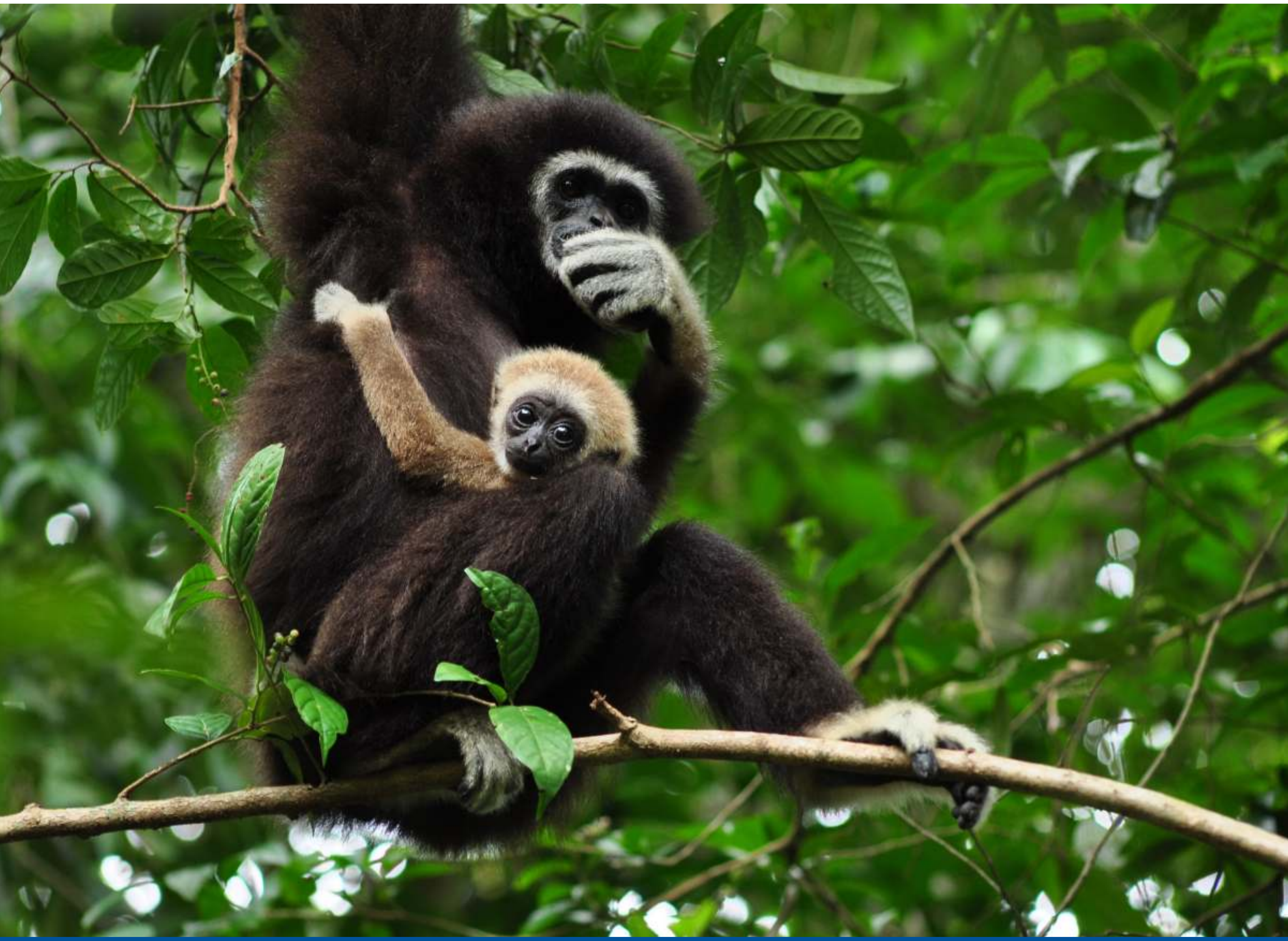
Best Practice Guidelines for the Rehabilitation and Translocation of Gibbons

Clare O. Campbell, Susan M. Cheyne and Benjamin M. Rawson



Occasional Paper of the IUCN Species Survival Commission No. 51

Species Survival Commission

About IUCN

IUCN, International Union for Conservation of Nature, helps the world find pragmatic solutions to our most pressing environment and development challenges.

IUCN's work focuses on valuing and conserving nature, ensuring effective and equitable governance of its use, and deploying nature-based solutions to global challenges in climate, food and development. IUCN supports scientific research, manages field projects all over the world, and brings governments, NGOs, the UN and companies together to develop policy, laws and best practice.

IUCN is the world's oldest and largest global environmental organization, with more than 1,200 government and NGO members and almost 11,000 volunteer experts in some 160 countries. IUCN's work is supported by over 1,000 staff in 45 offices and hundreds of partners in public, NGO and private sectors around the world.

www.iucn.org

IUCN Species Survival Commission

The Species Survival Commission (SSC) is the largest of IUCN's six volunteer commissions with a global membership of 9,000 experts. SSC advises IUCN and its members on the wide range of technical and scientific aspects of species conservation and is dedicated to securing a future for biodiversity. SSC has significant input into the international agreements dealing with biodiversity conservation.

IUCN Species Programme

The IUCN Species Programme supports the activities of the IUCN Species Survival Commission and individual Specialist Groups, as well as implementing global species conservation initiatives. It is an integral part of the IUCN Secretariat and is managed from IUCN's international headquarters in Gland, Switzerland. The Species Programme includes a number of technical units covering Wildlife Trade, the Red List, Freshwater Biodiversity Assessments (all located in Cambridge, UK), and the Global Biodiversity Assessment Initiative (located in Washington DC, USA).

IUCN SSC Primate Specialist Group

The IUCN SSC Primate Specialist Group (PSG) is concerned with the conservation of more than 690 species and subspecies of prosimians, monkeys, and apes. Its particular tasks include carrying out conservation status assessments, the compilation of action plans, making recommendations on taxonomic issues, and publishing information on primates to inform IUCN policy as a whole. The PSG facilitates the exchange of critical information among primatologists and the professional conservation community. The PSG Chairman is Dr. Russell A. Mittermeier, the Deputy Chair is Dr. Anthony B. Rylands, and the Vice Chair for the Section on Small Apes is Dr. Benjamin Rawson.

www.primate-sg.org/

IUCN SSC Reintroduction Specialist Group

The IUCN SSC Reintroduction Specialist Group (RSG) manages a Secretariat and network of global voluntary members and aims to provide reintroduction practitioners with tools such as reintroduction guidelines, networking resources and publications to provide a means for distributing information on reintroduction projects.

www.iucnsscrsg.org

Best Practice Guidelines for the Rehabilitation and Translocation of Gibbons

Clare O. Campbell, Susan M. Cheyne and Benjamin M. Rawson

IUCN
SSC Species Survival Commission
IUCN/SSC PRIMATE Specialist Group
arcus FOUNDATION
RSG Reintroduction Specialist Group
MARGOT MARSH BIODIVERSITY FOUNDATION

Published by: IUCN, Gland, Switzerland

Citation: Campbell, C.O., Cheyne, S.M. and Rawson, B.M. (2015). *Best Practice Guidelines for the Rehabilitation and Translocation of Gibbons*. Gland, Switzerland: IUCN SSC Primate Specialist Group. 56pp.

ISBN: 978-2-8317-1720-3

DOI: 10.2305/IUCN.CH.2015.SSC-OP.51.en

Cover photos: [Front Cover] Wild born gibbon to reintroduced pair at GRP. © Toffee Omyim, GRP.

[Back Cover] Wild *Hylobates albibarbis*. © Bernat Ripoll, OuTrop.

Layout by: Kim Meek, [e-mail] k.meek@mac.com

Available from: http://www.primate-sg.org

Produced by: IUCN SSC Primate Specialist Group Section on Small Apes

Available from: **www.primate-sg.org; www.gibbons.asia**

Funded by: Arcus Foundation and Margot Marsh Biodiversity Foundation

TABLE OF CONTENTS

Acknowledgements 1

Acronyms 2

Foreword 3

Introduction 4

Definition of Terms 6

Feasibility Assessment 7
- General Considerations 8
  - The Precautionary Principle 8
  - Conservation versus Welfare Translocations 8
  - Metapopulation Management 9
  - Funding Sustainability 9
  - CASE STUDY 1: A GLOBAL COOPERATIVE MANAGEMENT PROGRAM FOR JAVAN GIBBONS 10
  - Material Collation 10
- Taxonomic and Genetic Assessment 11
  - Taxonomic flux 11
  - Taxon identification and geographic range 12
  - Genetic screening 13
  - Population Viability 13
- Regulatory Assessment 14
  - Inclusion of local authorities 14
  - Land-use and land-use plans 14
- Release Site Assessment 14
  - Population assessment 15
  - CASE STUDY 2: CARRYING OUT AN ECOLOGICAL SURVEY 16
  - Habitat assessment 17
  - Threat assessment 17
    - Hunting 18
    - Habitat degradation and destruction 18
    - **Social Assessment 19**
- Risk Assessment 20
- Measuring Success 20

Rehabilitation 22
- Health rehabilitation 22
  - Disease tests on arrival 23
    - Essential health screening 23
    - Desirable health screening 23
    - Disease Research 24
- Ongoing health care 24
- Dietary rehabilitation 24
- Behavioural and social rehabilitation 26
  - Human contact/dehabituation 26
  - Stereotypic behaviours 27
  - Behavioural enrichment 27
  - Juvenile groupings 28
  - Pair formation 28

Selection of Candidates for Release 29
  Disease management 29
  Behavioural and psychological assessment 31
  Social structures 32
  Repatriated gibbons 33
    CASE STUDY 3: GIBBON HEPATITIS B VIRUS (GiHBV) 33
    Studbooks 34

Conducting a Conservation Translocation 34
  General considerations 34
    Soft vs. hard release 35
  Release site selection 36
  Pre-release preparation 36
    Site preparation 36
    Acclimatization cages 36
    CASE STUDY 4: POST RELEASE SUPPLEMENTAL FEEDING AND MONITORING 37
    Pre-release disease check 38
    Transportation 38
  Opening the doors 39
    Monitoring the area 39
    Behavioural assessment before release 39
    A note on media and ceremonies 39

Wild to Wild Translocation 39
  Justification and rationale 39
  Capture methods 40
  Health checks 41
  Transport 41
  Human presence at capture and release site 41
  Wild to Wild Translocation Release 41
    CASE STUDY 5: WILD TO WILD TRANSLOCATION 42

Post-release Monitoring 43
  Data collection immediately after releases 43
  When to intervene if something goes wrong? 44
  The role of collars 44
  Documentation – from monitoring to research 45
    CASE STUDY 6: THE USE OF RADIO TELEMETRY COLLARS 45

Post-release Protection 46

Data Sharing 46

The Decision Tree 47

References 50

Occasional Papers of the IUCN Species Survival Commission 54

ACKNOWLEDGEMENTS

We would like to warmly thank the participants of the Reintroduction and Translocation Workshop held in January 2014 in Phnom Penh Cambodia. The active participation and interest in the process and the wide variety of shared experience has driven the development these guidelines. Workshop participants and institutions represented included (in alphabetical order): Anton Ario (Javan Gibbon Centre), Asferi Ardiyanto (Kalaweit), Aurelien Brule (Kalaweit), Ben Rawson (Fauna & Flora International), Clare Campbell (Wildlife Asia), David Chivers (University of Cambridge), Dilip Chetry (Gibbon Conservation Centre), Carl Traeholt (Copenhagen Zoo), Duiying Cui (Beijing Zoo), Edwin Weik (Wildlife Friends Foundation Thailand), Farid Ahsan (University of Chittagong), Florian Magne (HURO Programme), Gabriella Skollar (Gibbon Conservation Center), Holly Thompson (Perth Zoo), Jayanta Das (Wildlife Areas Development and Welfare Trust), Jihosuo Biswas (Primate Research Centre), Kuladeep Roy (Wildlife Trust of India), Made Wedana (Aspinall Foundation), Nguyen Manh Ha (Centre for Natural Resources and Environmental Studies), Nguyen Xuan Dang (Institute of Ecology and Biological Resources), Nick Marx (Wildlife Alliance), Petra Osterberg (Gibbon Rehabilitation Project), Phamon Samphanthamit (Gibbon Rehabilitation Project), Roth Bunthoeun (Forestry Administration), Susan Cheyne (Orangutan Tropical Peatland Project), Yan Lu (Beijing Zoo), Zulfi Arsan (Aspinall Foundation).

The process of drafting the guidelines was an iterative one and relied on reviews from technical experts throughout the process. We would like to thank the following people for their comments including: Aurelien Brule (Kalaweit), Axel Moehrenschlager (IUCN SSC RSG), David Chivers (University of Cambridge), Elizabeth Bennett (WCS), Florian Magne (HURO Programme), Gabriella Skollar (Gibbon Conservation Center), Jane Hopper (Aspinall Foundation), Lynn Baker (American Unievrsity of Nigeria), Marina Kenyon (Endangered Asian Species Trust), Mike Jordan (IUCN SSC RSG), Natasha Lloyd (IUCN SSC RSG), Paolo Martelli (Ocean Park), Petra Osterberg (Gibbon Rehabilitation Project), Susan Lappan (Appalachian State University), Tony King (IUCN SSC RSG), Ulrike Streicher (Wildlife Veterinarian), Warren Brockelman (Mahidol University), Zulfi Arsan (Aspinall Foundation).

We thank Melinda Rostal, EcoHealth Alliance, Sabah Wildlife Department and experts who worked on the Stoplight Assessment which is used in this document.

We would also like to thank David Chivers and Howard Rawson for help in editing of these guidelines.

A special thank you to Tuy Sereivathana for helping with emergency logistics pertaining to the RRT Workshop in Phnom Penh.

The SSA deeply appreciates the ongoing support and advice of Liz Williamson of the IUCN SSC Section on Great Apes as well as the provision of materials for the completion of these guidelines. We also thank the IUCN publications staff, including Deborah Murith and Lynne Labanne.

The Rehabilitation, Reintroduction and Translocation Workshop and the production of this document was financially supported by Arcus Foundation and Margot Marsh Biodiversity Foundation.

ACRONYMS

AZA	American Association of Zoos and Aquariums
CBSG	Conservation Breeding Specialist Group of the IUCN SSC
CITES	Convention on International Trade of Endangered Species
CMV	Cytomegalovirus
DBH	Diameter at Breast Height
DNP	Department of National Parks, Wildlife and Plant Conservation
DTEPSC	The Dao Tien Endangered Primate Species Centre
EAZA	European Association of Zoos and Aquaria
FZS	Frankfurt Zoological Society
GCMP	Global Cooperative Management Programme
GiHBV	Gibbon Hepatitis B Virus
GIS	Geographic Information Systems
GPU	Gibbon Protection Units
GRP	Gibbon Rehabilitation Project
GSMP	Global Species Management Programme
HIV	Human Immunodeficiency Virus
HTLV	Human T-cell Leukaemia Virus
IATA	International Air Transport Association
IUCN	International Union for Conservation of Nature
JGC	Javan Gibbon Center
JPCP	Javan Primates Conservation Programme
JPRC	Javan Primates Rehabilitation Centre
HSV	Herpes Simplex
LAI	Leaf-Area Index
MOT	Mammalian Old Tuberculin
NTFP	Non-timber Forest Product
PASA	Pan African Sanctuary Alliance
PCR	Polymerase Chain Reaction
PHVA	Population and Habitat Viability Assessment
PSG	Primate Specialist Group of the IUCN SSC
RSG	Reintroduction Specialist Group of the IUCN SSC
RNHP	Regional Nature Heritage Program
SIV	Simian Immunodeficiency Virus
SGA	Section on Great Apes of the IUCN SSC
SOCP	Sumatran Orangutan Conservation Program
SSA	Section on Small Apes of the IUCN SSC
SSC	Species Survival Commission of IUCN
STLV	Simian T-cell Leukaemia Virus
TAF	The Aspinall Foundation
TB	Tuberculosis
TOP	The Orangutan Project
WARN	Wildlife Animal Rescue Network
WAZA	World Association of Zoos and Aquariums
WPU	Wildlife Protection Units
WTI	Wildlife Trust of India
ZAA	Zoo and Aquarium Association of Australasia

FOREWORD

It gives me great pleasure to write the foreword for this publication, the first Best Practice Guideline written by the new Primate Specialist Group's Section on Small Apes (SSA). Ultimately, improving in-situ protection and cracking down on the trade in gibbons are key elements for the long-term survival of gibbon species. However, given the large numbers of gibbons in both private hands and rescue centers across the gibbon range and the high level of threat that in-situ populations face, there is clearly great potential for translocations to be an important tool in gibbon conservation. This role for gibbon translocation will likely become increasingly necessary in the future. Repopulating areas where gibbons have been extirpated through reintroduction, reinforcing depleted populations that may no longer be viable, and translocating animals from isolated forest patches to areas where they may be conserved are all approaches that will increasingly be needed.

Some excellent work has already been done in the field of gibbon rehabilitation and translocation. The long-term efforts of the Gibbon Reintroduction Project in Phuket Thailand and work of Kalaweit in Sumatra and Borneo are but two examples, with many more recently established organizations also starting to return confiscated gibbons back to the forests from which they were removed. Initial work in India conducting wild to wild translocations is also instructive for what may become a necessary conservation intervention as gibbon habitats become more fragmented. Pulling together the experience from across organizations, determining what is working and what is not, and spreading the lessons learned is key in pushing forward the thinking about gibbon translocations for conservation. That is exactly what these Best Practice Guidelines for Gibbon Rehabilitation and Translocation are doing.

I congratulate the authors and contributors who have put together a comprehensive overview of the issues and potential solutions to make these guidelines an invaluable tool for those engaged in gibbon rehabilitation and translocation.

Russell A. Mittermeier, Ph.D.
Executive Vice-Chair, Conservation International; and
Chairman, IUCN/SSC Primate Specialist Group

INTRODUCTION

The IUCN Species Survival Commission's (SSC) Primate Specialist Group (PSG) Section on Small Apes (SSA) aims to coordinate gibbon (family Hylobatidae) conservation activities globally. Due to the incredibly high threat that gibbons face throughout their range, translocation can be an important component of conservation efforts given small population sizes, local extirpations and ready availability of gibbons in rescue centres.

Gibbons are recognized as one of the most threatened primate families globally (Melfi, 2013). With 19 species recognized (Mittermeier, et al., 2013), four are listed on the IUCN Red List as Critically Endangered, 13 as Endangered, only one as Vulnerable (IUCN 2013) and one (*Nomascus annamensis*) has not yet been assessed. All species of gibbons are considered to have been in decline over at least the past 30-40 years, primarily due to loss of habitat and the fragmentation of forests, as a result of timber felling, charcoal burning, encroachment cultivation and industrial agricultural expansion (Bleisch & Chen 1990; Nijman & Van Balen 1998; Nijman 2004; Campbell, et al., 2008; Cheyne 2010; Rainer, et al., 2014). Being strictly arboreal, maintenance of habitat quality is of high importance for gibbon persistence and therefore activities that destroy and fragment habitat impact gibbon populations.

Also of considerable concern is the threat posed by hunting, often for the wildlife trade. This has resulted in large numbers of gibbons held in private hands or surrendered to rescue centres across their range. For example, more than 600 gibbons were recorded between 2003 and 2008 in 31 *ex-situ* facilities in western Indonesia alone (Nijman 2005a; Nijman 2005b; Nijman, et al., 2009). This reflects only a tiny proportion of the total number of gibbons held globally that represent potential conservation value through the implementation of well planned, scientifically sound translocation programmes.

Rehabilitation and translocation programmes are increasingly becoming an important component of conservation action plans for threatened species. Translocation can help address gibbon conservation issues by allowing gibbons held in captivity (generally victims of illegal wildlife trade that have at some point been removed from the wild), to be rescued, rehabilitated and then returned to the wild. These translocations may involve releasing gibbons into areas where populations have low long-term viability, thereby reinforcing wild populations and improving the conservation status of the taxon (Kleiman, 1989; Cheyne, 2005; Cheyne, 2009a). Additionally, translocation programmes can provide an opportunity to reestablish populations that have become locally extinct (Komdeur & Deerenberg, 1997); considered as a 'reintroduction' under current IUCN terminology (IUCN SSC 2013; and see Definition of Terms, below).

It should be stressed that all gibbon translocations should have a positive impact on the conservation of the taxon in question or the ecosystem into which the gibbons are released. The IUCN Guidelines for Reintroductions and Other Conservation Translocations (IUCN SSC 2013) state that the principal aim for any conservation translocation should be to yield a measurable conservation benefit at the levels of population, species and ecosystem and not only provide benefit to the translocated individuals themselves. That is, translocations for the sole reason of improved welfare of the individual gibbons, here called welfare-based translocation, are not encouraged unless they also contribute to the conservation of the taxon and/or restoring natural ecosystem functions or processes.

Similarly, the preservation of wild populations and habitat should be considered as a priority over translocation, or considered in an integrated fashion. However, rehabilitation and translocation can play a significant role in supporting wild populations, if released animals present a minimal risk to the recipient ecosystem, have reasonable survival rates and in turn reproduce to benefit wild populations. Such projects may also raise awareness of the plight of these species. It is therefore recognized that translocation is a valid conservation measure for gibbons and one that may increasingly be necessary.

Rehabilitation and translocation of gibbons is a relatively new conservation strategy and, as such, there are very few data published or available for practitioners on the successful translocation of gibbons back into their native habitat. There are however a growing number of programmes across the hylobatid range which are engaged in translocation. Many governments are approving translocation programmes and working closely with non-government organizations to implement these activities as effectively as possible in the absence of taxon specific best practice guidelines and standardized, proven procedures (Yatbantoong, 2007; Cheyne, et al., 2008a; Cheyne, 2009b; Smith, 2010).

It has become increasingly important that the current understanding of effective rehabilitation and translocation approaches are synthesized to provide guidance and scientifically supported backing for future efforts. It is envisaged that the development of guidelines for rehabilitation and translocation will improve the success of programmes undertaking such work and ultimately improve survival probabilities for gibbons involved and the conservation impacts of these translocations. It is also intended that guidelines will aid decision making authorities by providing access to clear documented processes that can assist with the evaluation of translocation programmes.

These guidelines for the translocation of gibbons have been developed in collaboration with stakeholders involved in hylobatid conservation, especially those currently implementing rehabilitation and translocation programmes. The process was initiated during a workshop on Gibbon Rehabilitation, Reintroduction and Translocation, facilitated by the IUCN SSC PSG SSA, in January 2014. Issues were identified with current gibbon translocation efforts. These included: (1) lack of clear guidelines outlining habitat assessment, husbandry and release protocols; (2) lack of available and protected habitat; (3) no standardized post-release monitoring guidelines; (4) inadequate post-release protection strategies; (5) lack of government support in challenging contexts and; (6) lack of a specialized forum for information sharing specific to gibbons.

