International Conservation Planning Workshop for the Hainan Gibbon

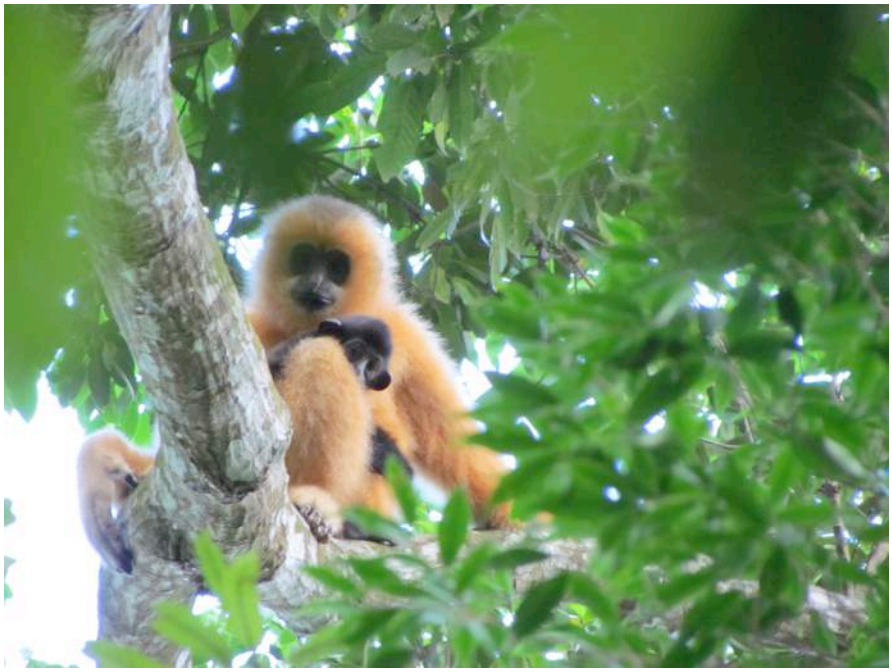
Bo'ao, Hainan, China
18 – 20 March 2014

Final Report

海南长臂猿保护博鳌国际论坛

中国海南省博鳌镇
2014年3月18至20日

总结报告



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A contribution of the IUCN SSC Conservation Breeding Specialist Group.

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ABBREVIATIONS
略 语 表

BNNR	Hainan Bawangling National Nature Reserve 海南霸王岭国家级自然保护区
BNNRMO	Hainan Bawangling National Nature Reserve Management Office 海南霸王岭国家级自然保护区管理局
CBSG	IUCN SSC Conservation Breeding Specialist Group 世界自然保护联盟 物种生存委员会 保护繁育专家组
CPSG	IUCN SSC China Primate Specialist Group 世界自然保护联盟 物种生存委员会 中国灵长类专家组
DWCT	Durrell Wildlife Conservation Trust 英国达雷尔野生动物保护信托
FFI	Fauna and Flora International 野生动植物保护国际
HFB	Hainan Forestry Bureau 海南省林业厅
KFBG	Kadoorie Farm & Botanic Garden 香港嘉道理农场暨植物园
PSG	IUCN SSC Primate Specialist Group 世界自然保护联盟 物种生存委员会 灵长类专家组
ZSL	Zoological Society of London 伦敦动物学会

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SECTION 1

Executive Summary

第一章　　摘要

Executive Summary

Once numbering around 2,000 individuals in the 1950s, the Critically Endangered Hainan gibbon (*Nomascus hainanus*) is now one of the most threatened primate species in the world, primarily due to past habitat loss and hunting. An estimated 23-25 individuals remain, restricted to a single population inhabiting Bawangling National Nature Reserve on Hainan, China, making this an Alliance for Zero Extinction (AZE) target species and a focus of international concern. A conservation planning workshop for the Hainan gibbon was held in 2003, and numerous management activities have been conducted since that time, including efforts to protect and restore potential gibbon habitat, with concurrent growth in the gibbon population. Despite these positive actions, the continued small size of this single population means that it remains at high risk of extinction due to stochastic events as well as other external threats.

To further promote effective conservation of the Hainan gibbon, a new conservation planning workshop was organised by the Zoological Society of London in cooperation with the Hainan Bawangling National Nature Reserve Management Office and the IUCN China Primate Specialist Group, with support from Kadoorie Farm & Botanic Garden and Fauna and Flora International. The IUCN SSC Conservation Breeding Specialist Group was invited to facilitate and provide modelling support. This international species conservation planning workshop was held from 18-20 March 2014 in Bo'ao, Hainan Province, China. Over 50 gibbon experts and stakeholders participated, including representatives from BNNRMO, other government offices, universities, conservation NGOs, zoos and rescue centres, and local communities. Financial support for the workshop was provided by the Arcus Foundation and the Mohamed bin Zayed Species Conservation Fund.

Workshop Process

The workshop began with a series of scientific presentations on gibbon status, genetics, conservation activities, and viability concerns. Participants then articulated their personal visions for the Hainan gibbon, followed by a plenary discussion and subsequent work by a small drafting group to reach a consensus vision statement. A group brainstorming session followed, in which participants identified potential threats, challenges or issues of concern that were thought to impact Hainan gibbon population viability and conservation and to impede realisation of the vision.

These topics were grouped into four major categories to form the basis of further discussion and analysis in small concurrent working groups. Group discussion topics focused on constraints on Hainan gibbons related to: 1) gibbon population status; 2) habitat quality, quantity and connectivity; 3) human activities that may impact gibbons; and 4) policy and effective communication. The Population Status working group later subdivided into three subgroups to tackle different aspects of population-related issues.

The working groups further defined the threats associated with each of these categories, their causes and consequences, and the degree of certainty in terms of the impact on gibbons. Goals were developed to address each threat, and management and research actions were recommended to help achieve these goals. Each group then discussed priority actions to achieve these goals, evaluating all alternatives based on potential benefit, costs, risks, and likelihood of success. Timelines, responsible parties/collaborators, resources needed, and priority for action were identified when possible for all recommended actions. Periodic

plenary reporting sessions allowed all workshop participants to provide relevant expertise and feedback for all discussion topics. Designated and volunteer translators provided essential translation between Chinese (Mandarin) and English for all plenary and working group sessions, both oral and written as needed.

Vortex Modelling as a PVA Tool

Prior to the workshop, a population model was developed for the surviving Hainan gibbon population using the Vortex software programme. A draft model was presented to a subgroup of gibbon experts in a pre-workshop meeting on 17 March to refine model inputs and assumptions. This model then was used to conduct a Population Viability Analysis (PVA) for the Hainan gibbon based on best estimates of current and anticipated future conditions. Sensitivity testing was used to identify those aspects of the population that most affected population viability.

Model results suggest that the Hainan gibbon is likely to be at high risk of extinction in the long term. The major factors affecting viability of the Hainan gibbon are its small population size, restriction to a single location, and low genetic variation. Future population growth and expansion are affected both by gibbon demographic rates (survival, group formation, and reproduction) and by habitat quality and quantity. These results informed the workshop participants regarding the vulnerability of this small single population and potential strategies for its conservation.

