | 0.006 / 0.142 | 24.05 /16.79 | 78.4 |
| 40 | None | None | 3% | -0.004 (0.075) | 0.002 / 0.068 | 29.06 / 21.44 | 81.6 |
| 50 | None | None | 3% | -0.001 (0.065) | 0.00 / 0.022 | 38.24 /32.44 | 82.2 |
| 75 | None | None | 3% | 0.001 (0.051) | 0 / 0 | 63.43 / 57.12 | 0 |
| 100 | None | None | 3% | 0.003 (0.045) | 0 / 0 | 88.76 /82.61 | 0 |
| 5 | None | None | 5% | -0.014 (0.181) | 0.956 / 1 | 0.32 / 0.01 | 20.8 |
| 10 | None | None | 5% | -0.021 (0.152) | 0.750 / 0.978 | 1.70 / 0.11 | 37.9 |
| 15 | None | None | 5% | -0.022 (0.136) | 0.484 / 0.92 | 3.97 / 0.53 | 51.2 |
| 20 | None | None | 5% | -0.021 (0.125) | 0.250 / 0.816 | 6.67 / 1.51 | 61.1 |
| 25 | None | None | 5% | -0.021 (0.118) | 0.154 / 0.71 | 9.65 / 2.52 | 67 |
| 30 | None | None | 5% | -0.02 (0.11) | 0.082 / 0.584 | 12.56 / 4.01 | 71.1 |
| 35 | None | None | 5% | -0.019 (0.104) | 0.054 / 0.506 | 15.76 / 5.28 | 73.7 |
| 40 | None | None | 5% | -0.018 (0.096) | 0.014 / 0.362 | 19.91 / 7.78 | 77.8 |
| 50 | None | None | 5% | -0.015 (0.086) | 0.002 / 0.2 | 27.60 / 13.17 | 84.4 |
| 75 | None | None | 5% | -0.012 (0.068) | 0.00 / 0.04 | 45.25 /26.39 | 87.3 |
| 100 | None | None | 5% | -0.01 (0.058) | 0.000 / 0.008 | 63.88 /39.6 | 85 |

Table 4 has indicated that mortality rates of 3-5% would impact the probability of survival of Western Hoolock Gibbons dramatically. In this instance "mortality" is taken to mean any instance in which animals are removed from the population without any chance of contributing to the population in the near future. For all practical purposes we can consider removal of animals for pets and also for zoos as examples of such an instance.

In both countries – India and Bangladesh – the keeping of Hoolock Gibbons by the citizenry were reported by researchers. Also there are Western Hoolock Gibbons in zoos in India and Bangladesh, but, most probably, no where else in the world.

India has largely curtailed any traffic in threatened species for zoos within its boundaries. All the Hoolock Gibbons currently in zoos were captured some years ago before specific and stringent legislation was passed and has come to be, for the most part, rigorously implemented.

Bangladesh also has legislation which could be used to restrict capture of Western Hoolock Gibbons for zoos but it is not implemented. Conversely there are a number of instances in which government institutions literally have floated tenders for the capture of Hoolock Gibbons and the current population of Hoolocks residing in Dhaka Zoo are examples of such transactions. Similarly, in Dulhazera Safari Park there are 2 of 3 Hoolock Gibbons which were captured by the staff of the Safari Park, one of which escaped, has not been recovered and is almost certainly dead, or perhaps recaptured by a local person.

Indian and Bangladesh zoos have not been successful in any scientific conservation breeding programme in which animals were bred past the second generation and systematically released to strengthen or replace a wild population. The chances of success of a delicate and difficult species such as Hoolock Gibbon are, even in the best of circumstances in the most expert of zoos, questionable. The chances of success without dramatic input of training, special infrastructural support and even administrative modification to insure that trained and interested persons remain with the project are next to impossible.

With this in mind a special scenario in which the removal of five Hoolock Gibbons (a typical number of an order to a trapper on tender basis) from the largest population in Bangladesh (the Lawachara group) was modeled. The probability of extinction for this scenario was very high: 90% probability of extinction of the population within the next two decades!

There are many factors impacting extinction which are difficult or practically impossible to curtail in time, such as habitat destruction in most places, natural catastrophe, or even pet-keeping since one has no idea which individual or family through the forests might take it into his head to collect one for a pet. The ordering of animal on tender basis or capturing of animals by departmental officials by government institutions, however, is one factor which could be completely stopped immediately, merely by a determined statement and show of political will.

The workshop may request the Government of Bangladesh to address this factor by an appropriate statement and demonstration of political will so that no Hoolock Gibbon should be captured from the wild, at least on the responsibility of own institutions or personnel.

period will be unable to resolve the longer-term impacts of habitat loss -- an impact that we can see as profound indeed.

### Risk analysis II: Specific populations

We modeled specific case studies to understand the impacts of the conditions prevailing for gibbons in three different locations, one in Bangladesh (Lawachara, N = 37) and two in India (Upper Dehring, N = 156 and Borajan, N = 34 / 8). Different variables in these locations indicated different probabilities of extinction with Borajan showing the most rapid decline. Larger population size naturally increases the probability of survival in the long term with Upper Dehring having the largest known Hoolock Gibbon populations showing negligible extinction probability in 100 years. However, an increase in adult mortality through hunting frequencies of more than one pair per year increased the extinction probability of the population after 50 years. Figures 5 and 6

**Table 5: Upper Dehring, India. N = 156, K = 200. AFR female = 8; AFR male = 10; % rep female = 33; Max repr age = 30 years; Mortality 0-3 = 18%; 3-6 = 9%; 6 onwards = 3%-5% per year. The mortality rates in adults have been increased to 3% and 5% per year. No inbreeding. No catastrophe. Poaching of four adults (2 males and 2 females) every alternate year. K decreasing at the rate of 5% in 10 years (.5% annually, based on Kashmira Kakati's information (in litt., 17 Feb. 2005)), 25 years and 100 years.**

| $N_0$ | Adult Mortality | K | Time (years) | $r_s$ (SD) | PE | N | T(E) |
|---|---|---|---|---|---|---|---|
| 156 | 3% | -0.5% | 10 | 0.005 (0.038) | 0 | 158.69 | 0 |
| 156 | 3% | -0.5% | 25 | 0.004 (0.039) | 0 | 142.35 | 0 |
| 156 | 3% | -0.5% | 100 | 0.004 (0.041) | 0 | 85.22 | 0 |
| 156 | 5% | -0.5% | 10 | -0.007 (0.045) | 0 | 81.83 | 0 |
| 156 | 5% | -0.5% | 25 | -0.008 (0.046) | 0 | 76.26 | 0 |
| 156 | 5% | -0.5% | 100 | -0.007 (0.046) | 0 | 65.06 | 0 |
| Poaching of 4 adults (2 males and 2 females) every two years | | | | | | | |
| 156 | 3% | -0.5% | 10 | -0.019 (0.099) | 0.09 | 54.35 | 43.4 |
| 156 | 3% | -0.5% | 25 | -0.019 (0.1) | 0.548 | 51.46 | 43.2 |
| 156 | 3% | -0.5% | 100 | -0.020 (0.11) | 1 | 0 | 45.7 |

**Table 6: Lawachara, Bangladesh. N = 37, K = 50. AFR female = 8; AFR male = 10; % rep female = 33; Max repr age = 30 years; Mortality 0-3 = 18%; 3-6 = 9%; 6 onwards = 3%-5% per year. The mortality rates in adults have been increased to 3% and 5% per year. Poaching of 4 adults (2 males and 2 females) every alternate year. No inbreeding. No catastrophe. K decreasing at the rate of 5% in 10 years (.5% annually), 25 years and 100 years.**

| $N_0$ | Adult Mortality | K | Time (years) | $r_s$ (SD) | PE | N | T(E) |
|---|---|---|---|---|---|---|---|
| 37 | 3% | -0.5% | 10 | -0.005 (0.078) | 0.088 | 21.34 | 81.1 |
| 37 | 3% | -0.5% | 25 | -0.005 (0.079) | 0.066 | 19.12 | 83.2 |
| 37 | 3% | -0.5% | 100 | -0.006 (0.083) | 0.11 | 11.78 | 84.4 |
| 37 | 5% | -0.5% | 10 | -0.018 (0.1) | 0.396 | 7.19 | 79.9 |
| 37 | 5% | -0.5% | 25 | -0.018 (0.098) | 0.39 | 6.65 | 76.6 |
| 37 | 5% | -0.5% | 100 | -0.019 (0.101) | 0.438 | 5.3 | 75.8 |
| Poaching of 4 adults (2 males and 2 females) every two years | | | | | | | |
| 156 | 3% | -0.5% | 10 | -0.026 (1.109) | 0.481 | 5.35 | 19.5 |
| 156 | 3% | -0.5% | 25 | -0.027 (1.11) | 0.898 | 2.46 | 18.5 |
| 156 | 3% | -0.5% | 100 | -0.026 (1.11) | 1 | 0 | 17.2 |

**Table 7. Borajan, India. N = 34, K = 34. AFR female = 8; AFR male = 10; % rep female = 33; Max repr age = 30 years; Mortality 0-3 = 21.7%; 3-6 = 10.5%; 6 onwards = 1% per year. The mortality rates in this case are based on the field data provided by Das et al. (2004). Poaching is not included, no inbreeding, no catastrophe. The main threat to the area is loss of habitat with 70% decline in 10 years (1990-2000) (Kashmira Kakati, in litt., 17 February, 2005; 53% decline in 10 years (1995-2005) (Das *et al.*, 2004). The canopy loss in the area is around 50% in 10 years, which is a crucial factor for gibbons (Jihosuo Biswas, pers. comm., 17 Feb. 2005). K modelled at -5% and -7% annually over 10 years.**

| $N_0$ | Mortality 0-3/3-6/ >6 | N=k; n>k | Trend | $r_s$ (SD) | PE | N | T(E) |
|---|---|---|---|---|---|---|---|
| 34 | 22/10/1 | N=k | -veK5 10yr | -0.01 (0.113) | 0.536 | 4.12 | 69.5 |
| 34 | 22/10/1 | n>k | -veK5 10yr | -0.012 (0.131) | 0.832 | 1.21 | 57 |
| 34 | 22/10/3 | n>k | -veK5 10yr | -0.02 (0.137) | 0.94 | 0.39 | 49.5 |
| 34 | 22/10/5 | n>k | -veK5 10yr | -0.03 (0.143) | 0.974 | 0.14 | 42.3 |
| 34 | 22/10/5 | n>k | -veK7 10yr | -0.027 (0.152) | 1 | 0.01 | 30.5 |

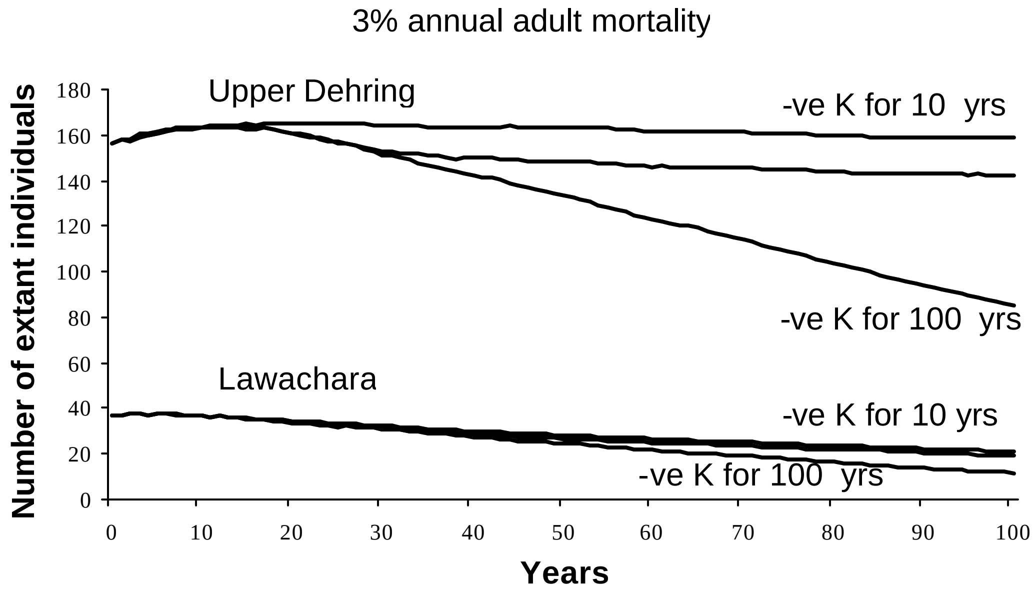



**Figure 5: A comparison between extinction probabilities of a smaller population (Lawachara in Bangladesh), versus that of a bigger one (Upper Dehring in India) indicating a common underlying threat to populations in the long run with continuing decline in the carrying capacity over 100 years.**

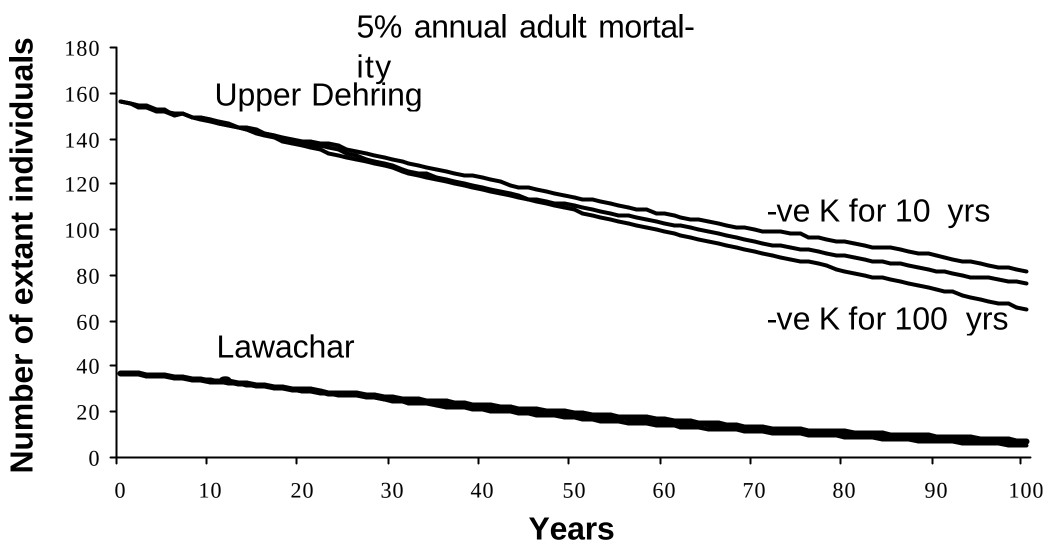



**Figure 6: A comparison between extinction probabilities of a smaller population (Lawachara in Bangladesh), versus that of a bigger one (Upper Dehring in India) indicating a common underlying threat to populations in the long run with continuing decline in the carrying capacity over 100 years. With adult mortality being at a higher rate (as seen in a persecuted small population), the risk of extinction is higher in either of the populations irrespective of a negative trend in carrying capacity.**

and Tables 5, 6 and 7 show the trends in populations with varying scenarios.

**Risk analysis III: Bangladesh populations**

We wanted to investigate the status of all known Bangladesh populations over 100 years and modeled all fragmented populations within a metapopulation scenario without incorporating migration. Initial population sizes varied from 1 to 37 across 22 populations. We constructed a set of models with the following characteristics:

- Carrying capacity: (a) equal to 2 times initial population size; (b) equal to initial population size; and (c) equal to initial population size and showing negative trend over 10 years, 25 years and 100 years
- Inbreeding depression: (a) none; and (b) 3.14.
- Annual adult mortality: (a) 1% ; and (b) 3%

Dramatic declines in the number of individuals at the end of 100 years is noted in scenarios where the carrying capacity is equal to initial population numbers, declining carrying capacity and increased adult mortality of 3%. Although the metapopulation does not go extinct in 100 years, the declining trend in the numbers is indicative of a spiraling population, with many smaller populations going extinct within that time. The scenario with carrying capacity twice as much as initial population indicates a higher probability of survival of the populations with higher number of individuals at the end of 10 years. However, higher mortality modeled into this scenario reduces the probability of survival and numbers, which is indicative of the trend in the populations of Hoolock Gibbons of Bangladesh if hunting / poaching were to affect them.

Table 8 summarises the scenarios along with the probability of extinction indicating a steady increase in extinction with increasing variables. Probability of Extinction increases with time in most cases, especially for all populations below 20 individuals. Lawachara with the most individuals in Bangladesh seems relatively well placed, while populations below 12 individuals face a very high risk of extinction requiring immediate action.

The probability of extinction predicted by the model without negative effects of staochastic events such as hunting gives a more optimistic projection for some of the larger populations. However, a single hunting catastrophe could render any of the populations in Bangladesh highly vulnerable to near-term extinction, as is noticed in eight of the locations where Hoolocks have gone extinct in just five years or less.

In some cases like Chunati where gibbons have gone extinct recently, the decline was gradual and noticed since 15 years and the last of the individuals were sighted in 2002.

The scenarios modeled for Bangladesh reveal that the situation in India is no different for most of the populations with population sizes of less than 15 individuals. The status of the Western Hoolock Gibbon in India, like in Bangladesh faces a serious threat of extinction in at least 80% of its populations over the next three to four decades. Details of the population numbers and locality names are provided in the Habitat Working Groups of Bangaldesh and India.

**Table 8: Surveyed locations in Bangladesh for Hoolock Gibbons indicated along with a summary of the probability of extinction in 25, 50 and 100 years with varying scenarios including inbreeding, declining carrying capacity and increased adult mortality. Time to extinction is indicated along with remarks on the need for conservation action.**

| Location | N (now) | $r_s$ (SD) | PE 25 / 50 /100 | PE Inb / -ve K / Ad. Mort. 3% | *N* | T(E) | Priority |
|---|---|---|---|---|---|---|---|
| Bhomarighona | 0 | - | - | - | - | - | Extinct |
| Chunati | 0 | - | - | - | - | - | Extinct |
| Himchari | 0 | - | - | - | - | - | Extinct |
| Hnila | 0 | - | - | - | - | - | Extinct |
| Horinchara | 0 | - | - | - | - | - | Extinct |
| Padua | 0 | - | - | - | - | - | Extinct |
| Satghar | 0 | - | - | - | - | - | Extinct |
| Teknaf | 0 | - | - | - | - | - | Extinct |
| Hazarikhil | ? | - | - | - | - | - | DD |
| Lama | ? | - | - | - | - | - | DD |
| Massalong | ? | - | - | - | - | - | DD |
| Kalenga | 1 | 0 (0) | 1 / 1 / 1 | 1 / 1 / 1 | 0 | 1 | Immediate |
| Patharia | 2 | 0.032 (0.18) | 0.72 / 0.94 / 1 | 1 / 1 / 1 | 0.01 | 23.7 | Immediate |
| Lathitila | 3 | 0.006 (0.182) | 0.57 / 0.80 / 0.97 | 0.99 / 1 / 0.99 | 0.15 | 31.4 | Immediate |
| Pablakhali | 4 | 0.002 (0.159) | 0.27 / 0.67 / 0.90 | 0.97 / 1 / 0.98 | 0.63 | 37.2 | Immediate |
| Chautoli | 5 | -0.002 (0.151) | 0.25 / 0.57 / 0.83 | 0.96 / 0.99 / 0.97 | 1.23 | 40.0 | Immediate |
| Inani | 5 | -0.002 (0.151) | 0.25 / 0.57 / 0.83 | 0.96 / 0.99 / 0.97 | 1.23 | 40.0 | Immediate |
| Ukhia | 6 | -0.002 (0.141) | 0.18 / 0.41 / 0.73 | 0.86 / 0.97 / 0.93 | 2.13 | 48.4 | Immediate |
| Bishari | 7 | -0.002 (0.131) | 0.10 / 0.30 / 0.63 | 0.82 / 0.95 / 0.91 | 3.3 | 52.8 | Immediate |
| Dhopachari | 7 | -0.002 (0.132) | 0.10 / 0.33 / 0.63 | 0.84 / 0.96 / 0.91 | 3.38 | 50.9 | Immediate |
| Dighinala | 7 | -0.001 (0.13) | 0.13 / 0.31 / 0.61 | 0.80 / 0.94 / 0.91 | 3.55 | 51.6 | Immediate |
| Satchari | 7 | -0.002 (0.131) | 0.11 / 0.34 / 0.64 | 0.86 / 0.95 / 0.92 | 3.22 | 50.3 | Immediate |
| Thanchi | 7 | -0.003 (0.134) | 0.09 / 0.28 / 0.62 | 0.83 / 0.96 / 0.92 | 3.37 | 53.6 | Immediate |
| Bangdepa | 8 | 0 (0.11) | 0.02 / 0.13 / 0.35 | 0.56 / 0.79 / 0.80 | 8.19 | 60.4 | Immediate |
| Barolekha | 8 | -0.001 (0.122) | 0.06 / 0.25 / 0.52 | 0.75 / 0.91 / 0.89 | 4.91 | 53.9 | Immediate |
| Sazak | 12 | 0.001 (0.102) | 0.01 / 0.09 / 0.25 | 0.43 / 0.83 / 0.72 | 11.64 | 62.0 | Immediate |
| Bamu | 14 | 0.003 (0.092) | 0.01 / 0.05 / 0.15 | 0.27 / 0.55 / 0.66 | 16.31 | 62.2 | Immediate |
| Kaptai | 14 | 0.003 (0.093) | 0.00 / 0.05 / 0.17 | 0.27 / 0.53 / 0.63 | 16.3 | 64.8 | Immediate |
| Adampur | 16 | 0.005 (0.085) | 0.00 / 0.01 / 0.10 | 0.194 / 0.42 / 0.56 | 21.14 | 68.7 | Immediate |
| Kalinji | 16 | 0.004 (0.085) | 0.00 / 0.02 / 0.11 | 0.23 / 0.42 / 0.61 | 20.56 | 70.7 | Immediate |
| Rampahar | 16 | 0.005 (0.084) | 0.00 / 0.01 / 0.09 | 0.18 / 0.45 / 0.58 | 21.17 | 70.7 | Immediate |
| Lawachara | 37 | 0.01 (0.057) | 0.00 / 0.00 / 0.00 | 0.00 / 0.01 / 0.07 | 44.39 | - | Later |

DD = Data Deficient

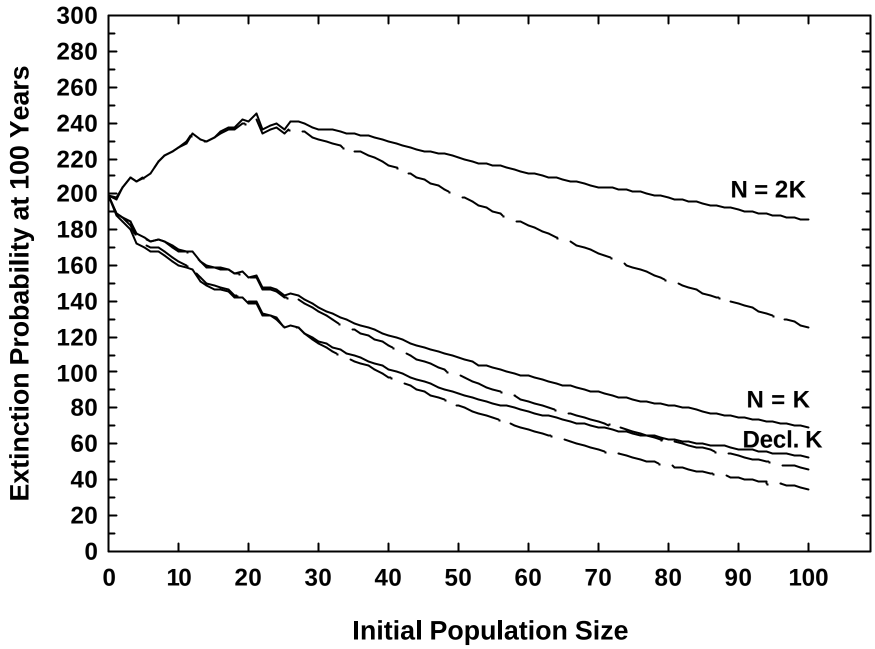



**Figure 7: Probability of extinction of the Bangladesh population of Hoolocks considered in the analysis as a single metapopulation indicates a clear decline in the probability of survival with declining habitat in the next 100 years.**

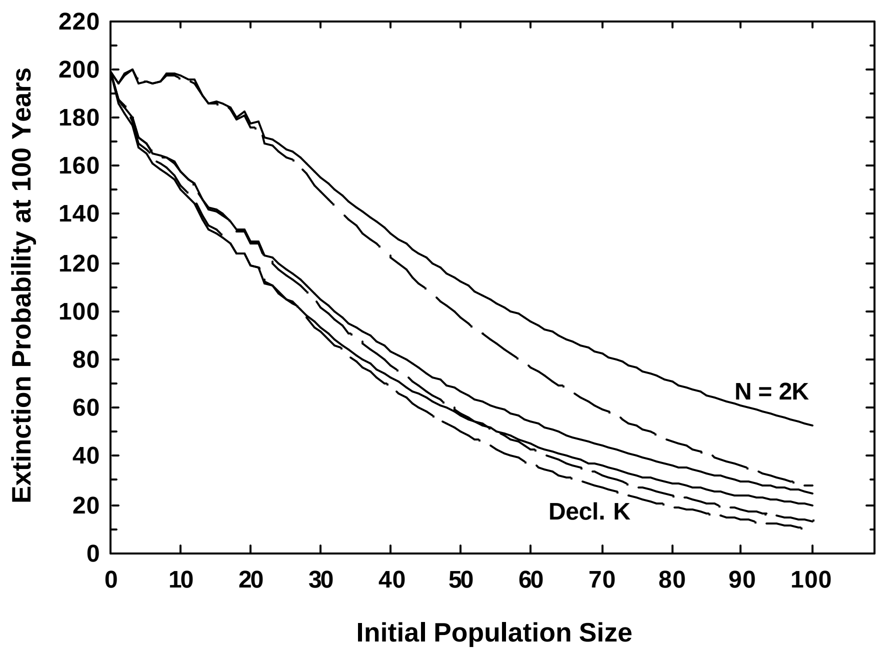



**Figure 8: Probability of extinction of the Bangladesh population of Hoolocks considered in the analysis as a single metapopulation with increased adult mortalities (experienced by many isolated fragments of Hoolocks in Bangladesh) indicates a drastic decline in the probability of survival irrespective of declining habitat in the next 100 years.**

## Directions for Future PVA Efforts

As discussed earlier within this document, it is unwise to use the results of a population viability analysis by themselves to determine precise and quantitative recovery targets for endangered species conservation and the strategies necessary for their achievement. The uncertainties surrounding our understanding of Hoolock biology, genetics, and ecology are too great for such precise predictions to be made. Nevertheless, we can gain considerable insight into the *relative response* of different gibbon populations to human activities, and thereby gain insight into how to best manage these populations to achieve a given level of security.

Although we are satisfied with the insights gained from this preliminary analysis, there are other factors and processes we see as potentially important to the future viability of Hoolock populations, but were unable to include in the models discussed here. Their omission from the current analysis reflects our lack of basic understanding of the processes involved, and/or our inability to precisely measure their impacts on gibbon populations. Such processes or factors include:

Impacts of disease

Although two observations of Hoolock deaths due to diseases have been noticed, this subject is largely unknown. Close interactions of Hoolocks with humans in small fragmented populations could make the animals susceptible to diseases not yet understood or investigated, thereby threatening the populations. The model with undefined catastrophe, if taken as disease, indicates an increased probability of extinction in the various small Hoolock populations. Detailed analysis with information on diseases and its impacts needs to done after specific studies in the wild.

Additional catastrophic processes

Our group engaged in very preliminary discussions on the impacts of other natural processes on Hoolock populations, but since this aspect is poorly understood in the wild, we modeled a generic catastrophe occurring once in 20 years. We are currently unable to describe theses processes and their consequences in sufficient detail.