In response to these challenges, workshop representatives contributed to the development of draft Best Practice Guidelines for the Rehabilitation and Translocation of Gibbons. This was followed by a period of review of the draft guidelines amongst the entire SSA. Subsequently, a period for public comment was initiated, with the guidelines made publically available on the internet and requests to review sent out to general SSC membership. Specific final review and ratification by the IUCN SSC Reintroduction Specialist Group (RSG) was then completed to ensure conformity with guidelines produced by this group.

The result of this process is the current document, *Best Practice Guidelines for the Rehabilitation and Translocation of Gibbons*. This document is based on shared knowledge and experience to date. The guidelines are designed to be a practical and useful document available for all stakeholders, with the aim of equipping field projects and decision makers with the tools for scientifically sound practice in gibbon rehabilitation and translocation. The authors recognize that this is a relatively new science for gibbons and propose that this document undergoes regular review and reassessment of agreed strategies.

These taxon specific guidelines should be used in conjunction with other accepted and rigorous publications and position statements which detail the general principles of captive care and translocation of animals. These include:

- *IUCN Position Statement on Translocation of Living Organisms* (1987)
- *CITES Guidelines for the Disposal of Confiscated Live Species* (1997)
- *IUCN Guidelines for the Prevention of Biodiversity Loss Caused by Alien Invasive Species* (2000)
- *Guidelines for Nonhuman Primate Re-introductions* (2002)
- *IUCN Guidelines for the Placement of Confiscated Animals* (2002)
- *IUCN RSG Reintroductions and other Conservation Translocations Guidelines* (2013)

DEFINITION OF TERMS

There has been considerable discussion over recent years about definitions surrounding reintroductions and translocations (Seddon, et al., 2012). Definitions for terms relating to translocations are now clearly articulated in the *IUCN Guidelines for Reintroductions and other Conservation Translocations* (IUCN SSC, 2013) and these are presented below:

I. **Translocation** *is the human-mediated movement of living organisms from one area, with release in another.*

Note that this can involve either the movement of individuals from wild populations to release sites in wild habitats, or the movement of individuals from captivity to wild habitats. Not all translocations are necessarily conducted for conservation purposes.

II. **Conservation translocation** *is the intentional movement and release of a living organism where the primary objective is a conservation benefit: this will usually comprise improving the conservation status of the focal species locally or globally, and/or restoring natural ecosystem functions or processes.*

Note that this can involve either the movement of individuals from wild populations to release sites in wild habitats, or the movement of individuals from captivity to wild habitats. All conservation translocations are necessarily conducted for conservation purposes.

a. **Population restoration** *is any conservation translocation to within indigenous range, and comprises two activities.*

i. **Reinforcement** *is the intentional movement and release of an organism into an existing population of conspecifics*

ii. **Reintroduction** *is the intentional movement and release of an organism inside its indigenous range from which it has disappeared*.

b. **Conservation introduction** *is the intentional movement and release of an organism outside its indigenous range.*

  i. **Assisted colonization** *is the intentional movement and release of an organism outside its indigenous range to avoid extinction of populations of the focal species.*

  ii. **Ecological replacement** *is the intentional movement and release of an organism outside its indigenous range to perform a specific ecological function.*

Some additional definitions are used throughout this document when discussing rehabilitation and translocations processes and motivations. These include:

III. **Rescue** *is the movement of wild gibbons to mitigate against a hazardous situation or to resolve human-primate conflicts, in an attempt to improve their welfare.*

IV. **Rehabilitation** *is the managed process by which a displaced, sick, injured or orphaned wild gibbon regains the health and skills it requires to function normally and live self-sufficiently.*

V. **Wild to wild translocation** *is the deliberate capture and movement of wild gibbons from one natural habitat to another without bringing the animal into an intermediate holding facility. Note that wild to wild translocations can be further defined under other translocation definitions above, but the term is used here to differentiate these kinds of translocations from captive to wild translocations.*

VI. **Captive to wild translocation** *is the deliberate translocation of a gibbon kept in a captive facility to the wild. Note that captive to wild translocations can be further defined under other translocation definitions above, but the term is used here to differentiate these kinds of translocations from wild to wild translocations.*

VII. **Welfare-based translocation** *is the release of captive gibbons, either within or outside their historic range, where the primary reason for the translocation is the welfare of the animals as opposed to any conservation benefit to the taxon. Such translocations may incidentally have positive or negative conservation impacts.*

In general, these guidelines focus on two most common scenarios for gibbon rehabilitation and translocation. These are:

1. Projects engaged in **captive to wild translocation** generally involving the **rescue** of orphaned or injured gibbons, providing **rehabilitation** to those gibbons and finally conducting a **conservation translocation** of suitable gibbons into a suitable habitat for the purposes of **population restoration** through either **reinforcement** or **reintroduction**.
2. Projects engaged in **wild to wild translocations** involving the movement of wild gibbons from an unsuitable location to a suitable location for the purposes of a **conservation translocation** with a **population restoration** outcome.

We do not discuss **welfare-based translocation** projects in detail within these guidelines as these guidelines recommend that planned translocations should be **conservation translocations**. All projects planning or conducting translocation of gibbons must fully consider and ensure that any translocation has a conservation benefit to the taxon being translocated or acts to restore natural ecosystem functions or processes as a priority. This includes consideration of the impacts of translocation on the viability of the local and global captive population. See Conservation versus Welfare Translocations and Risk Assessment sections for more information.

FEASIBILITY ASSESSMENT

All projects considering conducting a translocation project must explicitly conduct a feasibility assessment before beginning to ensure that the proposed translocation can meet the requirements for a successful translocation. The feasibility of the project will involve the consideration of multiple factors that may impact the success of the translocation. Projects should firstly consider the precautionary principle, that the proposed translocation will have no negative impact on resident gibbons, translocated gibbons, other indigenous taxa or the social integrity of the area in which they are being released. Secondly, projects need to consider the conservation impact that the translocation may have. Specifically, the proposed translocation should have a positive impact on the conservation status of the taxon being translocated and/or the ecosystem to which it is being translocated.

If these general principles can be demonstrated, then more specific feasibility assessments need to be conducted. The individuals slated for translocation need to be appropriately identified to species or sub-species level and the proposed site should be within the distribution range of the taxon. The feasibility of the proposed site for translocation needs to be assessed in terms of whether it contains appropriate habitat for the translocated gibbons and whether it is sufficiently well protected from anthropogenic threats. Projects also need to consider the regulatory environment in which they operate also to ensure that the proposed translocation follows relevant legislation and considers land tenure of the proposed site. A formalized risk assessment should be conducted which takes into account the feasibility assessment and potential actions to mitigate risks identified.

A summary of steps to conduct can be found in the documents Decision Tree.

General Considerations

The Precautionary Principle

The precautionary principle is an approach to decision making in risk management, which justifies preventive measures or policies despite scientific uncertainty about whether detrimental effects will occur. This approach should be taken when planning gibbon translocations, which in the context of these guidelines would mean that projects need to demonstrate that the release has no potentially harmful consequences at the site at which it occurs. More specifically, there is a burden of proof to show that the translocation does not endanger wild gibbon populations by threats of communicable disease, unintended hybridization, extreme social disruption, crowding, resource competition or other impacts. Translocations should also not endanger populations of other interacting indigenous taxa, or the ecological integrity of the area in which they live. The conservation of the taxon as a whole, and of existing viable wild gibbon populations, must take precedence over the welfare of individual apes in captivity. Translocations can also be conducted where the aim is to restore the ecological integrity of an area through reintroduction or reinforcement of gibbons which play an important role in forest ecology as seed dispersers; restoring natural ecosystem functions or processes meets the requirements of a conservation translocation. With this in mind, assessments addressing risks to gibbons, humans, other wildlife and existing ecosystems and habitats at the release site are essential. Such an approach documents issues which may arise and provides clear action points for unintended outcomes (see sections on Risk Assessment and the Decision Tree).

It should also be noted however that gibbon translocation is an experimental science. This document offers advice on current best practice based on examples to date. Alternative methods based on sound justification and accompanied by sufficient risk assessment and monitoring protocols should not be discouraged. Such experimental approaches should implement an adaptive management cycle, including rigorous monitoring, and publish broadly to ensure that lessons learnt feed back into both the project's approach as well as gibbon rehabilitation and translocation more broadly.

Conservation versus Welfare Translocations

To ensure that translocations have a conservation impact translocated gibbons should either; contribute to reinforcing an existing wild population; contribute to establishing a new wild population within the geographic range of the taxon; contribute to restoring natural ecosystem functions or processes. In some instances, reintroduced or reinforced populations may not be viable in the long-term. In such instances additional translocations or ensuring the population is managed as part of a metapopulation is appropriate for addressing viability issues.

In general, translocations defined as Welfare-based Translocations will not meet the requirements of these guidelines in having conservation impact. We briefly consider them here however as some welfare releases of gibbons are being conducted by projects and there is potential overlap between welfare releases and conservation releases. To improve welfare and relieve pressure on rescue centres' holding capacity, non-permanent releases for the purposes of welfare can be considered, but this approach should be conducted in-line with other recommendations in these guidelines to ensure best practice. 'Cage-emptying' simply to accommodate new arrivals should be avoided. Gibbons translocated as part of welfare releases should be considered for inclusion in metapopulation management although it is considered that temporary releases are not ideal as recapturing gibbons could be stressful on the animals.

In a resource constrained environment, increasing scrutiny is being placed on translocation by the welfare, conservation and donor communities to provide evidence that translocation enhances welfare and conservation outcomes. While different donors may have different priorities for funding gibbon work, with some donors for example focusing on welfare aspects, it is important for these projects to have a larger perspective that integrates both welfare and conservation issues. Welfare can be assessed through observing changes in behaviour following change in environmental enrichment, social situation and before and after release (e.g. Cheyne, 2007). Rehabilitation facilities should ultimately be a component of a holistic strategic approach that contributes to the conservation of the species through metapopulation management.

Metapopulation Management

Most gibbon populations are in decline, with increasing fragmentation and limited gene flow between populations. With these declining populations often forming the core of conservation efforts, we must anticipate the need for more integrated species management. Most gibbon rehabilitation and translocation projects have highlighted a lack of availability of large areas of habitat for translocation which illustrates the likely requirement for metapopulation management strategies for some gibbon species in the future. Metapopulation management involves managing a set of interacting populations under a common conservation goal. Its components may include multiple regional populations managed in human care (including in-country breeding programmes), multiple wild populations (including natural, reintroduced and reinforced populations) and even genome resource banks (Byers, et al., 2013).

The science of small population management, developed and generally utilized for managing *ex-situ* populations, is becoming increasingly relevant for the managed conservation of *in-situ* populations (Byers, et al., 2013). The most recent model proposed to facilitate the management and integration of *ex-situ* and *in-situ* populations is the IUCN SSC Conservation Breeding Specialist Group (CBSG) One Plan approach. The One Plan approach involves the joint development of management strategies and conservation actions by all responsible parties for all populations of a species. It aims to establish new partnerships, increase trust between conservationists involved in different management conditions of a species, accelerate the evolution of species planning tools and ensure that intensively managed populations are useful for species conservation (Byers, et al., 2013).

This approach follows previous attempts at such integration under Global Cooperative Management Programs (GCMP). This strategy was applied to Javan gibbons with limited success at integrating wild and captive population management (see Case Study 1). The One Plan approach aims to unite the conservation and action strategies to conserve wild populations with the management of sustainable *ex-situ* populations, resulting in one comprehensive conservation plan for the species.

It is strongly recommended that projects engaging in translocations of gibbons do so in light of consideration of metapopulation management approaches. This entails active engagement with other institutions housing captive gibbons of the same taxon and *in-situ* conservation managers working in areas where wild conspecific gibbons persist. Such networking allows for more explicit understanding of how individual gibbons may contribute to conservation efforts as a whole rather than only considering translocation efforts from the perspective of individual gibbons and individual sites. The ultimate aim of such an approach would be integration of the *in-situ* and *ex-situ* conservation efforts to improve the conservation status of the taxon in question.

Funding Sustainability

Without long-term and sustainable funding and support, conservation translocation projects are unlikely to be viable within the timeframes required for them to be effective conservation strategy. As such, conservation translocation projects should develop clear long-term management plans, which have associated financial projections. While it is appreciated that long-term funding is unlikely to be available over the timeframe required to successfully conduct a comprehensive translocation project that contributes to the conservation of the taxon, long-term financial projections should be conducted in order to assess the possibility that the goal can be delivered before starting. This is not to disparage smaller, dynamic projects, which are unlikely to have core funding to conduct activities, but to include the financial assessment as part of a long-term approach to understand the scope of the project being undertaken and the funding requirements that will have to be met.

To enable projects to secure long-term funding, practitioners need to engage in honest, open and realistic discussions with donors at the planning stage, including the need for projects to maintain 'emergency funds' for unexpected/unforeseen costs. Rational changes during the implementation phase are normal and budgets should contain enough flexibility to accommodate such changes (IUCN SSC, 2013). Key considerations include:

- Project activities and funding sources should be compartmentalized (within an overall master plan), such that if funding for one activity fails, the rest of the project is still viable.
- Identify point people within funding organizations, who can advise on the ongoing goals of funders.
- Communicate more effectively and frequently with donors throughout the relationship to ensure continuity in achieving shared goals even within changing parameters.
- Donor fidelity needs to be discussed when applying for grants; namely, is the grant renewable following successful completion of pre-approved goals?

Material Collation

Before setting out on a translocation project it is important that due diligence is done in collation of existing materials. This document aims to summarize best practice in implementation of rehabilitation and translocation processes however considerable additional information will need to be collated to ensure that projects have sufficient background knowledge to conduct a translocation project.

Examples of what key information is needed include information on the biology and ecology of wild populations (if they exist) of the species targeted for translocation projects. This should be

CASE STUDY 1: A GLOBAL COOPERATIVE MANAGEMENT PROGRAM FOR JAVAN GIBBONS

In 2009, a GCMP for Javan gibbons was born out of a recognized need for improved management of the captive population in order to make a significant and genuine contribution to the conservation of the species. The aim in the programme was to assist in the conservation of the species by:

- Holding an insurance population and/or providing gibbons for release to the wild as part of a managed conservation translocation programme;
- Act as an insurance population in case of catastrophic declines in the wild;
- Conserve high levels of the genetic variability found in wild populations;
- Conserve the behavioural repertoire of the species;
- Support the development and documentation of husbandry techniques for the species;
- Support regional fundraising efforts;
- Provide gibbons for zoo-based research; and,
- Ensure that a captive population persists in zoos for the purposes of educational display and/or fundraising by managing all captive animals as one unit.

Traditionally, as with many captive species, the Javan gibbon had been managed within regional zoo associations rather than globally, although some transfer had occurred between regions. Genetic analysis of regional populations identified this strategy as unsustainable. The GCMP provided the opportunity for the separate regional populations to be managed as one metapopulation, providing the best outcomes for genetic pairings and breeding management.

The GCMP also aimed to provide a tangible link between *ex-situ* management and *in-situ* conservation of Javan gibbons. In situations where both captive and wild populations are small, it makes sense to capitalize on any resources available. The key outcomes of this GCMP were proposed to result in having a protected and sustainable population of wild gibbons and a viable and well managed global captive population. In order to achieve this, it was essential to have commitment from all regional programmes and to operate under agreed values for management.

The World Association of Zoos and Aquariums (WAZA) have recently replaced this framework with the Global Species Management Program (GSMP) which focuses on the inter-regional management of the *ex-situ* population. For the Javan gibbon GSMP, gibbons housed within the JGC and JPRC in Java are gradually entered into the database as resources allow. Some of these gibbons are already forming the founding stock of reintroduced populations in the Mt. Malabar and Mt. Tilu regions of west Java bringing this programme in line with the One Plan approach.

collected or collated from available publications, reports, species action plans and consultations with relevant species experts, including both professional and amateur naturalists. Background biological knowledge should cover aspects such as reproduction, mating systems, social structure and behaviour, physical adaptations, individual growth and development, parental care and population dynamics in indigenous range. Projects should also collect background ecological knowledge including biotic and abiotic habitat requirements, intra-specific variation, adaptations to local ecological conditions, seasonality and plant productivity, dispersal and inter-specific relationships, including feeding, predation, commensalism, symbioses and mutualisms. All information on the species' biology, history of invasiveness in other geographical contexts (including closely related species in the same genus) and known pathogens or parasites should also be investigated. Up-to-date information on the taxonomic status of the taxon should also be sought.

Taxonomic and Genetic Assessment

Taxonomic flux

With the introduction of the Phylogenetic Species Concept into primatology, first proposed by Groves (2001), there has been an increase in the number of described species across the primate order. Increase in the number of taxa has been significant in the Hylobatidae in recent decades, increasing from six recognized species in the 1970s (Groves, 1984) to nineteen recognized in the most recent review (Mittermeier, et al., 2013) (although only sixteen species are recognized in the current IUCN Red List of Threatened Species (IUCN 2013)). This increase in the number of hylobatid taxa has occurred largely by way of elevation of subspecies to species level, aided by both new material and development of genetic assessments. A total of five subspecies of *Hylobates lar* and two subspecies of *Nomascus concolor* are also currently recognized (Mittermeier, et al., 2013). There is a perception by some commentators that taxonomic increase amounts to inflation and is counterproductive, as it results in the production of more conservation units requiring intervention and investment, both of which are already in chronic short supply (e.g. Zachos, 2013). This taxonomic elevation of previously recognized subspecies to full species in the Hylobatidae has considerable implications from the perspective of conservation in general, as well as specifically for translocations, although it has been noted that this may have resulted in additional funding for gibbons being available (Meijaard & Rawson, In Press).

It is not the intention here to assess the relative validity of different species concepts or debate current taxonomy, but rather to provide some guidance about how translocations should proceed within a changing and often challenging taxonomic framework. As a general principle, taxonomy should be appreciated as underpinning our understanding about the diversity of gibbons, and maintenance of this diversity should be the goal of translocations. However, there is no standard recognized taxonomy, with the IUCN Red List only updated sporadically and currently out of date at the time of writing. It should also be noted that to err on the side of caution, when determining minimum conservation units, is an appropriate approach to avoid loss of diversity and, thereby, the level of subspecies (and in some instances populations) is an appropriate guide for determining what translocations are appropriate. Thus, it should be ensured that projects in which translocations are conducted remain up-to-date on taxonomic and distribution changes of the taxon involved, ensuring that gibbons released are of the same species or subspecies to those with which they may come into contact within the release site, or which were previously present at the release site (except in instances of species sympatry or hybrid zones where such contact may occur naturally).

The challenge for translocation practitioners, however, is to know the taxonomic affinity of the gibbons with which they work. The provenance of gibbons in rescue centres is often unknown, and while some taxa are easily distinguishable, others are not. Gibbons must be identified to species, or where appropriate subspecies, level by experts able to determine the individuals taxonomic affinity and where this is not possible, or there is doubt, genetic tests should be conducted or releases should not go ahead. Some materials exist to help identify individuals to species level (e.g. Mootnick, 2006). Detailed maintenance of studbook records and information on individuals' origin should help avoid the issue of introducing hybrid individuals of previously undistinguished taxa that have been permitted to interbreed. If there are any doubts about these taxonomic issues in relation to candidates for reintroduction, then the SSA should be contacted so opinions from geneticists, taxonomist and ecologists can be sought to help guide a decision about whether a translocation should proceed.

Taxon identification and geographic range

In general, gibbons should only be translocated into their indigenous range, that is, within sites which historically had gibbons of the same taxonomic affinity as the release candidate. This is known as Population Restoration. Projects may be limited by which sites they have available for translocation, as well as which gibbons are available and are suitable for translocation, but it must be ensured that the site is within the individuals' historical distribution. Thus, site selection and selection of individuals for translocation need to be considered together. Gibbons found to be an inappropriate taxon for a given translocation programme should, where possible, be repatriated to a suitable rehabilitation centre that may enable their translocation into an appropriate area.

Translocations require projects to determine the taxonomic affinity of the candidate for translocation by an appropriate expert, either based on external morphology or genetic assessments where any doubt exists. Some taxa are particularly hard to differentiate, especially at the subspecies level, and caution is therefore advised. Where taxonomic identification is problematic or at all unclear, the proposed translocation should be postponed until resolution can be found. In some cases DNA assessments may be required prior to release to ensure that due diligence has been performed by the project (see Genetic Screening below). Projects should ensure they are equipped with the most up-to-date information on gibbon taxonomy and distribution, as our understanding is constantly evolving. Where such expertise is not available, projects should contact the IUCN SSC PSG's Section on Small Apes, which will find appropriate expertise to guide projects. Additional support for the identification of gibbons and knowledge of gibbon distributions for government authorities who conduct translocations may represent a high priority in some locations where *ad ho*c translocations are being performed.

In some instances it is possible that individual gibbons will be translocated, based on current understandings of taxonomy and distribution and that, after translocation, information on taxonomy and distribution is refined, resulting in a gibbon having been released outside its indigenous range. Such circumstances appear difficult or impossible to avoid, given the flux in gibbon taxonomy, and should not preclude translocation efforts.

There is currently no guidance on how recently a site should have been part of the species' geographic range to qualify as a release site within the indigenous range (Beck, et al., 2007). The accuracy of information on the presence and taxonomic affinity of gibbons at any site where they were extirpated more than a few decades ago may be unavailable.

In the future it may be necessary in some instances to translocate gibbons into a population of a different taxon in order to reinforce that population. This should only be conducted as a last resort when no other candidates from the taxon to be reinforced are available and there is demonstrated need for genetic management. Such an approach would require extensive consultation, risk assessments and strong scientific backing of the requirement for supplementation.

With accelerating ecological change and an increasing reduction in suitable habitat for some species, it may in future be required to consider the creation of suitable release sites outside the known historic range, providing the absence of other gibbon species and a viability and impact assessment on existing flora and fauna is conducted. Whilst this strategy presents greater risks and is likely to be controversial, it is also expected to be increasingly used in biodiversity conservation (IUCN SSC, 2013). For example, in emergency situations, it may be considered critical to conduct a translocation outside a taxon's indigenous range to save the taxon; defined as a Conservation Introduction with Assisted Colonization (IUCN SSC, 2013). An emergency translocation of a highly threatened species or subspecies outside of their geographic range may be considered in instances where the population faces an acute and unmanageable threat (e.g. warfare, disease outbreak etc.) where catastrophic population decline is known or inferred, but only if no available site exists within their geographic range and where there is no connectivity between the release site and any other site containing gibbons. Moreover, risks to the recipient ecosystem posed by gibbons themselves or diseases and parasites that they could carry, would need to be minimal. This is known as

Assisted Colonization (IUCN SSC 2013). In such instances, it is recommended that the IUCN SSC PSG SSA is consulted and an extensive risk assessment process is undertaken.

In very rare instances, translocation of a species or subspecies into an area outside a taxon's indigenous range may be conducted to restore ecological function to the site that has been lost through the global or regional extinction of another species; defined as a Conservation Introduction with Ecological Replacement (IUCN SSC 2013). This should not occur unless it can be demonstrated that a) the site is unoccupied by native gibbons and there is no connectivity to other areas where native gibbons occur and b) that the ecological function of the empty site has been compromised by virtue of the lack of a previously present gibbon taxon that could be functionally offset through the introduction a different gibbon taxon. Thus, there is a burden of proof on the translocation project for a clear demonstration that ecological function has been compromised because of the extirpation of a taxon that could be functionally replaced through the introduction of gibbons. In such instance it must be demonstrated by the project that no suitable candidates of the appropriate taxon exist (or may realistically exist in the future) for a Reintroduction as opposed to Ecological Replacement. In such instances, it is recommended that the IUCN SSC PSG SSA is consulted and an extensive risk assessment process is undertaken.