Summary of Workshop Findings

Workshop participants considered all information presented in the scientific presentations as well as the PVA conclusions to develop a consensus on a vision for Hainan gibbons, which included expansion of the gibbon population both in size and number of populations into several large areas as part of intact forest ecosystems:

> *VISION: We envision an increased healthy population of Hainan gibbons living in several large areas as part of intact biodiverse forest ecosystems. We envision this population as enjoying full support of the local community, the general public, the private sector and the government, and to be a source of local and national pride into the future.*

This vision helped to define a common understanding among the workshop participants on their ultimate goal for the species, and to guide the development of goals and actions to help achieve this vision.

Key goals identified by the workshop included:

1) effective protection and enhancement of gibbon habitat and connectivity at BNNR;
2) expansion of gibbons into additional good-quality habitat;
3) continued monitoring and improved understanding of factors affecting successful dispersal, breeding group formation, and colonisation of new habitat;
4) development of an emergency action plan in the event of a crisis situation; and
5) improved communication to facilitate collaboration among stakeholders.

Strong support was shown by all stakeholders to develop a more secure future for this rare primate species unique to Hainan.

This workshop report and the recommendations within it are considered advisory to the local and regional management teams for the Hainan gibbon and other collaborators, to help guide actions thought to be beneficial to the long-term survival of the Hainan gibbon in China.

摘要

上世纪五十年代海南长臂猿 (*Nomascus hainanus*) 的数量约有两千只，由于近年来它们的栖息地遭受到破坏和捕猎的影响，现已成为世界上最珍稀的灵长类动物。现今估计种群数量只有23-25只，栖息于海南霸王岭国家级自然保护区内，它被名列为“零灭绝联盟”（AZE）的濒危目标物种，也是国际社会重点关注的保护对象。于2003年首届海南长臂猿保护行动研讨会在海南霸王岭举办，此后，相关部门和机构在海南霸王岭国家级自然保护区开展和实施了与海南长臂猿保护工作有关的管理活动，其中包括长臂猿栖息地的保护与恢复，增加其种群数量，从13只增至到23只。尽管近年来的保护工作取到一定的成效，但是海南长臂猿种群数量依然较低，它们依旧处于灭绝的边缘，易受到随机事件和其它外来威胁。

为了有效地加强海南长臂猿的保护，伦敦动物学会、海南霸王岭国家级自然保护区管理局与中国灵长类专家组合力举办是次海南长臂猿保护论坛，同时得到香港嘉道理农场暨植物园与野生动植物保护国际的大力支持。世界自然保护联盟 物种生存委员会保护繁育专家组受邀担任论坛主持并提供技术支持。论坛于2014年3月18-20日在海南省琼海市博鳌镇举行，逾50位专家与相关者参与，包括保护区管理局工作人员、相关政府部门代表、来自科研单位、环保组织、动物园和救护中心的长臂猿专家以及当地社区代表。此次论坛由亚克斯基金会和穆罕默德本扎耶德物种保护基金赞助。

会议流程

会议的开幕式包括一系列的科学报告，其中包括对海南长臂猿的种群现状、基因特征、保护活动与面临的困难等基本情况进行介绍。首先，参会人员各自表达对海南长臂猿保护的展望，然后，经过全体参会人员的讨论，提出了一个共同的对海南长臂猿保护的远景声明。之后，参会人员进行小组讨论，对影响长臂猿种群生存、保护、及其潜在威胁、面临的问题、和潜在威胁和困难等因素进行了讨论。

所有讨论主题分为四类：（1）长臂猿种群现状，（2）栖息地质量、面积和连通性，（3）人类活动影响，（4）政策与管理。参会人员按照不同讨论主题分为四个工作小组，进行深入的讨论，其中，第一类讨论主题（长臂猿种群现状）工作小组又被分成三个亚组，针对种群不同三个方面进行讨论。

每个工作小组针对该组的讨论主题，进一步明确涉及其讨论主题的有关威胁因素，包括这些因素的起因、对长臂猿影响程度和产生的影响。每个主要威胁因素确立保护目标，依据确立好的目标提出相应的保护行动及建议。随后，工作小组对每个保护行动的有效性、风险和成功率进行评估，并对时间安排、相关合作部门的职能职责、优先行动等内容进行详细的讨论。当每个工作小组讨论完毕后，进行全体会议，彼此分享讨论的结果，并达成共识。会议上翻译员即时进行中英双向翻译，交流沟通无阻，从而保障会议顺利地进行。

种群生存力分析工具 – 漩涡模型

CBSG用漩涡模型软件为海南长臂猿建立了一个种群生存力的模型。于2014年3月17日举行了一次专家咨询会对该模型进行评估与调试，最终产生一个能够合理推测海南

长臂猿种群现在和未来的动态模型，并通过敏感性测试，指出影响种群生存力的主要因素，用来进行种群生存力的分析。

该模型结果显示，在未来较长时间内海南长臂猿种群灭绝的形势依然严峻。该物种濒临灭绝主要原因归于（1）种群数量太小，（2）种群分布集中，（3）种群遗传多样性较低。长臂猿种群数量增加取决于它的人口率（如存活率、种群形成与繁殖）和栖息地的面积与质量。以上结果对长臂猿的种群脆弱性和其相关保护建议具有重要的参考价值。

论坛结果概要

根据有关长臂猿有关的科学性文献资料和种群模型分析，参会人员共同确定了海南长臂猿的保护远景：

“我们期望海南长臂猿能够在更广阔的森林生态系统中健康地成长。我们期望在当地社区、公众、私营企业及政府有关部门的共同支持下，海南长臂猿物种能够得到更好地保护，并成为全人类引以为傲的物种。”

这个保护远景有利于参会人员更加了解物种保护规划的目标，同时，引导他们为实现该远景提出相应的保护策略与保护行动。

保护目标包括：

1）有效保护长臂猿栖息地，提高其栖息地质量与连通性
2）扩大长臂猿栖息地的面积
3）持续地进行该种群的监测和研究，以提高种群数量的增长和加快种群形成的速度
4）为可能发生的紧急情况确立紧急应变计划，做好万全准备
5）加强所有利益相关者之间的沟通与合作

所有参会的利益相关者对加强海南长臂猿保护、提高物种生存力都表示强烈支持。

此报告对当地、区域管理机构和其它合作部门在海南长臂猿保护工作上提出指导性的建议。

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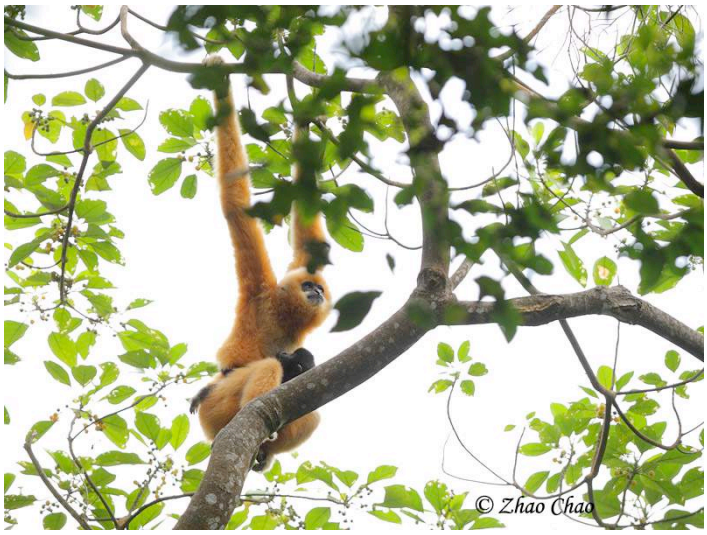