Optimal augmentation strategies

In addition to natural means of population augmentation through dispersal, would it be possible to boost the viability of local populations through augmentation? What would be the source of such individuals? Which populations within a given metapopulation should be the targets of augmentation in order to achieve the highest levels of metapopulation stability? What should be the optimal frequency and extent of augmentation? What types (i.e., age classes) of individuals should be used for augmentation? These questions may be of critical importance to the proper management of Hoolock populations, but we were unable to properly address them in this analysis.

Subsequent analyses of Hoolock population viability would greatly benefit from detailed discussions of these factors, in addition to those that were identified in the current analysis as both important in their contribution to population stability, yet also uncertain in their measurement.

**Conclusions**

We may conclude our preliminary analysis of Hoolock population viability by returning to the original set of questions that provided the foundation for our study. As a prelude, however, it may be worthwhile to discuss the general concept of extinction risk analysis and its use in endangered population management. Without specific guidance from the Bangladesh or Indian governments, individual Recovery Teams are left to develop their own definitions.

The analyses presented here suggest that sporadic observations and lack of action to safeguard the isolated populations immediately may be inadequate to demonstrate viability of a relatively small population of Hoolocks that can be negatively impacted by human activities across the landscape. This is largely due to the fact that some processes and their effects often occur on time scales that are longer than the monitoring period set forth by the draft Plan. Consequently, dynamic and largely unpredictable processes that are very important in determining longer-term population performance are not taken into account to the extent necessary when making a decision on whether or not a species can be suitable for recovery.

***Drawing by Arnab Roy***

# Conservation of Western Hoolock Gibbon *(Hoolock hoolock hoolock)* in India and Bangladesh

## Wild Population Management

## Working Group Report: Wild Population Management

***Working Group Members:*** *Mohammad Ali, Suprio Chakma, Tapan Kumar Dey, A.K. Gupta, Akbar Hussain, Md. Shahriar Mahmud, Phill Miller, Laskar Maqsudur Rahman, G.S. Solanki*

### INTRODUCTION

### PROBLEM STATEMENTS FOR HOOLOCK IN WILD IN ITS RANGE

***The working group members identified problems related to wild populations of Hoolock broadly classified into two categories.***
***Direct Effect***

**Habitat Loss**
This issue comprises of two facets: complete loss of habitat (quantitative loss) and degradation of habitat (qualitative loss). The working group members also opined that habitat loss, both quantitatively and qualitatively, is the most deterministic cause that controls its distribution as well as future existence in the wild. The quantitative loss was assigned due to habitat encroachment, development projects, *jhum* cultivation practice, denotification of protected areas, and habitat fragmentation. The qualitative loss was assigned to commercial logging, loss of food and cover trees, *jhum* cultivation practice, illegal felling, habitat fragmentation, monoculture plantation, infrastructure development (roads, dams), and other developmental projects.

**Inadequate legislative support**
This issue consists of three different facets: insufficient legislation, redundant clauses, and poor implementation, coordination and manpower.

**Livelihood issue for local people**
Lack of alternatives for meeting the subsistence needs of the local people is one reason coming in way of management of Hoolock.

**Small fragmented population**
Geographically isolated populations may lead to various causalities due to scattered distribution.

**Poaching**
It is considered as an issue when it is linked with commercial illegal harvesting of the species both in India and in Bangladesh.

**Hunting**
It is perceived as an issue, when the animal is used for traditional subsistence needs (food, medicine, various cultural practices).

**Improper sex-ratio**
This becomes an issue of concern when the population is fragmented and isolated leading to skewed sex

ratio (either male or female individuals).

**Lack of proper population census**
This issue has also three different situation worth considering: total absence of population estimation from certain areas, non-use of proper estimation methods, and lack of well defined periodicity for undertaking population estimation and monitoring.

*Indirect Effect*

**Lack of political will**
This refers to lack of allocation of funds for forestry and wildlife sector for conservation activities. More preference is given to the developmental projects over conservation-related projects. It is also perceived that direct and indirect issues leading to the problem in management of gibbons can be taken care provided the political will is present.

**Lack of proper administrative set up**
The administrative set up may be totally absent, or wherever present, manpower lacks competence to undertake the required tasks.

**Absence of proper conservation and management programmes**
Lack of species and area specific management plans inhibit the creation and funding of viable programmes and their implementation.

**Proper research and monitoring**
Inbuilt institutional applied research mechanisms and monitoring protocols are absent.

**Lack of co-ordination between different departments**
Various stakeholders have their own agenda to realise, without care to develop and implement a common conservation goal of effective *in situ* management of Hoolock Gibbon.

**Insufficient protected areas**
Lack of sufficient Protected Areas may lead to creating more pressures on the species present within the existing protected areas

**Socio cultural aspect**
There is no government policy to address the issue of socio-cultural needs of the people.

**DATA ASSEMBLY AND ANALYSIS**

***Direct issues:***

***Habitat loss***
Facts: There has been a substantial loss of habitat both in quantity and quality both in India and Bangladesh.

Assumption: Loss of Hoolock population.

Justification: The case of Digboi Reserve Forest (Assam, India) where in there was a loss of 30 groups. At Chunati Wildlife Sanctuary (Bangladesh) where in there was a loss of 7 groups (21 individuals) in 15 years.

Data availability: No data on the canopy cover density, inventorization.

***Improper legistlative support***

Facts:

1. Absence and redundant legislation and improper implementation and execution of existing legislation.
2. Lack of legislative support from other stakeholders (police, customs, local administration).

Assumption: 25-30% check in habitat loss and population decline could have been if effective legislation existed and was judiciously and aggressively implemented.

Justification: Actual case studies from Bangladesh and India.

Data availability: No researched data available on above facts.

***Livelihood issues for local people***

Facts: Subsistence needs of the local people lead them to encroach upon the vital habitat resources of the Hoolock.

Assumptions: Lack of alternatives responsible for above scenario.

Justification: Proper community-based programmes may lead to the protection of vital habitat (ecodevelopment and ecotourism in India and social forestry and ecotourism in Bangladesh).

Data availability: No researched data available.

***Small fragmented population***

Facts: Fragmented population exists in many parts of the gibbon habitat in India and Bangladesh.

Assumption: Decrease in population size may lead to extinction.

Justification: About 60% fragmented population in Bangladesh.

Data availability: Many case specific scenarios exist both in India and Bangladesh.

***Poaching***

Facts: Linked with commercial illegal harvesting of Hoolock.

Assumption:
(1) It might lead to decrease in population size.
(2) Uneven sex-ratio.

Justification: Presence of small isolated population in India and Bangladesh.

Data availability: A few case specific scenarios exist both in India and Bangladesh.

***Hunting***
Facts: The animals are used for meeting traditional subsistence needs of the aboriginals.

Assumptions: It may lead to fragmentation/ extinction of the population.

Justification: Many cases of fragmented and extinct cases in India and Bangladesh.

Data availability: Many case specific scenarios exist both in India and Bangladesh.

***Improper sex ratio***
Facts: This is an issue with fragmented and isolated population.

Assumption: Hunting and poaching as main reasons for above facts.

Justification: Refer Issues on poaching and hunting

Data availability: Many case specific scenarios exist both in India and Bangladesh.

***Lack of proper population estimates***
Facts: Absence of population estimation, non-use of proper estimation methods, and lack of periodicity for population estimation.

Assumption: Conservation status of gibbons could be better or worse than what is available now.

Justification: Proper conservation measures are contingent upon proper population estimation.

Data availability: Many case specific scenarios exist both in India and Bangladesh.

***Indirect issues:***

***Lack of political will.***
Facts: The political will is needed for allocation of budget and implementation of wildlife related legislations.

Assumptions: It will take care of habitat loss, improper legislative support, poaching and hunting under Direct issues as described earlier on management of wild Hoolock population and habitat.

Justification: Major revisions of Wildlife (Protection) Act was done twice since 1972 in India. About 40% of hunting has been reduced in Assam, India since the implementation of the Act. The revision of Wildlife Act is yet to be done in Bangladesh, yet, there is a ban on capture of Schedule III animals.

Data availability: Awareness about the Act is required to be spread amongst different stakeholders in India and about the ban under existing legislation in Bangladesh.

***Lack of proper administrative setup***

Facts: Absence of administrative set up, improper placement of man power.

Assumptions: Adequate administrative management leads to the protection of Hoolock habitat and population.

Justification: There are cases both from India and Bangladesh where the presence of proper administrative set up and management mechanisms has led to conservation of the habitat and population.

Data availability: In the earlier set up, posts like animal keepers, wildlife scouts, wildlife warden existed, which have been abolished in new set up in Bangladesh. Such posts, however, exists in India.

***Absence of proper conservation and management programmes***

Facts: Lack of species and area specific management plans and funds.

Assumptions: Feasible management plans and sufficient fund will help to conserve the species as well as the habitat.

Justification: These activities may help to solve the issues related to habitat, population loss and livelihood issues of local people.

Data availability: Conservation plans for the target species is missing in management plans and conservation projects for specific localities.

***Proper research and monitoring***

Facts: Research and monitoring system is not sufficiently organized.

Assumptions: Research and monitoring will include and take care of livelihood issues and fragmented population and habitat.

Justification: The establishments of research and monitoring institutions will develop research mechanism and monitoring protocols. There are State Forest Research Institutions in India which are engaged in research and monitoring activities. In Bangladesh, such institutions need to strengthen their infrastructure and financial base.

Data availability: Refer to the Working Group Reports

***Lack of co-ordination among different Departments***

Facts: Poor coordination amongst different implementing agencies.

Assumption: Lack of coordination adversely affects the target species and habitat which are often neglected as a result.

Justification: Practice of *Jhum* cultivation, issue of gun license, construction of dams etc. in prime Hoolock areas.

Data availability: Many case specific scenarios exist both in India and Bangladesh. In Chunati Wildlife Sanctuary, construction of Kaptai Dam without oversight by relevant departments has led to loss of Hoolock populations.

***Insufficient Protected Area***

Facts: Various prime habitat area still vulnerable without protected area status.

Assumption: More protected area in those areas will aid to the increase in conservation status of Hoolock.

Justification: Gibbon Wildlife Sanctuary in Assam. Certain Hoolock areas in Tripura, Mizoram, Meghalaya and also Karbi Anglong in Assam, and Rainkheong, Thega, Bamu, Adampur Reserve Forest in Bangladesh.

Data availability: Some protected areas exist both in India and Bangladesh.

**Socio-cultural aspects**

Facts: Socio-cultural needs are to be addressed for participatory conservation.

Assumption: This will lead to improvement of habitat and population.

Justification: Eco-tourism / eco-development in India and social forestry in Bangladesh.

Data availability: Many such areas exist both in India and Bangladesh.

## IDENTIFICATION OF GOALS

Following detailed discussions and inviting opinions from other working group members the following goals were identified.

### Direct Issues

1. To arrest habitat loss
2. To receive the legislative support
3. To improve livelihood for local people
4. To ensure the survival of small fragmented population
5. To arrest poaching
6. To check hunting
7. To rectify improper sex ratio
8. To undertake periodic population estimation

### Indirect Issues

1. To earn political will in favour of conservation.
2. To have proper administrative set up to support conservation programmes.
3. To formulate the proper conservation management programmes.
4. To develop proper research and monitoring facilities.
5. To facilitate co-ordination among various departments.
6. To bring more areas under protected area coverage to address problems of fragmented and isolated gibbon populations.
7. To address socio-cultural issues of local human population.

## PRIORITIZATION

Following the pair ranking method the working group identified the following problems as priority, although they did not exclude other problems from discussion and developed action plans.

| | |
|---|---|
| Priority I: | *To arrest habitat loss* |
| Priority II: | *To receive legislative support for preventing illegal activities for conservation of Hoolock* |
| Priority III: | *To improve the livelihoods of people living in and around Hoolock habitat* |
| Priority IV: | *To have proper administrative set up to support conservation programmes and to facilitate periodic population estimation of Hoolock* |
| Priority V: | *To earn political will in favour of conservation* |

## PRIORITIZATION OF GOALS AND ACTION PLANS RECOMMENDED

Goal I

*To arrest habitat loss*

Action Plan

Two fold actions are proposed to achieve the goal of arresting the loss of habitat, one by making good of the quantitative losses to the habitat, and second by restoring the qualitative losses to the existing habitat. Following specific Action Points are proposed:

1. The **quantitative losses** can be made good of by reclaiming encroached land by invoking the enabling legislative measures and by undertaking rehabilitation activities for the people to move them outside the Hoolock habitat.
2. The **qualitative losses** can be restored:
   i. By improving the degraded Hoolock habitats by facilitating aided natural regeneration, raising new plantations of food species, improving the canopy cover, and improving water regime inside gibbon habitat.
   ii. By completely checking illegal felling/cutting of trees.
   iii. By completely stopping or minimizing the collection of non-wood forest products by the local human populations from the Hoolock habitat.
   iv. By invoking the Conservation and Community Reserve Provisions of the Wildlife (P) Act of India to link fragmented Protected Areas having critical Hoolock habitat and population.
   v. By facilitating canopy connectivity using bamboo bridges (successfully done in Assam).

Goal II

*To earn political will in favour of conservation*

Action Plan

1. By conducting conservation awareness programmes for policy makers and politicians
2. By motivating the media to win favour of politicians by projecting ecological and economic benefits accruing through gibbon conservation programmes.
3. By highlighting the economic and other benefits to the local people from conservation of Hoolock and their habitat, which in turn may convince politicians about its importance.
4. By involving tribal or religious leaders while drawing up the conservation awareness programmes.
5. By creating publicity/extension wings/divisions/cells, etc. in the forest department for periodic and regular documentation and dissemination of success stories linking gibbon conservation with economic development of local human communities.
6. By preparing educational materials specifically tailor made for politicians and religious leaders for awareness.

Goal III

*To receive legislative support for preventing illegal activities for conservation of Hoolock*

Action Plan

1. Creation of infrastructures (e.g., protection camps, wireless networks, transportation facilities, watch towers, etc.) for enabling staff to perform protection activities effectively.
2. Introducing enabling amendments in the Wildlife Protection Act of Bangladesh to make it effective for Hoolock conservation in contemporary field situation.
3. By constituting co-ordination committees consisting of members from other enforcement agencies (Police, Customs, Judiciary, District Administration, Armed Forces, Paramilitary services, etc.) for supplementing and strengthening the Wildlife legislation with enabling provisions of other Acts / Legislation for effective conservation of Hoolock habitat and population.
4. By creating and constantly nurturing working relationships with the NGOs and other Research and Academic Institutions.
5. By inducting local communities to impart protection (e.g., Van Vahini) in the Hoolock habitat *in lieu* of the community based economic benefits rendered to them by the Forest Department.
6. By filling up all the vacant posts especially in gibbon areas and providing them training in wildlife related legislation and its implementation techniques.
7. By initiating and regularly conducting the in-service training programmes especially for the front line staff in various aspects of wildlife conservation with special reference to the conservation of Hoolock habitat and population. These training courses may cover aspects related with habitat improvement, conducting population estimation, undertaking effective community based programmes, wildlife laws, etc.
8. By sensitizing the lawyers / judges and policy makers in the importance of Hoolock conservation through theme based seminars / discussions etc.

***Drawing by Arnab Roy***

# Conservation of Western Hoolock Gibbon *(Hoolock hoolock hoolock)* in India and Bangladesh

## Habitat and Distribution in Bangladesh

## Working Group Report: Habitat and Distribution in Bangladesh

***Working Group Members:*** *Farid Ahsan, Abdul Aziz, M.M. Feeroz, Kamrul Hasan, Mofizul Kabir, Sanjay Molur, Shamsur Rahman and C. Srinivasulu*

### INTRODUCTION

The Working Group aimed to update the current distribution status of Western Hoolock Gibbon in Bangladesh and the issues that concern the habitat status, habitat requirement and the long-term management of the Western Hoolock Gibbon in Bangladesh. The Western Hoolock Gibbon populations in Bangladesh are restricted in distribution to the forested tracts in the Northeast and Southeast parts only, and in the recent past had been facing crisis showing declining trend in numbers. The Hoolock Gibbon has, in fact, become extinct from many sites. The Western Hoolock Gibbon habitats in Bangladesh are declining at an alarming rate due to the anthropogenic factors consisting of quantitative and qualitative habitat loss. Being a highly specialized species (forest canopy dweller, frugivorous, territorial, monogamous with long interbirth interval), the Western Hoolock Gibbon in Bangladesh requires stringent and timely conservation action plans for its survival.

### DISTRIBUTION

Until recently the Western Hoolock Gibbon in Bangladesh was known from six areas in northeast and eight areas in southeast Bangladesh. In the past as many as 25 areas were reported to have Western Hoolock Gibbon, of which only 14 distinct areas have been recognized. Further recent surveys by gibbon biologists of the country have put on record further sites harbouring gibbon populations. Table 9 updates the population distribution and its trend in Bangladesh.

In northeast Bangladesh a total of 10 sites from where the Hoolock was recorded of which one site, namely – Horinchara, has recently lost its Hoolock population. Further, the group opined that surveys should be carried out in potential Hoolock habitats in and around that of Puthichara, Ragna, Muraichara (Kulaura Range), Madhabkunda, and Shaltila Beat. In southeast Bangladesh a total of 22 such sites were recorded to have Hoolock Gibbon of which seven sites, namely – Chunati, Satghar, Padua, Bomarighona, Himchari, Hnila, and Teknaf have recently lost their Hoolock populations. From three sites, namely - Hazarikhil, Dopachari and Whykong, the Hoolock presence is considered based on the information from local villagers. The gibbon biologists of Bangladesh are yet to find any conclusive records of the Hoolock's presence in these areas. Fifteen sites, namely - Fatikchari, Kalapahar (Laxichari), Upper Rankheong Reserve, Thega Reserve, Bilaichari, Borokal, Sazack, Shisok Range, Ruma, in-between Kaptai and Bandarban, near Chimbuk, Alikadam, Upper Raju, Swankhali, and Monkhali were proposed to be surveyed to find out the presence of Hoolock.

**Table 9: Update of Western Hoolock Gibbon (*Hoolock hoolock hoolock*) distribution in Bangladesh**

| Rg | Reserve Forest | Range | Location | No. of Family Units | No. of Indivi-duals | 1990 & before | 1996 | 2002 | 2005 |
|---|---|---|---|---|---|---|---|---|---|
| | | Barolekha | Barolekha | 3 | 8 | - | - | + | + |
| | Patharia | | Patharia | 1 | 2 | + | + | + | + |
| | | Juri | Lathitila | 1 | 3 | - | - | | + |
| NE | Western | | Lawachara | 12 | 37 | + | + | + | + |
| | Banugach FR | | Chautoli | 2 | 5 | - | - | - | + |
| | Rajkandi | | Kalinji | 6 | 16 | - | - | + | + |
| | | | Adampur | 6 | 16 | + | + | + | + |
| | | | Horinchara | 0 | 0 | - | + | + | Lo |
| | Tarap Hill | | Kalenga | 1 | 1 | - | - | + | + |
| | Raghunandan Hill | | Satchari | 3 | 7 | + | + | + | + |
| | | Bariadhala | Hazarikhil | 0 | 0 | + | + | + | L[§] |
| | | | Kaptai | 4 | 14 | + | | + | + |
| | | | Chunati | 0 | 0 | + | + | + | Lo |
| | | | Satghar | 0 | 0 | + | + | - | Lo |
| | | | Padua | 0 | 0 | + | - | - | Lo |
| | | | Bhomarighona | 0 | 0 | + | + | - | Lo |
| SE | | | Himchari | 0 | 0 | + | + | - | Lo |
| | | | Inani | 2 | 5 | - | - | + | + |
| | | | Ukhia | 2 | 6 | + | + | + | + |
| | | | Hnila | 0 | 0 | + | + | - | Lo |
| | | | Teknaf | 0 | 0 | + | + | - | Lo |
| | | | Bamu | 4 | 14 | - | - | - | + |
| | | | Bangdepa | 3 | 8 | - | - | - | + |
| | | | Bishari | 3 | 7 | - | - | - | + |
| | | | Thanchi | 3 | 7 | - | - | - | + |
| | | | Rampahar | 5 | 16 | - | - | - | + |
| | | | Dighinala | 3 | 7 | - | - | + | + |
| | | | Pablakhali | 2 | 4 | + | + | + | + |
| | | | Massalong | ND | ND | - | - | - | + |
| | | | Lama | ND | ND | - | - | - | + |
| | | | Dhopachari | 3 | 7 | - | - | - | L[§] |
| | | | Sazak | 4 | 12 | - | - | - | + |
| | | | Whykong | ND | ND | - | - | - | L[§] |

*Key:* ND – No Data; Lo – Lost; L[§] - Based on local's report.
*Source:* Gittins and Akonda, 1982; Ahsan, 1984, 1994; Feeroz, 1991; Feeroz and Islam 1992; personal observations by the group members.

## PROBLEM STATEMENT FOR HOOLOCK IN BANGLADESH

The working group members identified problems related Hoolock and its habitats in Bangladesh, broadly classified into two categories (Table 10).

Under the category related to problems pertaining to the Hoolock habitat conditions, the working group felt that habitat depletion due to human interference and settlements (both within and in the fringes of Hoolock habitats), logging (illegal and systematic), habitat loss and degradation of habitat quality (due to fire wood collection, forest fire, and lack of fruit yielding tree), habitat degradation and fragmentation (due to agricultural land expansion, monoculture, betel leaf plantation and *jhum* cultivation), invasive alien species, subsistence hunting, collection for zoo/safari park, and developmental activities taken up in Hoolock habitats (road construction, laying of power line, gas field exploration, and brick field near forest edge).

With respect to the population problems, the group opined that the escalating habitat loss and disruption of continuous canopy has led to population fragmentation, isolation and inbreeding problems.

**Human interference**

With the ever-increasing human population both within the Hoolock areas and on the fringes of these habitats, more and more Hoolock viable habitats are altered / destroyed / shrinking resulting in continued decline in these habitats as well as the Hoolock populations. Human settlement in Chittagong Hill Tracts in and around Hoolocks' habitats has increased pressure resulting habitat reduction and their population.

**Habitat loss**

Many of the historic and recent Hoolock habitats have been or are being greatly altered due to illegal logging by the local tribal and settlers for their livelihood needs and subsistence existence. Lack of awareness, rampant firewood collection for both the local needs and the market demands; unmanaged forest fires for fuel wood collection and ash generation that is being used in the nearby paddy fields as fertilizers; expansion of agricultural lands within the forests by the settlers and systematic logging undertaken under the revenue-generation activities by Forest Department who are unaware about the biodiversity conservation (in general) and gibbon conservation (in particular) needs. The gibbon populations at Satghar, Padua, Bhomariaghona, Hnila, Teknaf have been lost due to illegal logging, fuel wood collection and large scale habitat alteration. At Himchari and Horinchara the illegal logging and systematic logging in some parts of the habitat has led to the loss of the gibbon populations. Habitat degradation leads to loss of food, shelter, and sleeping trees that in turn is directly affecting the Hoolock populations.

**Agriculture**

Expansion of paddy fields by the fringe dwellers, tribal practice of *Jhum* cultivation leads to large scale habitat destructions in the Hoolock's habitats. Cattle grazing in the forest leads to continued presence of human beings that disturb free movement of the Hoolock. Seasonal fruit cultivation or establishments of orchards are snatching away the Hoolock habitats. Recent expansion of betel leaf cultivation encroach habitat making fragmentation and movement barrier for the species. Previously uncontrolled plantation in Hoolock habitat has poached its habitats. In West Bhanugach RF the Forest Department has taken up moluccana (*Paraserianthes falcataria*) and it is also more commonly knows as *Albizzia moluccana* plantation to meet the commercial demands, which has deprived the Hoolock its habitat.

**Alien species**

Alien species like *Acacia* spp., *Eucalyptus* spp., Pine, etc. have been planted (eg., Lawachara National Park and Chunati Wildlife Sanctuary) due to their rapid growth as well as revenue resulting in the destruction of gibbon habitats.

**Extraction**
Indigenous people, like Boam tribe, occasionally hunt Hoolock for meat traditionally. Some instances of local people collecting wild Hoolocks for supplying to zoos / safari park has also resulted in depletion of Hoolock population. Recently, two hunters collected two Hoolock in Bangdepa Forest Beat, Jowarinala Range, Cox Bazar North Forest Division that was purchased by the officials of Chittagong Safari Park.

**Development**
Establishment of brickfields, violating existing rules and regulations of the country at the close proximity of forests, indiscriminate collection of fuel wood by logging trees as fuel for brick kilns has led to habitat decline in Satgarh block under Chunati Forest Range. Construction of roads and highways, and gas exploration activities too affects the Hoolock and its habitat. A fire mishap at Magurchara well, close to Lawachara National Park in early 1990 destroyed some habitat within the natonal park itself and scared away all the Hoolocks from the vicinity. Such explosion may pose serious threats to habitats preferred by Hoolocks. The gas line through Lawachara National Park albeit under the previously existing road, created problems to Hoolocks during the pipe laying operations. This could also to some extent create possible opportunities for illegal timber loggers and firewood collectors. Existence of power line passing through the forest (as in Lawachara National Park) breaks the canopy continuity thus isolating Hoolocks.

**Population fragmentation, isolation, inbreeding**
Habitat loss due to logging, agricultural expansion, human settlement, systematic and illegal logging leading to canopy gaps have fragmented and isolated the Hoolock populations reducing the chance of non-sibling pair formation. In the long term the inbred Hoolocks' have greater chance to succumb to stochastic events.

Population fragmentation due to habitat degradation leads to imbalance sex-ratio making the populations unviable. Isolation also leads to inbreeding depression. Habitat and population fragmentation isolates group and creates barrier for genetic exchange. At Chunati Wildlife Sanctuary, from where the Hoolocks are lost due to a combination of different factors, two cases of father-daughter pairing were observed that would have possibly have been too inbred to produce viable offsprings.

**PRIORITIZATION**
Following the pair ranking method the working group identified the following problems as priority, although they did not exclude other problems from discussion and developed action plans.

| | |
|---|---|
| Priority I: | *Habitat loss* |
| Priority II: | *Human interference* |
| Priority III: | *Agriculture* |
| Priority IV: | *Development* |
| Priority V: | *Extraction* |
| Priority VI: | *Alien species* |

**Table 10: Habitat and population problems of Hoolock in Bangladesh**

| | | |
|---|---|---|
| ***Habitat problems:*** | | |
| **Human interference** | Human pressure | Pop. Density more than 900 creating tremendous pressure on gibbon habitat |
| | Human settlement | Population increase, river erosion, infringement inside the gibbon habitat by refugees (eg., Rohingas) |
| | Illegal logging | Socio-economic condition, needs, market demand, unemployment, lack of awareness |
| | Systematic logging | Less concern of FD regarding biodiversity conservation and revenue |
| **Habitat loss** | Fire wood collection | Local needs, livelihood |
| | Forest fire | Fire wood, ash for nearby paddy field |
| | Lack of fruit yielding tree | Illegal logging and firewood collection of removal some planted and natural food trees create food scarcity. |
| | Habitat degradation | Small trees wiped-out for firewood, poles |
| | Political influence | Local politicians sometimes indirectly involve in some illegal events. For instance, when an illegal timber collector/poacher or land encroacher iscaught by local forest administration, the guilty receive unwritten influential support |
| | Habitat Fragmentation | Expansion of agricultural land, logging, human settlement |
| | Agricultural land expansion | Cultivation of paddy and vegetables in between small forest patches and gullies. |
| **Agriculture** | Monoculture | *Acacia auriculiformis*, Malakhana, Teak |
| | Betel leaf plantation | Livelihood and country wide demand |
| | Jhum cultivation | Traditional practice |
| **Alien species** | Invasive alien species | Rapid growth, increased competition, limited resources. Acacia auriculiformis, Malakhana (*Paraserianthes falcataria*). |
| **Extraction** | Hunting | Food, medicine |
| | Collection for zoo/safari park | Collected about 10 gibbons for zoos and safari park in Bangladesh. |
| | Road construction | Communication, urbanization |
| **Development** | Power line | Urbanization, demands |
| | Gas field exploration | Gas field exploration and accidental explosion close to gibbons' habitat. |
| | Brick field near forest edge | Establishment of brickfields close to forests violating existing rules of the country. |
| ***Population problems:*** | | |
| **Population fragmentation** | Habitat loss | Vast forest patch disappear due to logging, agricultural expansion, human settlement |
| **Isolation** | Habitat fragmentation and and disruption of continuous | Systematic and illegal logging, developmental activities fragment and also create disruption of canopy continuous canopy hamper gibbons' movement. |
| **Inbreeding depression** | | Habitat loss and fragmentation Less scope for non sibling pair formation due to fragmentation |

**Habitat loss**
All sorts of logging and collection of fire wood, house building materials, human settlement, lack of awareness and expansion of agricultural land leads to habitat shrinkage and fragmentation that in turn has direct bearing on the Hoolock population. The Hoolock populations in Chunati Wildlife Sanctuary and Himchari National Park succumbed due to habitat loss.