Genetic screening

Genetic screening and DNA sampling should be conducted for translocation programmes in cases where species or subspecies morphology is not easily distinguished visually. With reinforcement projects, genetic assessment (for example, karyotyping, calculation of genetic variation, pedigrees) of individuals to be released and of wild populations of the taxon concerned is essential. However, financial constraints and lack of reliable genetic testing in many range countries may preclude testing of all individuals. In such cases, where sufficient doubt exists as to the taxonomic affinity of the individual identified for potential release, translocations of the unscreened gibbon should not occur for reinforcement until the issue is resolved. The SSA can provide technical support to help address these issues.

In some instances it may be appropriate to go further than identifying individuals at the species or subspecies level. Many taxa will have geographically and genetically distinct subpopulations, where subspecific designations have not been broadly accepted (e.g. *Symphalangus syndactylus*). The issue of whether the population level is the appropriate conservation unit for translocated gibbons should be treated with some caution however, balancing the ideal of translocations occurring within the same population and the conservation needs of the taxon. It may be the case that the conservation benefit of cross-population translocations may outweigh potential issues, but explicit consideration of this issue should be made before translocating individuals into a population from which they did not originate.

In general, the project must consider the possibility that the individual gibbon may be translocated into a genetically or geographically distinct population, and in these cases explicit assessment as to whether there may be a more appropriate individual for release, or whether an alternative and appropriate site exists, should be conducted.

Population Viability

If the purpose of translocation efforts is to establish a new population, then it is important to establish that there are sufficient founders to ensure that the population would survive stochastic events (such as a natural disaster) and maintain adequate genetic heterozygosity. Currently, providing an estimation of what constitutes a minimum viable population in a reintroduced gibbon population is not possible, however, in almost all circumstances, sufficient gibbons will not be on hand at any one institution at one time to create a viable population. Meeting the minimum viable population size could be achieved through successive translocation cohorts and/or natural breeding processes and/or ensuring the population is managed as part of a metapopulation. Institutions should make an assessment about the potential opportunities for ongoing future translocations at the chosen site to move towards a population that may be sustainable after translocations are discontinued. Collaboration between institutions conducting reintroductions of the same taxa is recommended to explore opportunities for using the same reintroduction site to address this issue.

Regulatory Assessment

Inclusion of local authorities

Government commitment to any proposed translocation is essential. Depending on the status of a chosen release site, the involvement of local authorities will vary, but each translocation programme will invariably require permission from relevant government agencies. Government policy on translocation may vary and it is important to consider provincial, national and international legislation and regulations to ensure there is a legal basis for translocation and that appropriate permissions are granted prior to proceeding (Beck, et al., 2007).

A translocation programme should involve a close partnership between management authorities at the release site and the implementing party, commonly NGOs. In these instances management authorities are likely legally responsible for ensuring effective protection of the area and its resident wildlife and, therefore, they should be made fully aware of the responsibilities of protection requirements for translocated gibbons and be willing to allocate resources appropriately. In some instances resources, technical capacity and/or will to effectively protect the release site may be lacking by the management authority. In these instances, organizations responsible for the translocation need to assess carefully the appropriateness of the site for translocation or be prepared to support the management authorities to ensure effective protection.

Land-use and land-use plans

Landscapes within which gibbon populations reside are usually in a state of flux, with agricultural expansion, extractive industries and infrastructure developments impacting available habitats and, therefore, distribution and viability of subpopulations. Some surety about the permanence of sites selected for translocation projects should therefore be sought before a translocation occurs to avoid wasted conservation funds and loss of genetic resources. Current and proposed land-use plans for the proposed release site should be explored and discussed with relevant authorities. A release site should provide long-term secure habitat with limited potential for reduction in size, encroachment, infrastructure development or significant change in surrounding area due to these activities.

For example, the Leuser ecosystem in Aceh currently faces significant threat due to proposed changes to the Spatial Plan in this area, while in gibbon habitats within protected areas in Cambodia there have been a series of large-scale, non-transparent, allocations of forested areas for economic land concessions totaling hundreds of thousands of hectares. These examples highlight the need for commitment from governments for long-term protection to secure the integrity of proposed release sites to ensure conservation value and appropriate allocation of resources. In many circumstances, this may not be possible due to lack of transparency in land allocations, corruption, multiple overlapping titles to existing lands, illegal land clearance and lack of access to such documents.

With increasing pressure for economic development, land-use planning rarely favours conservation values, such as habitat protection and ecosystem preservation. Unfortunately, the threat of modification to existing protected area status is a reality. Due diligence requires, however, that the vulnerability of any release site should be thoroughly evaluated, with reasonable assurances of long-term protection.

Release Site Assessment

Selection of an appropriate site is key when planning for translocations (IUCN SSC 2013). Lack of due diligence in this area of planning can result in project failure for a host of reasons. It may also result in more damaging long-term conservation impacts than those to the individual gibbons if translocations are conducted using taxa not native to the area.

In brief, a release site should:

- Meet all biotic and abiotic requirements of the species to be translocated,
- Be protected and have threats controlled or managed,
- Be adequate for all seasonal habitat needs, and

- Be large enough or have suitable connectivity to support a viable population (or metapopulation management strategies are in place).

Due diligence must be undertaken in assessing the site for resident gibbons and assessment of the potential impact of a translocation on any population already existing at the site. Likewise, an assessment of the habitat quality and its ability to sustain any translocated gibbons should be conducted. Care must also be taken to ensure that the reasons for the local declines in that area have ceased or can be addressed. If hunting and/or deforestation were the primary causes of the species becoming extinct in an area, then evidence must be presented to show that the problem has been eliminated or drastically reduced or projects must address these issues before translocating gibbons to the site.

Population assessment

Before a translocation can be conducted at a proposed release site, a population assessment should be conducted to determine whether an existing gibbon population persists there. Sites which have a resident gibbon population require different considerations from those which do not; the former represents population reinforcement while the latter represents a reintroduction. Sites with existing populations need to be assessed as to whether population reinforcement is required for long-term viability of the resident population and, if not, translocations should not occur as the potential risks outweigh the potential benefits (e.g. risks of introducing disease, individuals of a different taxon, conflict etc.). Sites without a resident population need to take into consideration whether translocations can establish a viable population into the long-term.

Detailed population surveys should be conducted in any release site prior to translocation efforts to determine the population status and biology of wild populations (if they exist), as well as other species that may be directly or indirectly impacted by the proposed translocation. As a minimum standard, an assessment of the existing gibbon populations at a release site is essential. Using standard methods for gibbon surveys and monitoring (e.g. Brockelman & Ali, 1987; Brockelman & Srikosamatara, 1993; Cheyne, et al., 2008b; Nijman & Menken 2005; Rawson, et al. 2009; Rawson, 2010; Neilson, et al., 2013 however see *Best Practice Guidelines for Gibbon Surveys and Monitoring* for the newest thinking on this topic), which generally use the loud calls of gibbons, the approximate population size and distribution of existing groups within the release site should be ascertained. Matching distribution data with data from habitat surveys (see Habitat Assessment below) should provide information about potential areas of suitable habitat which are unoccupied and could potentially be used for a translocation. Assessment of potential carrying capacity should also be conducted, which will require data on both habitat availability and species home range requirements ideally from an assessment at the site or by using data from wild conspecifics or closely related heterospecifics in similar habitats (e.g. similar latitude, altitude, forest structure, floristic composition etc.).

If feasible, a Population Viability Analysis (PVA) can assist in identifying significant population variables and in assessing their potential interactions, which would guide long-term population management of a translocated population (IUCN SSC, 2013). Additionally, population modelling can, when coupled with data on the existing population size, demonstrate whether population reinforcement is required. It would also help to determine the required number of founders and potential population management requirements, such as metapopulation management strategies, to ensure future conservation value of both reinforcement and reintroduction projects.

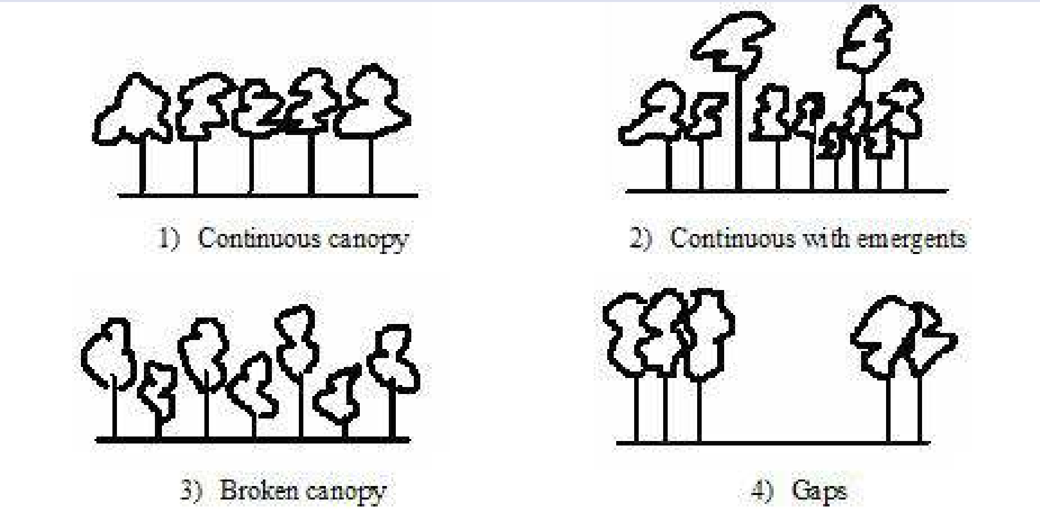
Although not currently an issue for gibbons, the impact of the introduction of exotic primates into the release site of the golden lion tamarin has been documented (Kleiman, 1996). Reportedly, due to the illegal trade in primate species, various primates have been released haphazardly by pet owners, threatening the survival and success of the reintroduced (but native) golden lion tamarins. Although the unplanned release of non-native gibbon species is likely to be limited, the density of other primates should be assessed in the absence of gibbons in regards to their competition for food and their potential capacity as vectors of anthropogenic infectious diseases (Foose & Ballou, 1988; Armstrong, et al., 2003).

CASE STUDY 2: CARRYING OUT AN ECOLOGICAL SURVEY

Ecological surveys can be conducted in a number of ways (e.g. Cheyne 2006; Cheyne, et al., 2008b; Hamard et al., 2010;), however some guidance on approaches has been provided below.

Plots: Measure out fixed plots of 50 x 5 m and measure the following (ideally 4 randomly placed plots should be measured for each 2 km^2 of forest):

- Identify species of all trees over 10 cm dbh (diameter at breast height). Tree size can be measured with a dbh tape measure or a normal tape measure to produce cbh (circumference at breast height) results which can then be converted to dbh ($d = c/\pi$)
- Measure the height of all trees in the plots.
- Determine habitat structure at start, middle and end of each plot using figure below.
- Determine food availability in plot trees (fruit, flowers, young leaves, figs) on a monthly basis using a predetermined scoring system. These surveys should be carried out over a minimum of at least one annual cycle to accurately determine food availability.



1) Continuous canopy

2) Continuous with emergents

3) Broken canopy

4) Gaps

Data analysis: From this the following habitat variables can be calculated:

- Species of trees: this should be compared to available data on what food tree species are consumed by the species of gibbon to be translocated.
- Patterns of food availability: leaves, flowers, fruit and figs phonological cycles assessed over at least one annual cycle to determine what foods are available especially during low fruit months. Gibbons should be able to access food throughout the year. The % of figs or other important/keystone food trees for that gibbon species in the habitat should be assessed.
- Habitat structure: gibbons preferentially use upper and lower canopy trees for daily travel, feeding, social activities and resting and avoid areas with large and frequent gaps in the canopy (Cannon & Leighton, 1996; Kadhafi, 2011; Cheyne, et al., 2013a). Emergents are essential for singing sites and sleeping sites (depending on species; Whitten, 1982; Reichard 1998; Chetry, et al., 2008; Poonjampa, et al., 2010; Cheyne, 2010; Cheyne, et al. 2013b).

An example of this kind of work was carried out to identify spatial characteristics and habitat preference of wild Javan gibbons in Gunung Tilu Nature Reserve, west Java, Indonesia, as part of the site assessment for the conservation and reinforcement of this isolated population proposed by the JPCP of The Aspinall Foundation and the BBKSDA west Java of the Indonesian Ministry of Forestry (Kadhafi 2011).

- Characteristics measured were: tree Diameter at Breast Height (DBH), height of tree, height of first branching, canopy shape, tree profile (tree crown position relative to surrounding trees) at upper and lower canopy and Leaf Area Index (LAI).

- Characteristics identified as positively influencing gibbon habitat preference were:
    - Trees ≥ 49 cm dbh
    - Tree height ≥ 19 m
    - Shape of the canopy – preferential use of trees with irregular crowns and half crown
    - Tree crown position – preferential use of upper and lower canopy and avoidance of emergent and under-storey trees.
    - LAI of 3.2-3.4 (equivalent of canopy cover)

Analysis of site characteristics (altitude, slope, distance from plantations, distance from road and distance from river) resulted in selection of the most suitable forest block for resident gibbons and could be extrapolated using GIS software to identify suitable forest blocks for translocation of other gibbon species. For this particular species and habitat the following variables were preferred by the gibbons at this site:

- More than 221 m from plantations,
- More than 646 m from roads,
- Less than 65 m from river,
- Attitude range from 1024-1093 m a.s.l.,
- Slope ≥ 39%.

Habitat assessment

Habitat assessments are essential to determine if sufficient resources are available to support translocated gibbons. Every effort must be made to find a release habitat that resembles the natural habitat as closely as possible. Even if a site has an existing population, or one that has only recently become locally extinct, a comprehensive assessment is required to ensure that there have been no significant changes in habitat quality. Long-term habitat assessment, both before and after release, can help increase the probable success of a translocation programme (Cheyne, 2006; Cheyne, et al., 2012).

Forest structure and composition should be assessed in potential release sites. Canopy connectivity and density is critical, as is the height, size and presence of specialist trees; for example, dipterocarp abundance has been shown to influence gibbon density (Mather, 1992; Cheyne, et al., 2006). Levels of existing and potential fragmentation should also be identified. The site should be evaluated for suitable food types, water availability and sleeping sites (Abbott, 2000; Cheyne, et al, 2006; Cheyne, et al., 2013b). It is essential that there are enough emergent trees from which gibbons can call (to allow the call to carry) and to afford gibbons protection from predators while they are sleeping (Whitten, 1982; Reichard, 1998; Chetry, et al, 2008; Phoonjampa, et al., 2010; Fan & Jiang, 2010, Cheyne, et al., 2013b). In areas with significant seasonal variation in fruiting, surveys should be conducted over a period of time that allows a complete cyclical/annual assessment of food availability. This should be assessed in parallel with existing knowledge of the ecology of the species to be translocated. It should be ensured that the release site is within the altitudinal range of the species of gibbon taxon introduced.

Threat assessment

In order for translocation efforts to be successful, it is critical that the cause of the threats faced by these species and their habitats, currently and historically, are thoroughly understood (Nijman, et al., 2009). The primary threats to the majority of gibbon populations are undoubtedly loss of habitat and hunting. As populations decline, the effects of threats from hunting, such as the illegal pet trade, and use of primates in traditional medicine, also become more important (Cowlishaw & Dunbar, 2000; Nijman, et al., 2009). The illegal trade of gibbons can have a drastic effect on already small populations, with, most often, reproductively viable adults killed in the process of obtaining infant gibbons for trade. An understanding of the socioeconomic status, human activities, cultural beliefs and overall security of the site provides useful information for planning of strategies to mitigate any threats and develop the need for various approaches such as law enforcement and environmental education.

Hunting

Gibbons are protected under national laws in all range states and all are listed on the Convention on International Trade of Endangered Species (CITES). Despite this, gibbons are commonly hunted for food, traditional medicine, the pet trade and, in some instances, sport and are also illegally traded across international borders. Because of the significant impact that hunting can have on gibbon populations, research must be conducted into the degree of threat that hunting may pose to translocated gibbons. This is most appropriately assessed through interviews conducted with local communities living in and around the site chosen for translocation. Of course, the likelihood of accurate reporting by local communities must also be taken into account, as areas where the awareness of the illegality of hunting is high is likely to result in under-reporting of the severity of hunting threat.

Likewise, since gibbons may not be a preferred species for hunting in many areas and, therefore, threat may be perceived to be low, gibbons are however often hunted opportunistically. For example, in 2012, a translocated Javan gibbon was shot and killed by a hunter believed to be in the area targeting other species, such as wild pigs. Similarly, two reintroduced gibbons in GRP were lost to poachers in 2006 and 2008 respectively. In both cases the hunters were believed to have been non-locals who entered the forest to hunt opportunistically (Osterberg pers. comm. 2014 and Punnadee pers. comm. 2006).

Human-gibbon conflict should also be considered as a possible issue for translocation projects. While human-gibbon conflict is likely to be less of an issue for gibbons than some great ape species, there are recorded instances where translocated gibbons and humans come into contact and gibbons behave unpredictably and act with hostility. For example, gibbons reintroduced onto uninhabited islands as part of the GRP translocations in the 1990s had conflicts with visiting tourists and fishermen (Osterberg pers. comm. 2014). In the rehabilitation phase it is critical that the gibbons become indifferent to humans; otherwise, they are potential targets for hunters or may cause conflict with local residents.

Understanding the prevalence of hunting, and the drivers for its occurrence, are key pieces of information. They will help determine whether a site is considered safe for translocation and how hunting threats can be addressed prior to translocation, if they are sufficiently high to preclude immediate translocation. If there is a reasonable threat that translocated gibbons may be hunted, then a translocation should not be continued until the threats have been addressed. Addressing hunting threats is likely to be a difficult undertaking, since cultural norms, poverty, trade linkages and ineffective enforcement have to be addressed if efforts are to be successful. Thus, responsibilities in translocation projects for addressing these long-term issues to ensure a hunting-free area for placement of gibbons must not be taken lightly. Significant and long-term investment is probably required in enforcement and education efforts. In some instances, working with authorities to set-up designated protection units to protect translocated gibbons may be necessary.

Habitat degradation and destruction

Processes impacting habitat quality are of particular concern for the long-term viability of resident gibbon populations. Selective logging, whether commercial or illegal, can alter the carrying capacity of an area, displacing gibbons causing increased intergroup contacts and conflicts, increased stress and mortality (especially in infants) and other negative effects (Rainer, et al., 2014). Thus, an understanding of current logging practices, including an indication of volumes, species targeted and their probable use by gibbons as feeding, calling or sleeping trees and hot spots of activity, should be taken into account when choosing a translocation location. Fuel wood collection is another potential impact on gibbon habitat and, if considerable fuel wood is being extracted by local communities for sale or local consumption, additional research and, potentially, mitigation strategies should be put into place.

Destroyed and degraded gibbon habitat. © HURO Programme

Habitat destruction is also a common occurrence in forested areas, whether through large-scale conversion for industrial agriculture or small-scale agricultural conversion by local communities. Understanding large-scale land-use pattern change, as in industrial agriculture, is addressed above (see section on land-use and land-use plans) and involves ensuring an understanding of planned land-use change. Understanding the relative threat that small-scale agriculture poses to a translocation project involves discussion with local communities and relevant government authorities to understand land allocation and tenure, and in some instances, land-grabbing, processes at the local level. Remote sensing of habitat change, using a time-series approach may reveal patterns and trends in habitat loss due to this process. Threats from forest fires may also pose a threat to gibbons and, although these may be difficult to predict and address, assessing the relative threat and potentially putting into place early-warning systems through one of the several online real-time fire-alert systems may be appropriate.

Social Assessment

Local community acceptance and understanding is imperative to the success of translocation programmes. These communities can play an important role in the project, potentially as salaried employees engaged in protection and monitoring activities, linking conservation and livelihoods. Using ex-poachers as patrollers is a common strategy and can be very effective. Initial assessment of community attitudes and behaviours can assist in developing appropriate education and socialization programmes. Ongoing environmental education activities can help build a sense of partnership between gibbon translocation projects and local communities. For example, GRP's long-term presence on Phuket and regular events, such as school visits and events and leaflet and poster distribution, have ensured that the project is well known and understood. Similarly, Kalaweit runs a local radio and television programme to raise awareness and get buy-in for conservation efforts, including handing-in of pet gibbons.

There should also be some evaluation of the impact of any translocation programme on resident communities, including costs and benefits to local human populations. Such programmes may restrict previous activities of local communities and, therefore, understanding these potential impacts and collaboratively developing ways of mitigating them (e.g. conservation agreements, alternative livelihoods, employment opportunities) is an important consideration. Ideally, conservation efforts should be combined with/or include long-term developments projects, such as community water management, long-term agriculture development, agroforestry development, creation of employment and healthcare support. For example, the HURO Programme supports local people through secular and free comprehensive primary education and facilities. Where this is beyond the means of the project, partnering with development organizations may be effective.

In many cases, unclear and/or unmarked protected area boundaries, limited knowledge regarding laws and regulations and economic incentives facilitate local community participation in illegal logging, encroachment and hunting, activities which pose potential threat to translocation programmes. Identifying and mitigating these issues may be important for developing a successful translocation programme.

Risk Assessment

Risk assessments are detailed management plans. Any translocation may fail to deliver desired results or have unintended consequences. The probability of achieving desired results is favoured by early identification of the risk factors that might be encountered across all aspects of the translocation (IUCN SSC 2013). Risk is assessed as the likelihood of any risk factor occurring, combined with the severity of its impact. The range of possible risks comprises the 'risk landscape'. In each project risks should be assessed at all stages, i.e. what may occur under various circumstances and consider all the likely permutations across the whole scope of activities and attempt to develop contingencies. Having the basic background, biological and ecological knowledge is key to determining what is not known, and identifying areas where more management may be needed (see Material Collation section for examples of knowledge needed).

Of particular importance is the setting of risk thresholds, i.e. at what point do we say the identified threat is too high and translocation should not continue? We advocate the following criteria be assessed to determine thresholds the project is willing to accept:

- The tenure of the release site (e.g. protected area, watershed forest, community forest) is appropriate from a legislative perspective for translocation.
- The release site is sufficiently protected from threats likely to impact gibbons, including, but not limited to, hunting, logging, extraction of NTFPs, land encroachment and conversion, and infrastructure development (roads, dams, power lines etc).
- Habitat at the site is capable of maintaining the translocated gibbons' needs for food and species appropriate behaviours.
- Relevant local authorities are aware of and engaged in the translocation process.
- Local communities are aware of the translocation and their perspectives and attitudes have been assessed and found to be sufficiently supportive.
- Risks of disease transfer from reintroduced gibbons to any resident gibbon population, other species' populations, or humans, are assessed and deemed to be of negligible threat relative to the conservation value of the translocation.