SECTION 2

Status Review

第二章　海南长臂猿现状综述

Status Review

The Critically Endangered Hainan gibbon (*Nomascus hainanus*), the only gibbon species endemic to China, is the world's rarest ape and unquestionably one of the world's most threatened mammals. Conservation of the Hainan gibbon therefore represents one of the most urgent priorities for mammal conservation at a global level.

Taxonomy and Systematics

Gibbon taxonomy is complex, and confusion over the taxonomic status of gibbons on Hainan has persisted until relatively recently, potentially hindering their conservation prioritisation. For much of the twentieth century, the Hainan gibbon was considered to be conspecific with the black crested gibbon (*Nomascus concolor*, formerly assigned to the genus *Hylobates*), which is present in China in southwestern Yunnan Province, although it was interpreted by many authors as being distinct at the subspecies level from populations in mainland China. More recently, it was considered to be possibly conspecific with the Cao Vit gibbon (*Nomascus nasutus*), which persists as a tiny, Critically Endangered population on the China-Vietnam border. As a result, different reports and publications from recent decades provide a bewildering range of taxonomic nomenclature for the Hainan gibbon, which in some cases explicitly reflects the uncertainty over its taxonomic relationships (e.g. *Hylobates concolor*, *Hylobates concolor hainanus*, *Nomascus* sp. cf. *nasutus hainanus*; Zhang and Sheeran 1993; Wu *et al*. 2004; Chan *et al*. 2005). Recent genetic research has clarified this persistent taxonomic confusion, and supports other proposed evidence (e.g. vocalisation behaviour, pelage colouration) for distinct species status of the Hainan gibbon. This genetic analysis has demonstrated that not only is the Hainan gibbon a valid species, but also that it represents a relatively ancient lineage within the Hylobatidae, which diverged from all other extant gibbon species over three million years ago (Thinh *et al*. 2010).

Historical Trends

Historical records indicate that the Hainan gibbon was once widespread across Hainan, with a widely cited estimate of about 2000 individuals distributed across 12 counties in the 1950s (Liu *et al*. 1984), but experienced a severe and precipitous decline between the 1950s and the 1980s (Chan *et al*. 2005) (Figure 1). This decline was driven by two main causes: a major decline in the extent and condition of forest on Hainan, specifically linked to the timber industry policy of clear-cutting and the development of a local rubber industry dependent on establishment of extensive rubber plantations; and intensive targeted hunting, primarily for Traditional Chinese Medicine (Liu *et al*. 1984; Zhou *et al*. 2005). By the time that field research on the species began with the work of Liu Zhenhe and colleagues in the early 1980s, the global population was estimated to number a total of only 30-40 individuals, with possibly as few as seven individuals surviving at Bawangling (Liu *et al*. 1984).

Current Status

Although isolated gibbon populations are now known to have persisted in a few other forest areas across Hainan during the 1980s and possibly more recently (Zhou *et al*. 2005), periodic surveys from 2003 onwards have failed to locate any populations or individuals outside BNNR (Chan *et al*. 2005; Fellowes *et al*. 2008; BPL Chan, personal communication 2014). Today only a single gibbon population of around 25 individuals in BNNR is known to exist, making this an Alliance for Zero Extinction (AZE) target species and a focus of major international concern. This population consists of only three social groups (Groups A, B and

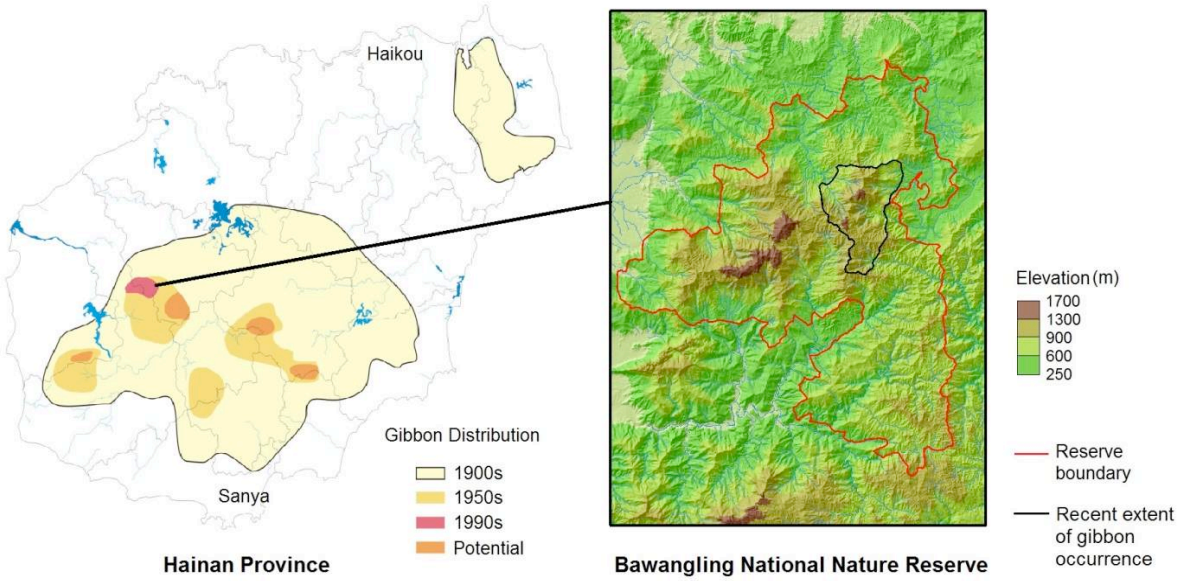

Figure 1. Left, past and present distribution of Hainan gibbons across Hainan Province, China. Right, current distribution of Hainan gibbons within BNNR.

C), together with an unknown but likely small number of solitary individuals (up to four), and contains only five females of breeding age who are in established social groups. Although BNNR is almost 300 km^2 in total area and straddles two counties (Changjiang and Baisha Li Autonomous Counties), the surviving gibbon population is apparently restricted to approximately 15 km^2 of highly fragmented, relatively high elevation and apparently suboptimal forest habitat, centred around the Futouling region of the reserve (Figure 1).

Field research by both Chinese and international researchers over the past three decades has gathered data on a number of key aspects of Hainan gibbon biology, behaviour and ecology, notably: home range and spatial requirements, feeding ecology, calling behaviour, reproductive biology, social group size and structure, and genetic diversity. Bawangling was gazetted as a protected area in 1980 to protect the Hainan gibbon and its habitat, and the species was afforded national protection in 1988 under the Chinese Wildlife Protection Law (Geissmann and Bleisch 2008).