**Human interference**
Ever increasing population pressure and settlements on the fringe of Hoolock's habitat with unemployment, joblessness, lack of alternative income source for livelihood is leading to habitat shrinkage at an unprecedented rate which is resulting in decimation of Hoolock population in some sites, as observed at Chunati Wildlife Sanctuary where the Hoolocks became extinct from a strong group of 20 individuals in a period of 15 years.

**Agriculture**
Agricultural land expansion, betel leaf and *jhum* cultivation qualitatively and quantitatively reduce the Hoolock habitats. Expansion of agriculture lands leading to habitat fragmentation and subsequently total or partial reduction in Hoolocks occured in Rema-Kalenga Wildlife Sanctuary, Chunati Wildlife Sanctuary and some areas in Chittagong region.

**Development**
Developmental activities such as construction of roads / Highways (as at Chunati Wildlife Sanctuary), laying power line (as at Lawachara National Park), gas exploration and explosion (as at Lawachara National Park), and establishment of brickfield (as at Chunati Wildlife Sanctuary), fragments Hoolock habitats and also create gaps big enough to act as barrier hindering Hoolocks' movement in their range.

**Extraction**
Hunting for meat and medicine, and collection for zoo/safari park also affect Hoolocks' family structure (that remains fairly stable over a long period of time) and sex-ratio rendering the effected population unviable. Hunting by the locals have been observed in Lawachara National Park and Rema-Kalenga Wildlife Sanctuary.

**Alien species**
Planting exotic species in the degraded habitat (as at Teknaf Game Reserve and Chunati Wildlife Sanctuary) under the Forest Department's monoculture plantation projects robbing the hoolocks' habitat of its varied natural characteristics.

**Other threats**
The Hoolock studies in Bangladesh are hindered due to unapproachable habitats, political unrest (conflict between local inhabitants - tribals and the government, the tribals and the recent settlers – made landless due to river erosion and floods; insurgents from Indian side both on the north-east and south-east, and the Rohingas from Myanmar); lack of communication and infrastructure in the hill tracts.

**GOALS**
- To assess and evaluate present status and distribution of hoolock and its habitats in

Bangladesh

- Recheck the local reports and lost gibbon groups from the previously marked locations/ areas.
- Survey five locations in the northeast and 15 in the southeast, those not yet been covered and also explore probable locations, if any.
- To create public awareness among primary stakeholders
- To minimize human and other biotic pressure on Hoolock habitats
- To earn firm political and social commitment for wildlife and habitat protections
- To generate alternative livelihood to check illegal activities in and around hoolock habitats
- To create digital database for Hoolock population and habitat

**PRIORITIZATION OF GOALS AND ACTION PLANS RECOMMENDED**

Goal I

*To earn firm commitment from politicians and policy makers for wildlife and habitat protection.*

Action Plan

Organizing conservation awareness programs for the politicians and policy makers.
Publicizing the successful Hoolock conservation cases in the media.
Projecting the economic benefit to the local communities through Hoolock related conservation programs.

**Potential persons/institution for achieving the goal**

Mr. Enayatullah Khan and Prof. Anwarul Islam of Wildlife Trust of Bangladesh, Dhaka will lead as agency to get commitment from the Bangladesh Government.

Goal II

*To assess and evaluate present status and distribution of Hoolock and its habitats in Bangladesh.*

Action Plan

1. By creating more posts for wildlife conservation at different levels
2. By imparting training to the staff.
3. By developing suitable infra-structure to facilitate the staff to assess and evaluate gibbon habitat and population.
4. By adopting proper scientific methods for periodic estimation and assessment of hoolock population and habitat.
5. By developing vibrant and working coordination between research/academic institutions and forest department.

**Potential persons/institution for achieving the goal**

Hoolock researchers based at Dhaka University, Jahangirnagar University, and Chittagong University, and Ministry of Environment and Forests (Wildlife Circle), Government of Bangladesh.

Goal III

*To generate alternative livelihood to check illegal activities in and around Hoolock habitats.*

Action Plan

To discourage local illicitors, joint efforts be developed for their alternative livelihood in and around Hoolock habitats.

**Potential persons/institution for achieving the goal**

Non Governmental Organisations (yet to be identified), Hoolock researchers of Dhaka University, Jahangirnagar University, and Chittagong University, Ministry of Environment and Forests (Wildlife Circle), Government of Bangladesh, local elites, religious leaders, and media (press, radio and television).

Goal IV

*To minimize human and other biotic pressure on Hoolock habitats.*

Action Plan

i. By initiating, facilitating and understanding community based programs (eg, eco-development, eco-tourism, joint conservation efforts, etc.) in and around Hoolock habitats.

**Potential persons/institution for achieving the goal**

Non Governmental Organisations (yet to be identified), Hoolock researchers of Dhaka University, Jahangirnagar University, and Chittagong University, Ministry of Environment and Forests (Wildlife Circle), Government of Bangladesh, local elites, religious leaders, and media (press, radio and television).

Goal V

*To create public awareness among primary stakeholders.*

Action Plan

i. By developing informal educational program for different stakeholders in and around Hoolock habitats.
ii. By organizing programs for school children to sensitize them about importance of gibbon conservation.
iii. By declaring and celebrating wildlife week, gibbon day, etc. with the active participation of local communities, children, and other stakeholders.
iv. By organizing theme based seminars and workshops.

**Potential persons/institution for achieving the goal**

Non Governmental Organisations (yet to be identified), Hoolock researchers of Dhaka University, Jahangirnagar University, and Chittagong University, Ministry of Environment and Forests (Wildlife Circle), Government of Bangladesh, local elites, religious leaders, and media (press, radio and television).

Goal VI.

*To create digital data base for gibbon population and habitat.*

Action Plan

i. Having GIS images for entire Hoolock habitats to digitize hoolock population and habitats for future comparison and management plan.

**Potential persons/institution for achieving the goal**

Hoolock researchers of Dhaka University, Jahangirnagar University, and Chittagong University, Ministry of Environment and Forests (Wildlife Circle), Government of Bangladesh, and Space and Remote Sensing Organization of Bangladesh (SPARSO).

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**TASK 4: Actions**

**Actions proposed by Habitat and Distribution in Bangladesh Working Group**

Goal- E-1

*To achieve greater understanding of Hoolock gibbon in Bangladesh.*

***Actions:*** Collect accurate demographic and ecological data as well as condition of the gibbon habitats in the country, which should include-

Demographic data of Hoolock in each habitat.

Digitalized distribution of Hoolock in each habitat.

Assessment of the habitat condition of hoolocks in its past and present ranges.

Longterm monitoring of population dynamics of hoolock in the country.

***Responsible Parties:*** Gibbon specialist group of the country.

***Timeline:*** Begin in 2005, continue every year.

***Outcome:*** Development of long-term management plan for gibbon conservation.

***Collaborators:***

Department of Zoology of Dhaka University, Jahangirnagar University, Chittagong University and Ministry of Forest and Environment, Government of Bangladesh (especially Wildlife Circle).

***Costs:*** USD 10,000.00 per year for 5 year.

***Consequences:*** Better knowledge about the gibbon distribution and habitat requirements in the

Country. Habitat and wildlife will be less disturbed.
***Obstacles:*** Funding to undertake such action is the major obstacle.

<u>Goal A-1</u>
*To improve the socio-economic as well as educational status of the people and alleviate poverty.*

***Actions:*** By initiating, facilitating and understanding community based programs (eg, eco-development, eco-tourism, joint conservation efforts, etc.) in and around Hoolock habitats.
***Responsible Parties:*** Different NGOs should be engaged to undertake poverty alleviation project in and around Hoolock habitats under supervision of FD (Wildlife Circle).
***Timeline:*** Beginning July 2005, continuing every year.
***Outcome:*** Forest dependent people (Forest users) will be engaged in other professions for their livelihood.
***Collaborators:*** NGOs, Department of Zoology of Dhaka University, Jahangirnagar University, Chittagong University and Ministry of Forest and Environment, Government of Bangladesh (especially Wildlife Circle), and local elites.
***Costs:*** a revolving capital of USD 50,000.00 to be provided to the NGOs for running program.
***Consequences:*** Habitat and wildlife will be less disturbed.
***Obstacles:*** Funding to undertake such action is the major obstacle.

***Drawing by Arnab Roy***

# Conservation of Western Hoolock Gibbon
# *(Hoolock hoolock hoolock)* in India and Bangladesh

## Habitat and Distribution in India

## Working Group Report: Distribution and Habitat of Hoolock Gibbon in India

**Working group members:** *Joy Ram Baruah, Surajit Baruah, Jihosuo Biswas, Joydeep Bose, Dilip Chetry, Basit Khan, Asif Ahmed Mazarita, Rekha Medhi, Sangita Mitra and P.O. Nameer*

### INTRODUCTION

The Western Hoolock Gibbon (*Hoolock hoolock hoolock*) is an endangered, monotypic, frugivorous, territorial, monogamous primate species. It is primarily a forest canopy dweller. The task of the Working Group was to update the current distribution status of WHG in India as well as the issues that concern its habitat status, habitat requirement and its long-term management.

The WHG is distributed between the Debang –Brahmaputra river system in the West (Tilson, 1979) and Chindwin river in the East (Groves, 1967, 1972; Das *et al.*, 2005). It is distributed in all the seven northeastern states of India, e.g., Meghalaya (Alfred and Sati, 1990; Choudhury, 1991); in Tripura (Singh, 1989); in Arunachal Pradesh (Choudhary, 1989, 1990); in Nagaland (Das *et al*., 2005), in Assam (Choudhury, 1987, 1988, 1990, 1991, 1996, 2000) and in Mizoram (Das *et al*., 2005).

### PROBLEM STATEMENT

Socio-political issues, mainly insurgency and boundary disputes, are hindering the distributional studies. Other hindrances are lack of infrastructure and difficult physiographic and climatic condition. Multiple factors such as encroachment, illegal timber extraction, lack of infrastructure, lack of enforcement of law, *jhum* cultivation, affect the habitat of Hoolock Gibbon in India.

#### A. Distribution

The major problems of distribution and habitat of Hoolock Gibbon in India as stated by the Working group in order of priority were : i) Socio-political issues (boundary disputes with neighbouring states, insurgency, lack of proper enforcement of law); ii) lack of infrastructure (such as funds, skilled man power, communication network); iii) physiography and climatic factors (in accessibility and prolonged monsoon creating hindrances for survey work); iv) dissemination of information and v) lack of institutional coordination (between different govt. departments).

#### B. Habitat

The major problems regarding the habitat of Western Hoolock Gibbon were discussed and prioritized as follows : i) encroachment: Large-scale encroachment of the forest areas by the tea estates, and moreover people also encroach upon the forest land for cultivation and construction of houses; ii) illegal timber extraction; iii) lack of infrastructure; iv) lack of law enforcement; and *jhum* cultivation Conversion of forest land to agricultural land.

Additional problems were : coal mining: the open cast mining of coal is a real problem for habitat particularly the habitat quality of Hoolock; grazing: Affect the habitat quality of gibbons; developmental activities such as construction of dams, roads etc., cause habitat degradation of Hoolock; selective logging; monoculture; fuel wood collection; NTFP collections; natural calamities.

## DATA ASSEMBLY

The Hoolock Gibbons occur in tropical wet evergreen forests, tropical semievergreen, tropical moist deciduous, and subtropical hill forests in India. The altitude ranges occupied by the Hoolocks are between 50 to 1400 m above mean sea level (Das, *et al*., 2005). Hoolock Gibbons occur in 22 protected areas in India, including six national parks and 16 wildlife sanctuaries in six north-eastern states and in more than 20 nonprotected areas. The detailed list is given in the Table 11 below.

**Table 11: Distribution of Hoolock in the Protected areas of India (Das *et al.*, 2005)**

| Name of PA | State |
|---|---|
| Kamlang WLS | Arunachal Pradesh |
| Mehao WLS | Arunachal Pradesh |
| Namdapha NP | Arunachal Pradesh |
| Bherjan WLS | Assam |
| Borajan WLS | Assam |
| Dibru-Saikhowa NP | Assam |
| Garampani WLS | Assam |
| Gibbon WLS | Assam |
| Kaziranga NP | Assam |
| Balapakram NP | Meghalaya |
| Nokrek NP | Meghalaya |
| Nongkhylem WLS | Meghalaya |
| Siju WLS | Meghalaya |
| Dampa WLS | Mizoram |
| Khawnglung WLS | Mizoram |
| Murlen WLS | Mizoram |
| Nengpui WLS | Mizoram |
| Phawangpui WLS | Mizoram |
| Intanki NP | Nagaland |
| Gumti WLS | Tripura |
| Sepahijala | Tripura |
| Trishna WLS | Tripura |

**<u>Distribution of Hoolock in Arunachal Pradesh</u>:** There are 168 HG in Arunachal Pradesh in seven populations as detailed below in Table 12. The average troop size is 2 to 5 with a mean of 3 (Choudhury, 1989, 1990).

**Table 12: Distribution of Hoolock in Arunachal Pradesh**

| Location | Area ($km^2$) | Popln. Size |
|---|---|---|
| Namdhapa NP | 20 | 45 |
| Miao RF | 1 | 2 |
| Mehao WLS | 240 | 48 |
| Kamlang WLS | 1 | 1 |
| Tengapani RF | 450 | 36 |
| Turung RF | 170 | 18 |
| Manabhum RF | 130 | 18 |
| | **1012** | **168** |

## Distribution of Hoolock in Assam:

Assam has the largest Hoolock population in India. There are 1985 Hoolocks in 94 populations out of which nine populations could not be sighted during the recent survey (Das *et al.*, 2005). The average troop size is 2 to 5 with a mean of 3 (Tilson, 1979; Choudhury, 1989, 1990; Das *et al.*, 2005).

**Table 13: Distribution of Hoolock in Assam**

| Location | Area ($km^2$) | Pop. Size |
|---|---|---|
| Digboi East | 0.7 | 3 |
| Digboi West | 9.3 | 7 |
| Kotha | 10.5 | 8 |
| Tengapani (Tinkopani) | 35.5 | 25 |
| Tipong | 4.5 | 7 |
| Tirap | 30.3 | 9 |
| Tirap | 14 | 10 |
| Upper Dehring | 131 | 156 |
| Lower Dehring | 274.9 | 201 |
| Dirak | 30.5 | 19 |
| Dilli | 30.1 | 4 |
| Abhayapuri | 67.35 | 0 |
| Jaypur | 108.7 | 69 |
| Dessai Valley | 174.5 | 15 |
| Gibbon WLS | 19.6 | 57 |
| Doboka | 117.4 | 30 |
| Lumding | 224 | 59 |
| Kakajan | 23.46 | 17 |
| Philobari | 3 | 7 |
| Takowani | 5 | 5 |
| Pengri | 3.2 | 3 |
| Doomdoma | 28.8 | 5 |
| Buridehing NB | 15 | 10 |
| Buroidehing SB | 7.8 | 11 |
| Kundilkalia | 72.8 | 25 |
| Tarani | 20.4 | 20 |
| Dibang valley | 35.7 | 13 |
| Hahkhati | 6.7 | 3 |
| Kumsang | 22.5 | 2 |
| Misaki | 13.6 | 9 |
| Dhanshiri | 70.4 | 25 |
| Daldali | 123.4 | 15 |
| Disama | 11.2 | 8 |
| Kaziranga NP | 429.9 | 28 |
| Panbari | 7.65 | 10 |
| Barail | 15.9 | 3 |
| Khurriming | 108.4 | 35 |
| Langtingmupa | 493.4 | 110 |
| Barail | 17.6 | 8 |
| Amreng | 56.9 | 10 |
| Mikir hill | 299.8 | 40 |
| Kalioni | 209.8 | 30 |
| Koonbamun | 65.5 | 15 |
| Nambar | 166.3 | 18 |
| Jhunthung | 32.5 | 20 |
| Patradisha | 67.3 | 10 |
| Longnit | 117.6 | 45 |
| Haithapathar | 54.4 | 19 |
| Mahamaya | 5.6 | 5 |
| Barjuri | 214.9 | 0 |
| Western Mikir Hills | 39.4 | 30 |
| Langluksho | 534.7 | 12 |
| Kaziranga NP | 33.9 | 45 |
| Dolamora | 5.5 | 0 |
| Kalapahar | 9.7 | 2 |
| Bokajan | 9.7 | 5 |
| Tikok | 25.9 | 10 |
| Innerline | 502.8 | 80 |
| Katakhal | 134.5 | 0 |
| Popahanga | 2.77 | 5 |
| Kashumari | 0.85 | 2 |
| Kashumari Part II | 0.21 | 2 |
| Khongkhal | 2.5 | 5 |
| Bagser | 33.7 | 18 |
| Deosur | 5.7 | 7 |
| Kamakhya | 5.17 | 12 |
| Kholahat | 61.6 | 20 |
| Killing | 4.5 | 3 |
| Kafitoli | 2.9 | 5 |
| Suang | 26.4 | 15 |
| South Diju | 13.06 | 10 |
| North Diju | 10 | 12 |
| Deosur Hill | 0.6 | 2 |
| Borajan WLS | 4.9 | 8 |
| Dibrisoikhowa | 765 | 30 |
| Innerline | 1136.9 | 30 |
| Longai | 131.2 | 45 |
| Singla | 138.2 | 25 |
| Patharia | 76 | 72 |
| N. Cachar | 270 | 60 |
| Innerline | 996 | 50 |
| Barail | 140 | 0 |
| Katakhal | 19.7 | 0 |
| Upper jiri | 63.2 | 0 |
| Gorbhanga | 114.6 | 20 |
| Jorsal | 12.5 | 0 |
| Kuwasing | 9.9 | 10 |
| Rani garhbhanga | 43.69 | 18 |
| South amchang | 15.5 | 18 |
| Chandubi | 2 | 12 |
| Choigaon | 12.9 | 2 |
| Kulsi | 18.5 | 20 |
| Pantan | 112.8 | 0 |
| Bogikhas | 246.7 | 0 |
| | **9905.51** | **1985** |

## Distribution of Hoolock in Meghalaya:

There are 236 Hoolocks in Meghalaya in ten populations as detailed below in the Table 14. The average troop size is 2 to 6 with a mean of 3.2 (Tilson, 1979).

**Table 14: Distribution of Hoolock in Meghalaya**

| Location | Area (km²) | Popln. Size |
|---|---|---|
| Nokrek NP | 16 | 25 |
| Songsek RF | 28.05 | 18 |
| Nongkhylum WLS | 2 | 3 |
| Baghmara RF | 1 (44) | 7 |
| Balpakram NP | 30 (6) | 15 |
| Rewak RF | 7 | 2 |
| Siju WLS | 5 (4) | 12 |
| West Garo (36 locations) | 179.5 | 130 |
| Jaintia hills | 62 | 10 |
| Saiphung RF | 18.2 | 14 |
| | **260.7** | **236** |

## Distribution of Hoolock in Mizoram:

There are 128 Hoolocks in Mizoram in nine populations as detailed below in the Table 15.

**Table 15: Distribution of Hoolock in Mizoram**

| Location | Area (km²) | Popln. Size |
|---|---|---|
| Murlen NP | 5 | 8 |
| Ngengpui RF | 3 | 1 |
| Ngengpui WLS | 10 | 3 |
| Dampa WLS | 2 | 20 |
| Tawi WLS | 156 | 22 |
| Phawngh | 23.5 | 6 |
| Murlen NP | 226 | 8 |
| Lengteng WLS | 73.5 | 24 |
| Khaunglung WLS | 48 | 36 |
| | **547** | **128** |

## Distribution of Hoolock in Tripura:

There are 97 Hoolock in Tripura in three populations as detailed below in the Table 16 . The average troop size is 2 to 4 with a mean of 3.2 (Das *et al.*, 2005).

**Table 16: Distribution of Hoolock in Tripura**

| Location | Area (km²) | Popln. Size |
|---|---|---|
| Trishna | 67 | 22 |
| N Tripura | 42 | 58 |
| Gumti | 62 | 17 |
| | **171** | **97** |

The Table 17 and Figure 9 given below gives the distribution of Hoolock Gibbons in different population size classes. It is interesting to note that about 81.98% of the Hoolock Gibbons in India are in small populations with a size of < 30 individuals in each of the populations.

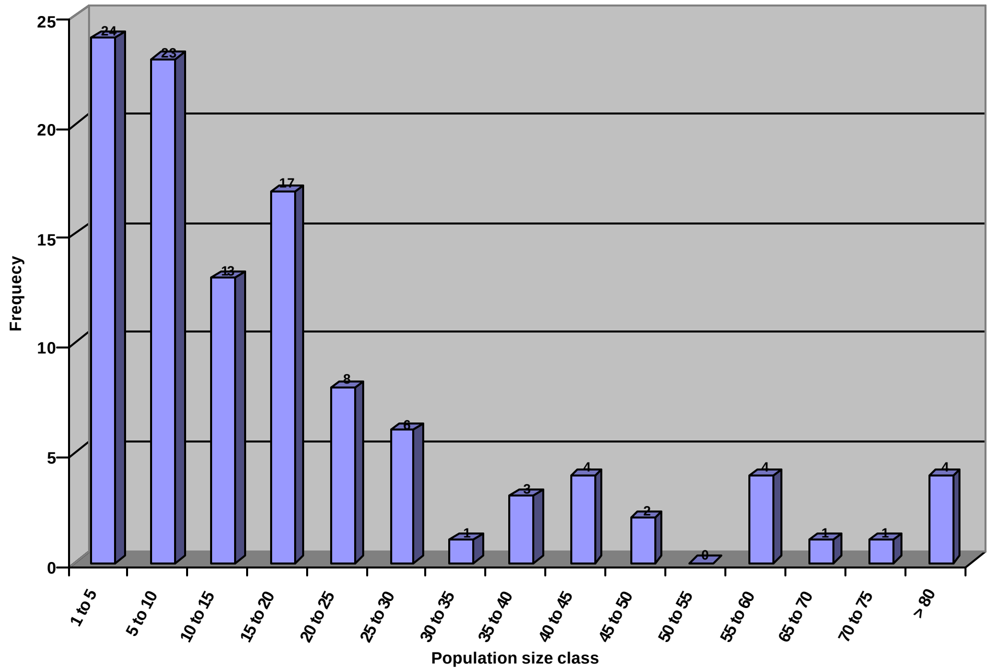


**Figure 9: The population size class of Hoolock Gibbon in India**

**Table 17: Number of populations of Hoolocks in the different population size classes in India**

| Population size class | # of populations in each classes |
|---|---|
| 1 to 5 | 24 |
| 5 to 10 | 23 |
| 10 to 15 | 13 |
| 15 to 20 | 17 |
| 20 to 25 | 8 |
| 25 to 30 | 6 |
| 30 to 35 | 1 |
| 35 to 40 | 3 |
| 40 to 45 | 4 |
| 45 to 50 | 2 |
| 50 to 55 | 0 |
| 55 to 60 | 4 |
| 65 to 70 | 1 |
| 70 to 75 | 1 |
| > 80 | 4 |
| **Total** | **111** |

The data regarding the distribution of Hoolocks for the five out of the seven States of northeastern India is more or less complete. The recent information about Gibbon of Nagaland and Manipur were not available as it was impossible to survey these States because of insurgency problems. However, more quantifiable information needs to be collected on the habitat loss and other threats of Hoolocks. More data is also required for the life history characters of Hoolocks particularly on the demographic factors.

**C. GOALS**

Keeping in mind the problem statements, we listed the following goals required to overcome these problems :

1. Develop political will
2. Coordinate between various agencies
3. Improvement of communication facilities except roads
4. Eviction of encroachers
5. Demarcation of forest boundaries
6. Enforce strict policing
7. More man-power for protection
8. Training on legal issues
9. Educate the community and religious leaders
10. Minimize jhum cultivation

**ACTION STATEMENT**

**1. Arrest habitat loss**

Prepare a detailed memorandum for the conservation of Hoolock Gibbons and submit the same to the state and central government. Include the recommendations of the PHVA workshop in the memorandum
Prepare a project proposal and submit the same to the Central govt. for declaring a *"Project Gibbon"* for the conservation of the species in its totality in line with *Project Tiger or Project Elephant*

**2. Better understanding of Hoolock Gibbon distribution**

Conduct surveys in unexplored habitat of Hoolocks in northeastern States and Reevaluate the current status of previously surveyed areas
Undertake extensive field research on several ecological parameters of Hoolock Gibbons.

**3. Political will**

Build up pressure on the government and politicians through involvement of celebrities as ambassadors of Hoolock Gibbon conservation in the wild.

**4. Socio-economic as well as educational status of people to alleviate poverty**

Conduct socio-economic survey among the fringe area people
Promote sustainable ecotourism and ecodevelopment activities
Creation of community forests to generate biomass (such as fuel wood, fodder, small timber etc)
Check cross border human infiltration.

**5. More man power for protection of Hoolock gibbon habitat**

Impress upon the government and try to accord sanction for the creation of new posts of wildlife protective staff, in the staff crunched Hoolock Gibbon habitats of northeastern India
Train the existing and newly recruited staff and equip them with advanced gadgets for effective implementation of the law for the conservation of the species
Provide incentives to the staff for outstanding services towards gibbon conservation

**6. Legislative support for preventing illegal activities**

Help the judiciary with necessary information through manuals and documents for speedy action on the cases related to wildlife in general and Hoolock Gibbon in particular

Establishment of more green benches for fast solving of legal issues on wildlife

The action statement along with the time frame and responsibility are summarized in Table 18 .