The risk assessment should take into account all sources of uncertainty and apply them at an appropriate spatial scale. In the case of translocations outside indigenous range, the risk assessment should include predictions of range expansion over various time periods.

The risk assessment should take the form of a formal document which specifically identifies all risks and suggests mitigation measures and potential impacts if risks cannot be mitigated. Details of the content of the risk categories to be considered are detailed in the IUCN *Guidelines for Reintroductions and Other Conservation Translocations* (IUCN SSC 2013) and should be used to guide a risk assessment for any translocation.

Measuring Success

The measurement of success of a translocation programme is essential, not only to ensure that the significant resources expended result in some positive conservation outcome, but also in terms of securing ongoing financial and government support for such programmes. Ultimately, the primary reason for translocation effort should be for conservation benefits to accrue at the levels of population, ' and ecosystem (IUCN SSC 2013) and, therefore, success should be measured against such criteria. Still, what exactly constitutes 'success' has been debated, with the long-term time scales required for positive conservation outcomes to be realized making success difficult to quantify (King, et al., 2012; Trayford & Farmer, 2012).

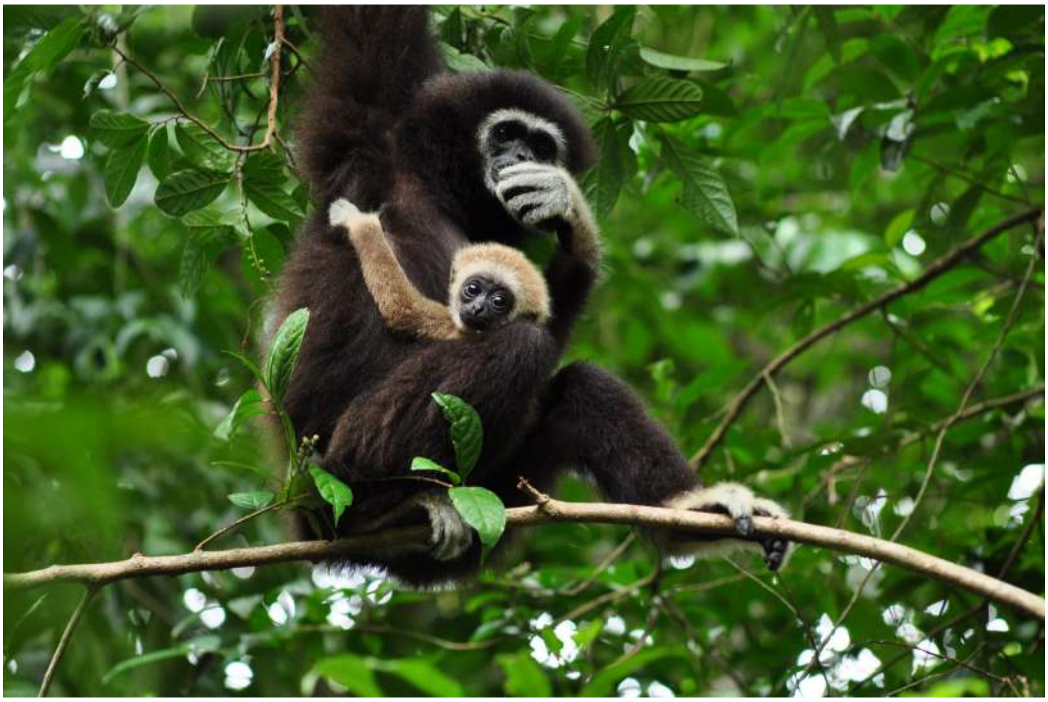
Determination of success must include the rationale for undertaking the translocation programme. Explicit goals (species- and site-specific) should be identified early in the project planning process, with measurable targets identified. The goals should include proposed numbers of gibbons to be translocated and the time scales for the translocation(s), an expected survival rate and anticipated time frame before reproduction. As post-release monitoring is essential in tracking these indictors, the goals should also include appropriate protocols to ensure that this information can be gathered.

In the short term, success is likely to be measured as survival and reproductive rates in translocated gibbons being roughly equivalent to their wild conspecifics (e.g. King, et al., 2012). Translocated gibbons will need to be able to survive through seasonal cycles of food availability, effectively finding appropriate food to avoid malnutrition and starvation. They will also need to behave appropriately to avoid predation and injury in the new environment. Singing, copulation and ultimately births should also be an indicator that the released gibbons have formed effective pair bonds. Monitoring of demographic events, such as births and deaths, copulations and general body condition of translocated gibbons may provide good indicators of immediate post-release success.

If the purpose in the translocation project is for the enhancement of the conservation of the species, then it must ultimately also be measured by the reproduction and survival of offspring from reintroduced gibbons. Whilst a self-sustaining population would indicate success (Fischer & Lindenmayer, 2000; Custance, et al., 2002), this is not an immediate requirement, as intensive population management by regular reinforcement or metapopulation management could also result in a viable population. Failures should be acknowledged, but measured against overall success. For example, survival rate may be low, but if this is sufficient to maintain or grow a population then this would constitute success. Ultimately, long-term success can be defined as the translocated gibbons breeding and producing viable offspring and contributing to a self-sustaining population.

Conducting a PVA to determine the probable trajectory of the population and the timeframe and number of gibbons required to bring the population to a self-sustaining level can be a useful process in making assumptions explicit. Of particular use would be the comparison of required releases to meet the goal of a self-sustaining population compared with the availability of gibbons for release and the likely carrying capacity of the site. Population modeling can also be a useful tool in measuring long-term success of a release project (e.g. King et al. 2014).

Generally, survival rates are measured in comparison to those of wild conspecifics (Kleiman, et al., 1991; Wimberger, et al., 2010; King, et al., 2012; Guy, et al., 2012). In long-lived species, such as gibbons, however, obtaining accurate estimates of demographic parameters can be challenging (King, et al., 2012). Although not yet quantified in the long term, the expected survival rate of translocated gibbons should take into consideration a decrease in survival skills related to the history of any given gibbon. In many cases, gibbons available for translocation have been hunted from the wild as dependent infants or juveniles and subsequently housed in captivity, resulting in a lack of learned survival skills. Whilst wild gibbon mortality rates can be used to determine likelihood



A successfully raised wild born gibbon to translocated parents in Phuket. © GRP of survival, it should reasonably be accepted that translocated gibbons may have comparatively increased mortality rates.

Evaluation and comparison of survival and reproduction rates in a translocated population allows for development of a population model to predict the probability of population persistence and, thereby, provide an indication of longer-term translocation success (King, et al., 2014). Examples of reproductive success in translocated gibbons are limited, but the Gibbon Rehabilitation Project (GRP) in Phuket has, as of May 2014, had 12 gibbons born within their release site and reported that both the age at first reproduction and the interbirth interval was comparable to wild gibbons (Osterberg, pers. comm). As one of the longest running translocation projects for gibbons, GRP has been able to measure success, with gibbons surviving 12 years post-release, maintaining pair bonds and raising wild born babies across two generations. Finally, all translocations should attempt to create self-sustaining *in-situ* populations, indistinguishable from their wild counterparts.

REHABILITATION

At the most basic level, all gibbons housed in rescue and rehabilitation facilities should undergo a level of health, dietary, behavioural and social rehabilitation that will address individual welfare. For potential translocation candidates this process should be such that it will optimise their suitability for translocation and release.

Health rehabilitation

Gibbons should undergo extensive medical testing on arrival at a centre, as well as throughout their stay, to ensure that diseases are not transmitted to other captive gibbons nor transferred to wild populations via release programmes. No gibbon can be completely free of microorganisms or parasites and, as such, disease risk assessment should be conducted in the planning stage and reviewed periodically (IUCN SSC 2013). Quarantine and biosecurity measures should be implemented at all levels of operation ensuring disease control within facilities and between facilities and the outside environment.

Best practice recommends:

- A specific and separate quarantine area for new arrivals.
- Separate housing for long-term healthy gibbons.
- Separate housing for sick residents demonstrating symptoms of disease, e.g. tuberculosis (TB), retroviruses etc. removed from resident healthy gibbons and quarantine areas.
- Contacts with humans should be kept to a minimum to avoid disease transfer.
- Use of gloves and masks are required and eye shields, boots and footbaths are a recommended means of preventing disease transfer, especially in quarantine areas or those areas with sick gibbons.
- Staff should be screened for TB at least once each year as TB is endemic in the human population in many areas where gibbons are found. In cases of suspected TB in gibbons, use of standard surgical masks is insufficient; N95 masks are recommended.
- Staff in contact with gibbons should be screened and treated for infectious diseases, such as tuberculosis and Hepatitis B.
- Staff showing symptoms of illness should not be in contact with gibbons or other staff. These include, but are not restricted to diarrhoea, stomach ache, urine infections, skin diseases, open wounds, respiratory symptoms etc.
- Infectious waste should be dealt with safely to ensure no risk of contamination.

Disease tests on arrival

As a start, the information below should be used as a minimum requirement for adequate health care and treatment.

Essential health screening

- Physical examination (including is it eating and moving appropriately, include dental/ are teeth clipped, tracheal exam, eyes, nails, bones, coat condition, check for bullets, deformities, dehydration, diarrhoea, respiratory difficulties, general condition).
- General blood profile (haematology and biochemistry).
- Faecal parasite screening—faecal examination: direct analysis, Baerman analysis, sedimentation tests floatation analysis to look for gastrointestinal parasites, such as strongyloidis, whipworms, roundworm eggs or larvae, tapeworm segment/eggs, liver flukes ntamoeba, balantidium, trichomonas and giardia. An amoeba culture and sensitivity for pathogenic bacteria; for example, *Salmonella*, *Shigella, Campylobacter* etc. This should also be carried out after the gibbons have been released.
- Tuberculosis testing: *M. tuberculosis* is carried in airborne particles, known as droplet nuclei that can be generated when persons/primates with pulmonary or laryngeal tuberculosis sneeze, cough, speak, or sing. The particles are so small (1-5 microns) that normal air currents keep them airborne and can spread them throughout a room or building. Infection occurs when a susceptible person inhales droplet nuclei containing *M. tuberculosis*, and bacilli become established in the alveoli of the lungs and spread throughout the body. Tuberculosis is a human disease that can cause significant mortality and morbidity in gibbons and other primates. Accurate diagnosis of this disease is difficult and every effort should be taken to ensure that captive primates, especially those destined for translocation, are free of this disease. Standard screening for TB ideally involves the use of Mammalian Old Tuberculin (MOT) and Avian Tuberculin on both eyelids, with three consecutive readings taken at 24, 48 and 72 hr, repeated three times during the quarantine period at 2-week intervals. These should show negative results, otherwise further investigation is required (e.g. Culture, PCR). SAT PAK Rapid test, blood testing, radiographs, culture and *polymerase chain reaction (PCR)* can also be used, depending on the level of risk and presence of clinical signs (see also Lécu & Ball, 2011).

Desirable health screening

- Hepatitis B profile (HBV)—serology for HBVsAb and HBVsAg: a gibbon-specific strain of HBV has been identified in both wild and captive populations of various gibbon species. It is yet to be determined if the disease causes long-term pathology, as seen in human infection with the human strain of HBV (hepatocellular carcinoma, cirrhosis), but elevated liver enzymes have been seen in a number of HBV infected gibbons. A significant proportion of the captive population of Javan gibbons is infected with the virus, which has been shown to be spread vertically and horizontally. While horizontal transmission often results in recovery and subsequent immunity, vertical transmission has a high likelihood of creating a carrier state. Vaccination has proven to be a successful means of reducing disease transmission. The risk of zoonosis from gibbon HBV is still unclear, but suspected not to be an issue for gibbon to human transmission (Grethe, et al., 2000; Noppornpanth, et al., 2003; Payne, 2004). Ideally, positive gibbons should be held separately from negative gibbons, unless they have been vaccinated. Any HBV gibbons recommended for potential release should have their virus sequenced to confirm that it is indeed a gibbon strain native to the proposed release site. This can be done using faecal samples, but issues remain with accuracy of in-country tests, complexities of exporting samples for testing and costs of tests (Arsan, pers. comm. 2014).
- Hepatitis A and C virus should also be screened for.

- Herpes Simplex (HSV1 & HSV2): test for anti-HSV1 and anti-HSV2 antibodies. Gibbons can be infected with HSV without showing clinical symptoms (Mootnick, et al., 1998). Once the symptoms do manifest, often triggered by an intense period of stress, the onset of cortical neuronal necrosis and degeneration is rapid and irreversible. The current recommendation is not to release gibbons shown to be infected with HSV (Mootnick, et al., 1998).

Disease Research

Other testing should be performed as determined by the local situation. The following *should* be considered if there is a risk of the disease being present in the area around the sanctuary/centre:

Malaria, trypanosomiasis (sleeping sickness), filariasis (dengue fever), strongyloides (producing strongyloidiasis—often the most frequent cause of death in captive gibbons (De Paoli & Johnsen, 1978), balantidium, polio, human immunodeficiency virus/simian immunodeficiency virus (HIV/SIV), simian retrovirus (SRV), cytomegalovirus (CMV), Varicella, Epstein-Barr virus, enteroviruses, flaviviruses, foamy viruses, human T-cell leukaemia virus/simian T-cell leukaemia virus (HTLV/STLV), measles, rabies, monkeypox and toxoplasmosis.

There have been many cases of diabetes diagnosed in captive gibbons which is potentially exercise/diet related, but also may have a genetic basis and, therefore, may also be prevalent in the wild population (Campbell, pers. obs. 2014). Monitoring and treatment is important to control diabetes and it would not be recommended to release gibbons with this condition.

Genetic material can be collected in the form of 2ml or more of EDTA blood in ethanol or frozen. NB. Collection from deceased specimens also advised, ideally ½-1cm tissue sample stored in ethanol or frozen.

Ongoing health care

Where detailed parasite screening cannot be performed, routine de-worming should be carried out every 3 months, using drugs such as *ivermectin* and *fenbendazole,* but beware of over-worming as gibbons must develop immunity to parasites they will encounter in the wild. There is also some risk of developing resistance to treatment with prolonged drug use.

Dietary rehabilitation

Wild gibbons consume up to 125 different species of food, including fruit (ripe and unripe), leaves (young), flowers, insects, seeds and nuts (Fan, et al,. 2009; Cheyne, 2010: Kim, et al,. 2010). Their diet varies with season and food availability and species consumed can range from 4/month to 50/month depending on season. Thus, it is essential that the gibbons have a varied and nutritionally suitable diet, in order to maintain their health and to encourage them to eat as wide a variety of food as they would in the wild. Where rehabilitation projects operate on a large scale, the use of local produce can assist in sustaining the local economy and encourage the community to participate in the conservation of the gibbons and their habitat.

Some rescued individuals may have been fed a diet which comprises inappropriate foods (such as rice) for long periods of time. In such instances a transition diet, where preferred inappropriate foods are phased out in favour of a natural diet, may be needed. In these circumstances, the impact of multiple stressors should be considered and the diet adjusted slowly, especially if the previous diet is vastly different to that being transitioned to. When gibbons are malnourished it is recommended that more frequent but smaller feeds are provided along with supplements to assist with the improvement of health and condition.

Manufactured pellets are available on the market, but they should be used with due consideration and we would recommend against over-reliance on pellets for gibbons intended for translocation. In these gibbons, a natural diet is preferred, but care needs to be taken to ensure that the diet is balanced and provides sufficient protein, energy and nutrient content and as such they may be used as a supplement. For gibbons that can not be released, pellets may represent a suitable alternative where natural foods are not available. However, pellets can be difficult and expensive to obtain and may not be able to be stored suitably in many rehabilitation centres to maintain optimal quality and longevity.

Captive raised gibbons must be taught to drink water as they would in the wild; that is, by dipping their hand into a water source and licking the water as it drips off their hair (Cheyne, pers. obs. 2004). Many gibbons will have been used to drinking out of a bottle or cup and may have trouble adapting to the new method, so observers should look out for signs of dehydration. The water can be dispensed automatically through a series of pipes, into an open container, into which the gibbons can easily dip their hands. As the gibbon becomes more adept at this drinking method, the containers can be made smaller and less accessible to mimic the difficulties of locating water sources in the wild.

Feeding routines should minimise the number of times gibbons have contact with humans each day, but also with the aim to mimic normal feeding regimes. In the wild gibbons eat more frequently than captive facilities can accommodate, thus, providing browse is of high importance, as gibbons in the wild will often 'snack' on vegetation. Feeding regimes should be non-invasive and feeding should occur off the ground to avoid unnatural terrestrial behaviours. Gibbons are not fastidious feeders and drop a lot of food which generally falls on the floor of the cage, encouraging gibbons to come down to retrieve dropped items. Wild gibbons do not come down to the ground to retrieve food and captive-housed gibbons should be discouraged from doing so in a captive setting by, for example, having mesh enclosures elevated off the ground to prevent this habit (Cheyne, et al,. 2012).

Water vessel that mimics natural water sources. © GRP.

Enclosure with elevated floor. © GRP.

Behavioural and social rehabilitation

Human contact/dehabituation

Gibbons have large canines and can sometimes be very aggressive towards humans and unfamiliar gibbons, especially when they reach maturity. Gibbons intended for release should have minimal contact with humans, not only to reduce the risk of human injury, but also to reduce the risk of zoonotic disease (both human to gibbon and gibbon to human). Minimal human contact is also essential to reduce human dependence and discourage association with people, to ensure that translocated gibbons display natural gibbon behaviours and are not drawn to human settlements.

A reduction in human contact is best achieved by implementing strategic feeding regimes and delivery of food remotely and by locating rehabilitation enclosures away from visual and auditory contact with humans. Ideally, the gibbons will only come into contact with humans for feeding and veterinary checks. Caregivers should be as consistent as resources will allow and wear uniforms that distinguish them from other humans that the gibbons may encounter. Caregivers should also behave in a way that does not encourage communication or physical contact from the gibbons.

A rehabilitated gibbon should not display the following behaviours in the presence of humans:

- Sexual presentation towards human's e.g. bobbing, presentation of genitals. Note: some of these signs can be very subtle and what may appear as soliciting play can quickly advance to sexual behavior.
- Masturbation towards humans.
- Direct aggression e.g. open mouth threat; shaking the chain-link bars of the enclosure or material in the enclosure; grabbing people aggressively; trying to bite or actually biting; aggressive calls in the presence of humans, or alarm calls; mooning.
- Calling/singing as an answer to human talking or human presence.
- Soliciting grooming or contact from humans e.g. initiating interactions with people, such as grooming and holding hands.
- Stereotypic behavior such as banging, head shaking, twitching, swinging back and forth at the same location, rocking and self-mutilation.

The presence of these behaviours should not permanently preclude gibbons from translocation but further rehabilitation would be required before they could be considered for release. In general,

Rehabilitated gibbons should not show certain behaviours such as mooning (pictured) © Susan M. Cheyne.

gibbons should not show extra interest in humans and should not stop social activities with other gibbons (e.g. grooming and singing) in the presence of humans. Gibbons should ideally demonstrate a lack of interest in humans. Aggression can be positive when an adult gibbon displays to defend their family if he/she otherwise does not pay much attention to humans; but aggression is also often seen in many very humanized, hand-raised gibbons that have a disturbed relationship with humans. These gibbons may become extremely (provocatively) aggressive at maturity. Direct aggression toward humans is problematic in a candidate for release as wild gibbons are not usually aggressive toward humans. A fear response is appropriate, but aggression, particularly severe aggression, may put both the gibbon and local people at risk, and is likely to interfere with post-release monitoring.

Stereotypic behaviours

Stereotypic behaviours indicate a behavioural response to a psychological stressor and can manifest in a variety of ways from repetitive rocking to self-harming (Cheyne, 2007). Reducing stereotypic behaviours is an important part of the rehabilitation process prior to translocation. While some behaviours, such as self-harming, will preclude an individual from translocation, it should be noted that some will not. It is not possible to be prescriptive as to which behaviours preclude translocation, but in general it is expected that the aim will be to reduce the severity and frequency of such behaviours and to assess their likelihood of impacting the candidate. When identifying individuals for potential translocation, their level of stereotypic behaviour should be assessed and the individual's responses to the mitigation measures put into place monitored. Approaches to reduce such behaviours may include:

- Housing the candidate with other gibbons.
- Minimizing human interaction (although in some cases increased human interactions/ reassurance can improve behaviours depending on individuals and their backgrounds).
- Ensuring enclosures are complex.
- Providing stimulating environmental enrichment.
- Providing stimulating behavioural enrichment.
- Finding a balance between frequency of feeding and human interaction.
- Food delivery practices that mimic wild feeding (i.e. never on the ground, minimal human contact, appropriate timing).

Behavioural enrichment

A sufficiently natural environment should be provided in cages/semi-wild enclosures, so the gibbons can exhibit natural behaviours as much as possible, as this will enable reliable observations to be made as to an individual's suitability for translocation. The most obvious approach is to fill enclosures with objects that will encourage the gibbon to brachiate and practice balance; for example, branches, swinging tyres and ropes. Branches facilitate the expression of species typical activities (Reinhardt & Smith, 1988) which in the case of gibbons are brachiating, swinging and perching. PVC pipes or bamboo can be used as alternatives to branches (Reinhardt & Smith, 1988) and hessian sacks can also be hung to provide sleeping sites (Dickie, 1994). The best type of manipulative object is one that responds to the gibbons' actions with unpredictable actions of its own (Carlstead, et al., 1991). For example, a hanging tyre, which swings unpredictably when the gibbon lands on it, is a good source of enrichment. Hebert and Bard (2000) have compiled a list of environmental enrichment that has been shown to result in positive behavioural changes in primates, including but not limited to:

- Dense bamboo structures.
- Uprooted trees.
- Novel objects.
- Food puzzles.
- Swings.
- Objects to manipulate/carry.

In a rehabilitation setting, where human contact is ideally minimized, providing other forms of behavioural enrichment can be challenging. Feeding strategies should provide optimal stimulation and encourage wild behaviours. Deciding on an appropriate feeding regime is critical, but there will probably need to be some compromise between reducing human contact and feeding at a frequency that most closely resembles wild feeding patterns. Food should never be provided at ground level and ideally should be scattered and hidden at height. Feeding devices such as those used in the zoo environment can be useful but require constant rotation to ensure the 'challenge' function remains.

Changes in behavior should be noted to determine whether enrichment strategies are having the desired effect on the gibbons. It should also be noted that the stability and composition of the pair/group (in the case of the socialization cages) may influence these behaviours more than aspects of the physical environment.

Juvenile groupings

Socialization of captive-raised gibbons of all ages is fundamental to their behavioural development and successful rehabilitation. There is evidence that both males and females can be adversely affected by long periods of social separation and lack of physical contact (Mootnick & Nadler, 1997; Cheyne, 2007). Wild adult gibbons rarely adopt non-kin, but there are some examples of success from captivity (Campbell, pers. obs. 2014), generally involving pairing juveniles with adult females, and also from translocated groups (Osterberg, pers. comm. 2014). One option is to place young gibbons with other youngsters, in the hope that they can learn from each other. The suggested maximum for such a juvenile group is ten individuals, depending on species, ranging in ages from 3–5 years old, although the composition is harder to predict and should be based on the compatibility of the individual gibbons. The theory behind this is that primates placed in a rehabilitation situation at a young age will not only copy the actions of others, but will also learn from them (Shumaker, et al., 1998). The 'peer-raising' approach has been shown to work with infant gorillas in the Congo (Courage, pers. comm. 2005), as well as with infant orangutans in the Wanariset Orangutan Reintroduction Centre, Kalimantan, Indonesia (Commitante, pers. comm. 2004). At the Gibbon Rehabilitation Project on Phuket several, now adult, peer-raised lar gibbons have successfully established pair bonds, bred and adjusted to the wild after translocation (Osterberg, pers. comm. 2014).