Recent Conservation Efforts

In 2003, an international conservation planning meeting was held to formulate a conservation strategy for the Hainan gibbon, and the first Conservation Action Plan for the species was produced in 2005 based on the conclusions and recommendations from that meeting (Chan *et al*. 2005). This action plan recommended management actions to address recognised threats to the Hainan gibbon, with specific actions including:

- ongoing monitoring of the sole known gibbon population;
- improved patrol effectiveness to minimise harmful human activities, including hunting, logging and forest clearance;
- implementation of a publicity campaign to raise awareness of the species; and
- reforestation of degraded habitats in strategic locations with species valuable to gibbons.

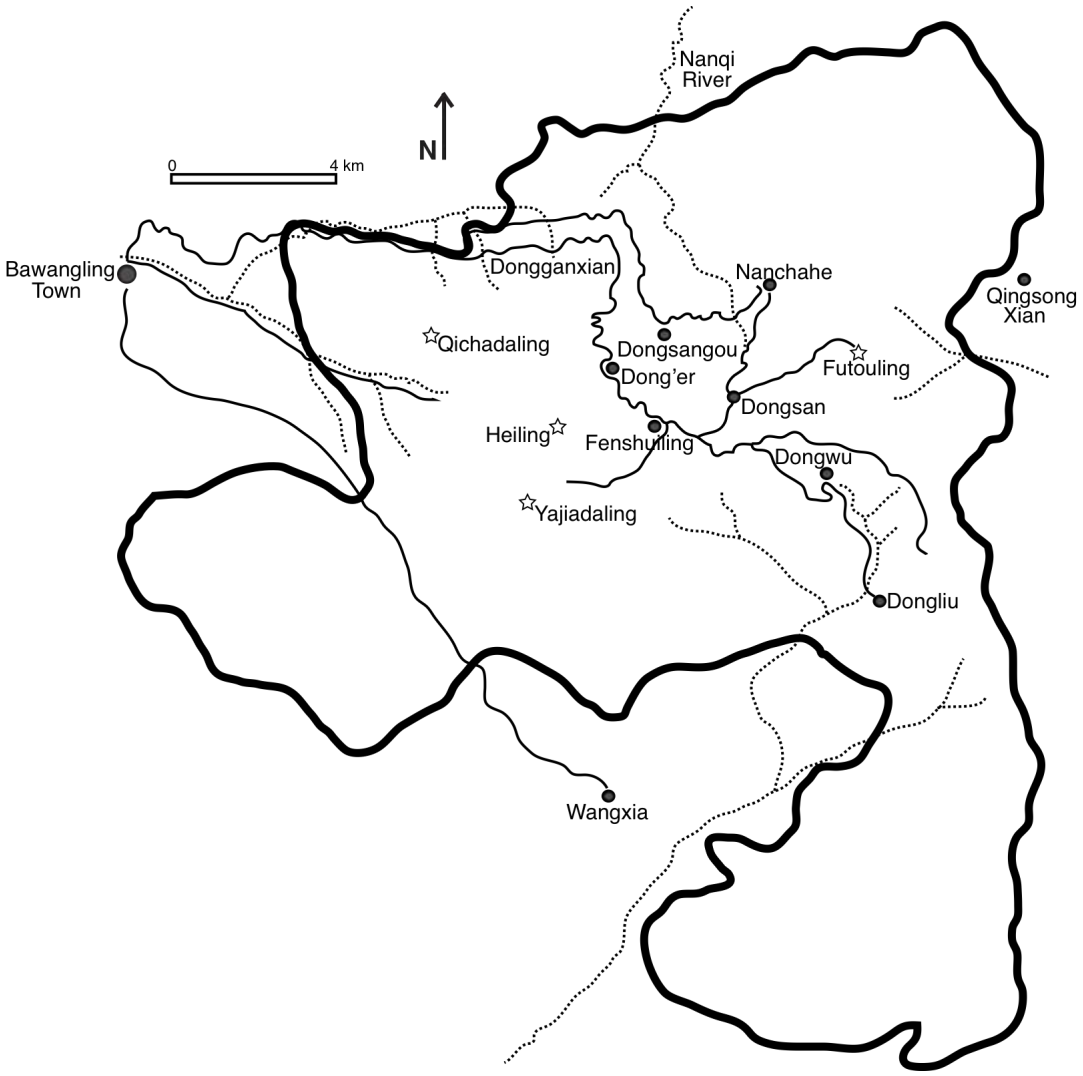

Figure 2. Map showing key sites across the BNNR landscape mentioned in the text. Key: thick line, approximate reserve boundary; thin lines, roads/tracks; dotted lines, rivers; stars, mountain peaks.

Additional recommendations put forward by this action plan also included research requirements (including improving understanding of direct threats to gibbon survival, and locating any additional gibbons surviving in Hainan), and establishing the capacity of the BNNR Management Office to conserve both the Hainan gibbon and the wider forest ecosystem as a whole. Since the 2003 planning meeting, management action to date has focused primarily on monitoring and protecting the remaining gibbon population at BNNR, on broader long-term landscape-level restoration of the BNNR habitat, and activities to raise public awareness.

Despite these formal protection measures, and an apparently normal birth rate (Fellowes *et al*. 2008), the species has shown little consistent population growth. Although a third social group (Group C) formed in 2011, dispersing subadult gibbons at BNNR typically fail to form new social groups after they leave their natal group. Available census data suggests that the overall population has fluctuated between around 15 and 25 gibbons for almost 30 years,

Figure 3. View of the Futouling forest area of BNNR from the road, showing medium-elevation forest habitat currently occupied by Hainan gibbons within a wider partly human-modified landscape.

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and has failed to grow beyond 25 individuals (e.g. Liu *et al*. 1989; Zhang and Sheeran 1993; Wu *et al*. 2004; Zhou *et al*. 2005; Li *et al*. 2010). The reasons behind this apparent lack of recovery are not well understood. However, unfortunately it is not possible to determine whether this apparent fluctuation reflects genuine variation in population size, or alternately a result of differential effort or detection success between surveys due to use of different survey techniques or experience of researchers.

Small Population Concerns

The lack of population growth shown by the sole known surviving Hainan gibbon population raises serious concerns for long-term survival of the species. Its continued small population size makes it vulnerable to stochastic processes and genetic impacts that threaten the species' long-term persistence. Small populations are at risk of severe decline or even extinction due to random fluctuations in demographic rates (e.g. temporary skewed sex ratio) and environmental conditions (e.g. a series of 'bad' years with low food availability). 'Catastrophic' events, either natural (e.g. disease outbreak) or human-related (e.g. poaching) have a greater negative impact on small populations. Small populations also lose genetic variation faster and at a rate that cannot be replaced through mutation, meaning that such populations can lose their potential to adapt to new conditions and become increasingly vulnerable over time to inbreeding effects. Any of these processes can lead to reduced

survival, reduced reproduction, and/or a decline in population size, making the population even more vulnerable and likely to decline further, a feedback loop known as the "extinction vortex" (Gilpin and Soulé 1986). Once underway, this process becomes even more challenging to halt or reverse. With only one population of Hainan gibbons remaining, there is no backup for the species if this population suddenly declines or is extirpated.