**Table 18: The summary of the action statement along with the time frame, responsibility and the budget**

| Action | Responsibility | Time line |
|---|---|---|
| Prepare a detailed memorandum for the conservation of Hoolock Gibbon and submit the same to the State and central government. Include the recommendations of the PHVA workshop in the memorandum | Sally Walker, ZOO, WTB, WTI, WWF, Gauhati University, Primate Research Centre, CBSG, WII, Gibbon Conservation Center | 3 months |
| Prepare a project proposal and submit the same to the Central govt. for declaring a "***Project Gibbon***" for the conservation of the species in its totality in line with ***Project Tiger or Project Elephant*** | AK Gupta, WII & ZOO | 5 months |
| Conduct surveys in unexplored habitat of gibbon in NE States and Reevaluate the current status of previously surveyed areas | Jihouso Biswas, Dilip Chetry, Rekha & Prof. M Mohnot, Primate Research Centre, Wild survey, WII, Forest departments, Gauhati University | 5 yrs. |
| Undertake extensive field research on several ecological parameters of Hoolock Gibbon | Jihouso, Dilip, Rekha & Prof. M Mohnot, Primate Research Centre, Wild survey, WII Forest departments, Gauhati University | 2 yrs. |
| Build up pressure on the govt. and politicians through involvement of celebrities as ambassdora of Hoolock Gibbon conservation | Joydeep Bose, Sangita Mitra, WTI, WWF | 2 yrs. |
| Conduct socio-economic survey among the fringe are people | Sangeeta Mitra, WWF, Dilip Chetry, Aranyak | 2 yrs. |
| Promote sustainable ecotourism and ecodevelopment activities | Dilip Chetry, Joydeep, Sangita | 5 yrs. |
| Creation of community forests to generate biomass (such as fuel wood, fodder, small timber etc) | Sangita Mitra, WWF, Dilip Chetry, WTI, PRC, forest department | 5 yrs. |
| Check cross border human infiltration. | MOEF, external affairs ministry human resource development, WTI, WWF | 5 yrs. |
| Impress upon the govt. and try to accord sanction for the creation of new posts of wildlife protective staff, in the staff crunched Hoolock Gibbon habitats of NE India | Joydeep Bose, WTI | 1 yr. |

| Action | Responsibility | Time line |
| --- | --- | --- |
| Train the existing and newly recruited staff and equip them with advanced gadgets for effective implementation of the law for the conservation of the species | Joydeep Bose, Sangita Mitra, WTI, WWF, Dilip Chetry, PRC | 5 yrs. |
| Provide incentives to the staff for outstanding services towards gibbon conservation | Joydeep Bose, WTI, WWF | 5 yrs. |
| Help the judiciary with necessary informaiton through manuals and documents for speedy action on the cases related to Wildlife in general and Hoolock Gibbon Gibbon in particular | Joydeep Bose, Sangita Mitra, WTI, WWF, Dilip Chetry, Aranyak | 5 yrs. |
| Establishment of more green benches for fast solving of legal issues on wildlife | Joydeep Bose, Sangita Mitra, WTI, WWF, Dilip Chetry, Aranyak | 5 yrs. |

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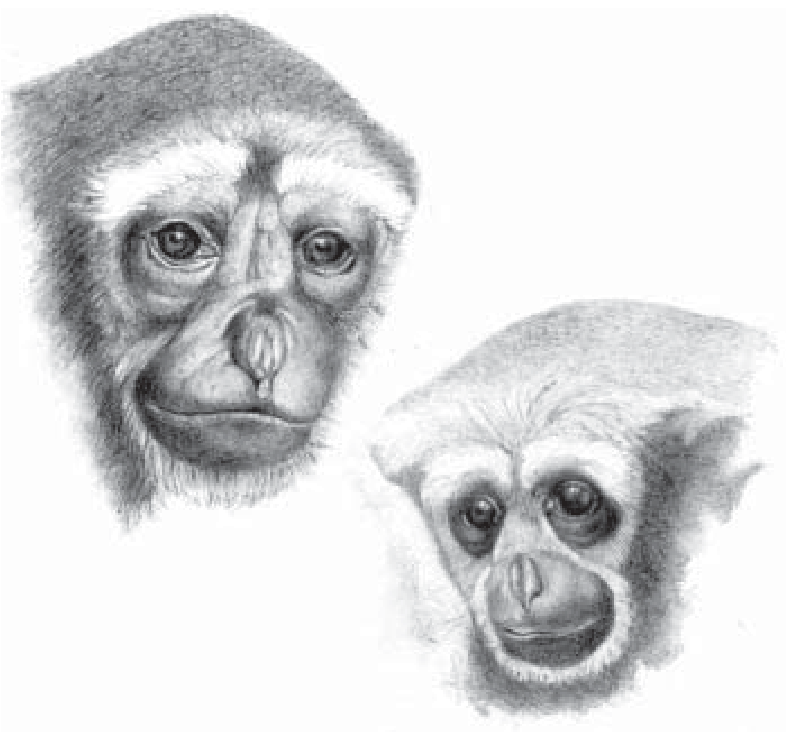
## Conservation of Western Hoolock Gibbon
## *(Hoolock hoolock hoolock)* in India and Bangladesh

### Political and Public Awareness



**Working Group Report: Political and public awareness**

***Working Group Members:*** *F.R. Al-Siddique, Gawsia Wahidunnessa Choudhury, Mehrab Chowdhury, B.A. Daniel, Mahmudul Hassan, Israt Jahan (Recorder), R. Marimuthu, Warda Mobassera and Farhana Ruma*

**INTRODUCTION**

The group, through intensive discussion, identified 19 issues as the root causes of the problems and as issues pertaining to political and public awareness. To identify all the issues the group did a detailed analysis of the existing problems in and around the Gibbon range areas of Bangladesh and India that hampers Hoolocks conservation with regards to awareness among the society. Short term and long term problems were discussed. The identified issues were grouped into six categories/themes: *a*. Education (formal and informal) and education policy; *b*. Conservation law; *c*. Political issues; *d*. Information and knowledge; *e*. Commitment and attitude and *f*. Socio economic status. The categories were prioritized using paired ranking and the following problem statement was developed based on the group discussion and consensus.

**PROBLEM STATEMENT**

The socio-economic status of the people living in and around the Hoolock Gibbon range area is under the influence of increasing poverty, low literacy, population explosion, and priority for personal needs and agenda. Thus people's economic status affects the Hoolock population directly or indirectly and also become a major barrier towards Hoolock conservation. The society including media, various stakeholders and policy makers (politicians and government officials) is not committed towards species conservation. The conservation progress is also hampered due to the prevailing negative mind-set based on religious reasons.

The present education system is not unified, particularly for Bangladesh, due to religious views and social status. Proper education system at fundamental level is also lacking for want of trained teachers and inexperienced policymakers.

Transfer of species information to the society is hampered due to non-availability of complete species information and its ecology. The existing species information is not easily available due to unmanaged information dissemination.

Implementation of existing conservation laws and general laws are not adequate due to lack of law enforcement. Political insurgency is also a major issue that hinders conservation activities. The negative influence of political leaders upon the law enforcing agencies is a barrier.

**DATA ASSEMBLY AND ANALYSIS**

To develop a detailed working knowledge of the facts and assumptions about political and public awareness, the group themes with justification and also identified what is lacking.

| Themes | Facts | Assumption | Justification | What we don't have? |
|---|---|---|---|---|
| Socio-economic status | Population explosion, low literacy rate and poverty: It is understood that these facts are the main reasons and also it have major impact on Hoolock Gibbon habitat that is for food source, building materials, encroachment, economical opportunities, shifting cultivation (jhuming), fuel wood, extraction of tree bark, cattle grazing, beteal leaf plantation. | Low literacy rate: The people in and around Hoolock Gibbon area has low literacy rate. May be that will be one of the reason they might not aware the importance of the species. | Human birth rate 17.90%<br>Death rate 3.70%<br>Growth rate 1.5%<br>Poverty rate 49.8%<br>Literacy rate62.66% (Bangladesh Economics Statistics 2004). In Bangladesh tribal from the Chittagong Hill Tracts area kill Hoolock for their food and even in India tribal from the north eastern parts hunt for food. And Hoolock habitats are also used for shifting cultivation (*jhuming*). | Poverty rate and Literacy rate in and around of Hoolock Gibbon habitat areas. There is also no readily available data on the rate of deforestation / habitat loss due in the species range areas. |
| Committment/ Attitude | Stake holders, policy makers including politicians and general public implementing agencies are not committed to conservation. That is, even though they have the responsibility and powers more than common man they do little for conservation.<br><br>Cultural wise there is a negative attitude on animals especially on Hoolock. | Media is supporting to a certain extent which is not sufficient enough to create awareness among required target group. | They might not be aware species conservation. | Interest about the species that could drive them for a change in their attitude. |
| Education (formal and informal) and education policy | School curriculum is not covering conservation topics.<br><br>Existing education system is not unified. Therefore, the students from different education system get education about conservation to different extent.<br><br>There are no trained | Still the education system is same in Bangladesh. But, In India the condition is improving. | | Religious system is same. It does not cover the conservation issues.<br><br>Lack of information about trained teachers.<br><br>Commission recommendations to improve basic educational system and |

| Themes | Facts | Assumption | Justification | What we don't have? |
|---|---|---|---|---|
| | teachers to teach conservation education at the schools.<br><br>There are not enough informal conservation education programmes for the people those who are living nearby forested areas. | | | inclusion of conservation topics in school curriculum is not followed.<br>Informal education programmes are conducted in the forested areas. |
| Information and Knowledge | There are not enough information about the species and the habitat. | No networking among the people who are expertise in Hoolock Gibbon.<br><br>Complete information about the species and its ecology are not available to general public. | | Communication gap between scientists, academicians, educationists, policy makers and law enforcement agencies<br><br>Non-availability of database on Hoolock Gibbon. |
| Conservation Law | Implementation of existing conservation laws are not satisfactory due to lack of law enforcement<br><br>Conservation laws are not updated. | Concerned authorities are not actively enforcing the law. | But it is considered under Schedule –III of Bangladesh Wildlife (Preservation) (Amendment) Act, 1974. Wildlife Protection Act 1972. | No specific laws for hoolock conservation.<br><br>Implementation of existing conservation laws are not effective. |
| Political Situation | There are some incidences of insurgency and unrest.<br><br>Political pressure seems to have influence in grapping the forestland. | | In Bangladesh, within Chittagong hill tract area and in India also some northeastern states in lesser extent. | Data on habitat destruction is unknown. |

## GOALS

To achieve overall conservation objective goals were set for each theme by the group to address the problem. The goals were prioritized using paired ranking. (Number in parenthesis is the total points given to it by the group).

1. To improve the economic as well as educational status of the people and alleviate poverty. (38)
2. To strengthen education system and teaching capacity there by including conservation topics in formal and in informal education. (36)
3. To create an attitudinal change towards conservation among the politicians and general public. (29)

4. To network all specialists, policymakers and law enforcement agencies and disseminate the information. (27)
5. To made species and habitat information available to whoever needs it. (23)
6. To strengthen conservation through wildlife laws. (17)
7. To unify all education systems under one. (17)
8. To refurbish present educational system by linking the conservation education issues with school curriculum. (10)

**ACTIONS PROPOSED BY POLITICAL AND PUBLIC AWARENESS WORKING GROUP**

**Goal 1: Improve the socio-economic as well as educational status of the people and alleviate poverty**

**<u>Action: 1.</u>** Conduct survey to collect data on Hoolock population habitat status threats ecological parameters.
<u>Responsible Parties:</u> Researchers, fieldworkers (who are working in and around the Hoolock area) local people, representatives from GOs and NGOs
<u>Timeline</u>: 1-2 years
<u>Outcome:</u> A complete report
<u>Partners:</u> Stakeholders
<u>Costs:</u> 2 personnel 2 years (full time); 50-60 thousands
<u>Consequences:</u> At the end we have HG population status, threats and all ecological parameters
<u>Obstacles:</u> Funding, Support from stakeholders

**<u>Action: 2.</u>** Study to understand status and attitude of the local people and various stakeholders towards the Hoolock species.
<u>Responsible Parties:</u> Researchers, fieldworkers (who are working in and around the Hoolock area) local people, representatives from GOs and NGOs
<u>Timeline:</u> 1 year
<u>Outcome:</u> Knowledge on the status of attitude, reports related to the study
<u>Collaborators:</u> GOs and NGOs
<u>Costs:</u> 30-35 thousands
<u>Consequences:</u> At the end we should be able to know the status and attitude of the local people and various stakeholders
<u>Obstacles:</u> Funding, Support of stakeholders

**<u>Action: 3.</u>** To educate and motivate local people through various technique and involve them in the conservation
<u>Responsible Parties:</u> GOs, NGOs, participation of local people
<u>Timeline</u>: 1 or 2 years (continuous monitoring)
<u>Outcome:</u> Awareness among local people
<u>Collaborators:</u> Local community, GOs, NGOs
<u>Costs:</u> 20 full time researchers and local volunteers
<u>Consequences:</u> Awareness and motivation amongst local people should be created

Obstacles: Funding

**Goal 2: To strengthen education system and teaching capacity there by including conservation topics in formal and in informal education.**

**Action: 1.** Revise school curriculum including conservation biology that should provide compulsory trips
Responsible Parties: Government (education dept.)
Timeline:
Outcome:
Collaborators: NGOs, university authority and education department curriculum development board
Costs:
Consequences: Revised Curiculum including compulsory field trips, and subject on conservation biology can be achieved.
Obstacles: Political Pressure

**Action: 2.** Conduct national level training for the teachers to educate the local people
Responsible Parties: GOs and NGOs
Timeline: Every year
Outcome: They will know about Conservation issues
Collaborators: Education Department
Costs:
Consequences: More trainied teachers are available
Obstacles: -

**Action: 3.** Develop education tools/techniques for informal education especially for Hoolock
Responsible Parties: NGOs
Timeline: Every year
Outcome: Knowledge about Hoolock Gibbon
Collaborators: GOs, NGOs, local people stake holders
Costs:
Consequences: They came to understand about the Hoolock Gibbon conservation.
Obstacles: -

**Action: 4.** Create interest among teachers through in service training
Responsible Parties: NGOs
Timeline: Every year
Outcome: Knowledge about Hoolock Gibbon
Collaborators: GOs, NGOs, local people stake holders
Costs:
Consequences: They came to understand about the Hoolock Gibbon conservation.
Obstacles: -

**Action: 5.** Implement compulsory primary education for the local people live in and around the Hoolock habitat.
Responsible Parties: Government
Timeline: May be introduce as soon as possible
Outcome: Everybody educated
Collaborators: Education Department
Costs:
Consequences:
Obstacles:

**Goal 3 : To create an attitudinal change towards conservation among the politicians and general public.**

**Action:** Formation of village level eco-development committees involving local people and stakeholders to conserve Hoolock and its habitat through participatory management.
Responsible Parties: Government as well as NGOs
Timeline: About 10 years
Outcome: Set up village forest committees
Collaborators: GOs, NGO and local people.
Costs:
Consequences: Village forest committees
Obstacles: Funding

**Goal 4: Networking all specialists, policymakers and law enforcement agencies and disseminate the information.**

**Action:** A network of primates should be initiated and information dissemination can be done through publication like newsletters, reviews, and directories.
Responsible Parties: University students, researchers and primatologists
Timeline: One year
Outcome: Network on primates especially on Hoolock Gibbon
Collaborators: NGOs, university departments, research institutions and stake holders
Costs:
Consequences: We have network on all peoples involving in Hoolock Gibbon conservation
Obstacles:

**Goal 5: Create species and habitat information available whoever needs.**

**Action: 1.** Formulate database on species and habitat information and uploading the information on web that should be available for layman in forms like documentary films.
Responsible Parties: NGOs, GOs, research institutes
Timeline: One year
Outcome: Data base on Hoolock Gibbon
Collaborators: NGOs, university departments, research institutions and stake holders

Costs:
Consequences: Information available on websites on Hoolock Gibbon.
Obstacles:

**Goal 6: To strengthen conservation through wildlife laws.**

**Actions:** Amendment of existing laws with the present scenario, which should emphasis on species and habitat conservation.
Responsible Parties: Government
Timeline:
Outcome: Amendment on laws regarding species and habitat conservation
Collaborators: Law department and NGOs
Costs:
Consequences: We have a new law on species conservation
Obstacles: May be political

**Goal 7: To unify all education system under one.**

**Action:** Explore and bring to light the religious truth about wildlife and its conservation to motivate religious leaders/ teacher to promote wildlife conservation that may alter the religion based education system.
Responsible Parties: GOs and NGOs
Timeline: Around the year
Outcome: Understand about the importance of Hoolock conservation
Collaborators: Education department and NGOs
Costs:
Consequences: The religious teachers and leaders came to know about the value of species conservation.
Obstacles: No political support in favour.

***Drawing by Arnab Roy***

## Conservation of Western Hoolock Gibbon *(Hoolock hoolock hoolock)* in India and Bangladesh

### Captive Management

**Working Group Report: Captive Management Group**

***Working Group Members:*** *Khudesta Akter, N.C. Banik, Dibyendu Biswas, Hasanuzzaman, Awadhesh Kumar, C. Loma, Alan Mootnick and Sally Walker*

## INTRODUCTION

The Western Hoolock Gibbon *(Hoolock hoolock hoolock)* is a threatened, monotypic ape which is found only in northeastern India, where it has been assessed as Endangered (CAMP, 2003) and in Bangladesh where it has been assessed as Critically Endangered (CAMP, 2003). It is the only gibbon or ape species in the region of South Asia.

According to the IUCN Technical Guidelines on the Management of *Ex situ* Populations for Conservation (IUCN, 2002), Hoolock Gibbon qualifies for *ex situ* management on two principles under the IUCN Red List Criteria quoted in the Guidelines, e.g., : "1. When the taxa/population is prone to effects of human activities or stochastic events and 2. When the taxa/population is likely to become Critically Endangered, Extinct in the Wild, or Extinct in a very short time" as well as the fact of its biological uniqueness and cultural importance.

The IUCN Technical Guidelines go on to say that "*Ex situ* conservation should be initiated only when an understanding of the target taxon's biology and *ex situ* management and storage needs are at a level where there is a reasonable probability that successful enhancement of species conservation can be achieved". In this regard special attention was given by the Working Group due to the fact that the Western Hoolock Gibbon is held only in captive facilities in India and in Bangladesh where capacity to manage the species along modern scientific lines has been lacking throughout the more than two centuries of its captive history. The Guidelines also state that "consideration must be given to institutional viability before embarking on a long term *ex situ* project", thus the Working Group focused on problems of captive management in India and Bangladesh. Building capacity to improve husbandry, propagation, and genetic management of existing animals before considering any further capture of wild individuals for zoos or breeding centres was considered crucial.

Hoolock Gibbon has been kept in captivity at least since *circa* 1806 when a pair of Hoolocks were described and drawn as part of the Indian Natural History Project based at a menagerie on the grounds of the Governor General's summer residence in Barrackpore near Calcutta. Since that time, zoos in India and possibly Bangladesh have kept the species sporadically with some success with longevity but very little success in breeding. Even today there is only one surviving captive born individual of Hoolock in the two countries, e.g. in Dhaka Zoo, Bangladesh. Reports of Hoolocks in zoos in the two countries exist but no record of surviving offspring until very recently.

## 1. PROBLEM STATEMENT FOR CAPTIVE POPULATION MANAGEMENT OF HOOLOCK GIBBON

The Working Group prioritized Husbandry, Conservation, Research, Animal Welfare and Education as the crucial issues of captive management of Western Hoolock Gibbon in South Asia. Currently there are reported to be 7.9.1 animals in 8 zoos and 1 rescue centre in India and 4.2 animals in two zoos in Bangladesh. As assessed by the Working Group, knowledge of basic husbandry is lacking in the areas of nutrition, housing, sanitation, health, safety, environmental enrichment, pairing, and breeding. Also potential and actual conservation measures suffer from lack of knowledge of capture methods, of breeding biology and management, numbers, handling, disease, reintroduction technique, budgetary constraints and (particularly in Bangladesh) viable habitat in which to release the animals. In research there are also problems as natural behaviour is compromised in captivity due to inadequate enclosures, visitor stress, skewed socialization and pairing, etc., although the need for research and its potential was recognized by the group for genetic studies, disease, nutrition, reproduction and epidemiology. Welfare standards for Gibbons are not fully known by the range countries facility managers. Education was recognized as having a very important conservation role for captive facilities but there is a need for training in how to best educate the visitors.

**Problems as enumerated by the Working Group are listed in Addendum at the end of this section.**

## 2. PRIORITIZATION OF ISSUES

Prioritisation was carried out by discussion as follows:

| | |
|---|---|
| Priority I: | *Conservation* |
| Priority II: | *Husbandry* |
| Priority III: | *Welfare* |
| Priority IV: | *Education* |
| Priority V: | *Research* |

## 3. GOALS

### 3.1. Zoo Conservation (Priority I)

To define the conservation purpose of Hoolock Gibbon in zoos to education, research and breeding in captivity for exchange with other South Asian country zoos. This is intended to strengthen existing and future legislation in both India and Bangladesh which strictly prohibits the capture of Hoolock Gibbon from the wild for any purpose.

### 3.2. Improve Management (Priority II, III, V)

To improve the overall scientific management of Hoolock Gibbon in captivity by:

- The creation of a systematic management plan for general animal well-being including monitoring protocols, records improvement (ISIS, ARKS), visitor management to reduce stress reduction and disease transmission, health/sanitation/pest control, systematic staff training for all levels of zoo personnel who work with Hoolock Gibbon.
- Creation of a regional studbook (SPARKS), and a regional cooperative breeding programme
- Creation of a scientific captive management manual as a living document with frequent updating.
- Provide training to staff in so that management will improve in order to create an adequate environment for research.

### 3.3. Ensure continuity of Staff (Priority II)

To request government to make appropriate changes in the zoo administration to ensure continuity of zoo staff who have acquired training, experience, expertise and interest in the care and management of Hoolock Gibbon.

### 3.4. Improve Enclosures (Priority II)

Assess all existing Hoolock Gibbon enclosures and where they are inadequate, both from a welfare, husbandry and an education point of view, remodel/reconstruct, and enrich according to an appropriate design for Hoolock Gibbon. Create model designs for different types of designs (open moat, cage, etc.) for distribution to facilities holding Hoolock Gibbons. These would include shelter from weather extremes, safety from the public, ability to maintain clean environment, reduce pests, and provide for the animal's natural behavioural needs. All future Hoolock Gibbon enclosure should follow these principles.

### 3.5 Zoo Education / Awareness (Priority IV)

To initiate a comprehensive public education programme for Hoolock Gibbon (both in the zoo and outreach including in and near Hoolock habitats) for all levels of people in urban and rural areas, particularly in the localities of Hoolock Gibbon, and provide training for potential educators for more effective teaching which would effect a change in attitude and actions relating to survival of Hoolock Gibbons.

## 4. ACTION steps

### 4.1 Topic: (Zoo) Conservation

**Problem:** Zoos in South Asia do not have a good track record for keeping and breeding delicate animals. Taking animals from the wild with the idea of conducting captive breeding for reintroduction and conservation has resulted in loss of important individuals from small wild populations. Moreover, but for one instance, captive breeding has not been successful. Further, in many localities, there is not sufficient or secure habitat for reintroduction. Existing legislation in both India and Bangladesh strictly prohibits the capture of Hoolock Gibbon from the wild, yet it has taken place. The Population Modelling Group found that populations with less than twenty individuals were highly vulnerable to extinction processes, if even a single adult individual was harvested annually. In case of a family group harvested the probability of extinction increases manifold.

**Goal:** To curtail the trapping of Hoolock Gibbons from the wild for captive breeding / conservation until techniques for success are well established and the causes of population decline in target localities of the habitat have been established and curtailed.

**Action:** The PHVA Workshop participants overwhelmingly agreed that the conservation purpose of Hoolock Gibbon in zoos should be limited to education, research and breeding for exchange with other range country zoos, and that no more animals should be taken from the wild for this purpose. The organizers of the Hoolock Gibbon PHVA will draft a letter recommending that the government endorse this view at a policy level.

**Description:** The letter for Bangladesh should be addressed to the Prime Minister and copied to the Ministries of Forest and of Livestock. The letter will be drafted by the workshop organizers and a suitable (influential) individual will be sought to sign the letter, failing which one of the organizers will sign. The letter for India can be sent to the Central Zoo Authority (CZA) who will forward it to suitable officials.

**Responsibility and Partners:** Workshop organizers, CZA, influential individuals in Bangladesh

**Timeline:** One month from the last day of the PHVA for Hoolock Gibbon

**Resources:** Provided by organizers of the PHVA

**Consequences:** This action is intended to stop zoos/safaris/breeding centres from placing orders of gibbons from trappers and even from capturing through the relevant department for captive breeding until expertise is established and the Guidelines of the Reintroduction Specialist Group can be met.

**Obstacles:** "Production" philosophy in some departments and over confidence may take precedence over global experience and common sense.

## 4.2 Topic: Continuity of Staff caring for Hoolock Gibbon

**Problem:** The staff of zoos and other captive facilities both in Indian and Bangladesh is frequently transferred and with them goes expertise gleaned during their tenure, which causes delicate species such as Hoolock Gibbon to suffer.

**Goal:** To request government to make appropriate changes in the zoo administration to ensure continuity of zoo staff who have acquired training, experience, expertise and interest in the care and management of Hoolock Gibbon.

**Action Step**: (Bangladesh) Enlist knowledgeable and influential people to work on this step with government, to write letters, to visit officials, to general work towards this goal.

**Description:** Suggestions from Working Group Members : Bob Lacy, Chair, Conservation Breeding Specialist Group, USA; Russ Mittermier, Chair, Primate Specialist Group /or/ Ardith Eudey, Vice Chair for Asia, PSG; Begum Hasna Moudud, Zoo Advisory Board Member, Dhaka Zoo; Dr. Shah Md. Farid, Bangladesh; Dr. Ainun Nishat, Head, IUCN Country Office, Bangladesh, Dr. Salehuddin Mahmud. Bangladesh
India: Dr. B.R. Sharma, CZA Member Secretary will be requested to communicate this request to the relevant Ministry officials and zoo directors in states holding Hoolock Gibbon.

**Responsibility:** Anwarul Islam and Sally Walker will contact the above mentioned people to approach government.

**Time line:** Letters will be written within end of April

**Collaborators:** Listed above

**Resources:** Not required

**Consequences:** If successful, this step will make it possible for a expert team to manage and care for

Hoolock Gibbon, increasing its chances of reproducing and surviving at least in captivity for the long term.

**Obstacles:** The transfer system is a long established in the administrative system and has not yielded to previous attempts (in India) even by government (Sharma, pers. comm.). However, sometimes individual officials have been successful at their level in remaining in the post and at times their superior officers have assisted them. The key to this important recommendation is continuous pressure.

**4.3 Topic: Enclosure model**

**Problem statement:** The health and well-being of Gibbons is very much dependent on specialized construction and furnishings of their captive housing. Expertise in the region is wanting in basic as well as subtle aspects of enclosure design.

**Goal:** To assess all existing hoolock gibbon enclosures for their appropriateness in guaranteeing the well-being, propagation and survival of Hoolock Gibbon in captivity.

**Action step:** To arrange an inspection of existing Hoolock Gibbon enclosures in Bangladesh and India and assess their effectiveness, note deficiencies, and create a report suggesting short term and long term improvements etc. It is also suggested to create a design of two ideal types of model enclosures, one for traditional flat ground, and one island or moat type exhibit. All zoos desiring to improve or construct Hoolock Gibbon enclosures could refer to these models.

**Responsibility:** Alan Mootnick has agreed to take on this task provided a consultancy and expenses are provided. Sally Walker has agreed to approach Central Zoo Authority in India and also try and find funds for this project.

**Partners:** Zoos holding Hoolock Gibbons in Bangladesh and India

**Timeline:** 18 months – 2 years

**Resources:** Resources have to be found. Approximate cost : between $3000 – 4000.00

**Consequences:** Zoos holding Hoolock Gibbon will have a valuable resource for constructing, furnishing and maintaining suitable housing for their gibbons which will make a big improvement in their health, well being, longevity and educational potential.

**Obstacles:** Finance, lack of awareness and interest of senior officers

**4.3.2 Subtopic: Enclosure improvement**

**Problem statement:** Zoos in South Asia are using old fashioned enclosures and need to modify or replace them.

**Goal:** To disseminate a detailed Report on Hoolock Gibbon housing to all the zoos exhibiting Hoolock Gibbons in India and Bangladesh.

**Action:** To recommend appropriate changes to each zoo according to Alan Mootnick's Report. Such changes may include shelter from weather extremes, safety from the public, ability to maintain clean environment, reduce pests, provide for the animals natural behavioural needs and other aspects, including general management. The presentation of these recommendations may need special handling.

**Partners:** Russ Mittermeier, PSG; South Asian Zoo Association for Regional Cooperation (R. K. Sahu, President; Sally Walker, Director), Adit Pal, Landscape Architect, Alan Mootnick, WAZA, (possibly) Endangered Primate Rescue Centre, Twycross Zoo, and other interested individuals and institutions.

**Time line:** For Bangladesh – Alan Mootnick will visit both facilities in a week and produce a report by end of March.

**Time line:** For India – Alan will visit India during this year if possible and produce a Report by the end of December if funds and time permit.