Pair formation

Most gibbons will sing, even if not raised by their parents, but the structure of gibbon song is such that practice is needed for the individual gibbon to develop their individual song. Young gibbons may sing, but will often sing an exact copy of the song of other gibbons in the rescue centre, sometimes even singing the opposite sex element of the duet. It is essential that young gibbons develop the individual elements which will allow them to duet, defend a territory and communicate information about themselves as individuals (Raemaekers & Raemaekers 1984; Geissmann, 1991; Geissmann, 1999; Geissmann & Orgeldinger 2000; Geissmann, et al., 2005; Geissmann & Nijman 2006; Cheyne, et al., 2007; Wanelik, et al., 2013). Singing is an instinct, duetting and producing an individual song repertoire needs to be learned.

In order to determine whether a pre-release gibbon will accept another gibbon as a mate and is capable of learning how to duet and mate, they must be housed in pairs. It is sometimes possible to determine to whom an individual gibbon is directing their singing, which can help facilitate successful pair formation in captivity (with the exception of *Hylobates moloch* and *Hylobates klossii*). Using the directionality and timing of the singing can help determine which individuals are calling together (from different enclosures) and this can help indicate which individuals may make a good pair. Since pairing gibbons can be complicated and has a risk of injury, using the gibbons' own singing to form pairs may help alleviate some of the risks and lead to more successful pair formation.

There are two approaches to pairing adults in the same cage:

Slow approach. This is recommended for particularly difficult gibbons; for example, gibbons with a strong attachment to humans, highly territorial individuals and those particularly fearful of conspecifics. Gibbons have the capacity to cause each other a great deal of harm and full-scale aggression will occur very quickly after introducing individuals if they are not compatible. Gibbons can be slowly acclimatized to each other by placing them in nearby enclosures to allow auditory contact followed by visual and then tactile contact e.g. place the gibbons in equal sized neighbouring enclosures with small mesh on the common wall and assess reactions of both individuals over the coming days. This method of introduction may help to acclimatize the fearful gibbon to the presence of another gibbon and provide the necessary learning opportunity without the stress of full contact with the conspecific.

Quick approach. For gibbons with no severe behavioural limitations, placing them immediately together into neutral territory can force them to adapt to the new conditions quickly. Encountering strange conspecifics initiates a fast learning experience for the gibbons concerned and forces them to use their natural instincts much more than the slow approach. This method should be used with extreme caution, as there is the potential for life-threatening injuries to occur.

There are several common reactions when new gibbons are paired:

- The gibbons attack either immediately after being introduced or when conflicts over access to food or sleeping sites occur.
- There is no direct physical aggression, but the interactions between the gibbons remain antagonistic. This is resolved when the female becomes pregnant.
- The gibbons do not fight, yet over time no positive interactions develop (e.g. grooming, playing or singing).
- The gibbons do not fight and mating behaviours develop over time.

Clearly, if there is any sign of aggression the gibbons must be separated immediately and the introduction strategy reviewed. In situations where there are a limited number of gibbons available for pairing there have been examples where perseverance with a seemingly incompatible pair have been successful (Campbell, pers. obs.).

Successfully paired gibbons should be permitted to hear but not see other gibbons. Duetting of paired gibbons is an important aspect of pair bonding and, thus, the stimulus of hearing other gibbons call may help develop this behavior and allow the pair to learn what other gibbons sound like and how to respond. Forming strong pair bonds before release may reduce the stress of finding a mate once they are translocated, facilitating an easier transition to the wild. It is also essential in reducing social turbulence/fighting and loss of lives when conducting consecutive releases into an existing population.

SELECTION OF CANDIDATES FOR RELEASE

The IUCN Guidelines for the Placement of Confiscated Animals (IUCN SSC, 2002b) outline three options for disposition of confiscated, rescued or repatriated apes: maintain in captivity for the remainder of the apes' lives, return to the wild, or euthanasia (where local religion does not preclude this option). Gibbon rehabilitation facilities should be familiar with these guidelines and consider them when assessing the suitability of gibbons for release.

As there are significant numbers of wild-born gibbons of many species currently housed within rehabilitation centres, and numerous examples of wild-born ex-pet gibbons surviving after release, there would need to be sound justification for breeding gibbons in captivity specifically for the purpose of a conservation translocation, unless the gibbon was born to parents already part of a rehabilitation programme. If other captive-born gibbons were to offer genetic enhancement of the reintroduced population, increase public awareness and political support, then breeding should be assessed on a case-by-case basis.

Disease management

A critical element of translocation of any species is the risk analysis of potential disease transmission between primates, between humans and primates and between primates and other species.

Sound quarantine protocols and veterinary management should be controlled throughout the rehabilitation phase with preventative medicine and pre-release screening. Ideally, qualified veterinarians, vet technicians or vet nurses are involved in the selection of suitable individuals for translocation.

Introduction of diseases into existing primate populations through translocation efforts has the potential to counteract the conservation value of such programmes, placing at risk conspecifics and even other species. Acknowledging that our understanding of diseases in wild gibbon populations is relatively poor, we must consider that primates can act as reservoirs for human pathogens and vice versa.

Clearly defined veterinary protocols should be implemented upon completion or adoption of a risk analysis. As this can be costly, and in some cases a lengthy process, this element should be incorporated into translocation planning and financial management. A risk analysis framework such as the Stoplight Hazard Analysis outlined below should be applied to ensure that gibbons considered suitable for translocation are free of pathogens that pose a risk to existing populations or significantly reduce the likelihood of survival of the released gibbons.

Release of gibbons with chronic viruses should depend on the prevalence of that virus in wild populations and the severity of morbidity caused by the virus (as several lifelong infections are persistently though sporadically shed over time).

In addition, the gibbons should be in sound general health and free from physical abnormalities that may hinder their ability to survive. Gibbons with any physical or behavioural condition that would inhibit their locomotor, feeding, defence or reproductive abilities should not be considered for conservation translocation. For example, blindness, missing limbs, deformities, partial or full paralysis, brain damage and post-reproductive age would preclude an individual from translocation. Gibbons should also be free of any atypical phenotypes that are likely to have a genetic basis.

In the case of parasites, infestation of release candidates should be assessed according to known presence and abundance in wild populations noting that parasite abundance can be dependent on seasonal variation. Wild gibbons carry between 6-10 concurrent parasites. The release of parasite free gibbons is not recommended, as this may lead to acute parasitism and clinical disease upon translocation (Kenyon, 2007; Beck, et al., 2007).

Whilst established protocols certainly exist in most regional zoo associations for the management of primates in captive facilities, they do not as yet exist for the movement of primates for the purpose of translocation. It should be reinforced that quarantine procedures and staff health and safely procedures are especially important during this phase, as the potential for transmission of diseases is increased with repeated contact and stressful conditions (Beck, et al., 2007).

A Stoplight Hazard Analysis provides a useful risk analysis framework, which can assess the susceptibility of the population, routes of transmission, severity of infection, likelihood of spread and other environmental concerns (see also; Armstrong, et al., 2003; Jakob-Hoff, et al. 2014). The intended application of the stoplight hazard analysis is that every pathogen in the high risk (red) category should be carefully analyzed, as should those deemed amber. Qualitative rank or quantitative probabilities should be assigned in a consistent and standardized manner so that useful comparisons can be made.

In the following example, only qualitative analyses have been conducted and it is important to note that the numbers presented are only for assistance in comparing disease risk between pathogens. Until sufficient data is acquired, it should be considered that red pathogens are high risk, amber pathogens are all of medium risk and it is likely that all green pathogens are of low risk. For any risk assessment it is important to be transparent in the ranking methodologies used to develop such that the reader can understand the potential uses and limitations of such a document.

This disease list is based on diseases reported in or assayed for in wild, rehabilitating or confiscated gibbons (inclusive of all species/subspecies) from the published literature. This example is intended as rough guide only for policy decisions on what disease surveillance will be most appropriate and it should be considered a living document to be updated on a regular basis as

Table 1. Stoplight Hazard Analysis of disease risk for reintroduced gibbons

Pathogen	Likely Prevalence in Wild	Transmission Route Risk	Risk of Transmission to Wild Gibbons	Morbidity	Severity	Risk of Fatality	Total Score
Mycobacterium spp. (tuberculosis)*	1.3	4.3	3.7	4.0	4.3	4.3	21.9
Plasmodium hylobati	2.8	4.0	4.0	2.8	2.6	2.2	18.4
Ternidens spp	1.8	3.3	2.3	2.3	2.8	2.3	14.8
Trichuris spp	2.3	3.0	2.5	2.5	2.3	2.0	14.6
Strongyloides fuelleborni	2.2	3.0	2.0	2.3	2.7	2.2	14.4
Brugia malayi	1.6	2.8	2.8	2.2	2.4	2.2	14.0
Brugia pahangi	1.8	2.8	2.8	2.2	2.2	2.0	13.8
Human herpes virus 1	1.0	3.0	2.0	2.0	3.0	2.6	13.6
Hepatitis b virus	3.3	3.0	2.2	2.0	1.6	1.4	13.5
Human herpes virus 4	1.3	3.0	2.2	2.7	2.2	1.8	13.2
Cercopithecine herpes virus 5	1.5	3.2	1.8	2.5	2.3	1.8	13.1
Balantidium coli	1.6	2.1	1.9	2.1	2.8	2.4	12.9
Lymphocryptovirus spp	1.7	2.8	2.2	2.2	2.0	1.8	12.7
Necator spp	1.8	2.3	1.3	2.3	2.5	2.0	12.2
Human herpes virus 2	1.0	2.8	1.5	2.2	2.4	2.2	12.1
Ascaris spp	2.1	2.1	1.7	2.1	2.3	1.7	12.0
Parastrongylus cantonensis	1.3	2.5	1.8	1.3	2.3	2.0	11.1
Cryptosporidium spp	1.3	1.8	1.5	1.8	2.0	1.7	10.1
Trichostrongylus spp	1.3	2.3	1.7	1.7	2.0	1.0	10.0
Simian foamy virus	1.6	2.2	1.6	1.8	1.2	1.0	9.4

our understanding of pathogenic agents in gibbons improves. The IUCN SSC PSG SSA Veterinary advisory group can be consulted for the most up-to-date information to be applied to gibbon assessments.

Behavioural and psychological assessment

Gibbons selected for translocation should be displaying behaviours necessary for survival and reproduction in the wild. These would include effective brachiation, preferential use of the upper level of the enclosure, a preference for wild fruit and foliage and maintenance of positive pair associations (i.e. grooming, playing, singing and copulation (Cheyne, et al., 2008a; Smith, 2010; Cheyne, et al., 2012)). Gibbons should have the ability to detect and avoid threats (e.g. appropriate alarm calling upon detection of predators), should be physically and sexually mature (unless a geriatric/sub-adult/juvenile/infant is included as part of a group) and should ideally be part of a well-bonded pair or family unit, or in the case of individual release, have demonstrated positive social interaction with another gibbon.

Stereotypic behaviour is relatively common in ex-captive gibbons that have been confined in inappropriate conditions for a period of time. With adequate housing and social interaction with other gibbons, these behaviours can generally be modified prior to release, but in extreme cases they may be permanent. Such stereotypic behaviour may not preclude selection, except in cases of self-harm or where the behaviour inhibits key survival skills highlighted previously. Gibbons selected for release should also show minimal habituation towards people; this should form a critical element of the rehabilitation process. Table 1 (Cheyne, et al., 2008a) provides criteria for assessing the suitability of gibbons for translocation based on case studies of eight different wild gibbon species.

Table 2. Criteria for assessing the suitability of gibbons for release.

Proposed criteria for assessing suitability of gibbons for release		**Behaviour of wild gibbons**
The gibbon should be able to move around the enclosure well and most of this movement should be by brachiation.		Gibbons spend 20–75% of travel time brachiating (Fleagle, 1976; Gittins, 1979; Cheyne, 2010).
No more than 5% of time spent on the ground for any purpose. Gibbons should be at the top of the enclosure for at least 40% of the time and should never be sleeping on the ground.		Gibbons spend 50–65% of their time in the upper and emergent canopy (Gittins, 1983; Cheyne, et al., 2008a; Fan & Jiang, 2008; Cheyne, 2010; Phoonjampa, et al., 2010) and have never been seen sleeping on the ground.
The pair should be spending at least 7% of total activity time in positive pair association defined as physical proximity and/or non-aggressive physical contact. At least 3% of total activity time should be spent allogrooming.		The cohesion of the pair is important for territorial defence and successful raising of offspring (Tenaza, 1975; MacKinnon & MacKinnon, 1977; Gittins, 1979; Fischer & Geissmann, 1990).
The pair should be singing and/or duetting regularly.		The duet/song is the main behaviour that gibbons use to advertise their bond and territory (Raemaekers & Raemaekers, 1984).
They should be copulating successfully and each member of the pair should be able to initiate successful copulation with the other.		Such copulation proves that the gibbons are sexually mature and active (Chivers, 1978; Cheyne & Chivers, 2006; Barelli, et al., 2007).
Activity budgets should approximate those of wild conspecifics in all major categories i.e. feeding, resting and travelling. Changes in these activity budgets pre- and post-release are to be expected.		To allow gibbons to survive once reintroduced their behaviour must mimic that of wild gibbons (Cheyne & Brulé, 2004; Cheyne, et al., 2007; Cheyne, et al., 2008a).
No more than 3% of total activity time should be engaged in a severe stereotypic behaviour such as rocking or self-harm.		Stereotypic behaviours are a product of captivity (Berkson, 1967; Berkson, 1968; Mason & Berkson, 1975; Cheyne, 2007).

Social structures

The generally accepted release strategy for gibbons is to be released in well-bonded pairs, replicating a natural social structure and eliminating an additional stressor of having to seek out mates and independently establish or defend territories. Based on experience to date this strategy would appear to have greater success than when gibbons have been released as individuals (Yatbantoong, 2007; Smith, 2010), but this is also an option under certain circumstances (Cheyne & Brulé, 2004). During the 22 years the GRP Phuket has been reintroducing gibbons they have experimented with releasing various social compositions including juvenile groups, families and pairs. Whilst the majority have survived many did not stay together or become wild. Those that have successfully adjusted to the wild and bred (and by now some of them have lived in the wild for up to 12 years) have been reintroduced in families with offspring, or as individuals into a social opening. Translocation of families has been key in establishing the reintroduced population that now exists on Phuket however GRP plans to renew attempts at releasing pairs with suitable post release monitoring methods in place (Osterberg, pers. comm. 2014). Some consideration has been given to the release of multiple pairs simultaneously into the same area of forest, though at time of writing this has not been tested.

Whilst gibbons may appear to bond with their mate in captivity, this may represent a behavioural compromise and, when presented with other options upon release, the pair will potentially

CASE STUDY 3: GIBBON HEPATITIS B VIRUS (GiHBV)

In 2010 attempts were made to repatriate a Javan gibbon from Perth Zoo, Australia to the Javan Gibbon Centre for eventual translocation as part of the GCMP. The gibbon had been determined medically and behaviourally suitable for transfer and translocation, but it was a known carrier of Gibbon Hepatitis B Virus (GiHBV).

The Hepatitis B Virus occurs in both human and non-human primates. Species-specific strains have been identified in many non-human primates, including gorillas, orangutans and gibbons, which, although closely related to the human genotypes, are genetically distinct. These primate-specific strains are thought to have separated from the human strain more than 6,000 years ago, perhaps even 20 million years, and thus ***do not*** represent a recent transmission from humans. To date, transmission between humans and gibbons has not been documented.

A gibbon-specific Hepatitis B Virus genotype has been found in at least six species of gibbons (*Hylobates moloch, H. lar, H. pileatus, Nomascus concolor, N. leucogenys, N. gabriellae*) and has been designated Gibbon Hepatitis B Virus. Different strains exist within this genotype among the different species, including the Javan gibbon specific strain (Payne, 2004). A test has been developed to differentiate between the human and gibbon genotypes of the virus. To date there is no evidence to suggest transmission of the Javan gibbon strain to other species, including humans (Payne, 2004).

Although the entire captive population of Javan gibbons has yet to be tested, it appears that more than 50% of gibbons in both western and Indonesian zoos are GiHBV positive. Despite this high level of infection, there are no documented cases of GiHBV caused disease in gibbons. The oldest living Javan gibbon in captivity was a carrier of GiHBV and died of other causes at the age of 50 years, which is significantly longer than the expected lifespan of wild and captive gibbons. A similar percentage is found in rehabilitation centres in Java, suggesting that there was probably a similarly high prevalence in wild populations.

In August 2010 the GCMP held a series of meetings, which were attended by leading Indonesian and international Javan gibbon experts. At the meeting it was agreed that elimination of GiHBV was not a reasonable objective given its apparent natural prevalence. Additionally, the conservation of Javan gibbons, both in the wild and in captivity, would not be possible if the ~50% of gibbons that have the virus were excluded. However, the Indonesian government remained firm on their decision not to allow the release of GiHBV positive gibbons.

Significant resources have subsequently been invested by the Aspinall Foundation into developing the technology and undertaking research to determine the presence of this disease in wild Javan gibbon populations. Preliminary results have indicated, as expected, a similar prevalence of GiHBV in the wild Javan gibbon population so far tested, and the Indonesian government has now approved the release of GiHBV positive gibbons (Arsan, pers. comm. 2014). Further non-invasive testing of wild gibbon populations is recommended.

The case of GiHBV highlights that, whilst it is important for rigorous scientific assessment of disease risk, we must also consider in the absence of knowledge, that we implement evidence-based decisions and avoid unnecessary exclusion of gibbons from translocation programmes.

separate. The effects of split pairs on an existing established reintroduced population may be hazardous, as both sexes in gibbons often appear to mate opportunistically and any lone individuals may thus interfere with existing pair bonds, lead to serious fighting, injuries or death in a worst-case scenario. The splitting of pairs can happen even when reintroducing families, but is (in GRP's experience from trying both methods) less likely as the young will keep parents from straying too far from each other.

Repatriated gibbons

Due to the large numbers of gibbons housed in captivity in their native countries, efforts should be focused on releasing these individuals (assuming they meet preconditions for release) before considering gibbons housed or bred outside of the range state. However, in some instances, gibbons in non-range states may provide the only opportunity for translocations, may be better rehabilitated, or may be more suitable for genetic augmentation of the wild population (e.g. the case of the Golden lion tamarins (*Leontopithecus rosalia* in Brazil (Mickelberg and Ballau 2013)). Repatriation of gibbons should apply only to those already maintained within the *ex-situ* population and is not considered justification for the removal of gibbons from their range state. More work is needed to investigate the suitability of managing some gibbon species as a metapopulation including wild, rescued and captive gibbons. Large numbers of gibbons held in multiple centres with limited coordination and cooperation between them however remains a challenge to the One Plan approach for almost all taxa of gibbons.

All captive gibbons and their future progeny, whether in range states or outside of them, should be considered as potential candidates for future translocation, even if such plans do not currently exist. As such, it should be ensured in captive breeding programmes, both within zoos and rescue centres, that unnatural hybridization does not occur, as this will preclude the gibbon being released in the future (Mootnick, 2006).

Studbooks

Studbooks document the pedigree (the recorded ancestry or lineage of an individual) and history of each individual in a managed captive population of a species. These collective histories comprise the population's genetic and demographic identity and are invaluable tools that track and manage each individual. Sound genetic management of gibbons through use of studbooks in *ex-situ* centres may help to build the foundations for successful assurance populations or generate individuals for translocation programmes. Documentation of the captive population through studbooks may also help avoid issues relating to uncertain provenance of gibbons and avoid unintentional cross-breeding or identify where it has already occurred. Gibbons housed in rescue and rehabilitation centres may form genetic founders for the creation of new, managed wild populations, and it is therefore recommended that captive facilities establish studbooks very early in the rescue and translocation process.

Most gibbons held within zoos, especially within the European Association of Zoos and Aquaria (EAZA), Zoo and Aquarium Association of Australasia (ZAA) and the American Association of Zoos and Aquariums (AZA), are identified within a studbook and incorporated into a managed programme. As an element of the Javan Gibbon GCMP, some efforts have been made to extend this approach to those gibbons held in rescue centres, although with limited success due to lack of information on the origin of individuals and insufficient skills and resources to manage the studbook. Additional efforts in this approach, as resources allow, should be undertaken by captive facilities where they are not already.

Population management goals should also be explicitly identified. Management often takes the form of genetic and demographic analyses of a given population with parameter values being tracked over time against goals. Goals might include components such as retaining a given level of genetic diversity over a given time period, reaching and maintaining a stable population size or the inclusion of an animal release component. Population management often includes the transfer of animals from one place to another to form the most suitable pairings genetically. Whilst the focus of population management work is largely science based, the inevitable practicalities of managing a population, which spans a large geographic area and consists of free-thinking animals, must also be factored in; for example issues relating to successful social integration.

CONDUCTING A CONSERVATION TRANSLOCATION

General considerations

Consideration of current social grouping, potential for aggressive interaction with previously released or wild gibbons, as well as capacity to monitor, must be taken into account when selecting the most suitable release strategy. Logistics must be in place to allow for post-release monitoring. No release of ex-captive gibbons should be undertaken without a programme to monitor the gibbons after release and to ensure that they are coping in the wild. Contingency planning should also be considered, with clear guidelines under which intervention and recapture would be attempted.

Current recommendations are for the release of compatible pairs or family groups, reducing the initial energy investment in searching for a mate**.** This has proven successful to date for releases of *Hylobates moloch, H. lar, H. albibaris, H. muelleri* (e.g. Cheyne, et al., 2008a). There are some reported cases of accidental individual releases (Cheyne & Brulé, 2004; Smith, 2010), where the gibbons appear to have survived and paired with wild gibbons and intentional releases of single individuals into social openings within the existing reintroduced population. Some of these individuals have paired up and reproduced in the wild (Osterberg, pers. comm. 2014) indicating that this strategy may be appropriate in some situations. Group releases of multiple unrelated gibbons in other projects have proven unsuccessful (DeVeer & van den Bos, 2000; Yatbantoong, 2007). Gibbon rehabilitation and release is still, however, in its beginning and recommendations may change in the future. At this stage, gibbons released in families (GRP, Phuket) or well-bonded pairs (JGC and Kalaweit) would appear more likely to thrive even after a few years of normal pair behaviour, with or without offspring.

All pre-release gibbons should ideally spend some time acclimatizing to a semi-natural environment (or half-way house). Gibbons should never be released immediately after transport to the release area: time is required to recover from the stress of the trip and for acclimatization. Ideally, gibbons should be released into an enclosed environment, where they cannot migrate and where observers can easily monitor the gibbons (Strum & Southwick, 1986), such as a large cage in a semi-natural environment.