Increasingly, various population management strategies are being used to counteract the impacts of stochastic processes that affect population size, demography (survival and reproduction) and genetics. These techniques can maintain short-term viability and prevent imminent extinction until all threats are reduced and the population can be expanded to a more secure size. Two recently revised IUCN guidelines, one for reintroduction and conservation translocation (IUCN/SSC 2013) and the second for *ex situ* management for conservation (IUCN/SSC 2014), provide a decision-making process for considering such options.

Planning for the Future

Long-term Hainan gibbon recovery will require not only effective conservation of the last surviving gibbon population in its restricted patch of forest at BNNR, but also gibbon population growth and range expansion across the wider BNNR forest landscape and beyond to recover its former geographic distribution. As has been the case for other species of extreme rarity, long-term recovery of the Hainan gibbon is likely to require intensive, carefully planned and co-ordinated conservation management.

海南长臂猿现状综述

海南长臂猿 (*Nomascus hainanus*) 被世界保护联盟定为极度濒危物种，是中国唯一特有的长臂猿物种，也是世上最稀有的猿类和世界上最受威胁的哺乳类动物。因此，海南长臂猿被视为全球性的重点保护对象。

物种分类学

长臂猿的分类比较复杂和具有争议性，而海南长臂猿的分类直到近年才被确定和公认，正因如此可能因而延误了对它的保护。在20世纪，专家一直认为海南长臂猿与分布于云南省西南部的西黑冠长臂猿 （*Nomascus concolor*, 过去被视为 *Hylobates*属）属同一个种物种或属于亚种关系。它也曾被认为与栖息于中国与越南边境交界地区的东黑冠长臂猿 （*N. nasutus*）属同一个物种。因而，这些不同的分类反映了海南长臂猿的分类具有争议性和不确定性（如 *Hylobates concolor*, *H. concolor hainanus*, *N.* sp. cf. *nasutus hainanus*; Zhang and Sheeran 1993; Wu *et al*. 2004; Chan *et al*. 2005）。这个疑团直至近年才被遗传基因学研究真正地解开，遗传学研究证明了它不仅是一个独立种，还是长臂猿科中一个古老的类群，在三百万年前就与其它种类的长臂猿有明显的区别，独力演化（Thinh *et al*. 2010），而它的鸣叫行为和毛色也说明了它的特有属性。

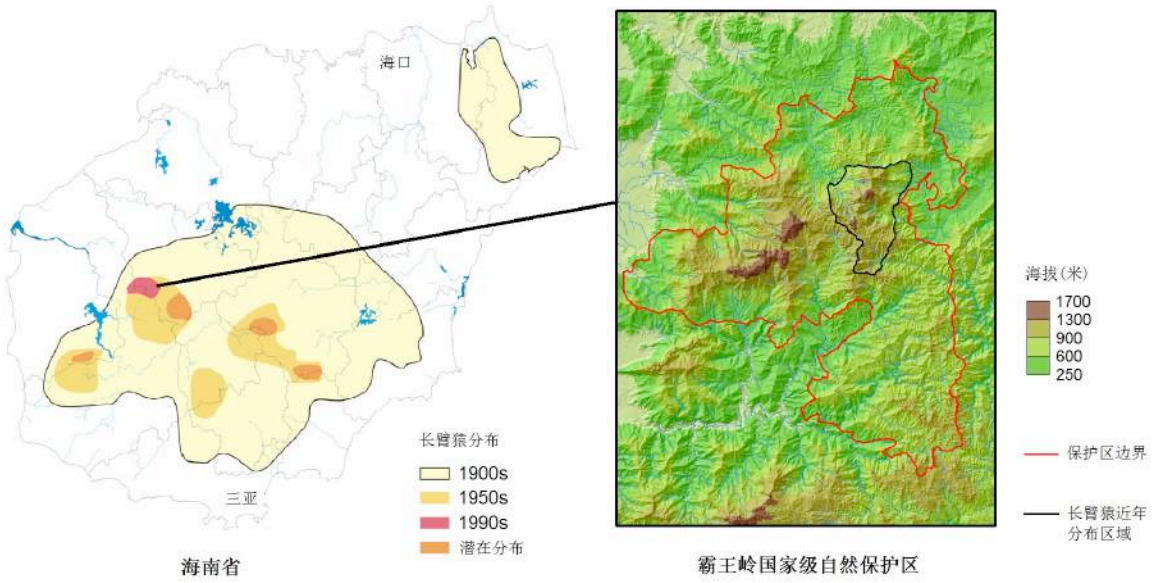
历史演化

历史记载了海南长臂猿曾在海南省广泛分布，在上世纪五十年代它遍布海南省的十二个县，其数量约有2000只 （Liu *et al*. 1984），但在20世纪五十年代到八十年代期间，海南长臂猿的数量急剧下降（Chan *et al*. 2005）（图1）。导致其数量下降主要有两个原因：一是林业改革大力地推动用材林和橡胶林大面积、单一的种植模式，使天然林遭受大规模的破坏；二是因长臂猿具有药用价值，加大人类的狩猎活动（Liu *et al*. 1984; Zhou *et al*. 2005）。当刘振河等（1984）专家在20世纪八十年代初对海南长臂猿的数量统计进行野外调查，估计其全球数量已下降至30-40只，而在霸王岭地区可能只有7只（Liu *et al*. 1984）。

种群现状

在20世纪八十年代，其它种群的长臂猿生存在除了霸王岭以外的森林中（Zhou *et al*. 2005）， 不幸的是多年来对长臂猿进行多次不同规模的搜查活动，都未在海南其它森林中发现其它种群的踪迹（Chan *et al*. 2005; Fellowes *et al*. 2008; 陈辈乐, 个人通信 2014）。现今，唯一能确认的长臂猿种群只栖息于海南霸王岭保护区内，数量仅约25只，成为了“零灭绝联盟 （Alliance for Zero Extinction）”的濒危物种之一和国际重点关注的保护对象。海南长臂猿种群有三个家庭群（即为A、B、C群），及数量尚不明确的独猿（估计不超过4只）。虽然霸王岭保护区总面积有300平方公里，横跨昌江与白沙两个自治县，然而海南长臂猿仅分布于斧头岭一带的15平方公里范围内（图一），这片森林分片，海拔地势较高，不利于长臂猿生存。

通过国内外研究人员近三十年的努力，使得我们对海南长臂猿这种生物的行为与形态特征有了基本的理解，包括对栖息地条件的需求、食性、鸣叫行为、繁殖特征、社会结构和遗传多样性等。海南霸王岭保护区成立于1980年，针对海南长臂猿的栖息地进行管护；海南长臂猿则在1988年被列为国家级保护动物，受《野生动物保护法》的保护（Geissmann and Bleisch 2008）。