**Resources:** Have to be found

**Consequences:** Improved Hoolock Gibbon housing.

**Obstacles:** Finance, time, agreement of government to host outside assessor

## 4.4 Topic: Zoo Education and Outreach

**Problem Statement:** Education and public awareness is one of the most valuable conservation tools of the zoo, but it is not being adequately utilized or implemented. Zoos require more knowledge of a variety of educational techniques, some infrastructural facilties and trained educational staff. Facilities and expertise both in the zoo as well as for outreach programmes outside the zoo premises are lacking. Within many zoos, graphics lack basic information such as correct scientific name and all of the various common and vernacular names of Hoolock Gibbon. Also lacking is information about the biology and ecology of the species as well as threats to its survival, and suggestions for positive actions to be taken by the public to insure survival of the species and its habitat. Also lacking are basic items such as audio visual material as well as printed material. Zoos currently do not attempt to reach out to villagers, tribals and human communities in Hoolock Gibbon range localities but they could do through outreach programmes. Zoo personnel also could effectively communicate important information to policy makers, politicians and other VIPs who visit zoos.

**Action:** To initiate a comprehensive public education programme for Hoolock Gibbon (both in the zoo and outreach) for all levels of people in urban and rural areas, particularly in the localities of Hoolock Gibbon.

**Description:** Model materials will be produced in multiple languages which can be used by zoos, non-governmental organizations, educational institutions, forest departments, etc., and distributed to key individuals in each country who will take responsibility for disseminating it to the public. Zoo Outreach Organisation has a network of over 150 zoos, NGOs, etc. which are carrying out much education with such materials provided by ZOO.

**Responsibility:** Zoo Outreach Organisation, Wildlife Trust of Bangladesh and U.S. Fish and Wildlife Service.

**Partners: Bangladesh** -- Dhaka Zoo, Wildlife Trust of Bangladesh (Anwar and staff), Chittagong Vety. College (Mr. Hasanuzzaman and Dr. Dibyendu Biswas, Bangladesh Agricultural University (Khudista and Bonik will meet and motivate), IRG (Phillip J. Decosse reminded by Sally)

**Partners: India** -- Biological Park, Itanagar (Mr. Loma and Awadhesh Kumar), Zoo Outreach Organisation, and their network of 150 zoos, NGOs, teachers, etc.

**Time line:** Within 3-6 months education model ref. Hoolock Gibbon will be made available and given for translation by Zoo Outreach Organisation and Wildlife Trust of Bangladesh. Other partners will be encouraged to use these quickly.

**Resources:** Funds provided by USFWS and other donors

**Consequences:** Education will become more effective in the zoo.

**Obstacles:** Nil

**Subtopic 4.4.1: Training in Educational techniques**
**Problem statement:** Those who are interested in education still do not have adequate tools and techniques to reach the hearts of people and thereby effect a behavioural change which would impact conservation.

**Action:** Provide training for potential educators for more effective teaching which would effect a change in attitude and actions relating to survival of Hoolock Gibbon. Zoo Outreach Organisation will provide a special training which will do as described above. A special booklet on primate education has been developed for this purpose which can be for time being for Hoolock Gibbon education. Materials will be prepared specifically for Hoolock Gibbon.

**Partners: Bangladesh** -- Dhaka Zoo, Wildlife Trust of Bangladesh (Anwar and staff), Chittagong Vety. College (Mr. Hasanuzzaman & Dr. Dibyendu Biswas, Bangladesh Agricultural University (Khudista and Bonik will meet and motivate), IRG (Phillip J. Decosse reminded by Sally)

**Partners: India** -- Biological Park, Itanagar (Mr. Loma and Awadhesh Kumar), Zoo Outreach Organisation, and their network of 150 zoos, NGOs, teachers, etc.

**Time line:** Within 6 months a teaching module ref. Hoolock Gibbons will be made available and given for translation by Zoo Outreach Organisation and Wildlife Trust of Bangladesh. Other partners will be encouraged to use these quickly.

**Resources:** USFWS grant ref. ZOO

**Consequences:** Improved education

**Obtacles:** Nil

**<u>4.5 Topic: Management</u>**

**Problem Statement:** The zoos of the range countries holding Hoolock Gibbons (Bangladesh and India) report gaps in knowledge of effective management of the species.

**Goal:** To improve the overall scientific management of Hoolock Gibbon in captivity.

**Subgoal 4.5.1:** The creation of scientific Captive Management Plans for the general well-being and longevity of Hoolock Gibbons in captivity in India and in Bangladesh.

**Action Step:** Creation of a written plan for each country, taking into consideration differences in their administrative set up, etc .

**Responsibility (Bangladesh):** For Bangladesh, there are two facilities holding Hoolock Gibbons from different Ministries. For the Forest Department which holds Hoolock Gibbons at the Chittagong Safari Park, Mr. Shamsur Rahman, Conservator of Forest agreed to initiate the process by nominating Mrs. Shirina Khatun, DCF to collaborate in formulating the document. For the Livestock Department, which holds Hoolock Gibbons at Dhaka Zoo, Dr. Salim, Dr. Bonik, Dr. Kudesta were present in the working group. The D.G., Livestock or Curator, Dhaka Zoo may like to nominate them for joining in this task.

**Responsibility (India):** For India, there are approximately five facilities holding Hoolock Gibbons, zoos and rescue centres in different states, all of which come under the administrative control of the Central Zoo Authority. Mr. C. Loma, from the Itanagar Zoo, Arunachal Pradesh has volunteered to assist with this action. The Central Zoo Authority being the nodal authority for all such decisions may like to utilize him and others from the zoos holding Hoolock Gibbons in India for formulating their management plan.

Sally Walker will write to the concerned governments of both countries, explain the management actions and request their cooperation.

**Partners:** Alan Mootnick Founder/Director, GCC, will assist with his practical expertise in housing and studying Gibbons since 1976, including eastern and western Hoolock Gibbons since 1981.

**Timeline:** The letter to the governments will be written by end of March.

**Resources:** It is likely that the governments concerned will cover costs of preparing and publishing the management plans.

**Consequences:** Both in India and in Bangladesh there is a transfer system in place for the officers. A

Management Plan will make it possible for new officers to get up to date with the management and care of Hoolock Gibbons and thus improve its chances for long-term survival. Ideally, a team should be trained in care of this species and permitted to remain in the facility.

**Obstacles:** Ordinary delays in bureaucratic action. Low priority of conservation action for smaller animals. Political rather than technical priorities in selection of writing team. Transfer of officials who have been involved. ***See Addendum at the end of this section– Some components of a Management Plan***

**4.5.2 – Management – Studbook of Hoolock Gibbon and Regional Cooperative Breeding Programme**

Creation of a regional studbook (SPARKS), and a regional cooperative breeding programme.

**Action Step:** Bring the zoos of the two countries together to maintain a regional studbook using the international format SPARKS and to create a systematic, scientific regional cooperative breeding programme.

**Description:** The programme would aim to utilize all individuals currently in captivity and any others which come into captivity by confiscation, donation and (unrecoverable) rescue. The objective is to maximize the genetic and breeding potential of the captive population so that there is no necessity or temptation to take Hoolock Gibbons from the wild.

**Responsibility:** Director, SAZARC (Sally Walker) will take responsibility for contacting the Indian and Bangladeshi zoos as well as the International Species Information System, and working out an agreement. It is suggested that authorities be informed of the expertise of Alan Mootnick.

**Time Line:** This will be done in two months time. The time line for the Studbook will depend on who actually is decided upon to keep it.

**Collaborators:** South Asian Zoo Association for Regional Cooperation, Central Zoo Authority, Bangladesh authorities, participating zoos, ISIS/ZIMs, Alan Mootnick (Gibbon SSP) in advisory capacity

**Resources:** ARKS, SPARKS for participating zoos. $5000.00. ISIS/ZIMS may be approached for ideas for donors.

**Consequences:** A coordinated captive breeding programme will make it possible to maintain a captive population sufficient to serve the needs of the zoos for educating the public, for benign research and for exhibition.

**Obstacles:** Cooperation between governments of the region regarding zoos has not been forthcoming till date. Also exchange of animals is not an established practice and may take much negotiation. Also zoos do not use permanent identification marking and have not maintained records and may require high tech methods which may prove prohibitively expensive. **See**

**Addendum at end of this section – Cooperative Captive Breeding Programme of Western Hoolock Gibbon**

### 4.5.3 Management – Sub-topic 3

**Problem: There has not been any consistent scientific management of Hoolock Gibbon so far.**

**Goal:** Creation of a scientific captive management Manual as a living document with frequent updating.

**Description:** The Manual should contain all relevant and useful information required to handle and maintain Hoolock Gibbon in a healthy and fit condition both physically and mentally, to achieve breeding success, to safely transport animals for exchange with other zoos, to pair and organize social groups, etc. The Manual should contain frequent updates in the form of Reports from different facilities of problems and successes they have had with their Hoolock Gibbons, lessons learned, new research results, etc.

**Action:** Alan Mootnick, Founder/Director, Gibbon Conservation Centre, has agreed to coordinate information, author and, from time to time, update a Hoolock Gibbon Management Manual. Alan Mootnick will visit Bangladesh and Indian zoo Hoolock facilities and assess their conditions, problems and needs.

**Responsibility:** Alan Mootnick will assess the zoos. Sally Walker will take responsibility for finding resources for this project.

**Time line:** One to one and a half year

**Partners:** Alan Mootnick, Dhaka Zoo personnel (Dr. Salim, Dr. Bonik, Dr. Kudesta), Chittagong Veterinary College (Mr. Hasanuzzaman & Dr. Dibyendu Biswas), and as yet unidentified Indian zoo personnel and vets from the Indian Zoo Association and the Indian Veterinary Association, most probably members of the CZA technical committee.

**Resources:** $5000.00

**Consequences:** An expert Manual of the details required to keep Hoolock Gibbon in captivity will improve the chances of breeding, survival and longevity of the species.

**Obstacles:** Current practices have been in place for a long time and it may take a long time to bring about change. Interest of frequently changing governments varies; permission and facilities to institute and maintain changes may not be consistent.

## Addendum : Problems of Captive Population Management for Hoolock Gibbon

### Husbandry

1. Uncertainty of nutritional requirement
2. Lack of knowledge of food habit
3. Uncertainty of enclosure design / housing / accommodation (confinement)
4. Difficulties in breeding in captive conditions (One birth in 40 years)
5. Insufficient knowledge of health care and management (Hygienic condition often are not provided)
6. Visitors stress / misbehaviour / numbers / teasing
7. Visitors feeding leads to disease and illness
8. Inability to carry out normal behavior in zoo enclosure
9. Lack of knowledge on the complexity of how to organize in pairs/groups
10. Lack of knowledge on captive breeding
11. Proper selection of competitive pair
12. Lack of continuity of staff

### Conservation

1. Lack of knowledge of reintroduction
2. Possible lack of knowledge viable habitat
3. Transmission of diseases
4. Ignorance of proper handling
5. Lack of legal source of animal
6. Lack of proper numbers of available Hoolock to start a breeding program
7. Capture in the wild results in high mortality
8. Reintroduction of Hoolock back in to the wild may not be possible or suitable
9. Cost of captive breeding programme and reintroduction
10. All animals currently held are wild caught except one.

### Research

1. Natural behavior is compromised in captivity
2. Genetic studies
3. Disease
4. Nutritional studies
5. Socialization of captive populations
6. Reproduction
7. Epidemiological studies

### Education and Welfare

1. The importance of the effective techniques of how to educate the visitors
2. Species specific welfare standards have not been developed for Hoolock.

**List of zoos holding Western Hoolock Gibbon in India and Bangladesh**

**India**

| | |
|---|---|
| Assam State Zoo Guwahati | 1.0 |
| Rescue centre at Bokakhat, Assam | 0.1 |
| Delhi Zoo | 0.1 |
| Imphal Zoo | 1.1 |
| Sepahijala Zoo, Tripura | 0.1 |
| Lucknow Zoo | 1.1 |
| Itanagar, Arunachal Pradesh | 0.0.1 |
| Aizawal Zoo, Mizoram | 2.4 |
| Miao Zoo, Arunachal Pradesh | 2.0 |
| Total for Indian zoos (Male.Female.Unknown) | 7.9.1 |

**Bangladesh**

| | |
|---|---|
| Dhaka Zoo | 3.1 |
| Duhazara Safari Park | 1.1 |
| Total for Bangladesh zoos (Male.Female) | 4.2 |

| | |
|---|---|
| Total for India and Bangladesh (Male.Female.Unknown) | 11.11.1 |

*Addendum -- Some topics to be included in the Hoolock Gibbon Husbandry Manual*

**Husbandry**

***Monitoring of water and food intake of individual Hoolocks***

In Bangladesh the captive Hoolocks are provided with water and food twice a day, while in India it is reportedly done once every day. Monitoring the food should be done a minimum of four times a day. Water should be changed a minimum of once a day in the morning, and monitored and changed if required an additional three times per day.

Remarks: It is important to remove any food or other items that the visitors have given the captive Hoolocks, because it could injure or be fatal to them. By monitoring food we can know if the Hoolocks are sick or stressed. Monitoring aids in letting us know if the Hoolocks require additional food, such as for lactating or pregnant females, or as individuals become mature. Some working group members reported that the intake of food varies from season to season and is higher in winter as compared to summer. Diet may change according to seasonal variations.

It will be important to have a food chart for the Hoolock enclosure, which includes the type of food and quantity, with a monthly chart keep in the Hoolock's records. The monitoring of the Hoolock's water is important to prevent dehydration, or the intake of contaminated water.

***Nutritional requirements in captivity***

The captive Hoolocks in Bangladesh are provided with food comprising bread, fruits, eggs, and vegetables (cucumber, carrots, and many more) three times a day. In India, the captive Hoolocks are fed only once a day.

**Feeding Schedule**

| | | |
|---|---|---|
| Bangladesh | 7:30 AM | Bread / Banana with Real (fruit juice). |
| | 11:00 AM | Fruits, eggs, hard boil without chicken, vegetables + bread, melon, such as *Epilipil* leafs, etc. |
| | 3:00 PM | Only banana, dates, apple, orange, mango (without skin), litchee, papaya, *Gab*, *Safeda*, and green coconut. |
| India | 7:00 AM | Bamboo leaf, wild fruits (*Mekhahi*, *Ber* or Ziziphus prunes), apple, guava, orange |

Intake in Captivity :

At the Gibbon Conservation Centre (GCC), gibbons are fed eight times a day, starting at 7AM. On average, in North American zoos they are fed three times a day. In GCC they supply mealworm, spider, seeds, nuts, grasshopper, cooked chicken, multivitamin (chewable), fruits (apple, banana, guava, melon, papaya, mango, green coconut, banus, fig (*Ficus* fruit).

The working group members have listed vegetables and other food material that could be fed to

Hoolocks in captivity after reviewing a list (provided by field biologists) of items Hoolock eats in the wild. The fruits and vegetables include green brans, chick pea, jalpai, latkon, dewa, kalojam, kodam, pear, cauliflower (high vitamin), pumkin with skin, corn (maize) stem, carrot stem, and brinjal. Leafy vegetables like spinach, lalsak, data shak, leaves, tender leaves and stems of ficus species. There is little known on what flowers are fed to captive gibbons. At GCC the Hoolocks are fed organic hibiscus, fucsia and rose flowers. It is advised not to feed tomato, orange and grapes to Hoolocks as these fruit lead to digestion-related discomfort.

***Enclosure design, proper housing, accommodation, etc.***

**Bangladesh**

At the Dhaka Zoo the Hoolock enclosure has two chambers, namely - open chamber (about 20 x30 x15 ft.) and night enclosure (about 10 x 10 x10 feet). Originally there were two ropes with a tyre and horizontal metal pipes at 11 ft. Allen Mootnick and the Dhaka Zoo staff added 12 additional bamboo poles at a lower level in the main enclosure, and 14 ropes in both enclosures. The floor of the open chamber is made of soil ground covered with green grass, while it is of concrete in night enclosure floor. Feed is provided on the concrete floor, which is between two chambers of the enclosure. There is a water feeder in the night enclosure (about 2 x1 x1 ft. ) about 1 foot above the ground level. There are two ropes with tires, branching trees, 2 or 3 rods for playing. Resting platform 4 x 6 ft. is made of concrete 7 feet high from ground. The roof of the open enclosure is made of wire mesh without any enrichment, while that of the night enclosure is of concrete.

**India**

In one captive facility in India the Hoolock is housed in a rescue center in an enclosure with dimension of 12 m height and 10 m length and 8 m breadth. The floor of the enclosure is cemented with water tub placed in the corner of the enclosure. Horizontal bamboo bar is provided in the enclosure to facilitate brachiating activities. No enrichment is provided.

**Ideal enclosure**

Ideal enclosure for one family of Hoolock should be about 20 x50 x15 ft. The enclosure should ideally include the following:

1. Two resting platform 9 feet above the ground
2. Branches (not very rough surfaced, 4 to 6 inches in diameter) of trees at 6 ft. and 11 ft. height (to enable Hoolocks to utilize various height of the enclosure).
3. Vertical ropes attached with ceiling to allow the Hoolocks to swing.
4. Food and water platforms should be placed at minimum 3 ft above the ground.

<u>Inability to carry out normal behaviour in zoo enclosure</u>

The Hoolocks are not able to carry out their normal behaviour in zoo enclosure.
Enclosure design is made up in such a way that Hoolock is provided with natural environment inside the enclosures. Enrichment work should be taken up as when necessary.

Improper enclosure design causes stress to the animal and result into illness and various physiological and psychological problem. It is crucial to know about the animal's behaviour and their natural habitat and design the enclosure accordingly.

### *Difficulties in captive breeding of Hoolock*

The successful captive breeding of Hoolock has not occurred so far in India. There may be isolated instances of stillbirth and short lived offspring. In Bangladesh, only one offspring has been born in the past 40 years. This is due to lack of knowledge in setting up a breeding program. In order to have successful breeding programs, zoos need the full cooperation of every institution involved. Each participating institution needs proper, enclosures, diet, veterinary care for their Hoolocks. Hoolocks need to be housed in a stress-free environment. It is important that Hoolocks involved in the breeding program are housed in compatible pairs and that Hoolock in the breeding program must be in good physical and mental health. It is crucial that the care-takers and zoo officers have been trained in captive Hoolock management. It is essential that the Hoolocks do not interact with people, so that the Hoolocks will become dependent only on other Hoolocks.

The captive population of Hoolock in Bangladesh and India is too small to initiate a conservation breeding program which would provide animals for supplementing the wild population. However, the numbers which currently exist, if carefully managed and occasionally supplemented with animals which have been confiscated or rescued could be sufficient for maintaining a captive population for education and observation. If properly housed, captive Hoolocks can provide new knowledge about the species in respect to their ecology and biology.

### *Health care and management*

Regular health checking and scanning of animals in the rescue center of India is done by the veterinary surgeon. Faecal studies to detect the presence of parasites and protozoans and bacteria culture is done in regular intervals to detect the status of the animal's health. A blood test is preformed only if there appears to be any abnormalities in the individual. Individual Hoolock's health records and treatment details are maintained by the veterinary dispensary unit. However, health screening for primate keepers is not done currently.

Additional studies and research is required to be done on health care and management of Hoolock, by sharing information amongst the experts on pathological aspect of the species. It is important to screen each Hoolock before and during the breeding program for tuberculosis, herpes simplex virus 1+2, hepatits B+C and vaccinate for tetanus. All Hoolocks should have a routine faecal exam every 3 months and additional faecal exams should be performed when clinical symptoms manifest. Treatment needs to be administered immediately after positive results. It is important that the Hoolock's enclosures are scrubbed on a daily basis and that all foreign matter be removed.

All zoo personnel who are involved in primate care must be tested for tuberculosis at least once a year and undergo complete faecal exam twice a year. Primate keepers who are sick should not be allowed to work with the primates in any capacity. In case of such a contact, the primates should be examined thoroughly.

### *Organising pairs monitoring aggression and introduction technique*

It has been observed that sometimes fighting takes place amongst individuals housed in same cage over food, mating opportunities and dominance. Sometimes problematic Hoolocks are segregated to avoid fighting amongst themselves. The reintroduction of Hoolock in the wild, has not been attempted so far in South Asia and is tricky due to lack of viable habitat, particularly in Bangladesh and lack of any good captive management programme specifically designed for such an exercise.

**Remarks**
A captive breeding programe may assist in understanding the behavioural aspects of the Hoolock in more detail.

***Prevention of injury and death due to transport***
Sometimes when a Hoolock is rescued it is transported in the rescue van to the rescue center. Care is taken to avoid any injuries during transportation and at the rescue center the animal is inspected for any injury before being released in the cage.

**Remarks**
Consultation of experts of proper handling and transportation technique would be useful for the well being of the Hoolock.

***Pest control for insects, rodents and birds***
Insects, rodents and small birds can enter the Hoolock enclosure in Bangladesh and in India. The food remnants need to be removed by 4:30 PM to prevent rodents and insects from entering the enclosure. Cleaning the wire where food has remained can prevent insects or bacteria build up on the enclosure wire. Setting traps near the enclosure but not in reach of the gibbon and out of the view of the visitors would help in controlling rodents. Do not use poison to remove rodents from the facility as this may be ingested by the gibbons. Keeping the areas clean to prevent insects from increasing in the enclosure. Small birds can only be prevented from entering the enclosure by installing small mesh wire on the enclosure.

***Deterioration of hardware and other dangerous objects in the enclosure***
The captive Hoolock facility in India is a very small rescue centre with limited enclosure for temporary housing of rescued animal. Only small scale repairs of damage or deterioration of the hardware is addressed. Due to prolonged rainy season in northeast India the hardware used for the enclosure gets rusted quickly and resulting in heavy maintenance cost.

**Remarks**
It is important have daily inspections of the enclosure to detect possible damage of hardware and other objects.

***Stochastic disturbances leading to stress, illness or death and possible aggression***
This is a big problem for every zoo throughout the world. However, strict monitoring of the movement of the visitors can be done to minimize the disturbances to the animals. The visitors try to get close to the Hoolock enclosure and attempt to excite the Hoolocks by teasing, feeding throwing stones and making noise. The item’s the visitors offer can range from food and candy, clothes, balls, plastic bags and items, soda cans, etc.

It is difficult for the staff to be able constantly explain to visitors not to interact with the Hoolock. This problem becomes worse on weekends and holidays. In order to solve this situation, zoo staff in India and Bangladesh need to explain to the visitors when entering the zoo that they cannot interact with the animals for any reason. All food items must stay within the cafeteria area. If visitors are found interacting with the animals twice (and have been already reprimanded earlier), they would be escorted out of the zoo. It is important that guardrails are far enough and high enough so that the public cannot reach the enclosure and that the stand off barriers will not allow visitors to crawl through openings. Planting hedges between the guardrails and Hoolock enclosures could also accomplish this. Fine mesh wire 6' high along the entire enclosure needs to be installed. It would be best if a captive breeding center is constructed that it is set up next to the forest with the idea to rehabilitate the Hoolock within a natural surrounding. No visitors would be permitted to get within close proximity to the Hoolock enclosures.

### *Research*

The captive breeding of Hoolock is advisable for insuring the educational potential of the species for future generations. Captive breeding for sharing with other zoos in a scientific breeding programme make it possible for zoos in the region to exhibit this species without having to capture further animals from the wild. Reintroduction of the species to enhance the long-term survival will be feasible only if sufficient protected habitat is insured.

Genetic studies of this species to establish the degree of genetic variation is useful as well as studies of disease and their epidemiology, which may help in identifying cause and prevention of further illness. Nutritional studies, such as quantities of nutritional composition will also be useful. Social studies of the captive population such as mother – infant relationship, father and mother relationship and male-female relationship and animal – visitor's relationship may be useful in more effectively managing the animals in captivity. Finally, if the husbandry requirements of the animals are met, then study of reproductive behavior may help in ascertaining age at sexual maturity/puberty, mating time and behavior, breeding season, gestation period, interbirth interval, oestrous cycle, birth peak (peak period), and suckling length.

### *Relating to Coordinated Captive Breeding Programme for* Western Hoolock

**Cooperative Captive Breeding Program of Western Hoolock Gibbon**

The captive population of Hoolock Gibbons in Bangladesh consists of 3.1 at the Dhaka Zoo and 1.1 at the Dulahazara Safari Park, Chakoria in the Cox's Bazaar District.

**Workshop report for India**

The report of the workshop with corrections from Central Authority is :

| | |
|---|---|
| Assam State Zoo Guwahati | 1.0 |
| Rescue Centre at Bokakhat, Assam | 0.1 |
| National Zoo, New Delhi | 0.1 |
| Imphal Zoo, Manipur | 1.1 |
| Sepahijala Zoo, Tripura | 0.1 |
| Lucknow Zoo, Uttar Pradesh | 1.1 |
| Aizawal Zoo, Mizoram | 2.4 |

| | |
|---|---|
| Miao Zoo, Arunachal Pradesh | 2.0 |
| Itanagar Zoo, Arunachal Pradesh | 0.0.1 |

In the workshop a participant from NE report that there were 1.0 who is 2 yr old and 0.1 three year old at the Miao Rescue Center, Changlang District, Arunachal Pradesh, NE India. Amal Ch. Sharmah, DFO Digboi District, Itabhata, Assam has report a 20 year old unknown sex Hoolock Gibbon in a village in Ketotong, District Tinsukia, Assam. We were unable to confirm this information.

It is important that a captive breeding program for the Western Hoolock Gibbon should only include gibbons that are from the western portion of the Chindwin River in Myanmar, NE India, and Bangladesh. The Eastern Hoolock Gibbon is only found east of the Chindwin River in Myanmar, and southern China. It takes millions of years for a species or subspecies to be created. In just one breeding mistake all of that would change if two different subspecies or species created an offspring. There are many subtle morphological differences that would be lost, and those offspring would not be helpful for a future release program.

A species could be saved for 75 years in captivity if the breeding program has five unrelated pairs, all of which produce at least five offspring, and that a new unrelated pair obtained through a confiscation or donation is introduced to the breeding program every eight years which also produces five offspring. At this time a perfect cooperative Hoolock breeding program cannot be established, due to the low captive numbers. In addition, the current numbers in the zoos would not help in a captive breeding program in supplementing the wild population. A good captive breeding program should avoid the need for obtaining Hoolocks from the wild. Having a captive breeding program can assist the zoos with a source of where to obtain Hoolock Gibbons for their facilities, or provide new knowledge about the species in respect to their ecology and biology. However, it should be emphasized that fresh capture should not be undertaken unless captive techniques are perfected and it has been established that the animals captured would neither survive in the wild, nor be able to join a larger wild population, etc. Capturing from small populations in the wild drastically reduces the potential of survival of that population.

It is important that a training program be created for the care-givers and supervisors involved in the Hoolock Gibbon breeding program. This training program could take place with a 3- month training course at the Gibbon Conservation Center, Santa Clarita, California, USA where Hoolock Gibbons have been housed since 1982.

It is important that DNA testing be performed in the beginning stages of the breeding program if it is not confirmed the relationship of the gibbons that are housed at a particular zoo. At the same time zoos may like to consider assisting the scientific community with non-invasive samples for DNA studies, which can be obtained through hair or faeces. During yearly physical exams collecting additional blood could be considered for virus, parasite, DNA, or chromosome studies. Precautions must be considered at all times when the gibbon is tranquilized to make sure that it has fully recovered, before care takers have left the premises.

Zoos will need to loan their gibbons to other zoos that are involved in the cooperative captive-breeding program of Western Hoolock Gibbons. Animals should be transferred only to facilities that house their gibbons in appropriately designed enclosures, have proper veterinary care and management practices, and will not obtain or transfer their gibbons to facilities who are not in this cooperative program, and only obtain their gibbons legally.

The Western Hoolock Gibbon Management Plan should consider following similar guidelines to those that are used by the Gibbon Species Survival Plan (SSP) in the American Zoo and Aquarium Association (AZA) and/or the EEP in Europe and/or the ASMP or Australian Breeding Programme . Those guidelines can be obtained from these zoo associations, either from the internet (aza.org or eaza.org) or by correspondence.