Soft vs. hard release

In reality, hard and soft are not strictly dichotomous, but represent extremes of a continuum. Soft release, in the case of gibbon translocation, is defined in terms of provision of an acclimatization enclosure within the release site. A minimum period of three weeks should allow some level of adaptation to the new environment and assessment of likely interference from other gibbons in the area. Additional time would be required should gibbons fail to demonstrate key essential survival behaviours (Cheyne, et al., 2008a). Depending on the size of the enclosure, care should be taken to avoid an overly extended period that may result in the deterioration of positive behaviours. A soft release would ensure the demonstration of appropriate behaviours and calling as triggers prior to release from a soft release cage. Post-release support, including protection from predators, is usually provided in a soft release strategy.

A hard release strategy would mean gibbons are not held in enclosures prior to release, except during transport. Gibbons are immediately released at the release site and generally there is no post-release support. We strongly advise against this approach, as evidence suggests this method has little success and a high mortality rate for the reintroduced gibbons (IUCN SSC PSG SSA, 2014).

Projects are currently primarily using soft release strategies with variations in food provisioning and time spent in acclimatization enclosures. We recommend that consideration is given to the logistics of moving gibbons, proximity of release site to rehabilitation site and number of staff available for post-release monitoring (see section on Post-release Monitoring) when determining which form of release is employed.

After release, cages should be left open at the release site, so that the gibbons can use them as sleeping sites and to provide a familiar object in a strange place. If there is no acclimatization cage or ‘half-way house’ for the gibbons at the release site then they should remain in the transport cages for up to a week to allow them to acclimatize to the sounds and smells of the forest. Food (ideally natural foods found within the release site) can also be provisioned near the cage immediately after release, but should be gradually reduced to encourage foraging and reduce dependence.

If gibbons can be provided with as near to an entirely wild diet prior to release and released during high fruiting periods with adequate natural food supply, food provisioning may not be essential for the adaptation and survival of reintroduced gibbons. Prolonged food provisioning maybe required, however, for certain individuals e.g. pregnant or lactating females. In several case studies, gibbons immediately sourced adequate wild food when provisioning was not provided and remained able to do so for several years (Campbell, pers. obs.). In some cases where food has been supplied for newly released gibbons this has been ignored (Marx and Brulé, pers. comm. 2014). Longer-term projects (e.g. GRP) continue to provision released gibbons as they have required lengthy post-release support before becoming independent (see Case Study 4).

During provisioning, consideration must be given to the impact of continued interaction and potential aggression with human food providers. Strategies to encourage full independence should be

Acclimitization enclosure at a release site. ©JGC.

developed to reduce provisioning gradually over time. It is suggested that there should be differentiation between those staff monitoring the gibbons and those supplying food to reduce behaviour modification in the presence of monitoring staff. Food should always be delivered at height with no physical interaction with humans.

Food provisioning is also a useful tool to enable the initial close monitoring of released gibbons, avoiding rapid dispersal from the release site. Additionally, it may enable the releases of more families into an existing reintroduced population without causing unnecessary social turbulence, as newly released gibbons will not have to travel extensively to meet their nutritional requirements and risk encounters with resident groups (Osterberg, pers. comm. 2014).

Release site selection

After the main release site has been selected, it then becomes necessary to consider where within that area the gibbons will be released. This becomes particularly important for long-term projects in which reinforcement is planned. Extensive knowledge of all previously released gibbons' (and their descendants') current territories is necessary in order to choose a safe release area for a new group. At GRP their experience is that reintroduced gibbons can use a lot more space and travel widely when they have no territorial neighbours (Osterberg, pers. comm. 2014). Gibbons will often travel to visit new gibbons in an area so a new release site must be at least one average territory size (for that species) from any area used by other groups, in order to offer the newly released gibbons time to adjust before encountering others.

Pre-release preparation

Site preparation

The release site should be prepared to facilitate adequate monitoring of released gibbons. The site should be mapped and demarcated. Depending on terrain, the construction of a trail system may be required to enable easier access and accurate recording and communication of information after release. Some nearby infrastructure may be required for staff facilities, as well as access to electricity, water and communication and an acclimatization enclosure for the gibbons.

Acclimatization cages

Acclimatization cages serve the purpose of allowing sensory adaptation to the new environment, as well as assessment of potential interference from other gibbons or species. They should be

Remote feeding system. © GRP

CASE STUDY 4: POST RELEASE SUPPLEMENTAL FEEDING AND MONITORING

Supplemental feeding at the GRP:

AT GRP gibbons receive supplemental feeding for a long time after release while they learn to forage and explore their territory. If the adult female in the group is pregnant or lactating, feeding supplements are continued for over a year to ensure a sufficient energy intake. On a few occasions when the decision had been made to stop feeding a group, there was a need to reconsider after the female in the group appeared hungry and descended to the ground to meet staff. All feeding is conducted using a basket that is pulled up at least 10 metres into the trees. To help the family expand their territory the feeding station is moved further into the prepared territory with time. Initially the family is fed the same amount as the captive ratio, at 1kg/day/individual, but as the gibbons learn to find wild foods the amount is gradually reduced until food was no longer taken, at which artificial provisioning was stopped. It normally takes at least one year, or a full seasonal cycle, for the gibbons to acquire a large enough territory to become fully independent.

Follow up and post-release monitoring at GRP:

Before release, a grid of trails spaced 50 m apart are cut around the site of release extending at least 200 m in all directions to facilitate post-release monitoring. For the first 2-4 weeks (depending on volunteer and staff availability) after the release the GRP will do full day focal gibbon sampling of one of the family members in order to assess activity budgets. After this initial period the gibbons will continue to be checked on a daily basis for another one to two years, but much of this monitoring happens in conjunction with food supplementation and observations are reduced to only *ad-libitum* observations.

Monitoring of the population continues indefinitely. Even the first gibbons that were released in 2002 are still regularly being checked upon in 2015. GRP aims to check on all reintroduced gibbons and their descendants at least every few months to be able to follow their lives in the wild. Unexpected events regularly take place within the release site and so valuable experience on the behaviour of reintroduced gibbons can be gained. The continued monitoring also allows demographic data to be gathered and compared to that of wild lar gibbons in Thailand (Osterberg, et al, 2014; Osterberg, et al, 2015).

large enough to allow for normal behaviours and preferably be larger than the gibbons' previous enclosure, though this is not always possible due to terrain at release sites. It is also important to consider that the size is sufficient should there be unforeseen delays in the release.

Pre-release disease check

Pre-release health checks and final disease assessment should be conducted prior to transfer to the acclimatization enclosure within the release site. Strict quarantine protocols must be followed during the transportation process, to eliminate the risk of exposure to human diseases post testing. Close observation of gibbons whilst housed in the acclimatization enclosure is important to ensure there is no injury or onset of medical or behavioural abnormalities. Ideally, the gibbon will not be handled during the acclimatization phase.

Transportation

Transportation of gibbons to the release site should be planned to minimize stress and the potential for injury as well as exposure to disease. Capture, confiscation and transportation are events which are highly likely to cause stress and lead to gibbons injuring themselves and thus should not be undertaken lightly. While in transit, the gibbons should be provided with adequate space, food, water and the correct temperature must be maintained. Transport boxes should be covered on all sides to reduce stress. The IATA Live Animals Regulations (2010) recommends that primates be housed at an air temperature between 12.8 and 26.7 degrees Celsius. Any dependent ventral infants must be housed with their mother and small juveniles should be transported in pairs if available, especially if they are alert during the journey. The gibbons must be shaded throughout the transport journey and every precaution should be made to ensure that the vehicles do not break down. If several cages are to be transported, they should all be covered and designed such that the gibbons cannot reach out and cause injury to their limbs. If the gibbon is highly excitable, sedation may be required (Cheyne, et al., 2012). It is also important that suitably qualified and experienced personnel are present during transport in case they are required to deal with an acute health crisis or escape (Beck, et al., 2007).

Strict quarantine protocols must be implemented during the transport phase with any staff handling the cage and/or gibbons to be wearing gloves and facemasks as a minimum requirement. A plan for transferring the gibbons from the transport cage to the acclimatization enclosure should be in place prior to arrival to avoid unnecessary delays with caution to avoid injury and escape during this procedure.

Transportation cages.
© Kalaweit

Opening the doors

Monitoring the area

Prior to the release of gibbons into any area, a threat assessment should have been conducted to determine any current hunting activities that may present a risk to released gibbons (see Threat Assessment section). Ideally, a protection unit will be in operation prior to release to undertake continual monitoring, coordinate intelligence and provide ongoing mitigation of threats.

Behavioural assessment before release

Gibbons should have been determined physically and behaviourally suitable for release prior to transfer to an acclimatization enclosure. Only once the behaviour of the gibbons at this stage has again been deemed satisfactory (i.e. meeting basic behavioural requirements; for full review see Cheyne, et al., 2008a; Cheyne, 2009b; Cheyne, et al., 2012) should the gibbon be confirmed for release from the acclimatization enclosure.

Transfer to the new environment may well result in the reoccurrence of previously displayed negative behaviours, such as moving to the ground, cessation of calling and stereotypic behaviors (Ario, pers. comm. 2013). These behaviours may be due to stress of the new surroundings, but may also be an indicator of difficulty in adapting to new surroundings and careful assessment should be made prior to release. Gibbons should not be spending any time on the ground of the enclosure, as this is likely to increase risk of predation after release. Enclosures should always be designed in a way that discourages this behaviour and any indication of this behaviour after release should also be managed using deterrents.

Gibbons should be consuming a predominantly natural diet prior to release and able to recognize water sources. The onset of regular calling is a general indication that gibbons are comfortable in the new environment and, providing that other key behavioural indicators are met, release from the acclimatization cage would then be appropriate. Calling will also help to determine if there are other gibbons or other species nearby that are likely to present a territorial challenge once the gibbons are released.

A note on media and ceremonies

The political and cultural significance of translocating endangered wildlife species can often dictate a requirement for extensive ceremonial activities to be attended by dignitaries, government and media personnel. Many of these visitors will only be present for the release and will not have been involved in the project since the beginning. It is important that local people are not sidelined during these ceremonies. Whilst these activities in some cases are necessary and important, reducing risk and maximizing the success of the translocation should be given priority and so human presence at gibbon releases should be minimized as much as possible.

In order to reduce stress, all ceremonial activities should be conducted at both visual and auditory distance from the gibbons, preferably at another location altogether. Human presence at the release should be limited to monitoring staff and, if required, camera and media crews accompanied by project staff for documentation of the process. A code of conduct should be determined prior to the event and personnel nominated to ensure compliance by all parties.

WILD TO WILD TRANSLOCATION

Justification and rationale

The following issues apply specifically to wild to wild translocations, defined here as the deliberate capture and movement of wild gibbons from one natural habitat to another. Wild to wild translocations should adhere to the guidelines listed previously in this document, e.g. site, habitat and threat assessments, post release monitoring and protection, but the capture and removal of wild gibbons must also be adequately justified. Additionally, all efforts should be made to translocate entire groups together to avoid disrupting social cohesion and causing additional stress.

Here translocation means wild to wild translocation and does not include capture of wild gibbons for use in captive breeding programmes, which is not addressed in this document. Nevertheless, translocation of wild gibbons to captivity may under some extreme circumstances be necessary, but should not be conducted without wide consultation and only as an emergency measure, acknowledging the high potential risks, with all possible safeguards in place.

Translocation projects are generally considered due to the fact that gibbons are severely impacted by loss of forest quality due to their arboreal nature. Issues affecting gibbons include: 1) loss of canopy continuity (e.g. through logging), 2) isolation (e.g. families/individuals stranded in a small number of trees), or 3) fragmentation (e.g. gibbons forced to come down to the ground to reach other forest fragments to find sufficient food, making them vulnerable to predation and potentially causing human-gibbon conflicts). Fragmentation can also lead to the risk of malnutrition, increased exposure to pathogens in areas with human populations (Chetry, et al., 2007) and population decline in the long term through stochastic processes and small population size.

Thus, gibbons may be considered for wild to wild translocation for a variety of reasons, but the relative merit and feasibility of habitat restoration and connecting habitat fragments as interventions that could avoid the necessity for translocation must also be considered. In wild to wild translocation projects to date, translocated gibbons have generally been completely isolated in tiny patches of forest, or in some cases only a few trees, and any options for habitat restoration have been minimal (IUCN SSC PSG SSA, 2014). These have generally been emergency translocations. As habitat fragmentation becomes increasingly problematic within gibbon range states, and our knowledge of how to conduct effective wild to wild translocations improves, wild to wild translocation may be seen as an increasingly attractive option for gibbon conservation. Full and due consideration needs to be given, however, to improving connectivity between habitat fragments (e.g. vegetation or canopy bridges) and forest restoration, as these are the underlying causes of threat. These options may provide better long-term solutions, especially when the logistical difficulties and potentially high level of risk associated with wild to wild translocations is considered.

Capture methods

Currently, methods for capturing gibbons for wild to wild translocations have inherent welfare risks and pose considerable logistical issues. The science of translocation of gibbons is relatively nascent and is based on the experiences of relatively few projects. As such, it is currently not possible to provide definitive guidelines for capture methods here. Considerable additional testing will have to be conducted before wild capture of gibbons can be seen as a low risk conservation strategy, but this should not necessarily discourage translocation efforts where the circumstances demand such an approach as discussed above. This in turn will lead to an improvement in understanding and applicability of the approach, which may become essential in the future. Thus, it is of significant importance that in translocation projects experiences are documented and made available to guide best practice.

Considerable planning will be required in any wild to wild translocation. Risk assessments and contingency plans should be in place, as the potential for unplanned results is significant. It is essential that veterinary expertise is on hand, as the risks of injury to gibbons is significant during the capture process. If injuries are sustained to a gibbon in the capture process, a qualified veterinarian should make a decision as to the suitability of that gibbon for release based on the injuries sustained, on a case-by-case basis. If the injured gibbon is to be taken into captivity, careful consideration needs to be given to a) the stress incurred by the wild gibbon being brought into captivity, b) the impact on the social structure of the translocated group and c) the likelihood of that gibbon being successfully returned to its original social group.

Gibbons may become isolated in agricultural landscapes.

To date, the authors are aware of two different approaches that have been used for capture of wild gibbons. The first approach involves translocating gibbons isolated to only a few trees in highly fragmented habitats, where they can be chased to the ground by climbers and subsequently captured in nets or baskets. This approach is detailed in the case study below. A second approach has involved more traditional darting of gibbons using blow-pipes or air guns and then capturing gibbons with nets. Both these approaches are likely to hold considerable risks to gibbons and they should not be interpreted here as best practice *per se*, but rather as approaches that have been tested to date and upon which additional expertise can be built. As such they should be treated as a description of processes rather than a 'how-to' guide.

Health checks

Health checks during wild to wild translocations should be restricted to those tests that can be conducted without protracting the capture and transport process. As with all such operations, masks and gloves should be worn by examining staff. These would include:

- General physical examination and checking for injuries that may have occurred during the capture process.
- Where possible blood and faecal samples should be taken.
- Implant of microchip.
- Aside from sedation, or in the event of injury, no other medications should be administered.

Transport

As wild to wild translocation involves the transport of wild gibbons there are additional factors that must be considered due to the high likelihood of stress on the gibbons:

- All efforts must be made to expedite the transport process including comprehensive planning and contingency planning in case of injury or other unforeseen circumstances.
- Females are not separated from infants <6 months old, but older infants and all other individuals are transported separately. This method generally reduces the risk of injury.
- The gibbons must be shaded, with all sides of the transport box covered throughout transport and every precaution should be made to ensure that the vehicles do not break down.
- If several cages are to be transported, they should all be covered and designed such that the gibbons cannot reach out and cause injury to their limbs.
- If the gibbon is highly excitable, sedation may be required, but experience to date has suggested that as long as crates are fully enclosed, translocated gibbons remain calm and even accept food.
- Health and safety precautions should be implemented with diligence, especially the use of face masks, gloves and disinfected crates and materials.

Human presence at capture and release site

Health and safety precautions for both gibbons and staff outlined in the transport section should be adhered to at the release site. Humans must protect themselves against transmission of disease and injury, as well as protecting the gibbons from retro-zoonosis. Contact with humans should be kept to a minimum throughout the process. In addition, safety harnesses should be used for captures that involve tree climbers.

Wild to Wild Translocation Release

Wild to wild translocation releases will be managed considerably differently from captive to wild translocations, due to the speed with which they should be conducted and the lack of requirement for an acclimatization process:

CASE STUDY 5: WILD TO WILD TRANSLOCATION

Wild to wild translocation of a hoolock gibbon. © WTI.

The Hoolock Gibbon Translocation Project of WTI conducted translocations of isolated eastern Hoolock gibbons (*Hoolock leuconedys*) from Dello Village to Mehao Wildlife Sanctuary (WS) in Arunachal Pradesh, India. Between 2011 and 2014 eight groups, comprising 22 individuals, have been translocated of a total of 20 groups identified as in need of translocation. Gibbon groups were identified to require translocation due to large-scale habitat conversion in the area. Lack of canopy closure and the low number of fruit trees had resulted in gibbons being isolated and forced to travel terrestrially between trees within the agricultural-rural landscape. This made them vulnerable to attack by domestic dogs and created a risk of malnutrition in the longer term and was resulting in population decline.

As such the WTI began planning translocations in 2009, developing translocation and veterinary protocols. Assessments were made of gibbon groups appropriate and in need for translocation to determine which groups could be candidates for capture. Identification and assessment of the potential release site of Mehao WS included population assessment of resident gibbons, resource availability assessment, habitat suitability assessment and a threat assessment. Entire groups were targeted for translocation, rather than individuals, to maintain social cohesion and reduce stress.

Various capture methods were tested and found to be unsuitable at this site. An attempt was made to lure gibbons into isolated trees using canopy bridges constructed of bamboo, but gibbons did not use them. Attempts were also made to lure gibbons into box traps using baits, but this also proved unsuccessful and has the added drawback that not all gibbons may enter the cage at the same time. Climbers were then sent up to chase the gibbons to ground, where they could subsequently be captured using baskets and nets. This approach has now been used for multiple translocations.

While each capture has been somewhat different, the same general principles have been applied. Gibbons in isolated trees or groups of trees are partially ringed with vertical tarpaulin walls on the ground some 15-20 metres from the base of the tree to reduce options for escape and to provide the illusion that remaining unwalled areas are the best escape options. Nets have been also been placed under the trees in case of accidental falls, however nets appear to discourage gibbons coming to the ground and may in fact protract the capture process. Expert local climbers (protected with harnesses where possible) are sent up the trees, attempting to force gibbons to the ground or into lower trees where they can be accessed. In some instances, pruning of the trees through cutting limbs during the process has been required in order to reduce options for the gibbons to evade climbers who can eventually position themselves above the gibbons and chase them to the ground.

Once on the ground the gibbons are caught by a team of 5 to 10 trappers (who have been hiding behind trees and bushes) using conical baskets and ring nets. Trappers wear gloves and masks to avoid the transmission of disease. The entire group should be captured for translocation rather than just a few individuals to maintain social bonds and cohesion. Sometimes ‘escapes’ occur when more than one gibbon comes to ground at the same time, but having multiple capture teams can avoid this issue. Once captured, gibbons are anaesthetized, excepting pregnant females and juveniles and physical examination for ectoparasites and body condition assessed. Biological (hair samples with intact follicles) and clinical materials (whole blood serum, faecal swabs) for genetic, seroprevalence and haematological studies are collected. Animals are weighed and one individual from the group marked, using hair dye on the eyebrows or forehead for post-release monitoring. Any individual found with a heavy parasitic infestation will be quarantined for a few days until they are treated with a parenteral administration of drugs, such as Ivermectin. After examination animals are transferred to crates for recovery.

Translocation of gibbons to the release site has been conducted using crates, usually holding gibbons overnight to allow for gibbons to be released early in the morning. Releases have all been hard releases, with no acclimatization cages used. Releases are conducted in the fruiting season to facilitate translocated gibbons finding food. Generally the entire process has taken from two to eight days and to date there have been no instances of mortality, although protracted captures are likely to place considerable stress on gibbons.

- Current evidence suggests that hard releases are usually appropriate for wild to wild translocation methods for gibbons.
- Wild to wild translocation release site selection should be the same as that for captive to wild translocated gibbons (see Release Site section).
- When selecting suitable habitat of the gibbons, consider distance to new site for length of transport time.
- Gibbons should be released at least one average territory size for that species away from the nearest gibbon family at the release site.
- Post-release monitoring should follow the same protocol as that for captive to wild translocated gibbons (see Post-release Monitoring section).
- Collars can be considered for wild to wild translocation of gibbons, (see Case Study 6) as can hair dying.

POST-RELEASE MONITORING

Data collection immediately after releases

Gibbons can be located after release by learning their ranging patterns and following them out to where they were seen to sleep for the night. In some species duetting can also be used to estimate where the gibbon groups are, but many pairs do not sing every day, so there are limits to this method (Brockelman & Ali, 1987; Brockelman & Srikosamatara, 1993; Nijman & Menken, 2005; Cheyne, et al., 2008b; Hamard, et al., 2010). Because the gibbons will be semi-habituated, it is hoped that, after a short space of time, the home ranges and daily travel routes of the released gibbons will be known, thus making the following and observing easier than if the gibbons were fully wild. Post-release monitoring includes the collection of data on behaviour, ranging, ecology, socialization and on the interactions the gibbons have with other gibbons in the release area; for example, macaques and birds.

We recommend the following schedule for post-release monitoring:

Method	**Length of time**
Direct behavior observations	First 4 months
Location data for both individuals in a pair	5-12 months

Location data are especially important to map home ranges to determine suitable release sites for future releases.

The gibbons should be located as often as possible for at least 1 year, or until they have experienced every season in the wild. After this the area should be regularly resurveyed to find out population status and trends over the years. We define success of a conservation translocation as the F1 generation surviving to produce offspring that then survive to weaning; that is, the same statistical chance of survival and reproduction in the wild as other gibbons. Thus, data on infants born and surviving will also provide information on how well the reintroduced gibbons are thriving; success depends on stabilizing or increasing the population, as well as percentage of surviving gibbons. There will always be individual failures.

When to intervene if something goes wrong?

This must be determined on a case-by-case basis and will depend on:

- The ability to retrieve safely the released gibbon(s).
- The impact on the pair/group by removing one individual.
- Reason for retrieving the gibbon e.g. injury, loss of condition.
- Separation from pair-mate should initiate increased monitoring efforts to determine what happens post split.

The role of collars

Monitoring technologies are varied and include indirect methods like radio-telemetry and satellite telemetry with implants (e.g. miniaturized VHF transmitters implanted subcutaneously) and collars or direct methods like observation with drones and human observation. New technology can undoubtedly facilitate monitoring activities. Thus, it is essential to share knowledge about the advantages and disadvantages of new innovations; as well as strengthen the collaborations among rehabilitation centres, zoos, researchers and technical experts to maximize the success of any future gibbon translocation.