图一 海南长臂猿过去和现在的分布（左）。海南长臂猿现在在霸王岭保护区内的分布区域（右）。

近年保护工作

首届海南长臂猿保护行动研讨会于2003年举行，根据研讨会成果发表了第一个海南长臂猿保护行动计划（Chan *et al*. 2005）。此行动计划提出了一系列的管理措施，主要包括以下几个方面：

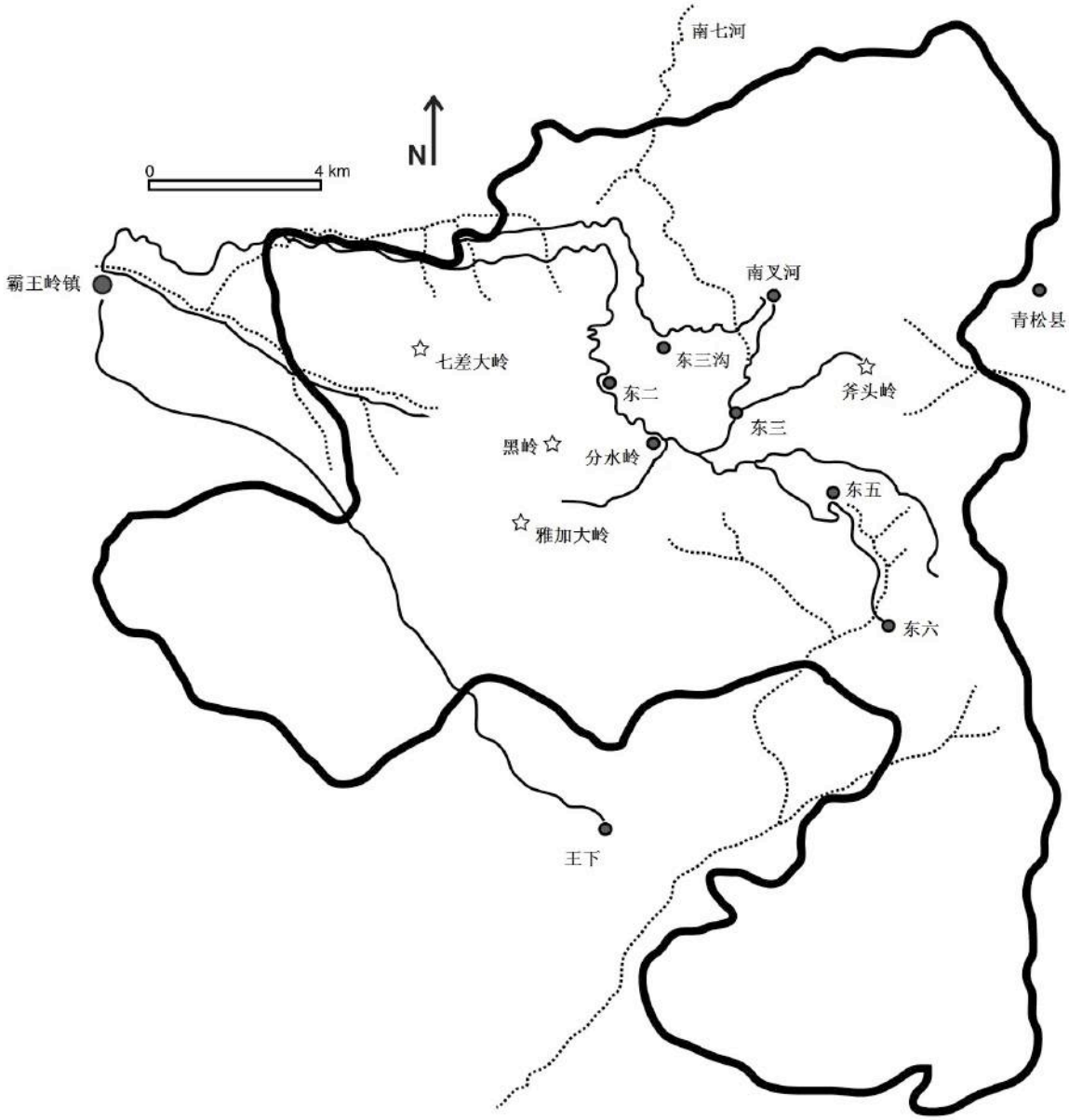
- 对海南长臂猿种群进行持续的监测；
- 加大人类活动的管护力度，减少捕猎和森林破坏等活动；
- 加强宣传教育活动，提高公众对海南长臂猿保护意识；
- 在特定的区域种植利于长臂猿生存的树种，从而有利于恢复和扩大其栖息地。

此行动计划还提出研究方向（如，分析长臂猿面临的威胁和寻找其未知的种群），和如何加强对海南长臂猿的保护工作及其栖息地的恢复和管护。自2003年起，海南长臂猿的保护工作主要是对霸王岭保护区内的特有的长臂猿种群的保护、监测、，栖息地恢复和传宣教育等工作。

在这些悉心管护工作和种群能正常繁殖（Fellowes *et al*. 2008）的情形下，长臂猿种群数量依然未能增长。虽然于2011年发现新组成的长臂猿家庭群（C群），多年来生活在霸王岭中大部分的年轻独猿均不能成功组建新家庭。调查数据表明，海南长臂猿的数量在过去30年内一直于15-25只数量之间波动，未能突破25只（如Liu *et al*. 1989; Zhang and Sheeran 1993; Wu *et al*. 2004; Zhou et al. 2005; Li *et al*. 2010）其数量未能增加的原因不明，可能是因为该物种的自然发展轨迹，也可能是在调查中调查手段和力度存在不同的的差异。

小种群的保护问题

由于海南长臂猿种群数量缺乏持续性增长，引起人们对其生存能力的担忧。若长臂猿种群数量无法稳步增长，小种群易受到随机作用（如性别比不均衡）、遗传多样性



图二 主要地名与地标。粗线：保护区范围；细线：道路；虚线：河流；星号：主峰。

低和自然环境条件（如因恶劣自然条件导致的食物短缺）的共同影响下，不利于小种群的生存，使而种群衰退甚至灭绝。而自然灾害（如导致疾病的爆发）与人为因素（如偷猎）等事件也会对小种群具有严重的影响。小种群的遗传多样性的流失速度相对较快，使得种群适应环境的能力降低，近亲繁殖的风险也会变高。以上所述的任何一种情况都可能导致小种群死亡率增加，繁殖率下降，种群数量减少，让该物种更加容易受到各种威胁，因而陷入“灭绝漩涡”（Gilpin and Soulé 1986）。若物种一旦陷入“灭绝漩涡”，种群退化速度加快，种群将要面临灭绝。海南长臂猿现存只有一个种群，它的消失意味着物种的灭亡，因此海南长臂猿的保护工作任重道远。