**Important Hoolock Gibbon food could be supplied for captive animals**

| No. | Family | Species | Part Eaten | Local Name |
|---|---|---|---|---|
| 1 | Acanthaceae | *Thunbergia grandiflora* | flower / fruit | Tit pollah |
| 2 | Anacardiaceae | *Spondias pinnata* | mature fruit, sweet variety ripe fruit, sour variety (??) | Amra |
| 3 | Bombacaceae | *Salmalia malabaricum* (better known as *Bombax malabaricum*) aka *Bombax ceiba* | flower | Shimal |
| 5 | Burseraceae | *Protium serratum* | ripe fruit | Gutgutia |
| 6 | Dilleniaceae | *Dillenia pentagyna* | ripe fruit | Hargoia / Ayugi |
| 7 | Euphorbiaceae | *Baccaurea sapida* | ripe fruit | Babi / Latkon |
| 8 | Elaeocarpaceae | *Elaeocarpus robustus* | young leaf | Jalpai |
| 9 | Euphorbiaceae | *Mallotus albus* | Mature leaf | Bura |
| 10 | Moraceae | *Artocarpus chaplasha* | ripe fruit | Chapalish |
| 11 | | *Artocarpus heterophyllus** | ripe fruit | Jackfruit |
| 12 | | *Artocarpus lacucha* | ripe fruit | Dewa / Bhorfe |
| 13 | | *Ficus glomerata* | young leaf, fig | Dumur |
| 14 | | *Ficus variegata* | fig | |
| 15 | | *Ficus benghalensis* | fig | Bot |
| 16 | Myrtaceae | *Syzygium cumini* | ripe fruit | Kalojam |
| 17 | Rubiaceae | *Anthocephalus chinensis* | fruit | Kadam |

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# Conservation of Western Hoolock Gibbon *(Hoolock hoolock hoolock)* in India and Bangladesh

## Appendix I
## Simulation Modeling and Population Viability Analysis

## Appendix I
## Simulation Modeling and Population Viability Analysis

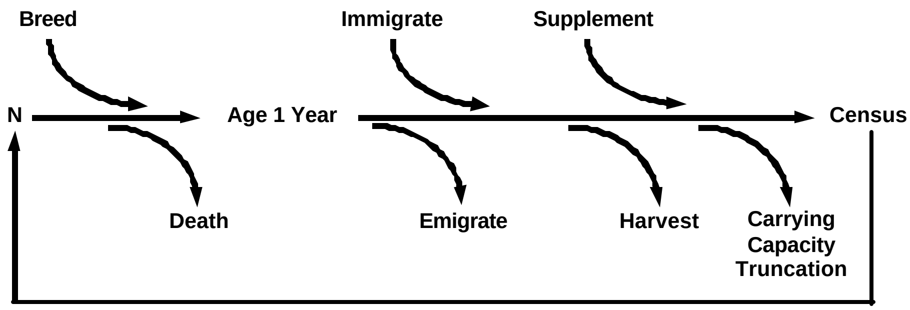
A model is any simplified representation of a real system. We use models in all aspects of our lives, in order to: (1) extract the important trends from complex processes, (2) permit comparison among systems, (3) facilitate analysis of causes of processes acting on the system, and (4) make predictions about the future. A complete description of a natural system, if it were possible, would often decrease our understanding relative to that provided by a good model, because there is "noise" in the system that is extraneous to the processes we wish to understand. For example, the typical representation of the growth of a wildlife population by an annual percent growth rate is a simplified mathematical model of the much more complex changes in population size. Representing population growth as an annual percent change assumes constant exponential growth, ignoring the irregular fluctuations as individuals are born or immigrate, and die or emigrate. For many purposes, such a simplified model of population growth is very useful, because it captures the essential information we might need regarding the average change in population size, and it allows us to make predictions about the future size of the population. A detailed description of the exact changes in numbers of individuals, while a true description of the population, would often be of much less value because the essential pattern would be obscured, and it would be difficult or impossible to make predictions about the future population size.

In considerations of the vulnerability of a population to extinction, as is so often required for conservation planning and management, the simple model of population growth as a constant annual rate of change is inadequate for our needs. The fluctuations in population size that are omitted from the standard ecological models of population change can cause population extinction, and therefore are often the primary focus of concern. In order to understand and predict the vulnerability of a wildlife population to extinction, we need to use a model which incorporates the processes which cause fluctuations in the population, as well as those which control the long-term trends in population size (Shaffer 1981). Many processes can cause fluctuations in population size: variation in the environment (such as weather, food supplies, and predation), genetic changes in the population (such as genetic drift, inbreeding, and response to natural selection), catastrophic effects (such as disease epidemics, floods, and droughts), decimation of the population or its habitats by humans, the chance results of the probabilistic events in the lives of individuals (sex determination, location of mates, breeding success, survival), and interactions among these factors (Gilpin and Soulé 1986).

Models of population dynamics which incorporate causes of fluctuations in population size in order to predict probabilities of extinction, and to help identify the processes which contribute to a population's vulnerability, are used in "Population Viability Analysis" (PVA) (Lacy 1993/4). For the purpose of predicting vulnerability to extinction, any and all population processes that impact population dynamics can be important. Much analysis of conservation issues is conducted by largely intuitive assessments by biologists with experience with the system. Assessments by experts can be quite valuable, and are often contrasted with "models" used to evaluate population vulnerability to extinction. Such a contrast is not valid, however, as *any* synthesis of facts and understanding of processes constitutes a model, even if it is a mental model within the mind of the expert and perhaps only vaguely specified to others (or even to the expert himself or herself).

A number of properties of the problem of assessing vulnerability of a population to extinction make it difficult to rely on mental or intuitive models. Numerous processes impact population dynamics, and many of the factors interact in complex ways. For example, increased fragmentation of habitat can make it more difficult to locate mates, can lead to greater mortality as individuals disperse greater distances across unsuitable habitat, and can lead to increased inbreeding which in turn can further reduce ability to attract mates and to survive. In addition, many of the processes impacting population dynamics are intrinsically probabilistic, with a random component. Sex determination, disease, predation, mate acquisition -- indeed, almost all events in the life of an individual -- are stochastic events, occurring with certain probabilities rather than with absolute certainty at any given time. The consequences of factors influencing population dynamics are often delayed for years or even generations. With a long-lived species, a population might persist for 20 to 40 years beyond the emergence of factors that ultimately cause extinction. Humans can synthesize mentally only a few factors at a time, most people have difficulty assessing probabilities intuitively, and it is difficult to consider delayed effects. Moreover, the data needed for models of population dynamics are often very uncertain. Optimal decision-making when data are uncertain is difficult, as it involves correct assessment of probabilities that the true values fall within certain ranges, adding yet another probabilistic or chance component to the evaluation of the situation.

**VORTEX Simulation Model Timeline**




Events listed above the timeline increase N, while events listed below the timeline decrease N.

The difficulty of incorporating multiple, interacting, probabilistic processes into a model that can utilize uncertain data has prevented (to date) development of analytical models (mathematical equations developed from theory) which encompass more than a small subset of the processes known to affect wildlife population dynamics. It is possible that the mental models of some biologists are sufficiently complex to predict accurately population vulnerabilities to extinction under a range of conditions, but it is not possible to assess objectively the precision of such intuitive assessments, and it is difficult to transfer that knowledge to others who need also to evaluate the situation. Computer simulation models have increasingly been used to assist in PVA. Although rarely as elegant as models framed in analytical equations, computer simulation models can be well suited for the complex task of evaluating risks of extinction. Simulation models can include as many factors that influence population dynamics as the modeler and the user of the model want to assess. Interactions between processes can be modeled, if the nature of those interactions can be specified. Probabilistic events can be easily simulated by computer programs, providing output that gives both the mean expected result and the range or distribution of possible outcomes. In theory, simulation programs can be used to build models of population dynamics that include all the knowledge of the system which is available to experts. In practice, the models will be simpler, because some factors are judged unlikely to be important, and because the persons who developed the model did not have access to the full array of expert knowledge.

Although computer simulation models can be complex and confusing, they are precisely defined and all the assumptions and algorithms can be examined. Therefore, the models are objective, testable, and open to challenge and improvement. PVA models allow use of all available data on the biology of the taxon, facilitate testing of the effects of unknown or uncertain data, and expedite the comparison of the likely results of various possible management options.

PVA models also have weaknesses and limitations. A model of the population dynamics does not define the goals for conservation planning. Goals, in terms of population growth, probability of persistence, number of extant populations, genetic diversity, or other measures of population performance must be defined by the management authorities before the results of population modeling can be used. Because the models incorporate many factors, the number of possibilities to test can seem endless, and it can be difficult to determine which of the factors that were analyzed are most important to the population dynamics. PVA models are necessarily incomplete. We can model only those factors which we understand and for which we can specify the parameters. Therefore, it is important to realize that the models probably underestimate the threats facing the population. Finally, the models are used to predict the long-term effects of the processes presently acting on the population. Many aspects of the situation could change radically within the time span that is modeled. Therefore, it is important to reassess the data and model results periodically, with changes made to the conservation programs as needed (see Lacy and Miller (2002), Nyhus et al. (2002) and Westley and Miller (2003) for more details).

### The *VORTEX* Population Viability Analysis Model

For the analyses presented here, the *VORTEX* computer software (Lacy 1993) for population viability analysis was used. *VORTEX* models demographic stochasticity (the randomness of reproduction and deaths among individuals in a population), environmental variation in the annual birth and death rates, the impacts of sporadic catastrophes, and the effects of inbreeding in small populations. *VORTEX* also allows analysis of the effects of losses or gains in habitat, harvest or supplementation of populations, and movement of individuals among local populations.

Density dependence in mortality is modeled by specifying a carrying capacity of the habitat. When the population size exceeds the carrying capacity, additional morality is imposed across all age classes to bring the population back down to the carrying capacity. The carrying capacity can be specified to change linearly over time, to model losses or gains in the amount or quality of habitat. Density dependence in reproduction is modeled by specifying the proportion of adult females breeding each year as a function of the population size.

*VORTEX* models loss of genetic variation in populations, by simulating the transmission of alleles from parents to offspring at a hypothetical genetic locus. Each animal at the start of the simulation is assigned two unique alleles at the locus. During the simulation, *VORTEX* monitors how many of the original alleles remain within the population, and the average heterozygosity and gene diversity (or "expected heterozygosity") relative to the starting levels. *VORTEX* also monitors the inbreeding coefficients of each animal, and can reduce the juvenile survival of inbred animals to model the effects of inbreeding depression.

*VORTEX* is an *individual-based* model. That is, *VORTEX* creates a representation of each animal in its memory and follows the fate of the animal through each year of its lifetime. *VORTEX* keeps track of the sex, age, and parentage of each animal. Demographic events (birth, sex determination, mating, dispersal, and death) are modeled by determining for each animal in each year of the simulation whether any of the events occur. (See figure above.) Events occur according to the specified age and sex-specific probabilities. Demographic stochasticity is therefore a consequence of the uncertainty regarding whether each demographic event occurs for any given animal.

*VORTEX* requires a lot of population-specific data. For example, the user must specify the amount of annual variation in each demographic rate caused by fluctuations in the environment. In addition, the frequency of each type of catastrophe (drought, flood, epidemic disease) and the effects of the catastrophes on survival and reproduction must be specified. Rates of migration (dispersal) between each pair of local populations must be specified. Because *VORTEX* requires specification of many biological parameters, it is not necessarily a good model for the examination of population dynamics that would result from some generalized life history. It is most usefully applied to the analysis of a specific population in a specific environment.

Further information on *VORTEX* is available in Lacy (2000) and Miller and Lacy (2003).

**Dealing with Uncertainty**

It is important to recognize that uncertainty regarding the biological parameters of a population and its consequent fate occurs at several levels and for independent reasons. Uncertainty can occur because the parameters have never been measured on the population. Uncertainty can occur because limited field data have yielded estimates with potentially large sampling error. Uncertainty can occur because independent studies have generated discordant estimates. Uncertainty can occur because environmental conditions or population status have been changing over time, and field surveys were conducted during periods which may not be representative of long-term averages. Uncertainty can occur because the environment will change in the future, so that measurements made in the past may not accurately predict future conditions.

Sensitivity testing is necessary to determine the extent to which uncertainty in input parameters results in uncertainty regarding the future fate of the pronghorn population. If alternative plausible parameter values result in divergent predictions for the population, then it is important to try to resolve the uncertainty with better data. Sensitivity of population dynamics to certain parameters also indicates that those parameters describe factors that could be critical determinants of population viability. Such factors are therefore good candidates for efficient management actions designed to ensure the persistence of the population.

The above kinds of uncertainty should be distinguished from several more sources of uncertainty about the future of the population. Even if long-term average demographic rates are known with precision, variation over time caused by fluctuating environmental conditions will cause uncertainty in the fate of the population at any given time in the future. Such environmental variation should be incorporated into the model used to assess population dynamics, and will generate a range of possible outcomes (perhaps represented as a mean and standard deviation) from the model. In addition, most biological processes are inherently stochastic, having a random component. The stochastic or probabilistic nature of survival, sex determination, transmission of genes, acquisition of mates, reproduction, and other processes preclude exact determination of the future state of a population. Such demographic stochasticity should also be incorporated into a population model, because such variability both increases our uncertainty about the future and can also change the expected or mean outcome relative to that which would result if there were no such variation. Finally, there is "uncertainty" which represents the alternative actions or interventions which might be pursued as a management strategy. The likely effectiveness of such management options can be explored by testing alternative scenarios in the model of population dynamics, in much the same way that sensitivity testing is used to explore the effects of uncertain biological parameters.

**Results**

Results reported for each scenario include:

Deterministic r – The deterministic population growth rate, a projection of the mean rate of growth of the population expected from the average birth and death rates. Impacts of harvest, inbreeding, and density dependence are not considered in the calculation. When $r = 0$, a population with no growth is expected; $r < 0$ indicates population decline; $r > 0$ indicates long-term population growth. The value of r is approximately the rate of growth or decline per year.

The deterministic growth rate is the average population growth expected if the population is so large as to be unaffected by stochastic, random processes. The deterministic growth rate will correctly predict future population growth if: the population is presently at a stable age distribution; birth and death rates remain constant over time and space (i.e., not only do the probabilities remain constant, but the actual number of births and deaths each year match the expected values); there is no inbreeding depression; there is never a limitation of mates preventing some females from breeding; and there is no density dependence in birth or death rates, such as a Allee effects or a habitat "carrying capacity" limiting population growth. Because some or all of these assumptions are usually violated, the average population growth of real populations (and stochastically simulated ones) will usually be less than the deterministic growth rate.

Stochastic r – The mean rate of stochastic population growth or decline demonstrated by the simulated populations, averaged across years and iterations, for all those simulated populations that are not extinct. This population growth rate is calculated each year of the simulation, prior to any truncation of the population size due to the population exceeding the carrying capacity. Usually, this stochastic r will be less than the deterministic r predicted from birth and death rates. The stochastic r from the simulations will be close to the deterministic r if the population growth is steady and robust. The stochastic r will be notably less than the deterministic r if the population is subjected to large fluctuations due to environmental variation, catastrophes, or the genetic and demographic instabilities inherent in small populations.

P(E) – The probability of population extinction, determined by the proportion of, for example, 500 iterations within that given scenario that have gone extinct in the simulations. "Extinction" is defined in the VORTEX model as the lack of either sex.

N – The mean population size, averaged across those simulated populations which are not extinct.

SD(N) – The variation across simulated populations (expressed as the standard deviation) in the size of the population at each time interval. SDs greater than about half the size of mean N often indicate highly unstable population sizes, with some simulated populations very near extinction. When SD(N) is large relative to N, and especially when SD(N) increases over the years of the simulation, then the population is vulnerable to large random fluctuations and may go extinct even if the mean population growth rate is positive. SD(N) will be small and often declining relative to N when the population is either growing steadily toward the carrying capacity or declining rapidly (and deterministically) toward extinction. SD(N) will also decline considerably when the population size approaches and is limited by the carrying capacity.

H – The gene diversity or expected heterozygosity of the extant populations, expressed as a percent of the initial gene diversity of the population. Fitness of individuals usually declines proportionately with gene diversity (Lacy 1993b), with a 10% decline in gene diversity typically causing about 15% decline in survival of captive mammals (Ralls et al. 1988). Impacts of inbreeding on wild populations are less well known, but may be more severe than those observed in captive populations (Jiménez et al. 1994). Adaptive response to natural selection is also expected to be proportional to gene diversity. Long-term conservation programs often set a goal of retaining 90% of initial gene diversity (Soulé et al. 1986). Reduction to 75% of gene diversity would be equivalent to one generation of full-sibling or parent-offspring inbreeding.

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# Conservation of Western Hoolock Gibbon
# *(Hoolock hoolock hoolock)* in India and Bangladesh

## Appendix II
## Pledges or Personal Commitments of Participants

**Appendix II**
**Pledges or Personal Commitments of Participants of the Population and Habitat Viability Assessment (PHVA) for Western Hoolock Gibbon**

***Dr. Sangita Mitra, Sr. Project Officer, WWF-India, West Bengal State Office***

- Building up education and awareness programmes to generate public opinion and political will for conserving Hoolock Gibbon in wild.
- Liaisoning with different government and non government agencies/institutions to initiate action based programme and field research for detail understanding of Hoolock Gibbon biology in wild.

***Dr. C. Srinivasulu, Research Associate, Department of Zoology, Osmania University***

- Finish PHVA report in time and help CBSG-SA to do so.
- Continue modeling case specific scenarios in future as and when such information is available

***Dr. A. K. Gupta, Chief Conservator of Forests Professor, Wildlife Institute of India***

- Helping in protection of the habitat and gibbon across its range in NE India, Bangladesh and Myanmar.
- Generating public awareness, working for sensitization of policy makers, educating the people about conservation importance.
- Bringing the issue of bilateral coordination / cooperation for the conservation of Hoolock Gibbon in the international boundaries such as collaborative research and collaborative management programmes to the attention of authorities in both countries.

***Mr. Chukhu Loma, Director, Biological Park, Itanagar***

- Submit proposal to government for declaring sanctuary/national park of these habitat located outside Protected Area.
- Habitat loss of population survey and estimation of gibbon population in Arunachal Pradesh
- Work towards having areas holding HG populations outside the protected areas declared as protected area.

Work towards rehabilitating people residing inside the HG habitat in comfortable areas outside the HG habitat.

- Work toward translocation of animals in degraded areas or in small populations to viable habitats after becoming fully knowledgeable about Guidelines of Reintroduction Specialist Group..

***Mr. Surajit Baruah, Ex. Jt Coordinator, NBSAP India***

- Evaluation and assessment of threats to Hoolock Gibbon habitats in some selected habitat areas in Assam.
- Awareness programmes for the conservation of Hoolock Gibbon habitats

***Mr. Alan Mootnick, Director, Gibbon Conservation Center, California, USA***

- Assist zoos in a captive management plan
- Assist with the proposed captive breeding problem.

***Mr. Mohammad Ali, ACF, Wildlife Management and Nature Cons. Division***

- Establishing legal status of the Hoolock Gibbons declare. Proposed political will for conservation.
- Emphasis on more research. Monitoring and reorganization of department.

***Mr. Awadhesh Kumar, Wildlife Researcher, North Eastern Regional Institute of Science and Technology***

- Habitat and population survey
- Causes of habitat loss and Hoolock Gibbon population loss

***Mr. R. Marimuthu, Education Officer, Zoo Outreach Organisation***

- Create awareness among all walks of life about Hoolock Gibbon conservation.
- To create awareness I look for ways to make it possible.

***Mr. Laskar Muqsudur Rahman, DFO, Wildlife Management and Nature Cons. Division***

- Organizing the field staff for better patrolling in Pas (i.e. habitat of Hoolock Gibbon)
- Motivating the community in and around Protected Area's (i.e. habitat of Gibbon) not to disturb habitat & gibbon as well.

***Ms. Shimona A. Quazi, Lecturer, Dept. of Environmental Studies (Former), North South University***

- Continuing to work on park conservation issues in Lawachara contacting media, legal lobbying.
- Incorporation of Hoolock Gibbon conservation in future research more directly.

***Mr. Asif Ahmed Hazarika, Director, Wild Survey North East***

- Field survey of status and distribution
- Habitat improvement and increasing of protected areas.

***Mr. Amal Ch. Sarmah, Divisional Forest Office Digboi Division***

- By planting trees in fragmented areas which will create corridor to the large chunk of forests. Canopy Bridge can be made in small fragmented area homing isolated group of Hoolock Gibbon.
- If it is necessary translocation section may be carried out for isolated Hoolock gibbon.

***Mr. Md. Hasanuzzaman, Assistant Professor, Dept. of Animal Science and Nutrition, Chittagong Govt. Veterinary College***

- Studying the habitat of Hoolock Gibbon. Agreed to form a group and make public awareness.
- To assist any group who work to preserve Hoolock Gibbon.

***Dr. Md. Salim Iqbal, Veterinary Surgeon, Dhaka Zoo***

- To establish a research program on captive breeding of Hoolock Gibbon in Dhaka Zoo and in Dulhafa Safari Park.
- To develop a network among all agencies whose are working on Hoolock Gibbon and to study the behavioral pattern of Hoolock Gibbon in captivity.

**Dr. Dilip Chetry, Conservation Biologist, Primate Research Centre, (Northeast India)**

- Detail survey on status and population in Northeast India as well as trans boundary with Bangladesh and Mynamar.
- Conducting Eco-biological studies as well as Hoolock Conservation program in Northeast India.

***Mr. Suprio Chakma, Research Assistant, Encyclopedia of Flora and Fauna Project, Asiatic Society of Bangladesh***

- Discouraging hunting or poaching and awareness building to forest dependent people.
- Trying to release fragmented population in better habitat.

**Sanjay Molur**

***Dr. G. S. Solanki, Senior Lecturer, North Eastern Regional Institute of Science & Technology***

- Undertaking research programmes on Hoolock Gibbon addressing the issues and goal prioritically identified.
- Generating awareness among the different groups in society.

***Mr. Joyram Baruah, Assam***

- Carry out the detail survey of Hoolock Gibbon habitat and increasing more Hoolock Gibbon areas.
- Stick monitoring of gibbon habitat and also do plantation to link fragmented habitat.

***Mr. Md. Abdul Aziz, Department of Zoology, Jahangirnagar University***

- Studying demographic and population dynamics.
- Public awareness campaign.

***Dr. Narayan Chandra Banik, Deputy Curator, Dhaka Zoo***

- To take care proper captive breeding programmes in Dhaka zoo.
- To develop technique for behavioral studies and breeding strategy in captivity.

***Dr. Jihosuo Biswas, Field Biologist, Primate Research Centre, (Northeast India)***

- Action based research on habitat manipulation, translocation on other meta population management through PRC and like minded organisation.
- Prioritization of landscape, habitat assessment of Assam, Arunachal Pradesh and Meghalaya.
- Work towards prioritization of Hoolock Gibbon habitats / population in different areas in terms of conservation

***Mr. Md. Shamsur Rahman, CF (Wildlife & Nature Conservation Circle)***

- Immediate instruction to all forest officials near by Hoolock Gibbon Habitat to protect the habitat and Hoolock Gibbon at their capacity.
- Inform the Government (MOEF) regarding condition of Hoolock Gibbon.

***Dr. F.R. Al-Siddique, Bangladesh***

Write article to be published in periodicals to improve consciousness amongst peoples, that ultimately me lead to publication of a book.

***Dr. Rekha Medhi, Lecturer, Department of Zoology, Jawaharlal Nehru College***

- Doing detail survey on selected habitat to evaluate the status along with behavioural study.
- By involving myself in education and awareness program to get support from local communities for the conservation of Hoolock Gibbon.

***Dr. M.M. Feeroz, Department of Zoology, Jahangirnagar University***

- Creating non formal education programme in and around Hoolock Gibbon habitat in Bangladesh.
- Continuing studying Hoolock gibbon.

***Dr. M. Farid Ahsan, Department of Zoology, University of Chittagong***

- Why population lost in Bangladesh
- Transboundary

***Mr. Joydeep Bose, Programme Officer (Wild Aid), Wildlife Trust of India***

- As a person and as a representative of Wildlife Trust of India – translocation of small groups / individual through Wildlife Trust of India
- Arrange for rapid action on Projects (finding) for conservation actions in the field.
- WTI is launching Hoolock Gibbon conservation projects, rescues rehabilitation and species focus.
- Working towards convincing authorities to provide more protection for small HG population areas by appointing more staff / watchers to protect such populations
- Working towards goal of translocation HG based on the IUCN guidelines

***Ms. Afroza Yasmin, Programme Officer, Wildlife Trust of Bangladesh***

- I try to work with professor Anwarul Islam for protect our Bangladeshi Hoolock Gibbon.

***Mr. Nurul Basar Sarker, Programme Officer, Wildlife Trust of Bangladesh***

- By awaring local people
- By protecting the habitat of Hoolock Gibbon.

***Mr. P.O. Nameer, Assistant Professor, Kerala Agricultural University***

- By helping bring out a PHVA report in time
- Help ZOO/CBSG S. Asia in their conservation activities to conserve Hoolock Gibbon.

***Ms. Gawsia Wahidunnessa Chowdhury, Programme Officer, Wildlife Trust of Bangladesh***

- By developing awareness among local people
- By developing participatory scientific management programme with the help of the tools of this workshop.

***Ms. Israt Jahan, Research Assistant, Wildlife Trust of Bangladesh***

- Create awareness among the local people
- By developing participatory scientific management programme.

***Ms. Mehrab Chowdhury, Research Assistant, Wildlife Trust of Bangladesh***

- By developing participatory scientific management programme
- By protecting the habitat of Hoolock Gibbon.

***Ms. Sally Walker, Coordinator, South Asian Primate Network of IUCN SSC PSG***

- Giving presentations on this workshop and the plight of Hoolock Gibbon in international fora
- Raising funds for further studies of HG and in particular Sanjay Molur's suggestion and workshop recommendation of systematic studies of the localities of the eight population of Hoolock Gibbon which has gone extinct from Bangladesh should be undertaken in order to find out the reasons and causative factors so that the same could be recognized early in other localities.
- Producing educational material on Hoolock Gibbon for use in India and in Bangladesh
- Getting the Report out within a year and circulating it and a Summary widely.

**Sanjay Molur**

- To follow up the personal commitments made by the following from every locality to take responsibility for following up the recommendations coming out of this workshop in their area: Jihouso Biswas for Assam; Hazarika, Loma and Biswas for Arunachal Pradesh; Atul Gupta for other states of northeastern India; Anwarul Islam for Bangladesh; Anwarul Islam, M.M. Feeroz, and Atul Gupta for Transboundary issues.