Current issues with monitoring devices for gibbons:

- Siamangs: radio collars are currently considered unsuitable for siamangs, due to their unique neck morphology and large throat sacs.
- Ankle collars: There may be potential for collars to be used on the ankle of a gibbon, but 200g is likely to be too heavy. Females with newborn infants, however, sometimes hold their legs higher to support their infant while they are brachiating for the first days until the infant can cling securely. Additional weight on the ankle during this time may make this difficult, which may reduce her ability to forage, or may jeopardize the infant's safety. If there are concerns about the weight of the collar on the ankle, then this method should first be tested on males (male siamangs also carry infants, but not during the newborn stage).
- Implanted transmitters: The invasive nature of surgery has its inherent risks. This technology is still in the trial stages, but is developing rapidly.
    - Practitioners have also reported instances of cracked ceramic casings within the body of the gibbon.
    - Failure of devices long before their supposed battery life and, opportunities for diagnosing the cause of transmission problems are limited by the negative impact that recapture and retrieval of the implant would cause to the host gibbon.
    - Transmission range in normal forested conditions and in inclement weather can be poor, thus increasing the likelihood of losing far-ranging gibbons.
    - Size limitations of implanted transmitters: Adding GPS or activity sensor functionality is difficult if the size of the device is to remain small. This limits the possibility to monitor the dispersing gibbons.

Radio-collar used for post-release monitoring. © EAST

CASE STUDY 6: THE USE OF RADIO TELEMETRY COLLARS

The Dao Tien Endangered Primate Species Centre (DTEPSC), in southern Vietnam has fitted VHF or VHF/GPS transmitters on biothane collars to eight adult *Nomascus gabriellae* gibbons between 2010 and 2013.

In 2010/2011 four adult *N. gabriellae* gibbons were fitted with VHF collars during semi-forested enclosure training (male and female), to assess the suitability as a monitoring tool for full release in the future. Standard VHF collars with 7 months battery and no programmed drop-off were used. Units weighed 47g. The collars stayed on for up to 13 months before the gibbons were recaptured for removal. There was no observed skin irritation, behavioural or physical problems. In thick secondary forest the radio signal travelled 700m, allowing easy monitoring of the gibbons, which rarely travelled more than 1 km in a day.

In 2011 for release into continuous forest larger VHF/GSM collars were fitted, weighing 230g (*N. gabriellae* weight 5.5-7kg). These collars were in place for 13 months before the gibbons were recaptured for removal. Hair loss was noticed at the site of the GPS unit. Although the collars were not believed to be too heavy, the sheer bulk was considered to be an issue. The GPS data collected by the collar (four locations/day) has provided an enormous insight into the movements of the gibbons, showing that the gibbons cover a much larger area than the ground monitoring team had observed.

In 2012 two gibbons were fitted with VHF collars with a timed drop-off buckle (176g) so recapture would not be necessary. These collars enabled full-day follows for data collection three days/week, to assess feeding, behaviour and travel.

The use of telemetry collars on *N. gabriellae* is a viable tool and provided valuable data for monitoring the behavior and movements of the gibbons, for the first year, when reintroduced back into continuous forest.

Documentation – from monitoring to research

A significant gap in gibbon translocation practice is the lack of an agreed monitoring and evaluation framework, making it difficult to amass and compare data, identify trends both locally and at a meta-population level, to test the assumptions embedded in every methods and, ultimately, to demonstrate welfare and conservation impacts.

Table 3. Post release monitoring requirements

	Minimum Requirement	**Intermediate**	**Best Practice**
Action	Frequent contact with released gibbons to observe body condition and group status and reproduction	Regular contact with released gibbons to collect data on behaviour, feeding ecology, ranging, interactions with conspecifics and other species, and demography (reproduction)	Regular contact with released gibbons to collect data on behaviour, feeding ecology, ranging, interactions with conspecifics and other species, monitor health and group dynamics and demography (reproduction and dispersal)
Timeline	For at least 12 months	1-2 years	Ideally for several years to encompass change in all the variables above

POST-RELEASE PROTECTION

Translocation projects have a duty of care to ensure released gibbons are, within reason, safe from potential threats at the time of the release and into the future. Thus it should be ensured that key threats have been identified and addressed prior to release. Habitat should be secure into the foreseeable future and, where hunting pressure is evident, strategies implemented to mitigate such risk. Projects should also consider that, in some areas, gibbons may be a high-value species in the wildlife trade and, therefore, hunting threat may increase after release. Every effort should be made to engage local authorities and local communities in order for effective translocation and follow-up protection activities. Ongoing threat mitigation through enforcement efforts and environmental education are usually necessary.

Several models of protection have proven effective with other species conservation programmes in Indonesia, for example the Rhino Protection Units operating in Way Kambas and Ujung Kulon National Park and the Wildlife Protection Units operating in Bukit Tigapuluh National Park (Sectionov, pers. comm. 2014.). The Javan Gibbon Foundation programme currently uses a combination of community engagement activities, as well as a Gibbon Patrol Unit, which monitor an area of about 8000ha for signs of illegal activity. The aim of the HURO Programme in India is to deliver collaborative patrol efforts e.g. Sonja Wildlife Rescue Unit and Forest Department Units (Magne, pers. comm. 2014). GRPs release site in Phuket is a protected area and the GRP shares information about any activities observed within the forest with rangers and locals who live nearby. Perhaps because of GRPs locally well known status and long-term presence in the area, this traditional method of communication works surprisingly well within the Thai community and all parties benefit; GRP staff will notify forestry staff of GPS coordinates where illegal logging has been spotted and local people keep an eye out for the translocated gibbons and may phone GRP to inform where within the release site a gibbon family has been seen with a newborn, for example.

Protection efforts should consider the entire population. Extensive habitat loss or hunting in other areas, especially in reinforcement projects, could undermine the conservation value of any translocation and, as such, expanding protection efforts beyond the release site should be encouraged.

Direct protection efforts in the release site is recommended until it can be demonstrated that no further threat persists to the translocated gibbons. It is important to understand this responsibility, as protection effort and financial and technical support may be required for extended periods of time. The threats of hunting and habitat loss are ongoing across the Hylobatid range and most sites are likely to suffer from these threats into the medium term. Costs for such protection efforts, where they are not implemented and financed by the site management authority, should be factored into projects long-term financial plans.

DATA SHARING

Gibbon translocation is a relatively new science with projects testing and conducting innovative work in many countries in South and Southeast Asia. Currently, informal data sharing networks exist and some formal but non-gibbon-specific fora are available (e.g. WARN, RSG) for those seeking information when developing gibbon translocation projects. Documentation on gibbon translocations is currently very limited, with few published sources for developing projects to refer to. Thus, the results of translocation efforts should be published and made publically available in order that successes and failures can be shared and improve general practice and understanding of the science. Ideally, a centralized clearing-house mechanism would be developed in order to increase access for documentation for practitioners

Community members can form effective gibbon protection groups. © FFI.

THE DECISION TREE

Planning is key to effective and successful Rescue, Rehabilitation and Translocation projects. Issues to be addressed during project planning include: 1) translocation plan and risk assessment, 2) taxonomy and geographic range of gibbons involved, 3) a technical plan, 4) the need for a financial plan and 5) the need for a multi-disciplinary approach and an adaptive management strategy. The decision trees below are adapted from those for the Great Apes (Beck, et al., 2007).

Table 4. Decision tree for reintroduction of gibbons

A1	Is there a need for conservation translocation, i.e., could conservation translocation re-establish or reinforce a viable, self-sustaining wild population to enhance the long-term survival of a taxon or help restore natural ecosystem functions or processes?	No →	If no, discontinue.
	Yes ↓		
A2	Can all local, national and international laws and regulations be met?	No →	Revise your plans to meet laws and regulations and continue to step A3, or discontinue translocation planning.
	Yes ↓		
A3	Is conservation translocation the most immediate and effective approach for conservation of the taxon within the mandate of your organization?	No →	If funding is translocation specific, continue to A4. If not, consider whether other conservation interventions (e.g. enforcement, confiscations, sanctuary infrastructure policy development) may be more immediately beneficial for the long-term survival of a taxon.
	Yes ↓		
A4	Is an expert, multi-disciplinary team in place to plan and guide the translocation? E.g. gibbon ecologist, veterinarian, botanical expert, technical & financial manager (these roles are not exclusive or exhaustive).	No →	Establish your team and continue to step A5, or discontinue translocation planning.
	Yes ↓		

Continued on next page

Table 4. Decision tree for reintroduction of gibbons, *continued*

A5	Is there a written proposal detailing the project's background, objectives, methods, risk assessment, schedule and budget? Is there a compilation of the socio-ecological, behavioural, and biomedical knowledge of the taxon?	Yes	No	Compile your literature review and continue to step A6, or discontinue translocation planning.
A6	Is there a potentially suitable release site within the indigenous range of the taxon?	Yes	No	Discontinue translocation planning, or consider whether a conservation introduction is warranted.
A7	Is the taxon present at the study site? The presence of a population must be determined using standardised survey approaches (see Best Practice Guidelines on Gibbon Surveying and Monitoring)	Yes	No	Continue to step A9.
A8	Does the population require reinforcement? Reinforcement requirement must be assessed through formal methods which are likely to include population surveys and viability analysis.	Yes	No	Discontinue translocation planning for that site.
A9	Is there a full site assessment to determine whether the site is appropriate in relation to land tenure, habitat, food availability, protection and has local stakeholder buy-in.	Yes	No	Conduct a site assessment.
A10	Have the original causes of decline or extinction of the taxon been addressed?	Yes	No	If no, address original causes of decline and then continue to step A11, or discontinue translocation planning.
A11	Is there a reasonable likelihood of secure, long-term funding for the translocation project, including adequate preparation of the gibbons to be released, and long-term post-release monitoring?	Yes	No	Search for and secure adequate funding and continue to step A12, or discontinue translocation planning.
A12	Do the governments of the nation and district in which the release site is located support the translocation, and is there support by local communities?	Yes	No	Build stakeholder buy-in for the translocation and continue to step A13, or discontinue translocation planning
A13	Have the gibbons to be translocated been behaviourally and developmentally assessed; and have they acquired natural social and ecological skills, and been weaned from human contact and dependence, such that they can survive independently (or with greater independence) in the wild, i.e. been rehabilitated?	Yes	No	Conduct assessment, training and development of rehabilitation and continue to step A14, or discontinue translocation planning.

Continued on next page

Table 4. Decision tree for reintroduction of gibbons, *continued*

A14	Have the gibbons to be released been identified to the level of species or sub-species, depending on current taxonomy, using morphological, behavioural and/or or genetic assessments to ensure that they are of the same taxon as the population that previously existed or still exists at the release site?	Yes	No	If no, conduct your taxonomic assessment to ensure taxon equivalency and continue to step A15, or if not the same taxon go back to step A1, or discontinue translocation planning.
A15	Have the gibbons to be translocated been medically-screened and examined, quarantined, treated, vaccinated and cleared for release?	Yes	No	If no, quarantine and treat gibbons and continue to step A16, or discontinue translocation planning.
A16	Is there a plan in place to transport gibbons safely to the release point, and to release them?	Yes	No	If no, formulate your plan and continue to step A17, or discontinue translocation planning.
A17	Can the Precautionary Principle be upheld?	Yes	No	Discontinue translocation planning.
A18	Release gibbons, begin post-release monitoring and management. Continue to step A19.	Yes		
A19	Document and publish post-release outcomes.			

REFERENCES

Abbott, I. (2000). 'Improving the Conservation of Threatened and Rare Mammal Species through Translocation to Islands: A Case Study, Western Australia'. *Biological Conservation* 93:95–201.

Armstrong, D., Jakob-Hoff, R. and Seal, U.S. (2003). *Animal Movements and Disease Risk: A Workbook*. Apple Valley, USA: IUCN SSC Conservation Breeding Specialist Group.

Barelli, C., Heistermann, M., Boesch, C. and Reichard, U. H. (2007). 'Sexual Swellings in Wild White-handed Gibbon Females (*Hylobates lar*) Indicate the Probability of Ovulation'. *Hormones and Behavior* 51:221–230.

Beck, B., Walkup, K., Rodrigues, M., Unwin, S., Travis, D. and Stoinski, T. (2007). *Best Practice Guidelines for the Re-Introduction of Great Apes.* Gland, Switzerland: IUCN SSC Primate Specialist Group.

Berkson, G. (1967). 'Abnormal Stereotyped Motor Acts'. In: J. Zubin and H. F. Hunt,(eds). *Comparative Psychipathology: Animal and Human*, pp. 76–94. New York: Grune and Stratton.

Berkson, G. (1968). 'Development of Abnormal Stereotyped Behaviours'. *Developmental Psychobiology* 1:118–132.

Bleisch, W. and Chen, N. (1990). 'Conservation of the Black-crested Gibbon in China'. *Oryx* 24:147–156.

Brockelman, W.Y. and Ali, R. (1987). 'Methods of Surveying and Sampling Forest Primate Populations'. In: R.A. Mittermeier and R.W. Marsh (eds.). *Primate Conservation in the Tropical Rainforest*, pp.23–62. New York, USA: Alan Liss.

Brockelman, W.Y. and Srikosamatara, S. (1993). 'Estimation of Density of Gibbon Groups by Use of the Loud Songs'. *American Journal of Primatology* 29:93–108.

Byers, O., Lee, C., Wilcken, J. and Schwitzer, C. (2013). 'The One Plan Approach: The Philosophy and Implementation of CBSG's Approach to Integrated Species Conservation Planning'. *WAZA Magazine* 14:2-5.

Campbell, C., Andayani, N., Cheyne, S. M., Pamungkas, J., Manullang, B., Usman, F., Wedana, M. and Traylor-Holzer, K. (eds.) (2008). *Indonesian Gibbon Conservation and Management Workshop Final Report.* Apple Valley, MN: IUCN SSC Conservation Breeding Specialist Group.

Cannon, C.H. and Leighton, M. (1996). 'Comparative Locomotor Ecology of Gibbons and Macaques: Does Brachiation Minimize Travel Costs?'. *Tropical Biodiversity* 3(3): 261–267.

Carlstead, K., Seidensticker, J.C. and Baldwin, R. (1991). 'Environmental Enrichment for Zoo Bears'. *Zoo Biology* 10:3–16.

Chetry, D., Chetry, R. and Bhattacharjee, P.C. (2007). '*Hoolock, The Ape of India*'. Mariani, Assam, India: Gibbon Conservation Centre and Gibbon Wildlife Sanctuary.

Chetry, D., Chetry, R. and Ghosh, K. (2008). 'Sleeping Tree Selection by Sympatric Primates in Gibbon Wildlife Sanctuary, Assam, India'. Paper delivered at the International Primatological Society. Edinburgh, August 2008.

Cheyne, S.M. and Brulé, A. (2004). 'Adaptation of a Captive-raised Gibbon to the Wild'. *Folia Primatologica* 75(1):37–39.

Cheyne, S.M. (2005). 'Re-introduction of Captive-raised Gibbons in Central Kalimantan, Indonesia'. *Reintroduction News* 24:22–25.

Cheyne, S.M. (2006). Wildlife Reintroduction: Considerations of Habitat Quality at the Release Site. *BMC Ecology* 6(1):1–8.

Cheyne, S.M., Chivers, D.J. and Sugardjito, J. (2006). 'Wildlife Reintroduction: Considerations of Habitat Quality at the Release Site'. *BioMed Central Ecology* 6(1):1-8.

Cheyne, S.M. and Chivers, D.J. (2006). 'Sexual Swellings of Female Gibbons'. *Folia Primatologica* 77(5):345–352.

Cheyne, S.M. (2007). 'Unusual Behaviour of Captive-raised Gibbons: Implications for Welfare'. *Primates* 47:322–326.

Cheyne, S.M., Chivers, D.J. and Sugardjito, J. (2007). 'Covariation in the Great Calls of Rehabilitant and Wild Gibbons *Hylobates agilis albibarbis*'. *Raffles Bulletin of Zoology* 55(1):201–207.

Cheyne, S.M., Chivers, D.J. and Sugardjito, J. (2008a). 'Biology and Behaviour of Released Gibbons'. *Biodiversity and Conservation* 17:1741–1751.

Cheyne, S.M., Thompson, C.J.H., Phillips, A.C., Hill, R.M.C. and Limin, S.H. (2008b). 'Density and Population Estimate of Gibbons (*Hylobates albibarbis*) in the Sabangau Catchment, Central Kalimantan, Indonesia.' *Primates* 49(1):50–56.

Cheyne, S.M. (2009a). 'Challenges and Opportunities of Primate Rehabilitation – Gibbons as a Case Study'. *Endangered Species Research* 9:159-165.

Cheyne, S.M. (2009b). The Role of Reintroduction in Gibbon Conservation: Opportunities and Challenges. In: S.M. Lappan and D.L. Whittaker (eds.). *The Gibbons: New Perspectives on Small Ape Socioecology and Population Biology*, pp. 477–496. New York, USA: Springer.

Cheyne, S.M. (2010). 'Behavioural Ecology and Socio-biology of Gibbons (*Hylobates albibarbis*) in a Degraded Peat-swamp Forest'. In J. Supriatna and S.L. Gursky (eds.) *Indonesian Primates*, pp. 121-156. New York, USA: Springer.

Cheyne, S.M., Campbell, C.O. and Payne, K.L. (2012). 'Proposed Guidelines for Gibbon Rehabilitation and Reintroduction.' *International Zoo News* 46:1–17.

Cheyne, S.M., Thompson, C.J.H. and Chivers, D.J. (2013a). 'Travel Adaptations of Gibbons *Hylobates albibarbis* (Primates: Hylobatidae) in a Degraded Secondary Forest, Indonesia'. *Journal of Threatened Taxa* 5(5):3963-3968.

Cheyne, S.M., Hoing, A., Rinear, J. and Sheeran, L.K. (2013b). 'Sleeping Site Selection by Agile Gibbons: The Influence of Tree Stability, Fruit Availability, and Predation Risk'. *Folia Primatologica* 89:299–311.

Chivers, D.J. (1978). 'Sexual Behaviour of Wild Siamang'. In D.J. Chivers & J. Herbert (eds). *Recent Advances in Primatology*, pp. 609–610. London, UK: Academic Press.

Cowlishaw, G. and Dunbar, R. (eds.) (2000). *Primate Conservation Biology.* Chicago, USA: Chicago University Press.

Custance, D.M., Whiten, A. and Fredman, T. (2002). 'Social Learning and Primate Reintroduction'. *International Journal of Primatology* 23(3):479–499.

De Paoli, A. and Johnsen, D.O. (1978). 'Fatal Strogyloidiasis in Gibbons (*Hylobates lar*)'. *Veterinary Pathology* 15:31–39.

DeVeer, M.W. and van den Bos, R. (2000). 'Assessing the Quality of Relationships in Rehabilitating Lar Gibbons (*Hylobates lar*)'. *Animal Welfare* 9:223–224.

Dickie, L.A. (1994). 'Environmental Enrichment in Captive Primates: A Survey and Review'. MPhil Thesis. Cambridge: University of Cambridge.

Fan, P.F. and Jiang, X.L. (2008). 'Sleeping Sites, Sleeping Trees, and Sleep-related Behaviors of Black Crested Gibbons (*Nomascus concolor jingdongensis*) at Mt. Wuliang, Central Yunnan, China'. *American Journal of Primatology* 70:153–160.

Fan, P.F., Ni, Q., Sun, G., Huang, B. and Jiang, X. (2009). 'Gibbons Under Seasonal Stress: The Diet of the Black Crested Gibbon (*Nomascus concolor*) on Mt. Wuliang, Central Yunnan, China'. *Primates* 50:37–44.

Fischer, J.O. and Geissmann, T. (1990). 'Group Harmony in Gibbons: Comparison Between the White-handed Gibbon (*H. lar*) and Siamang (*H. syndactylus*)'. *Primates* 31(4):481–494.

Fischer, J. and Lindenmayer, D.B. (2000). 'An Assessment of the Published Results of Animal Relocations'. *Biological Conservation* 96:1–11.

Fleagle, J.G. (1976). 'Locomotion and Posture of the Malayan Siamang and Implications for Hominid Evolution'. *Folia Primatologica* 26:245-269.

Foose, T.J. and Ballou, J.D. (1988). 'Population Management: Theory and Practice'. *International Zoo Yearbook* 27:26–41.

Geissmann, T. (1991). 'Reassessment of the Age of Sexual Maturity in Gibbons (*H. lar*)'. *American Journal of Primatology* 23:11–22.

Geissmann, T. (1999). 'Duet Songs of the Siamang, *Hylobates syndactylus*: II Testing the Pair-bond Hypothesis During a Partner Exchange'. *Behaviour* 136:1005–1039.

Geissmann, T. and Orgeldinger, M. (2000). 'The Relationship Between Duet Songs and Pair Bonds in Siamangs, *Hylobates syndactylus*'. *Animal Behaviour* 60:805–809.

Geissmann, T. and Nijman, V. (2006). 'Calling in Wild Silvery Gibbons (*Hylobates moloch*) in Java (Indonesia): Behavior, Phylogeny, and Conservation'. *American Journal of Primatology* 68(1):1–19.

Geissmann, T., Bohlen-Eyring, S. and Heuck, A. (2005). 'The Male Solo Song of the Javan Silvery Gibbon (*Hylobates moloch*)'. *Contributions to Zoology* 74:1–2.

Gittins, S.P. (1979). 'The Behaviour and Ecology of the Agile Gibbon (*Hylobates agilis*)'. PhD Thesis. Cambridge: University of Cambridge.

Gittins, S.P. (1983). 'Use of the Forest Canopy by the Agile Gibbon'. *Folia Primatologica* 40:134–144.

Grethe, S., Heckel, J-O., Reitschel, W. and Hufert, FT. (2000). 'Molecular Epidemiology of Hepatitis B Virus Variants in Non-human Primates'. *Journal of Human Evolution* 74:5377–5381.

Groves, C.P. (1984). 'A New Look at the Taxonomy and Phylogeny of the Gibbons'. In: H. Preuschoft, D.J. Chivers, W.Y. Brockelman and N. Creel. (eds.). *The Lesser Apes: Evolutionary and Behavioural Biology*, pp.542–561. Edinburgh, Scotland: Edinburgh University Press.

Groves, C. (2001). *Primate Taxonomy*. Washington DC, USA: Smithsonian Institute Press.

Guy, A.J., Stone, O.M.L. and Curnoe, D. (2012). Assessment of the Release of Rehabilitated Vervet Monkeys into the Ntendeka Wilderness Area, KwaZulu-Natal, South Africa: a case study. *Primates* 53(2):171–179.

Hamard, M.C.L., Cheyne, S.M. and Nijman, V. (2010). 'Vegetation Correlates of Gibbon Density in the Peat-swamp Forest of the Sabangau Catchment, Central Kalimantan, Indonesia'. *American Journal of Primatology* 72(7):607–616.

Hebert, P.L. and Bard, K. (2000). 'Orang-utan Use of Vertical Space in an Innovative Habitat'. *Zoo Biology* 19:239–251.

IATA. (2010). 'Live Animals Regulations. International Air Transport Association'. University of Wisoconsin

IUCN (2013). *The IUCN Red list of Threatened Species*. Version 2014.3. http://www.redlist.org. Downloaded January 20, 2014.