为了减少濒危物种的随机作用，多种种群管理手段在近年开始被广泛应用，有利于提高种群数量、生存力和遗传多样性，有效地确保种群数量，增强生存力，从而避免

灭绝。世界保护联盟产出了两份最新的技术指导，一是放归和迁地保护（IUCN/SSC 2013），二是异地保护（IUCN/SSC 2014），这些指导能够帮助有关部门评估相关管理手段的有效性和可行性，作出合理的决策。

展望未来

海南长臂猿种群的长期保护不仅需要致力于对其进行有效管护，还必须增大长臂猿种群的栖息地面积，扩大它在海南省的地理分布。与保护其它极度濒危物种一样，海南长臂猿种群的保护及其栖息地的恢复需要有效的、科学的保护管理计划。

图三 斧头岭景观。海南长臂猿现栖息于半山腰，被退化植被所包围。

International Conservation Planning Workshop for the Hainan Gibbon

Bo'ao, Hainan, China
18 – 20 March 2014

Final Report

海南长臂猿保护博鳌国际论坛

中国海南省博鳌镇
2014年3月18至20日

总结报告

SECTION 3

Vision Statement and Threat Analysis
Plenary Discussion

第三章　　全体会议: 愿景宣言和威胁评估

Plenary Discussion: Vision Statement and Threat Analysis

Once the scientific overview presentations concluded, the remainder of the first day of the workshop was spent in group plenary discussion, to develop a common vision for the Hainan gibbon and to use the participants' knowledge to begin an analysis of the threats or potential threats to Hainan gibbon conservation.

Vision Statement

A vision statement is a short statement that outlines the desired future state of the species, and is long-term and ambitious. There may be several different components to a vision statement, including the scope (i.e. geographic range, time scale) and representation, functionality, and desired degree of management intervention.

During introductions, each workshop participant was asked to describe his or her vision for Hainan gibbons as the future desired state. Participants then engaged in a plenary discussion of the desired future for the Hainan gibbon, and generated a list of components that were integrated (by a small subgroup) to form the following vision:

> ***VISION: We envision an increased healthy population of Hainan gibbons living in several large areas as part of intact biodiverse forest ecosystems. We envision this population as enjoying full support of the local community, the general public, the private sector and the government, and to be a source of local and national pride into the future.***

This vision helped to define a common understanding among the workshop participants on their ultimate goal for the species, and to guide the development of objectives and actions to help achieve this vision. Specific components that were considered included expansion (in both population size and number of populations) of Hainan gibbons; the importance of natural ecosystems; and stakeholder support for gibbon conservation.

Threat Analysis

A thorough understanding of factors that impact the viability of the Hainan gibbon population is important to identify and evaluate management strategies to address these threats and promote viability.

Workshop participants were asked to brainstorm and contribute threats or challenges to Hainan gibbon conservation. They wrote each threat or issue on a card (in both Chinese and English) and placed it on the wall. Clusters of related factors were identified to form the basis of more detailed working group discussions.

Below is the list of these challenges or threats generated by the workshop participants. This was a brainstorming exercise in which all ideas were gathered prior to discussion or further consideration. This list is not prioritised and represents individual opinions and potential concerns, not the consensus of the group; rather, it represents a starting point for further workshop discussions and analysis.

Small population size
Restricted to one population
Decline in reproductive rate
Low survivorship
Demographic stochasticity
Sex ratio imbalance
Breakdown in social behavior
Lack of territories for dispersing subadults
Inbreeding
Low genetic diversity
Low survival of dispersing gibbons
No information on solitary/dispersed gibbons
Insufficient scientific knowledge
Lack of in-depth scientific research
Lack of ecological knowledge
Need more information on forest ecology
Dry season starvation in gibbons
Deforestation
Habitat loss and fragmentation
Low habitat quality
Small habitat size
No possibility for population to expand
Lack of canopy connectivity
Lack of lowland habitat
Specialised habitat requirements
Roads through habitat
Ongoing encroachment from cattle pastures
Biodiversity loss
Plantations
Economic pressure for more rubber plantations
Human disturbance
Tourism development
Hunting
Capture
Market-driven bushmeat
Economic value of the gibbon
Medicinal value of the gibbon
Outdated traditions/beliefs in local communities
Domestic animals
Improper human behavior (e.g. feeding)
Lack of incentive for local people to protect
Increasing human population
Unsustainable economic development
Poverty in the local community
Lack of alternative livelihoods for local villagers
Human-gibbon competition for resources
Conflict between community resource use and conservation
Local resentment of conservation measures
Land ownership disputes
Pollution or toxins
Invasive species
Disease outbreak
Zoonosis
Typhoon
Fire
Extreme weather
Climate change
Lack of collaboration among stakeholders
Lack of shared ownership
No coordination of conservation activities
Complicated institutional landscape
Politics
Government bureaucracy
Apathy
Delays/lack of urgency in making necessary management decisions
Lack of action
Lack of understanding about stochastic threats to small populations
Unwillingness to consider 'risky' intensive management decisions
Lack of sufficient funding
Lack of sufficient conservation staff
Insufficient policy support
Low conservation awareness of community
Public awareness

The complex interconnectivity of these issues makes it difficult to subset them into mutually exclusive categories. However, it was possible to identify four primary categories of issues or potential threats:

1. Issues related to the gibbon population and its current status;
2. Issues related to gibbon habitat;
3. Potential impacts of human activities on gibbons; and
4. Issues related to policy and stakeholder communication.

These categories formed the basis of four working group discussions for the remainder of the workshop.

Working Group Discussions

Each of the four working groups were asked to complete the following tasks, using existing information from the 2005 Conservation Action Plan and other sources of data available at the workshop (Chinese-language and English-language scientific publications on the Hainan gibbon; stakeholder knowledge of specific conditions relating to Hainan gibbons, the ecology and management of BNNR, etc.) as relevant or appropriate:

Issue Development

1. Discuss the threats or issues that fall within your group's topic. Consider the causes of each issue or threat and the consequences for Hainan gibbons.
2. Develop a problem statement for each issue that describes the root cause, intermediate steps, and resulting impact on gibbons.
3. Identify where these relationships are based on data or on assumptions, and identify any important data gaps.
4. Categorise each issue as having a High, Moderate or Low impact on gibbon viability.

Goal and Recommended Actions

1. For each problem statement, develop one or more long-term goals to address the problem and contribute to gibbon conservation. Consider adding short-term goals to work toward achieving the primary goal.
2. Identify potential strategies for achieving each goal. For each strategy, consider the conservation benefit, costs, risks, and likelihood of success.
3. Choose one or more actions per goal as appropriate based on the above evaluation.
4. For each recommended action, identify the following:
    a. Resources needed
    b. Responsible party
    c. Collaborators and potential partners
    d. Timeline
    e. Potential conservation benefit (High/Moderate/Low)
    f. Likelihood of success (High/Moderate/Low)
    g. Priority for action (High/Moderate/Low)

A plenary session was held at regular intervals during the workshop to allow each working group to summarise their discussions, decisions, and recommendations to the entire group. This allowed all workshop participants to provide feedback and additional information to all working group discussions and topics, and to take full advantage of all expertise present.