# Conservation of Western Hoolock Gibbon *(Hoolock hoolock hoolock)* in India and Bangladesh

## Appendix III
## Distribution of *Bunopithecus hoolock hoolock*

**Distribution of *Bunopithecus hoolock hoolock* in Bangladesh and India from literature and recent field studies**

| Distribution in South Asia | Lat. | Long. | Area ($km^2$) | Habitat | Threats<br>Past, Present, Future | Pop. trend<br>Past %/yr | <br>Future %/yr | Pop. No. | Mat. Ind. | Notes / Sources |
|---|---|---|---|---|---|---|---|---|---|---|
| **BANGLADESH**<br>**Chittagong** | | | | | | | | | | |
| Bamu | | | | | | | | 14 | - | Gittins and Akonda, 1982; Ahsan, 1984, 1994; Feeroz, 1991; Feeroz and Islam 1992; personal observations by the group members. (In this workshop) |
| Bangdepa | | | | | | | | 8 | - | Gittins and Akonda, 1982; Ahsan, 1984, 1994; Feeroz, 1991; Feeroz and Islam 1992; personal observations by the group members. (In this Workshop) |
| Bishari | | | | | | | | 7 | - | Gittins and Akonda, 1982; Ahsan, 1984, 1994; Feeroz, 1991; Feeroz and Islam 1992; personal observations by the group members. (in this workshop) |
| Chunathi WLS | 21°58 | 92°04 | 11 | E | Habitat destruction (P/Pr/F), encroachment (P/Pr/F) | Decline | Decline | 0 | 0 | Ahsan, 1994; Feeroz, 1991, 1999a; Feeroz & Islam, 1992; Feeroz, *et al.*, 1995.(In this Workshop) |
| Dhopachari | | | | | | | | 7 | - | Gittins and Akonda, 1982; Ahsan, 1984, 1994; Feeroz, 1991; Feeroz and Islam 1992; personal observations by the group members. (In this Workshop) |
| Dighinala | | | | | | | | 7 | - | Gittins and Akonda, 1982; Ahsan, 1984, 1994; Feeroz, 1991; Feeroz and Islam 1992; personal observations by the group members. (In this Workshop) |
| Hazarikhil<br>Bariadhala range | - | - | 6 | E | Habitat destruction (P/Pr/F), encroachment (P/Pr/F), hunting (Pr) | Decline | Decline | 0 | 0 | Ahsan, 1994; Feeroz, 1999a (In this Workshop) |
| Inani | | | | | | | | 5 | - | Gittins and Akonda, 1982; Ahsan, 1984, 1994; Feeroz, 1991; |

**Distribution of *Bunopithecus hoolock hoolock* in Bangladesh and India from literature and recent field studies ... continued**

| Distribution in South Asia | Lat. | Long. | Area (km²) | Habitat | Threats<br>Past, Present, Future | Pop. trend<br>Past %/yr | <br>Future %/yr | Pop. No. | Mat. Ind. | Notes / Sources |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | Feeroz and Islam 1992; personal observations by the group members. (In this Workshop) |
| Kaptai | 22°21 | 92°17 | 5 | E | Habitat destruction (P/Pr/F), encroachment (F) | Decline | Decline | 14 | - | Feeroz *et al*., 1995; M. Farid Ahsan pers. comm.(In this Workshop) |
| Lama | | | | | | | | ND | ND | Gittins and Akonda, 1982; Ahsan, 1984, 1994; Feeroz, 1991; Feeroz and Islam 1992; personal observations by the group members. (In this Workshop) |
| Massalong | | | | | | | | ND | ND | Gittins and Akonda, 1982; Ahsan, 1984, 1994; Feeroz, 1991; Feeroz and Islam 1992; personal observations by the group members. (In this Workshop) |
| Pablakhali | 23°16 | 92°05 | 5 | E | Habitat destruction (P/Pr/F), encroachment (F) | Decline | Decline | 4 | - | Feeroz *et al*., 1995; M. Farid Ahsan pers. comm.(In this Workshop) |
| Padua | 22°03 | 92°07 | 5 | SE | Habitat destruction (P/Pr/F), encroachment (Pr/F) | Decline | Decline | 0 | 0 | Feeroz *et al*., 1995; M.M. Feeroz pers. comm.(In this Workshop) |
| Rampahar | | | | | | | | 16 | - | (In this Workshop) |
| Satghar | ~27°00 | ~92°00 | 6 | E | Habitat destruction (P/Pr/F), encroachment (Pr/F) | Decline | Decline | 0 | 0 | Feeroz & Islam, 1992; Ahsan, 1994.(In this Workshop) |
| Sazak | | | | | | | | 12 | - | (In this Workshop) |
| Thanchi | | | | | | | | 7 | - | Gittins and Akonda, 1982; Ahsan, 1984, 1994; Feeroz, 1991; Feeroz and Islam 1992; personal observations by the group members. (In this Workshop) |
| ***Cox's Bazar*** | | | | | | | | | | |
| Bhomarighona | - | - | 12 | E | Habitat destruction (P/Pr/F), | Decline | Decline | 0 | 0 | Ahsan, 1994; Feeroz, |

**Distribution of *Bunopithecus hoolock hoolock* in Bangladesh and India from literature and recent field studies ... continued**

| Distribution in South Asia | Lat. | Long. | Area (km²) | Habitat | Threats<br>Past, Present, Future | Pop. trend<br>Past %/yr | <br>Future %/yr | Pop. No. | Mat. Ind. | Notes / Sources |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | encroachment (Pr/F),<br>selective logging (Pr) | | | | | *et al*., 1995.(In this Workshop) |
| Himchari | - | - | 6 | E | Habitat destruction (P/Pr/F),<br>encroachment (Pr/F) | Decline | Decline | 0 | 0 | Feeroz *et al*., 1995;<br>Feeroz, 1999a; M. Farid Ahsan pers. comm.(In this Workshop) |
| Hnila | - | - | 5 | E | Habitat destruction (P/Pr/F),<br>encroachment (F) | Decline | Decline | 0 | 0 | Feeroz *et al*., 1995.(In this workshop) |
| Teknaf | - | - | - | E | Habitat destruction (P/Pr/F),<br>encroachment (Pr/F), fragmentation (Pr) | - | - | 0 | 0 | Das *et al*., 2002a.(in this Workshop) |
| Ukhia | 21°15 | 92°07 | 6 | E | Habitat destruction (P/Pr/F),<br>encroachment (Pr/F) | Decline | Decline | 6 | 0 | Feeroz, 1999a.(In this Work shop) |
| **Sylhet**<br>Chautoli<br>Banugach FR | | | | | | | | 5 | - | Gittins and Akonda, 1982;<br>Ahsan, 1984, 1994; Feeroz, 1991; Feeroz and Islam 1992; personal observations by the group members. (In this Workshop) |
| *Hobigang*<br>Satchari<br>Raghunandan hill RF | - | - | 8 | SE,<br>BLME | Habitat destruction (P/Pr/F),<br>encroachment (F) | - | Decline | 7 | 0 | Feeroz, 1999a.(In this Work shop) |
| *Moulvi Bazar*<br>Adampur | 23°18 | 89°52 | 10 | SE | Habitat destruction (P/Pr/F),<br>encroachment (Pr), timber plantation (Pr) | - | Decline | 16 | 0 | Feeroz, 1999a;<br>M. Farid Ahsan pers. comm.(In this workshop) |
| Horinchara | - | - | 11 | SE, TMD | Habitat destruction (P/Pr/F),<br>encroachment (Pr) | - | Decline | 0 | 0 | Feeroz, 1999a.(In this Work shop) |
| Patharia RF | 24°11 | 24°31 | 10 | SE, TMD | Habitat destruction (P/Pr/F),<br>encroachment (Pr) | - | Decline | 2 | - | Feeroz, 1999a, M.M. Feeroz, pers. comm. M. Farid Ahsan, pers. comm.(In this Workshop) |
| Barolekha | | | | | | | | 8 | - | (In this Workshop) |

**Distribution of *Bunopithecus hoolock hoolock* in Bangladesh and India from literature and recent field studies ... continued**

| Distribution in South Asia | Lat. | Long. | Area (km²) | Habitat | Threats<br>Past, Present, Future | Pop. trend<br>Past %/yr | <br>Future %/yr | Pop. No. | Mat. Ind. | Notes / Sources |
|---|---|---|---|---|---|---|---|---|---|---|
| Lathitila<br>Juri Range | | | | | | | | 3 | - | Gittins and Akonda, 1982; Ahsan, 1984, 1994; Feeroz, 1991; Feeroz and Islam 1992; personal observations by the group members. (In this Workshop) |
| Kalinjl<br>Rajkandi RF | - | - | 8 | SE | Habitat destruction (P/Pr/F)<br>encroachment (P/Pr),<br>timber plantation (Pr) | - | Decline | 16 | - | Feeroz,1999a.(In this work shop) |
| Lawachara WLS | 24°21 | 91°48 | 20 | SE | Habitat destruction (P/Pr/F),<br>Encroachment(Pr),<br>Gas field exploration (Pr), Tourism (F) | - | Decline | 37 | - | Ahsan, 1984, 1994;<br>Feeroz, 1991, 1999a;<br>Feeroz *et al*., 1995;<br>Feeroz & Islam 1992, 2000 |
| **INDIA**<br>**Arunachal Pradesh**<br>*Changlang*<br>Namdapha NP | ~27°39 | ~96°30 | 20 | E | Hunting (P/Pr/F),<br>habitat destruction (Pr), encroachment (F) | Decline | Decline | 45 | - | IUSPP Annual reports, 1994-99<br>Choudhury, 1991<br>Found in adjacent areas.<br>S.S. Chandiramani, 2002. |
| Miao RF | ~27°39 | ~96°15 | 1 | SE | Encroachment (P/Pr/F),<br>hunting (P/Pr/F),<br>habitat destruction (P/Pr/F) | Decline | Decline | 2 | - | IUSPP Annual reports, 1994-99<br>(In this workshop) |
| *Debang Valley*<br>Roing | 28°10 | 95°50 | - | - | - | - | - | | - | IUSPP Annual reports, 1994-99<br>Tilsong, 1979.(In this Workshop) |
| Mehao WLS | ~27°39 | ~96°15 | 1 | TWE | Habitat destruction (P/Pr/F), hunting (F) | Decline | Decline | 48 | - | IUSPP Annual reports, 1994-99,<br>Rare in adjacent areas. A.K. Sen, 2002 |
| *Lohit*<br>Kamlang WLS | 27°44 | 96°39 | 1 | E | Hunting (P/Pr/F),<br>habitat destruction (P/Pr/F),<br>encroachment (Pr) | - | Decline | 1 | 1 | IUSPP Annual reports, 1994-99<br>Choudhury, 1991 |
| Tengapani RF | | | 450 | | | | | 36 | - | Choudhury, 1989, 1990. (In this |

**Distribution of *Bunopithecus hoolock hoolock* in Bangladesh and India from literature and recent field studies ... continued**

| Distribution in South Asia | Lat. | Long. | Area (km²) | Habitat | Threats Past, Present, Future | Pop. trend Past %/yr | Pop. trend Future %/yr | Pop. No. | Mat. Ind. | Notes / Sources |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | Workshop) |
| Turung RF | | | 170 | | | | | 18 | - | Choudhury, 1989, 1990. (In this Workshop) |
| Manabhum RF | | | 130 | | | | | 18 | - | Choudhury, 1989, 1990. (In this Workshop) |
| **Assam** | | | | | | | | | | |
| Sadya | 27°50 | 95°03 | - | - | - | - | - | - | - | Jenkins, 1987 |
| Zubza | 25°41 | 94°03 | - | - | - | - | - | - | - | Jenkins, 1987 |
| *Cachar* | | | | | | | | | | |
| Barail RF | - | - | 173.5 | TWE | Habitat destruction (P/Pr/F), hunting (F), encroachment (P/Pr/F) | - | - | 11 | - | Das et al., 2002a, 2005. Tilson, 1979; Choudhury, 1989, 1990; Das et al., 2005. (In this Workshop) |
| Hatikhali | 25°39 | 95°30 | - | - | | - | - | - | - | 485m. Jenkins, 1987 |
| *Dibrugarh* | | | | | | | | | | |
| Joypur RF | 27°14 | 95°34 | 108.7 | TWE | Habitat destruction (P/Pr/F) hunting (P/Pr/F), encroachment (P/Pr/F) | Decline | Decline | 69 | - | IUSPP Annual reports, 1994-99; Tilson, 1979; Choudhury, 1989, 1990; Das et al., 2005. (In this Workshop) |
| *Goalpara* | | | | | | | | | | |
| Moghaghar RF | - | - | 0.373 | TMD | Habitat destruction (P/Pr/F), hunting (P/Pr/F), encroachment (P/Pr/F) | Decline | Decline | 1 | 1 | IUSPP Annual reports, 1994-99 |
| *Golaghat* | | | | | | | | | | |
| Kaziranga NP | ~26°37 | ~93°18 | 463.8 | TSE | Habitat destruction (P/Pr/F), encroachment (P/Pr/F) | Decline | Decline | 73 | - | IUSPP Annual reports, 1994-99; Tilson, 1979; Choudhury, 1989, 1990; Das *et al*., 2005. (In this Workshop) |
| Nambar West Block RF | - | - | 166.3 | TSE | Habitat destruction (P/Pr/F), hunting (Pr), encroachment (P/Pr/F) | Decline | Decline | 18 | - | IUSPP Annual reports, 1994-99; Tilson, 1979; Choudhury, 1989, 1990; Das *et al*., 2005. (In this Workshop) |
| Panbari | - | - | 7.65 | TSE | Habitat destruction (P/Pr/F), hunting (P/Pr/F), encroachment (P/Pr/F) | Decline | Decline | 10 | - | IUSPP Annual reports, 1994-99; Tilson, 1979; Choudhury, 1989, |

**Distribution of *Bunopithecus hoolock hoolock* in Bangladesh and India from literature and recent field studies ... continued**

| Distribution in South Asia | Lat. | Long. | Area (km²) | Habitat | Threats<br>Past, Present, Future | Pop. trend<br>Past %/yr | <br>Future %/yr | Pop. No. | Mat. Ind. | Notes / Sources |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | 1990; Das *et al*., 2005. (In this Workshop) |
| *Hailakandi* | | | | | | | | | | |
| Innerline | - | - | 2635.7 | TWE | Habitat destruction (P/Pr/F), hunting (P/Pr/F), encroachment (P/Pr/F) | Decline | Decline | 160 | - | IUSPP Annual reports, 1994-99; Das *et al*. 2002a; Tilson, 1979; Choudhury, 1989, 1990; Das *et al*., 2005. (In this Workshop) |
| Katakhal RF | - | - | 154.2 | TWE | Habitat destruction (P/Pr/F), hunting (P/Pr/F), encroachment (P/Pr/F) | Decline | Decline | 0 | 0 | IUSPP Annual reports, 1994-99; Choudhury, 1991, Das *et al.* 2002a; Tilson, 1979; Choudhury, 1989, 1990; Das *et al*., 2005. (In this Workshop) |
| *Jorhat* | | | | | | | | | | |
| Gibbon WLS | - | - | 19.6 | TWE | Habitat destruction (P/Pr/F), hunting (P/F), encroachment (P/Pr/F) | Decline | Decline | 57 | - | IUSPP Annual reports, 1994-99; G. Santha, 2002; Tilson, 1979; Choudhury, 1989, 1990; Das *et al*., 2005. (In this Workshop) |
| *Kamrup* | | | | | | | | | | |
| Apricola RF | 26°19 | 91°15 | - | TMD | - | - | - | - | - | Choudhury, 1987 |
| Badsahilia RF | - | - | - | TSE | - | - | - | - | - | Choudhury, 1987 |
| Chandubi USF | - | - | 2 | TMD | Habitat destruction (P/Pr/F), encroachment (P/Pr/F) | Decline | Decline | 12 | - | IUSPP Annual reports, 1994-99; Tilson, 1979; Choudhury, 1989, 1990; Das *et al*., 2005. (In this Workshop) |
| Gorbhanga RF | - | - | 114.6 | TMD | Habitat destruction (P/Pr/F), encroachment (P/Pr/F) | Decline | Decline | 20 | - | IUSPP Annual reports, 1994-99; Tilson, 1979; Choudhury, 1989, 1990; Das *et al*., 2005. (In this Workshop) |
| Jorsal RF | - | - | 12.5 | TMD | Habitat destruction (P/Pr/F), encroachment (P/Pr/F) | Decline | Decline | 0 | 0 | IUSPP Annual reports, 1994-99; Tilson, 1979; Choudhury, 1989, 1990; Das *et al*., 2005. (In this Workshop) |
| Kulsi Plantation RF | ~25°50 | ~91°20 | 18.5 | TMD | Habitat destruction (P/Pr/F), | Decline | Decline | 20 | 0 | IUSPP Annual reports, 1994-99 Jenkins, 1987 - Collected on 4 Sep 1920 at 121m. Tilson, 1979; Choudhury, 1989, 1990; Das *et al*., 2005. (In this Workshop) |

**Distribution of *Bunopithecus hoolock hoolock* in Bangladesh and India from literature and recent field studies ... continued**

| Distribution in South Asia | Lat. | Long. | Area (km²) | Habitat | Threats<br>Past, Present, Future | Pop. trend<br>Past %/yr | <br>Future %/yr | Pop. No. | Mat. Ind. | Notes / Sources |
|---|---|---|---|---|---|---|---|---|---|---|
| Kuwasing RF | - | - | 9.9 | TMD | Habitat destruction (P/Pr/F), encroachment (P/Pr/F) | Decline | Decline | 10 | 8 | IUSPP Annual reports, 1994-99 |
| Nellie RF | - | - | - | TMD | - | - | - | - | - | Choudhury, 1987 |
| Pantan RF | - | - | 112.85 | TMD | Habitat destruction (P/Pr/F), encroachment (P/Pr/F) | Decline | Decline | 0 | 0 | IUSPP Annual reports, 1994-99; Tilson, 1979; Choudhury, 1989, 1990; Das *et al*., 2005. (In this Workshop) |
| Ranni RF | - | - | 4.369 | TMD | Habitat destruction (P/Pr/F), encroachment (P/Pr/F) | Decline | Decline | 12 | 10 | IUSPP Annual reports, 1994-99; Choudhury, 1997 |
| Sama RF | - | - | - | TMD | - | - | - | - | - | Choudhury, 1987 |
| *Karbi Anglong* | | | | | | | | | | |
| Amreng RF | 25°43 | 92°60 | 56.9 | TSE | Habitat destruction (P/Pr/F), hunting (P/Pr/F), encroachment (P/Pr/F) | Decline | Decline | 10 | - | IUSPP Annual reports, 1994-99; Tilson, 1979; Choudhury, 1989, 1990; Das *et al*., 2005. (In this Workshop) |
| Amsolong PRF | 26°00 | 93°30 | 1 | TSE | Habitat destruction (P/Pr/F), hunting (P/Pr/F), encroachment (P/Pr/F) | Decline | Decline | 1 | 1 | IUSPP Annual reports, 1994-99 |
| Balasore PRF | 06°30 | 80°20 | 1 | TSE | Habitat destruction (P/Pr/F), hunting (P/Pr/F), encroachment (P/Pr/F) | Decline | Decline | 2 | 2 | IUSPP Annual reports, 1994-99 |
| Bokajan PRF | 26°00 | 93°43 | 9.75 | TSE | Habitat destruction (P/Pr/F), hunting (P/Pr/F), encroachment (P/Pr/F) | Decline | Decline | 5 | - | IUSPP Annual reports, 1994-99; Tilson, 1979; Choudhury, 1989, 1990; Das *et al*., 2005. (In this Workshop) |
| Barjuri PRF | - | - | 214.9 | TWE | Habitat destruction (P/Pr/F), hunting (P/Pr/F), encroachment (P/Pr/F) | Decline | Decline | 0 | 0 | IUSPP Annual reports, 1994-99; Tilson, 1979; Choudhury, 1989, 1990; Das *et al*., 2005. (In this Workshop) |
| Borlander DCRF | - | - | 2 | TSE | Habitat destruction (P/Pr/F), hunting (P/Pr/F), encroachment (P/Pr/F) | Decline | Decline | 5 | 3 | IUSPP Annual reports, 1994-99 |
| Daldali RF | - | - | 123.4 | TSE | Habitat destruction (P/Pr/F), hunting (P/Pr/F), encroachment (P/Pr/F) | Decline | Decline | 15 | - | IUSPP Annual reports, 1994-99; Tilson, 1979; Choudhury, 1989, 1990; Das *et al*., 2005. (In this Workshop) |
| Dhanshiri RF | - | - | 70.4 | TSE | Habitat destruction (P/Pr/F), hunting (P/Pr/F), encroachment (P/Pr/F) | Decline | Decline | 25 | - | IUSPP Annual reports, 1994-99; Tilson, 1979; Choudhury, 1989, 1990; Das *et al*., 2005. (In this |

**Distribution of *Bunopithecus hoolock hoolock* in Bangladesh and India from literature and recent field studies ... continued**

| Distribution in South Asia | Lat. | Long. | Area (km²) | Habitat | Threats Past, Present, Future | Pop. trend Past %/yr | Future %/yr | Pop. No. | Mat. Ind. | Notes / Sources |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | Workshop) |
| Disama RF | - | - | 11.2 | TSE | Habitat destruction (P/Pr/F), hunting (P/Pr/F), encroachment (P/Pr/F) | Decline | Decline | 8 | - | IUSPP Annual reports, 1994-99; Tilson, 1979; Choudhury, 1989, 1990; Das *et al*., 2005. (In this Workshop) |
| Dolamora PRF | - | - | 5.5 | TSE | Habitat destruction (P/Pr/F), hunting (P/Pr/F), encroachment (P/Pr/F) | Decline | Decline | 0 | 0 | IUSPP Annual reports, 1994-99; Tilson, 1979; Choudhury, 1989, 1990; Das *et al*., 2005. (In this Workshop) |
| Englongiri DCRF | - | - | 4 | TSE | Habitat destruction (P/Pr/F), hunting (P/Pr/F), encroachment (P/Pr/F) | Decline | Decline | 2 | 2 | IUSPP Annual reports, 1994-99 |
| Garampani WLS | 26°93 | 93°52 | 1 | TSE | Habitat destruction (P/Pr/F), hunting (P/Pr/F), encroachment (P/Pr/F) | Decline | Decline | - | - | IUSPP Annual reports, 1994-99 |
| Hafjan PRF | - | - | 1 | TSE | Habitat destruction (P/Pr/F), hunting (P/Pr/F), encroachment (P/Pr/F) | Decline | Decline | 1 | 1 | IUSPP Annual reports, 1994-99 |
| Haithapathar DCRF | - | - | 54.4 | TSE | Habitat destruction (P/Pr/F), hunting (P/Pr/F), encroachment (P/Pr/F) | Decline | Decline | 19 | - | IUSPP Annual reports, 1994-99; Tilson, 1979; Choudhury, 1989, 1990; Das *et al*., 2005. (In this Workshop) |
| Jhunthung RF | - | - | 32.5 | TSE | Habitat destruction (P/Pr/F), hunting (P/Pr/F), encroachment (P/Pr/F) | Decline | Decline | 20 | - | IUSPP Annual reports, 1994-99; Tilson, 1979; Choudhury, 1989, 1990; Das *et al*., 2005. (In this Workshop) |
| Kalapahar PRF | - | - | 9.7 | TSE | Habitat destruction (P/Pr/F), hunting (P/Pr/F), encroachment (P/Pr/F) | Decline | Decline | 2 | - | IUSPP Annual reports, 1994-99; Tilson, 1979; Choudhury, 1989, 1990; Das *et al*., 2005. (In this Workshop) |
| Kalioni RF | - | - | 209.8 | TSE | Habitat destruction (P/Pr/F), hunting (P/Pr/F), encroachment (P/Pr/F) | Decline | Decline | 30 | - | IUSPP Annual reports, 1994-99; Tilson, 1979; Choudhury, 1989, 1990; Das *et al*., 2005. (In this Workshop) |
| Koonbamun RF | - | - | 65.5 | TSE | Habitat destruction (P/Pr/F), hunting (P/Pr/F), encroachment (P/Pr/F) | Decline | Decline | 15 | - | IUSPP Annual reports, 1994-99; Tilson, 1979; Choudhury, 1989, 1990; Das *et al*., 2005. (In this Workshop) |

**Distribution of *Bunopithecus hoolock hoolock* in Bangladesh and India from literature and recent field studies ... continued**

| **Distribution in South Asia** | **Lat.** | **Long.** | **Area ($km^2$)** | **Habitat** | **Threats** Past, Present, Future | **Pop. trend** Past %/yr | Future %/yr | **Pop. No.** | **Mat. Ind.** | **Notes / Sources** |
|---|---|---|---|---|---|---|---|---|---|---|
| Langluksho PRF | - | - | 534.7 | TSE | Habitat destruction (P/Pr/F), hunting (P/Pr/F), encroachment (P/Pr/F) | Decline | Decline | 12 | - | IUSPP Annual reports, 1994-99; Tilson, 1979; Choudhury, 1989, 1990; Das *et al*., 2005. (In this Workshop) |
| Longnit DCRF | - | - | 117.6 | TSE | Habitat destruction (P/Pr/F), hunting (P/Pr/F), encroachment (P/Pr/F) | Decline | Decline | 45 | - | IUSPP Annual reports, 1994-99; Tilson, 1979; Choudhury, 1989, 1990; Das *et al*., 2005. (In this Workshop) |
| Mahamaya DCRF | - | - | 5.6 | TSE | Habitat destruction (P/Pr/F), hunting (P/Pr/F), encroachment (P/Pr/F) | Decline | Decline | 5 | - | IUSPP Annual reports, 1994-99; Tilson, 1979; Choudhury, 1989, 1990; Das *et al*., 2005. (In this Workshop) |
| Mikir Hills RF | ~26°25 | ~93°20 | 299.8 | TSE | Habitat destruction (P/Pr/F), hunting (P/Pr/F), encroachment (P/Pr/F) | Decline | Decline | 40 | - | IUSPP Annual reports, 1994-99; Tilson, 1979; Choudhury, 1989, 1990; Das *et al*., 2005. (In this Workshop) |
| Miyungdisa DCRF | - | - | 5 | TSE | Habitat destruction (P/Pr/F), hunting (P/Pr/F), encroachment (P/Pr/F) | Decline | Decline | 3 | 3 | IUSPP Annual reports, 1994-99 |
| Nambor North Block RF | - | - | 5 | TSE | Habitat destruction (P/Pr/F), hunting (P/Pr/F), encroachment (P/Pr/F) | Decline | Decline | 4 | 3 | IUSPP Annual reports, 1994-99 |
| Nambor West Block RF | - | - | 3 | TSE | Habitat destruction (P/Pr/F), hunting (P/Pr/F), encroachment (P/Pr/F) | Decline | Decline | 2 | 2 | IUSPP Annual reports, 1994-99 |
| Patradisha DCRF | - | - | 67.3 | TSE | Habitat destruction (P/Pr/F), hunting (P/Pr/F), encroachment (P/Pr/F) | Decline | Decline | 10 | - | IUSPP Annual reports, 1994-99; Tilson, 1979; Choudhury, 1989, 1990; Das *et al*., 2005. (In this Workshop) |
| Tikok PRF | - | - | 25.9 | TSE | Habitat destruction (P/Pr/F), hunting (P/Pr/F), encroachment (P/Pr/F) | Decline | Decline | 10 | - | IUSPP Annual reports, 1994-99; Tilson, 1979; Choudhury, 1989, 1990; Das *et al*., 2005. (In this Workshop) |
| Umjakani PRF | - | - | 1 | TSE | Habitat destruction (P/Pr/F), hunting (P/Pr/F), encroachment (P/Pr/F) | Decline | Decline | 1 | 1 | IUSPP Annual reports, 1994-99 |
| Western Mikir Hills PRF | - | - | 39.4 | TSE | Habitat destruction (P/Pr/F), hunting (P/Pr/F), encroachment (P/Pr/F) | Decline | Decline | 30 | - | IUSPP Annual reports, 1994-99; Tilson, 1979; Choudhury, 1989, 1990; Das *et al*., 2005. (In this Workshop) |