IUCN SSC (2002). *Guidelines for the Placement of Confiscated Animals*. Gland, Switzerland: IUCN Species Survival Commission.

IUCN SSC (2013). *Guidelines for Reintroductions and other Conservation Translocations.* Gland, Switzerland: IUCN Species Survival Commission.

IUCN SSC PSG SSA (2014). 'Gibbon Rehabilitation, Reintroduction and Translocation Workshop'. January 2014 in Phnom Penh, Cambodia.

Jakob-Hoff, R.M. et al., 2014. *Manual of Procedures for Wildlife Disease Risk Analysis*, IUCN Species Survival Commission. Available at: http://www.cbsg.org/sites/cbsg.org/files/documents/IUCN.

Kadhafi, A.M. (2011). 'Characteristics Preferential Studies of Javan Gibbons Habitat at Gunung Tilu Nature Reserve, West Java'. PhD Thesis. Bogor: IPB University.

Kenyon, M. (2007). 'Behavioural Ecology of Golden-cheeked Gibbons (*Nomascus gabriellae*)'. PhD Thesis. Cambridge: University of Cambridge.

Kim, S., Lappan, S. and Choe, J.C. (2010). 'Diet and Ranging Behavior of the Endangered Javan Gibbon (*Hylobates moloch*) in a Submontane Tropical Rainforest'. *American Journal of Primatology* 71:1–11.

King, T., Chamberlan, C. and Courage, A. (2012). 'Assessing Initial Reintroduction Success in Long-lived Primates by Quantifying Survival, Reproduction, and Dispersal Parameters: Western Lowland Gorillas (*Gorilla gorilla gorilla*) in Congo and Gabon'. *International Journal of Primatology* 33:134–149.

King, T., Chamberlan, C. and Courage, A. (2014). 'Assessing Reintroduction Success in Long-lived Primates through Population Viability Analysis: Western Lowland Gorillas (*Gorilla gorilla gorilla*) in Central Africa'. *Oryx* 48:294-303.

Kleiman, D.G. (1989). 'Reintroduction of Captive Mammals for Conservation: Guidelines for Reintroducing Endangered Animals into the Wild'. *Bioscience* 39:152–161.

Kleiman, D.G., Beck, B.B., Dietz, J.M and Dietz, L.A. (1991). 'Costs of Reintroduction and Criteria for Success: Accounting and Accountability in the Golden Lion Tamarin Conservation Program'. *Symposium of the Zoological Society of London* 62:125–142.

Kleiman, D.G. (1996). 'Reintroduction Programs'. In D. G. Kleiman et al., (eds). *Wild mammals in captivity, principles & techniques.* pp. 297–305. Chicago: University of Chicago Press.

Komdeur, J. and Deerenberg, C. (1997). 'The importance of Social Behavior Studies for Conservation'. In: J.R. Clemmons and R. Buchholz (eds.) *Behavioral Approaches to Conservation in the Wild*, pp. 262-277. Cambridge, UK: Cambridge University Press.

Lécu, A. and Ball, R. (2011). 'Mycobacterial Infections in Zoo Animals: Relevance, Diagnosis and Management'. *International Zoo Yearbook* 45:183–202.

MacKinnon, J. and MacKinnon, K. (1977). 'The Formation of a New Gibbon Group'. *Primates* 18(3):701–708.

Mason, W.A. and Berkson, G. (1975). 'Effects of Maternal Mobility on the Development of Rocking and Other Behaviours in Rhesus Monkeys: A Study with Artificial Mothers'. *Developmental Psychobiology* 8:197–211.

Mather, R. (1992). 'Distribution and Abundance of Primates in Northern Kalimantan Tengah: Comparisons with other Parts of Borneo, and Peninsular Malaysia'. In: G. Ismail, M. Mohamed and S. Omar (eds.) *Forest Biology and Conservation in Borneo*, pp. 175-189. Kota Kinabalu: Sabah Foundation.

Meijard, E. and Rawson, B. (In Press). 'The Phylogenetioc Species Concept and it's Role in South-east Asian Mammal Conservation'. In: Behie, A.B. and Oxenham, M.F. *Taxonimic Tapestries: The Threads of Evolutions Behavioural and Conservation Research*, pp. 343-358.

Melfi, V.A. (2013). 'Gibbons: Probably the Most Endangered Primates in the World'. *International Zoo Yearbook* 46:239–240.

Mickelberg, J. and Ballou, J.D. (2013). 'The Golden Lion Tamarin Conservation Programme's One Plan Approach'. *WAZA Magazine* 14:27-29.

Mittermeier, R.A., Rylands, A.B. and Wilson, D.E. (eds.) (2013). '*Handbook of the Mammals of the World: Volume 3: Primates'*. Barcelona, Spain: Lynx Edicions.

Mootnick, A. and Nadler, R.D. (1997). 'Sexual Behaviour of Maternally Separated Gibbons (*Hylobates*)'. *Developmental Psychobiology* 31:149–161.

Mootnick, A.R., Reingold, M., Holshul, H.J. and Mirkovic, R.R. (1998). 'Isolation of a Herpes Simplex Virus-like Agent in the Mountain Agile Gibbon (*Hylobates agilis agilis*)'. *Journal of Zoo & Wildlife Medicine* 29(1):61–64.

Mootnick, A.R. (2006). 'Gibbon (Hylobatidae) Species Identification Recommended for Rescue or Breeding Centers'. *Primate Conservation* 21:103-138.

Neilson, E., Nijman, V. and Nekaris, K.A.I. (2013). 'Conservation Assessments of Arboreal Mammals in Difficult Terrain: Occupancy Modeling of Pileated Gibbons (*Hylobates pileatus*)'. *International Journal of Primatology* 34:823–835.

Nijman, V. and Van Balen, S. (1998). 'A Faunal Survey of the Dieng Mountains, Central Java, Indonesia: Distribution and Conservation of Endemic Primate Taxa'. *Oryx* 32:145–156.

Nijman, V. (2004). 'Conservation of the Javan Gibbon *Hylobates moloch*: Population Estimates, Local Extinctions and Conservation Priorities'. *Raffles Bulletin of Zoology* 51:271–280.

Nijman, V. (2005a). *Hanging in the Balance: An Assessment of the Trade in Orangutans and Gibbons on Kalimantan, Indonesia*. Kuala Lumpur, Malaysia: TRAFFIC South-east Asia.

Nijman, V. (2005b). *In Full Swing: An Assessment of the Trade in Orangutans and Gibbons on Java and Bali, Indonesia.* Kuala Lumpur: TRAFFIC South-east Asia.

Nijman, V. and Menken S.B.J. (2005). 'Assessment of Census Techniques for Estimating Density and Biomass of Gibbons (Primates: Hylobatidae)'. *The Raffles Bulletin of Zoology* 53(1):169–179.

Nijman, V., Martinez, C.Y. and Shepherd, C.R. (2009). 'Saved from Trade: Donated and Confiscated Gibbons in Zoos and Rescue Centres in Indonesia'. *Endangered Species Research* 9:151-157.

Noppornpanth, S., Haagmans, B.L., Bhattarakosol, P., Ratanakorn, P., Niesters, H. G., Osterhaus, A.D and Poovorawan, Y. (2003). 'Molecular Epidemology of Gibbon Hepatitis B Virus Transmission'. *Journal of General Virology* 84:147–155.

Osterberg, P., Samphanthamit, P., Maprang, O., Punnadee, S. and Brockelman W.Y. (2014). Population Dynamics of a Reintroduced Population of Captive Raised Gibbons (*Hylobates lar*) in Phuket, Thailand. *Primate Conservation* 28:179–188.

Osterberg, P., Samphanthamit, P., Maprang, O., Punnadee, S. and Brockelman W.Y. (2015). Gibbon (*Hylobates lar*) Reintroduction Success in Phuket, Thailand, and its Conservation Benefits. *American Journal of Primatology* 77(5):492-501.

Payne, K.L. (2004). Hepatitis B Virus in Silvery Gibbons (*Hylobates moloch*). MSc Thesis. Murdoch University, Australia.

Phoonjampa, R., Koenig, A., Borries, C., Gale, G.A., and Savini, T. (2010). 'Selection of Sleeping Trees in Pileated Gibbons (*Hylobates pileatus*)'. *American Journal of Primatology* 72:617-625.

Raemaekers, J.J. and Raemaekers, P.M. (1984). 'The Ooaa Duet of the Gibbon (*Hylobates lar*): A Group Call which Triggers Other Groups to Respond in Kind'. *Folia Primatologica* 42:209–215.

Rainer, H., White, A. and Lanjouw, A. (eds.) (2014). *State of the Apes: Extractive Industries and Ape Conservation*. Cambridge, UK: Cambridge University Press.

Rawson, B.M. (2010). 'The Use and Abuse of Gibbon Survey Techniques: Shortcomings of Auditory Survey Techniques'. In: Nadler, T., Rawson, B.M. and Van Ngoc Thinh (eds.) *Conservation of Primates in Indochina*, pp.253-258. Hanoi, Vietnam: Frankfurt Zoological Society and Conservation International.

Rawson, B.M., Clements, T. and Nut Meng Hor (2009). 'Status and Conservation of Yellow-cheeked Crested Gibbons (*Nomascus gabriellae*) in the Seima Biodiversity Conservation Area, Mondulkiri Province, Cambodia'. In: S. Lappan, S. and D.J. Whittaker (eds.) *The Gibbons: New Perspectives on Small Ape Socioecology and Population Biology*, pp.378-408. New York, USA: Springer.

Reichard, U. (1998). Sleeping Sites, Sleeping Places and Presleep Behaviour of Gibbons (*Hylobates lar*). *American Journal of Primatology* 46:35–62.

Reinhardt, V. and Smith, M.D. (1988). 'PVC Pipes Effectively Enrich the Environment of Caged Rhesus Macaques'. *Laboratory Primate Newsletter* 27(3):4-5.

Seddon, P.J., Strauss, W.M. and Innes, J. (2012). 'Animal Translocations: What are they and why do we do them?'. In: J.G. Ewen, D.P. Armstrong, K.A. Parker and P.J. Seddon (eds.) *Reintroduction Biology: Integrating Science and Management*, pp.1-32. Chichester, UK: John Wiley & Sons, Ltd.

Shumaker, R.W., Beck, B.B., Brown, L and Taub, S. (1998). 'Observational Learning in Orang-utans'. *American Journal of Primatology* 45(2):208.

Smith, J. (2010). 'Reintroducing Javan Gibbons (*Hylobates moloch*): An Assessment of Behavioral Preparedness'. *The Gibbon's Voice* 12: 2–7.

Strum, S.C. and Southwick, C.H. (1986). 'Translocation of Primates'. In K. Benirschke, (ed). *Primates: The Road to Self-sustaining Populations*. pp. 949–957. New York: Springer Verlag.

Tenaza, R.R. (1975). 'Territory and Monogamy Among Kloss' gibbons (*Hylobates klossii*) in Siberut Island, Indonesia'. *Primates* 24:60–80.

Trayford, H.R. and Farmer, K.H. (2012). 'An Assessment of the Use of Telemetry for Primate Reintroductions'. *Journal for Nature Conservation* 20: 311–325.

Wanelik, K., Abdulazis and Cheyne, S.M. (2013). 'Note-, Phase- and Song-specific Acoustic Variables Contributing to the Individuality of Male Duet Song in the Bornean Southern gibbon (*Hylobates albibarbis*)'. *Primates* 54(2):159-170

Whitten, A.J. (1982). 'The Role of Ants in Selection of Night Trees by Gibbons'. *Biotropica* 14(3): 237–238.

Wimberger, K., Downs, C.T. & Perin, M.R. (2010). 'Postrelease Success of Two Rehabilitated Vervet Monkey (*Chlorocebus aethiops*) Troops in KwaZulu-Natal, South Africa'. *Folia Primatologia* 81:96–108.

Yatbantoong, N. (2007). 'Reintroduction of Pileated Gibbons (*Hylobates pileatus*): A Study in South East Thailand'. MS Thesis. Bangkok, Thailand: Mahidol University.

Zachos, F.E. (2013). 'Taxonomy: Species Splitting Puts Conservation at Risk'. *Nature* 494:35.

OCCASIONAL PAPERS OF THE IUCN SPECIES SURVIVAL COMMISSION

1. *Species Conservation Priorities in the Tropical Forests of Southeast Asia*. Edited by R.A. Mittermeier and W.R. Konstant, 1985, 58pp. (Out of print)

2. *Priorités en matière de conservation des espèces à Madagascar*. Edited by R.A. Mittermeier, L.H. Rakotovao, V. Randrianasolo, E.J. Sterling and D. Devitre, 1987, 167pp. (Out of print)

3. *Biology and Conservation of River Dolphins.* Edited by W.F. Perrin, R.K. Brownell, Zhou Kaiya and Liu Jiankang, 1989, 173pp. (Out of print)

4. *Rodents. A World Survey of Species of Conservation Concern*. Edited by W.Z. Lidicker, Jr., 1989, 60pp.

5. *The Conservation Biology of Tortoises.* Edited by I.R. Swingland and M.W. Klemens, 1989, 202pp. (Out of print)

6. *Biodiversity in Sub-Saharan Africa and its Islands: Conservation, Management, and Sustainable Use.* Compiled by Simon N. Stuart and Richard J. Adams, with a contribution from Martin D. Jenkins, 1991, 242pp.

7. *Polar Bears: Proceedings of the Tenth Working Meeting of the IUCN/SSC Polar Bear Specialist Group*, 1991, 107pp.

8. *Conservation Biology of Lycaenidae (Butterflies).* Edited by T.R. New, 1993, 173pp. (Out of print)

9. *The Conservation Biology of Molluscs: Proceedings of a Symposium held at the 9th International Malacological Congress, Edinburgh, Scotland*, 1986. Edited by Alison Kay. Including a Status Report on Molluscan Diversity, written by Alison Kay, 1995, 81pp.

10. *Polar Bears: Proceedings of the Eleventh Working Meeting of the IUCN/SSC Polar Bear Specialist Group,* January 25 – 28 1993, Copenhagen, Denmark. Compiled and edited by Øystein Wiig, Erik W. Born and Gerald W. Garner, 1995, 192pp.

11. *African Elephant Database* 1995. M.Y. Said, R.N. Chunge, G.C. Craig, C.R. Thouless, R.F.W. Barnes and H.T. Dublin, 1995, *225pp.*

12. *Assessing the Sustainability of Uses of Wild Species: Case Studies and Initial Assessment Procedure*. Edited by Robert and Christine Prescott-Allen, 1996, 135pp.

13. *Tecnicas para el Manejo del Guanaco [Techniques for the Management of the Guanaco].* Edited by Sylvia Puig, Chair of the South American Camelid Specialist Group, 1995, 231pp.

14. *Tourist Hunting in Tanzania.* Edited by N. Leader-Williams, J. A. Kayera and G. L. Overton, 1996, 138pp.

15. *Community-based Conservation in Tanzania*. Edited by N. Leader-Williams, J. A. Kayera and G.L. Overton, 1996, 226pp.

16. *The Live Bird Trade in Tanzania.* Edited by N. Leader-Williams and R.K. Tibanyenda, 1996, 129pp.

17. *Sturgeon Stocks and Caviar Trade Workshop*. Proceedings of a workshop held on 9 – 10 October 1995 Bonn, Germany by the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety and the Federal Agency for Nature Conservation. Edited by Vadin J. Birstein, Andreas Bauer and Astrid Kaiser-Pohlmann. 1997, viii + 88pp.

18. *Manejo y Uso Sustentable de Pecaries en la Amazonia Peruana.* Richard Bodmer, Rolando Aquino, Pablo Puertas, Cesar Reyes, Tula Fang and Nicole Gottdenker, 1997, iv + 102pp.

19. *Proceedings of the Twelfth Working Meeting of the IUCN/SSC Polar Bear Specialist Group,* 3 – 7 February 1997, Oslo, Norway. Compiled and edited by Andrew E. Derocher, Gerald W. Garner, Nicholas J. Lunn and Øystein Wiig, 1998, v + 159pp.

20. *Sharks and their Relatives – Ecology and Conservation*. Written and compiled by Merry Camhi, Sarah Fowler, John Musick, Amie Bräutigam and Sonja Fordham, 1998, iv + 39pp. (Also available in French)

21. *African Antelope Database 1998*. Compiled by Rod East and the IUCN/SSC Antelope Specialist Group, 1999, x + 434pp.

22. *African Elephant Database 1998*. R.F.W. Barnes, G.C. Craig, H.T. Dublin, G. Overton, W. Simons and C.R. Thouless, 1999, vi + 249pp.

23. *Biology and Conservation of Freshwater Cetaceans in Asia*. Edited by Randall R. Reeves, Brian D. Smith and Toshio Kasuya, 2000, viii + 152pp.

24. *Links between Biodiversity Conservation, Livelihoods and Food Security: The sustainable use of wild species for meat*. Edited by S.A. Mainka and M. Trivedi, 2002, ix + 137pp. (Also available in French)

25. *Elasmobranch Biodiversity, Conservation and Management. Proceedings of the International Seminar and Workshop, Sabah, Malaysia, July 1997*. Edited by Sarah L. Fowler, Tim M. Reed and Frances A. Dipper, 2002, xv + 258pp.

26. *Polar Bears: Proceedings of the Thirteenth Working Meeting of the IUCN/SSC Polar Bear Specialist Group, 23 – 28 June 2001*, Nuuk, Greenland. Compiled and edited by N. J. Lunn, S. Schliebe and E. W. Born, 2002, viii + 153pp.

27. *Guidance for CITES Scientific Authorities: Checklist to assist in making non-detriment findings for Appendix II exports*. Compiled by A.R. Rosser and M.J. Haywood, 2002, xi + 146pp.

28. *Turning the Tide: The Eradication of Invasive Species. Proceedings of the International Conference on Eradication of Island Invasives*. Edited by C.R. Veitch and M.N. Clout, 2002, viii + 414pp.

29. *African Elephant Status Report 2002 : an update from the African Elephant Database*. J.J. Blanc, C.R. Thouless, J.A. Hart, H.T. Dublin, I. Douglas-Hamilton, C.G. Craig and R.F.W. Barnes, 2003, vi + 302pp.

30. *Conservation and Development Interventions at the Wildlife/Livestock Interface: Implications for Wildlife, Livestock and Human Health*. Compiled and edited by Steven A. Osofsky; Associate editors: Sarah Cleaveland, William B. Karesh, Michael D. Kock, Philip J. Nyhus, Lisa Starr and Angela Yang. 2005, xxxiii +220pp.

31. *The Status and Distribution of Freshwater Biodiversity in Eastern Africa*. Compiled by W. Darwall, K. Smith, T. Lower and J.-C. Vié, 2005, viii + 36pp.

32. *Polar Bears: Proceedings of the 14th Working Meeting of the IUCN/SSC Polar Bear Specialist Group, 20–24 June 2005, Seattle, Washington, USA*. Compiled and edited by Jon Aars, Nicholas J. Lunn and Andrew E. Derocher. 2006. v + 189pp.

33. *African Elephant Status Report 2007: An update from the African Elephant Database*. Compiled and edited by J.J. Blanc, R.F.W. Barnes, C.G. Craig, H.T. Dublin, C.R. Thouless, I. Douglas-Hamilton and J.A. Hart. 2007. vi + 275pp.

34. *Best Practice Guidelines for Reducing the Impact of Commercial Logging on Great Apes in Western Equatorial Africa*. D. Morgan and C. Sanz. 2007. 32pp.

35. *Guidelines for Great Ape Re-introduction*. Edited by Benjamin Beck, Kristina Walkup, Michelle Rodrigues, Steve Unwin, Dominic Travis, and Tara Stoinski, 2007. 48pp.

36. *Best Practice Guidelines for Surveys and Monitoring of Great Ape Populations*. H. Kühl, F. Maisels, M. Ancrenaz & E.A. Williamson 2008 36pp.

37. *Best Practice Guidelines for the Prevention and Mitigation of conflict Between Humans and Great Apes*. K. Hockings & T. Humle 2009 48pp

38. *Best Practice Guidelines for Wild Great Ape Tourism*. Elizabeth J. Macfie with contributions by Christina Ellis, Chloe Hodgkinson, and Marc Ancrenaz. 84pp

39. *Guidelines for the in situ Re-introduction and Translocation of African and Asian Rhino*. Edited by Richard H Emslie, Rajan Amin & Richard Kock 125pp

40. *Indo pacific Bottlenose Dolphins (Tursiops Aduncus) Assessment Workshop Report*. Edited by R.R. Reeves and R.L Brownell Jr 61pp

41. *Guidelines for the Reintroduction of Galliformes for Conservation Purposes*. Edited by the World Pheasant Association and IUCN/SSC Re-introduction Specialist Group. 2009. 86pp

42. *Island Invasives: Irradication and Management: Proceedings of the International Conference on Island Invasives.* Edited by Veitch, C. R., Clout, M. N. and Towns, D. R. 2011. 542pp.

43. *Polar Bears:* Proceedings of the 15th Working Meeting of the IUCN/SSC Polar Beasr Specialist Group, Copenhgagen, Denmark, 29 June-3 July 2009. 2010. 235pp.

44. *Sustainability Assessment of Beluga (Delphinapterus leucas) Live-capture Removals in the Sakhalin-Amur Region, Okhotsk Sea, Russia: Report of an Independent Scientific Review Panel*. Randall R. Reeves, Robert L. Brownell, Jr., Vladimir Burkanov, Michael C.S. Kingsley, Lloyd F. Lowry, and Barbara L. Taylor Due. 2011. 34pp.

45. *Elephant Meat Trade in Central Africa: Summary Report*. Stiles, D. 2011. 103pp.

46. *CITES and CBNRM: Proceedings of an International Symposium on "The Relevance of CBNRM to the Conservation and Sustainable Use of CITES-listed Species in Exporting Countries" Vienna, Austria, 18-20 May 2011*. Edited by Abensperg-Traun, M., Roe, D. and O'Criodain, C. 2011. 172pp.

47. *IUCN Situation Analysis on East and Southeast Asian Intertidal Habitats, with Particular Reference to the Yellow Sea (Including the Bohai Sea).* MacKinnon, J., Verkuil, Y. I. and Murray, N. 2012. 70pp.

48. *Vital but Vulnerable: Climate Change Vulnerability and Human Use of Wildlife in Africa's Albertine Rift*. Carr, J. A. Outhwaite, W. E., Goodman, G. L. Oldfield, T. E. E. and Foden, W. B. 2013. 224pp.

49. *Great Apes and FSC: Implementing 'Ape-Friendly' Practices in Central African Logging Concessions.* Morgan, D., Sanz, C., Greer, D., Rayden, T., Maisels, F. and Williams, E. A. 2013. 36pp.

Many of these publications are available online on the Species pages of the IUCN website. See http://www.iucn.org/about/work/programmes/species/publications/thematic_publications/

INTERNATIONAL UNION
FOR CONSERVATION OF NATURE

WORLD HEADQUARTERS
Rue Mauverney 28
1196 Gland, Switzerland
Tel +41 22 999 0000
Fax +41 22 999 0002
www.iucn.org