**Distribution of *Bunopithecus hoolock hoolock* in Bangladesh and India from literature and recent field studies ... continued**

| Distribution in South Asia | Lat. | Long. | Area ($km^2$) | Habitat | Threats Past, Present, Future | Pop. trend Past %/yr | Future %/yr | Pop. No. | Mat. Ind. | Notes / Sources |
|---|---|---|---|---|---|---|---|---|---|---|
| Longai RF | - | - | 131.2 | TSE | Habitat destruction (P/Pr/F), hunting (P/Pr/F), encroachment (P/Pr/F) | Decline | Decline | 45 | - | IUSPP Annual reports, 1994-99; Das *et al.,* 2002a, 2005; Tilson, 1979; Choudhury, 1989, 1990. (In this Workshop) |
| Patharia RF | 24°11 | 24°31 | 76 | TSE | Habitat destruction (P/Pr/F), hunting (P/Pr/F), encroachment (P/Pr/F) | Decline | Decline | 72 | - | IUSPP Annual reports, 1994-99; Das *et al.,* 2002a, 2005; Tilson, 1979; Choudhury, 1989, 1990. (In this Workshop) |
| Singla RF | ~27°02 | ~88°19 | 138.2 | TSE | Habitat destruction (P/Pr/F), hunting (P/Pr/F), encroachment (P/Pr/F) | Decline | Decline | 25 | - | IUSPP Annual reports, 1994-99 Das *et al.,* 2002a, 2005; Tilson, 1979; Choudhury, 1989, 1990. (In this Workshop) |
| *Lakhimpur* | | | | | | | | | | |
| Bara Hapjan | 27°32 | 95°30 | - | - | - | - | - | - | - | 100m. Jenkins, 1987 |
| North Cachar | - | - | 270 | - | - | - | - | 60 | - | Tilson, 1979; Choudhury, 1989, 1990; Das *et al*., 2005. (In this Workshop) |
| Khurriming RF | - | - | 108.4 | TWE | Habitat destruction (P/Pr/F), hunting (P/Pr/F), encroachment (P/Pr/F) | Decline | Decline | 35 | - | IUSPP Annual reports, 1994-99; Tilson, 1979; Choudhury, 1989, 1990; Das *et al*., 2005. (In this Workshop) |
| Langtingmupa RF | 25°30 | 90°07 | 493.4 | TSE | Habitat destruction (P/Pr/F), hunting (P/Pr/F), encroachment (P/Pr/F) | Decline | Decline | 110 | - | IUSPP Annual reports, 1994-99; Tilson, 1979; Choudhury, 1989, 1990; Das *et al*., 2005. (In this Workshop) |
| Panimur PRF | - | - | 1 | STBLH | Habitat destruction (P/Pr/F), hunting (P/F), encroachment (P/Pr/F) | Decline | Decline | 1 | 1 | IUSPP Annual reports, 1994-99 |
| *Tinsukhia* | | | | | | | | | | |
| Bherjan WLS | ~27°30 | ~95°22 | 1 | TWE | Habitat destruction (P/Pr/F), encroachment (P/Pr/F) | Decline | Decline | 1 | 1 | IUSPP Annual reports, 1994-99 |
| Borajan WLS | 27°05 | 95°04 | 4.9 | TSE | Habitat destruction (P/Pr/F), hunting (P/F), encroachment (P/Pr/F) | Decline | Decline | 8 | - | IUSPP Annual reports, 1994-99; Tilson, 1979; Choudhury, 1989, 1990; Das *et al*., 2005. (In this Workshop) |
| Buridehing | 27°13 | 94°42 | 22.8 | TWE | Habitat destruction (P/Pr/F), hunting (P/Pr/F), encroachment (P/Pr/F) | Decline | Decline | 21 | - | IUSPP Annual reports, 1994-99; Tilson, 1979; Choudhury, 1989, |

**Distribution of *Bunopithecus hoolock hoolock* in Bangladesh and India from literature and recent field studies ... continued**

| **Distribution in South Asia** | **Lat.** | **Long.** | **Area (km²)** | **Habitat** | **Threats** Past, Present, Future | **Pop. trend** Past %/yr | Future %/yr | **Pop. No.** | **Mat. Ind.** | **Notes / Sources** |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | 1990; Das *et al*., 2005. (In this Workshop) |
| Dibang Valley RF | ~28°00 | ~95°38 | 35.7 | TWE | Habitat destruction (P/Pr/F), encroachment (P/Pr/F) | Decline | Decline | 13 | - | IUSPP Annual reports, 1994-99; Tilson, 1979; Choudhury, 1989, 1990; Das *et al*., 2005. (In this Workshop) |
| Dibrisoikhowa NP | 27°40 | 95°24 | 765 | TWE | Habitat destruction (P/Pr/F), encroachment (P/Pr/F) | Decline | Decline | 30 | - | IUSPP Annual reports, 1994-99; Tilson, 1979; Choudhury, 1989, 1990; Das *et al*., 2005. (In this Workshop) |
| Hahkhati RF | 27°44 | 95°40 | 6.7 | TWE | Habitat destruction (P/Pr/F), encroachment (P/Pr/F) | Decline | Decline | 3 | 3 | IUSPP Annual reports, 1994-99; Choudhury, 1991 |
| Kakajan RF | 27°29 | 95°39 | 23.46 | TWE | Habitat destruction (P/Pr/F), encroachment (P/Pr/F) | Decline | Decline | 17 | - | IUSPP Annual reports, 1994-99; Tilson, 1979; Choudhury, 1989, 1990; Das *et al*., 2005. (In this Workshop) |
| Kumsang RF | 27°44 | 95°44 | 22.52 | TWE | Habitat destruction (P/Pr/F), encroachment (P/Pr/F) | Decline | Decline | 2 | - | IUSPP Annual reports, 1994-99; Choudhury, 1991; Tilson, 1979; Choudhury, 1989, 1990; Das *et al*., 2005. (In this Workshop) |
| Kundikalia RF | - | - | 72.8 | TWE | Habitat destruction (P/Pr/F), encroachment (P/Pr/F) | Decline | Decline | 25 | - | IUSPP Annual reports, 1994-99; Tilson, 1979; Choudhury, 1989, 1990; Das *et al*., 2005. (In this Workshop) |
| Margharita | 27°17 | 95°41 | - | - | - | - | - | - | - | Jenkins, 1987, collected on 29 Oct 1919 |
| Misaki RF | ~27°42 | ~95°40 | 13.6 | TWE | Habitat destruction (P/Pr/F), encroachment (P/Pr/F) | Decline | Decline | 9 | - | IUSPP Annual reports, 1994-99; Tilson, 1979; Choudhury, 1989, 1990; Das *et al*., 2005. (In this Workshop) |
| Upper Dehring | 27°25 | 95°42 | 131 | TWE | Habitat destruction (P/Pr/F), encroachment (P/Pr/F) | Decline | Decline | 156 | - | IUSPP Annual reports, 1994-99; Tilson, 1979; Choudhury, 1989, 1990; Das *et al*., 2005. (In this Workshop) |

**Distribution of *Bunopithecus hoolock hoolock* in Bangladesh and India from literature and recent field studies ... continued**

| Distribution in South Asia | Lat. | Long. | Area (km²) | Habitat | Threats Past, Present, Future | Pop. trend Past %/yr | Future %/yr | Pop. No. | Mat. Ind. | Notes / Sources |
|---|---|---|---|---|---|---|---|---|---|---|
| **Informations from PHVA for which Districts are unknown** | | | | | | | | | | |
| Digboi East | - | - | 0.7 | - | - | - | - | 3 | - | Tilson, 1979; Choudhury, 1989, 1990; Das *et al*., 2005. (In this Workshop) |
| Digboi West | - | - | 9.3 | - | - | - | - | 7 | - | Tilson, 1979; Choudhury, 1989, 1990; Das *et al*., 2005. (In this Workshop) |
| Kotha | - | - | 10.5 | - | - | - | - | 8 | - | Tilson, 1979; Choudhury, 1989, 1990; Das *et al*., 2005. (In this Workshop) |
| Tengapani (Tinkopani) | - | - | 35.5 | - | - | - | - | 25 | - | Tilson, 1979; Choudhury, 1989, 1990; Das *et al*., 2005. (In this Workshop) |
| Tipong | - | - | 4.5 | - | - | - | - | 7 | - | Tilson, 1979; Choudhury, 1989, 1990; Das *et al*., 2005. (In this Workshop) |
| Tirap | - | - | 44.3 | - | - | - | - | 19 | - | Tilson, 1979; Choudhury, 1989, 1990; Das *et al*., 2005. (In this Workshop) |
| Lower Dehring | - | - | 274.9 | - | - | - | - | 201 | - | Tilson, 1979; Choudhury, 1989, 1990; Das *et al*., 2005. (In this Workshop) |
| Dirak | - | - | 30.5 | - | - | - | - | 19 | - | Tilson, 1979; Choudhury, 1989, 1990; Das *et al*., 2005. (In this Workshop) |
| Dilli | - | - | 30.1 | - | - | - | - | 4 | - | Tilson, 1979; Choudhury, 1989, 1990; Das *et al*., 2005. (In this Workshop) |
| Abhayapuri | - | - | 67.35 | - | - | - | - | 0 | 0 | Tilson, 1979; Choudhury, 1989, 1990; Das *et al*., 2005. (In this Workshop) |
| Dessai Valley | - | - | 174.5 | - | - | - | - | 15 | - | Tilson, 1979; Choudhury, 1989, 1990; Das *et al*., 2005. (In this Workshop) |
| Doboka | - | - | 117.4 | - | - | - | - | 30 | - | Tilson, 1979; Choudhury, 1989, 1990; Das *et al*., 2005. (In this Workshop) |
| Lumding | - | - | 224 | - | - | - | - | 59 | - | Tilson, 1979; Choudhury, 1989, 1990; Das *et al*., 2005. (In this Workshop) |

**Distribution of *Bunopithecus hoolock hoolock* in Bangladesh and India from literature and recent field studies ... continued**

| Distribution in South Asia | Lat. | Long. | Area ($km^2$) | Habitat | Threats Past, Present, Future | Pop. trend Past %/yr | Pop. trend Future %/yr | Pop. No. | Mat. Ind. | Notes / Sources |
|---|---|---|---|---|---|---|---|---|---|---|
| Philobari | - | - | 3 | - | - | - | - | 7 | - | Tilson, 1979; Choudhury, 1989, 1990; Das *et al*., 2005. (In this Workshop) |
| Takowani | - | - | 5 | - | - | - | - | 5 | - | Tilson, 1979; Choudhury, 1989, 1990; Das *et al*., 2005. (In this Workshop) |
| Pengri | - | - | 3.2 | - | - | - | - | 3 | - | Tilson, 1979; Choudhury, 1989, 1990; Das *et al*., 2005. (In this Workshop) |
| Doomdoma | - | - | 28.8 | - | - | - | - | 5 | - | Tilson, 1979; Choudhury, 1989, 1990; Das *et al*., 2005. (In this Workshop) |
| Tarani | - | - | 20.4 | - | - | - | - | 20 | - | Tilson, 1979; Choudhury, 1989, 1990; Das *et al*., 2005. (In this Workshop) |
| Popahanga | - | - | 2.77 | - | - | - | - | 5 | - | Tilson, 1979; Choudhury, 1989, 1990; Das *et al*., 2005. (In this Workshop) |
| Kashumari | - | - | 0.85 | - | - | - | - | 2 | - | Tilson, 1979; Choudhury, 1989, 1990; Das *et al*., 2005. (In this Workshop) |
| Kashumari Part II | - | - | 0.21 | - | - | - | - | 2 | - | Tilson, 1979; Choudhury, 1989, 1990; Das *et al*., 2005. (In this Workshop) |
| Khongkhal | - | - | 2.5 | - | - | - | - | 5 | - | Tilson, 1979; Choudhury, 1989, 1990; Das *et al*., 2005. (In this Workshop) |
| Bagser | - | - | 33.7 | - | - | - | - | 18 | - | Tilson, 1979; Choudhury, 1989, 1990; Das *et al*., 2005. (In this Workshop) |
| Deosur | - | - | 5.7 | - | - | - | - | 7 | - | Tilson, 1979; Choudhury, 1989, 1990; Das *et al*., 2005. (In this Workshop) |
| Kamakhya | - | - | 5.17 | - | - | - | - | 12 | - | Tilson, 1979; Choudhury, 1989, 1990; Das *et al*., 2005. (In this Workshop) |
| Kholahat | - | - | 61.6 | - | - | - | - | 20 | - | Tilson, 1979; Choudhury, 1989, 1990; Das *et al*., 2005. (In this Workshop) |

**Distribution of *Bunopithecus hoolock hoolock* in Bangladesh and India from literature and recent field studies ... continued**

| Distribution in South Asia | Lat. | Long. | Area (km²) | Habitat | Threats<br>Past, Present, Future | Pop. trend<br>Past %/yr | <br>Future %/yr | Pop. No. | Mat. Ind. | Notes / Sources |
|---|---|---|---|---|---|---|---|---|---|---|
| Killing | - | - | 4.5 | - | - | - | - | 3 | - | Tilson, 1979; Choudhury, 1989, 1990; Das *et al*., 2005. (In this Workshop) |
| Kafitoli | - | - | 2.9 | - | - | - | - | 5 | - | Tilson, 1979; Choudhury, 1989, 1990; Das *et al*., 2005. (In this Workshop) |
| Susang | - | - | 26.4 | - | - | - | - | 15 | - | Tilson, 1979; Choudhury, 1989, 1990; Das *et al*., 2005. (In this Workshop) |
| South Diju | - | - | 13.06 | - | - | - | - | 10 | - | Tilson, 1979; Choudhury, 1989, 1990; Das *et al*., 2005. (In this Workshop) |
| North Diju | - | - | 10 | - | - | - | - | 12 | - | Tilson, 1979; Choudhury, 1989, 1990; Das *et al*., 2005. (In this Workshop) |
| Deosur Hill | - | - | 0.6 | - | - | - | - | 2 | - | Tilson, 1979; Choudhury, 1989, 1990; Das *et al*., 2005. (In this Workshop) |
| Upper jiri | - | - | 63.2 | - | - | - | - | 0 | 0 | Tilson, 1979; Choudhury, 1989, 1990; Das *et al*., 2005. (In this Workshop) |
| Choigaon | - | - | 12.9 | - | - | - | - | 2 | - | Tilson, 1979; Choudhury, 1989, 1990; Das *et al*., 2005. (In this Workshop) |
| Bogikhas | - | - | 246.7 | - | - | - | - | 0 | 0 | Tilson, 1979; Choudhury, 1989, 1990; Das *et al*., 2005. (In this Workshop) |
| South Amchang | - | - | 15.5 | - | - | - | - | 18 | - | Tilson, 1979; Choudhury, 1989, 1990; Das *et al*., 2005. (In this Workshop) |
| Rani Garhbhanga | - | - | 43.69 | - | - | - | - | 18 | - | Tilson, 1979; Choudhury, 1989, 1990; Das *et al*., 2005. (In this Workshop) |
| **Manipur** | - | - | - | - | - | - | - | - | - | Gupta, 1994; V. Ramakantha, 1991 |
| *Ukrul Senapathi* | 25°07 | 94°22 | - | - | - | - | - | - | - | Gupta, 1994; V. Ramakantha, 1991 |

**Distribution of *Bunopithecus hoolock hoolock* in Bangladesh and India from literature and recent field studies ... continued**

| Distribution in South Asia | Lat. | Long. | Area (km²) | Habitat | Threats Past, Present, Future | Pop. trend Past %/yr | Pop. trend Future %/yr | Pop. No. | Mat. Ind. | Notes / Sources |
|---|---|---|---|---|---|---|---|---|---|---|
| **Meghalaya** | | | | | | | | | | |
| Garo Hills | - | - | - | - | - | - | - | - | - | Alfred & Sati, 1990 |
| Khasi Hills, | - | - | - | - | - | - | - | - | - | IUSPP Annual reports, 1994-99; |
| Jaintia Hills | - | - | 62 | - | - | - | - | 10 | - | Tilson, 1979 |
| *East Garo hills* | | | | | | | | | | |
| Nokrek NP | - | - | 16 | TMD | Habitat destruction (P/Pr/F), hunting (P/Pr/F), horticulture (P/Pr/F) | Decline | Decline | 25 | - | IUSPP Annual reports, 1994-99; Choudhury, 1991. Also found adjacent to the protected area. W.G. Momin, 2002 |
| West Garo (36 locations) | - | - | 179.5 | - | - | - | - | 130 | - | Tilson, 1979. (In this work shop) |
| Songsek Tasek RF | 25°38 | 90°35 | 28.05 | TMD | Habitat destruction (P/Pr/F), hunting (P/Pr/F), horticulture (P/Pr/F) | Decline | Decline | 18 | - | IUSPP Annual reports, 1994-99 ; Choudhury, 1991 |
| *Ri Bhoi* | | | | | | | | | | |
| Nongkhylem WLS | - | - | 2 | TMD | Encroachment(P/Pr/F), habitat destruction (P/Pr/F) | Decline | Decline | 3 | - | IUSPP Annual reports, 1994-99 |
| *South Garo* | | | | | | | | | | |
| Baghmara RF | - | - | 1 (44) | TMD | Habitat destruction (P/Pr/F), hunting (P/Pr/F) | Decline | Decline | 7 | - | IUSPP Annual reports, 1994-99; Choudhury, 1991 |
| Balpakram NP | - | - | 30 | TMD | Habitat destruction (P/Pr/F), hunting (P/Pr/F), horticulture (P/Pr/F) | Decline | Decline | 15 | - | IUSPP Annual reports, 1994-99; Choudhury, 1991 |
| Rewak RF | - | - | 7 | TMD | Habitat destruction (P/Pr/F), hunting (P/Pr/F), horticulture (P/Pr/F) | Decline | Decline | 2 | 2 | IUSPP Annual reports, 1994-99; Choudhury, 1991 |
| Siju WLS | 25°32 | 90°14 | 5 | TMD | Habitat destruction (P/Pr/F), hunting (P/Pr/F), horticulture (P/Pr/F) | Decline | Decline | 12 | - | IUSPP Annual reports, 1994-99; Choudhury, 1991 |
| Saiphung RF | - | - | 18.2 | - | - | - | - | 14 | - | Tilson, 1979. (In this work shop) |
| **Mizoram** | | | | | | | | | | |
| Mizo Hills | - | - | - | - | - | - | - | - | - | Tilson, 1979 |
| *Champai* | | | | | | | | | | |
| Murlen NP | 23°37 | 93°18 | 231 | TWE | Habitat destruction (P/Pr/F), hunting (P/Pr/F) | Decline | Decline | 16 | - | IUSPP Annual reports, 1994-99; Choudhury, 1991 |
| *Chhintuipui* | | | | | | | | | | |
| Ngengpui RF | - | - | 3 | TWE | Habitat destruction (P/Pr/F), hunting (P/Pr/F) | Decline | Decline | 1 | 1 | IUSPP Annual reports, 1994-99; Choudhury, 1991 |
| Ngengpui WLS | - | - | 10 | TWE | Habitat destruction (P/Pr/F), hunting (P/Pr/F) | Decline | Decline | 3 | - | IUSPP Annual reports, 1994-99; Choudhury, 1991 |
| Phawangpui WLS | - | - | - | - | - | - | - | - | - | Raman *et al*., 1995 |

**Distribution of *Bunopithecus hoolock hoolock* in Bangladesh and India from literature and recent field studies ... continued**

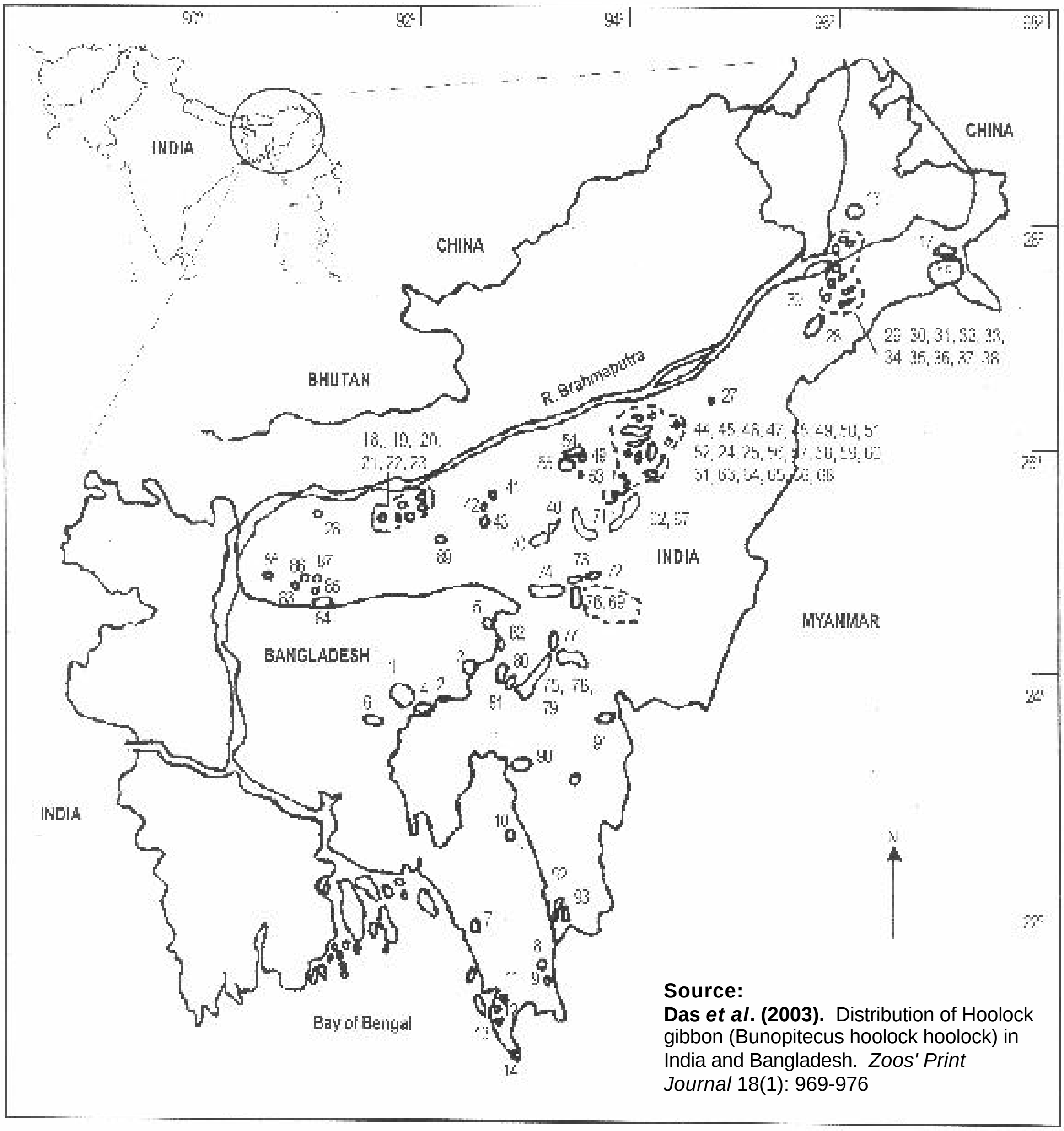
| **Distribution in South Asia** | **Lat.** | **Long.** | **Area (km²)** | **Habitat** | **Threats** Past, Present, Future | **Pop. trend** Past %/yr | Future %/yr | **Pop. No.** | **Mat. Ind.** | **Notes / Sources** |
|---|---|---|---|---|---|---|---|---|---|---|
| Phawngh | - | - | 23.5 | - | - | - | - | 6 | - | - |
| *Mamit* | | | | | | | | | | |
| Dampa WLS | - | - | 2 | TWE | Habitat destruction (P/Pr/F), hunting (P/Pr/F), encroachment (P/Pr/F) | Decline | Decline | 20 | - | IUSPP Annual reports, 1994-99; Choudhury, 1991. (In this Workshop) |
| *Sercchip* | | | | | | | | | | |
| Khaunglung WLS | - | - | 48 | - | - | - | - | 36 | - | (In this Workshop) |
| Tawi WLS | - | - | 156 | - | - | - | - | 22 | - | (In this Workshop) |
| Lengteng WLS | - | - | 73.5 | - | - | - | - | 24 | - | (In this Workshop) |
| **Nagaland** | | | | | | | | | | |
| Khonoma | 25°39 | 94°02 | - | TWE | - | Decline | Decline | - | - | IUSPP Annual reports, 1994-99 |
| Mokokchung | 26°19 | 94°31 | - | - | - | - | - | - | - | Jenkins, 1987, collected on 6 Sep 1919; 15 Sep 1919; 26 Mar 1920 |
| Yuapik | - | - | - | TWE | - | Decline | Decline | - | - | IUSPP Annual reports, 1994-99 |
| *Dimapur* | | | | | | | | | | |
| Itanki NP | - | - | - | - | - | - | - | - | - | State Forest Report, 1988 |
| **Tripura** | | | ~138 | | | | | | | AOO given is for all three districts (North, South & West) |
| *North Tripura* | - | - | - | - | - | - | - | 58 | - | Gupta, 1994; Mukherjee *et al.* 1993; *Das* et al. *2005.* (In this Workshop) |
| Atharamora Hill Range | 23°49 | 91°45 | - | - | - | - | - | - | - | Bhattacharya & Charkrabarty, 1990 |
| *South Tripura* | - | - | - | - | - | - | - | 38 | 19 | Mukherjee *et al*., 1993; Gupta, 1994 |
| Gumti WLS | - | - | 62 | - | - | - | - | 17 | - | J. Bose, IUSPP; Das *et al.* 2005 (In this Workshop) |
| Trishna WLS | - | - | 67 | - | - | - | - | 22 | - | J. Bose, IUSPP; Das *et al.* 2005 (In this Workshop) |

**Distribution of *Bunopithecus hoolock hoolock* in Bangladesh and India from literature and recent field studies ... continued**

| Distribution in South Asia | Lat. | Long. | Area ($km^2$) | Habitat | Threats<br>Past, Present, Future | Pop. trend<br>Past %/yr | <br>Future %/yr | Pop. No. | Mat. Ind. | Notes / Sources |
|---|---|---|---|---|---|---|---|---|---|---|
| *West Tripura* | - | - | - | - | - | - | - | 12 | 4 | Gupta, 1994; Mukherjee *et al*., 1993 |
| Sepahijala WLS | - | - | - | - | - | - | - | - | - | IUSPP Annual reports, 1994-99 |

BLME - Broad-leaf Mixed Evergreen forests, E- Evergreen forest, SE - Semi-evergreen forest, STBLH - Sub-tropical Broadleaved Hill forest, TMD - Tropical Moist Deciduous forests, TSE - Tropical Semi-evergreen forest, TWE - Tropical Wet Evergreen forests

## Distribution of Hoolock Gibbon in India and Bangladesh




**Source:**
**Das *et al*. (2003).** Distribution of Hoolock gibbon (Bunopitecus hoolock hoolock) in India and Bangladesh. *Zoos' Print Journal* 18(1): 969-976

***Distribution of Hoolock Gibbon in India and Bangladesh***

**Bangladesh**
1. West Bhanugach FR
2. Adampur
3. Rajkandhi
4. Horin chara
5. Patharia
6. Shatchari
7. Chunati
8. Satghar
9. Padua
10. Hazarikhil
11. Bhomarighona
12. Ukhia
13. Himchari
14. Teknaf

**India**
15. Namdapha NP
16. Miao RF
17. Kamlang WLS
18. Kuwasingh RF
19. Jorsal RF
20. Rani RF
21. Gorbanga RF
22. Lulshi plantation reserve
23.Pantan RF
24. Nambar RF
25. Panbari RF
26. Moghaghar RF
27. Gibbon WLS
28. Joypur RF
29. Upper Dehing West Block RF
30. Upper Dehing East Block RF
31. Buri Dehing RF
32. Hahkati RF
33. Kakojan RF
34. Kumsang RF
35. Mesaki RF
36. Kundilkalia RF
37. Dibang Valley RF
38. Podumoni-Bherjan-Borajan WLS
39. Dibru-Saikhowa NP
40. Amreng RF
41. Amsolong PRF
42. Balasore PRF
43. Umjakini PRF
44. Mikir Hills RF
45. Kalioni RF
46. Khonbamon RF
47. Nambor North Block RF
48. Nambor West Block RF
49. Jungphung RF
50. Patradisha RF
51. Longnith RF
52. Haithapahar DCRF
53. Mahamaya DCRF
54. Borjuri PRF
55. Western Mikir Hills PRF
56. Lanlakso PRF
57. Kaziranga PRF
58. Dalamora PRF
59. Kalapahar RF
60. Bokajan PRF
61. Tikok PRF
62. Danshiri RF
63. Daldii RF
64. Disama RF
65. Englongari DCRF
66. Miyungdisa DCRF
67. Borlanfer DCRF
68. Hafjan PRF
69. Barail RF
70. Khrumming RF
71. Langting Mupa RF
72. Panimur PRF
73. Barail PRF
74. North Cachar Hills RF
75. Innerlinr RF
76. Barail Rf
77. Katakhal RF
78. Innerline RF
79. Innerline RF
80. Longai RF
81. Singla RF
82. Patharia RF
83. Nokrek NP
84. Balpakram NP
85. Siju WLS
86. Rewak RF
87. Baghmara RF
88. Songsek-Tasek RF
89. Nongkhylem WLS
90. Dampa WLS
91. Murlen NP
92. Nengpui WLS
93. Nengpui RF