The results of each working group discussion and their respective recommended actions are presented in Sections 4–7 of this report. It is important to note that different working groups sometimes recommended similar actions to address different identified categories of issues facing the Hainan gibbon; to avoid repetition and maintain clarity in the structure of this report, thematically similar actions recommended by different groups are grouped together in the text below, with a clear statement of which group proposed each action. Estimated costs associated with different actions are presented in the sections below where these costs were estimated during working group discussions.

全体会议：愿景宣言和威胁评估

科学报告结束后，与会人员在全体会议上为海南长臂猿的共同愿景以及物种现在与未来面临的威胁进行研讨。

愿景宣言

愿景宣言扼要描述物种未来的理想状态，包含地理分布和时间范围，物种数量，以及生态功能与管理水平等。

每个与会人员首先各自描述了对海南长臂猿的展望，在集体讨论重点以后交由写作小组最终产生以下宣言：

“我们期望海南长臂猿能够在更广阔的森林生态系统中健康地成长。我们期望在当地社区、公众、私营企业及政府有关部门的共同支持下，海南长臂猿物种能够得到更好地保护，并成为全人类引以为傲的物种。”

这个共同愿景帮助与会人员了解物种保护规划的目标，同时，引导他们为实现该愿景提出相应的保护目的与行动。其中包括几个重要组成部分：种群数量的增长（在个体数量与种群数量两方面）、自然生态系统的重要性，以及各利益相关者对长臂猿保护的关注与支持。

威胁评估

系统分析影响海南长臂猿种群生存力的各种威胁因素是有效管理的前提。

与会人员把物种可能面对的威胁因素写在卡片上（中英文），并粘贴于墙上。这些威胁因素稍后被分成四个题目，成为工作小组的研讨主题。以下将列举若干的威胁因素，这些因素只用作研讨的基础，并不分优先次序也不代表所有人的共同看法。

极小种群
单个种群
繁殖率下降
生存率较低
种群特征与过程的随机性
性别比不平衡
社会行为退化
扩散的年轻独猿缺乏建立领地所需的生境
近亲繁殖
遗传多样性较低
扩散的年轻独猿生存率低
对扩散的年轻独猿了解太少
缺乏足够的科学知识
缺乏深入的科学调查
缺乏生态知识
对森林生态系统的知识不足
长臂猿在旱季缺乏食物
森林砍伐
栖息地破坏与破碎化
栖息地质量较低
栖息地面积不足
缺乏种群扩散的可能性
林冠连通性差
缺乏低地生境（最适宜生境）
特化的生境要求
穿越栖息地的公路
放牧压力
生物多样性下降
经济林
橡胶树的经济价值

人类活动的干扰
旅游开发
捕杀
捕捉
野味市场
长臂猿的经济价值
长臂猿的药用价值
当地社区已落伍的传统观念
家养禽畜
不适当的人类行为，如投食
当地居民缺乏保护动机
人口增长
不可持续的经济开发
贫困
缺乏替代生计
人猿之间的资源冲突
社区资源使用与自然保护的冲突
居民对保护政策与部门的误解/怨恨
土地所有权纠纷
环境污染与毒素
入侵物种
疾病暴发
人畜共患病
台风
林火
极端气候
气候变化
利益相关者之间缺乏沟通与合作
缺乏共有权
保护活动缺乏合作与协调性
管理混乱
政治因素
政府部门官僚主义
缺少社会关注
管理决策的延误
缺乏行动
缺乏对小种群随机性威胁的认知
管理者不愿承担高强度管理手段的风险
保护/管理经费不足
管理人员不足
缺乏政策支持
当地保护意识不足
公众意识不足

威胁因素被分为四大类，略有重叠：

1. 关于长臂猿种群特征与现状的议题
2. 关于长臂猿栖息地的议题
3. 人类活动对长臂猿的潜在威胁
4. 与政策和利益相关者关系相关的议题

研讨会的往后部分围绕以上四个主要题目分四个工作小组进行针对性的讨论。

工作小组讨论

每个工作小组须根据2005年的保护行动计划以及有关海南长臂猿的所有中英文文献还有相关部门专家意见等完成以下任务：

议题的拓展

1. 对每个议题/威胁因素的前因与后果进行讨论。
2. 为每个威胁因素编写一句扼要陈述，说明问题的根源、影响过程以及最终对海南长臂猿造成的影响。
3. 表明各因果关系是有确切数据支撑的还是推测，并指出哪些重要数据有待补充。
4. 把每个威胁因素对种群生存力的影响力分为高、中、低等。

保护目的与建议行动

1. 为每个问题陈述定立一个或多个长远保护目标，能有效解决或缓和该威胁对长臂猿的影响。在适当情况下考虑通过短期目标来达成长远目标。
2. 针对每个保护目标提出相应对策，并分析每个对策的保护效果、所需经费、风险与成功率。
3. 根据上述分析对所以保护行动建议进行筛选。
4. 指出每个建议行动的：
   a) 所需资源
   b) 负责单位
   c) 合作单位
   d) 时间安排
   e) 保护效果 (高/中/低)
   f) 成功机率 (高/中/低)
   g) 优先性 (高/中/低)

每节小组讨论后均进行全体会议，分享讨论内容、决策过程和保护建议。这环节让每个与会人员有机会为不同工作小组提供建议，以更有效发挥在场人士的专业及本土特长。

以下第四至第七章分别是四个工作小组的工作总结报告。 应注意不同工作小组可能会为解决不同方面的问题提出类似的答案，为了减少报告内容的重复，以下建议行动的叙述会把同类的建议集中，并标明提出该建议的工作小组。以下所有内容，包括经费预算，均是会上讨论的结果，并没有在会后经过确认或修改。

International Conservation Planning Workshop for the Hainan Gibbon

Bo'ao, Hainan, China
18 – 20 March 2014

Final Report

海南长臂猿保护博鳌国际论坛

中国海南省博鳌镇
2014年3月18至20日

总结报告

SECTION 4

Population Status Constraints
Working Group Report

第四章　工作小组报告:种群现状

Participants

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Catastrophic Decline Subgroup:

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Vicky MELFI, Taronga Conservation Society, Australia
Ulrike STREICHER, Cuc Phuong National Park, Vietnam

All participants of this working group first met together to identify and discuss issues related to the current status of the Hainan gibbon population, its demographic, genetic and life history characteristics, and important knowledge gaps in these areas. The participants then split into three smaller working groups to focus concurrently on different aspects of these issues: gibbon breeding group formation; habitat connectivity; and potential for catastrophic decline in the population.

General Problem Statement

The ultimate problem is that there is one population of only 20+ individuals remaining for the Hainan gibbon. The major population-level mechanisms considered to be affecting this small population are low survival, low recruitment, and low rate of group formation, all of which are highly important to address. Population growth may be limited by external factors such as lack of space for new territory formation, human activities, and catastrophes. If these threats are not mitigated soon, the population is likely to be trapped by the "extinction vortex", making it increasingly difficult to recover.

Major Issues Identified

Low Rate of Group Formation

Other than the formation of Group C in 2011, dispersing gibbon individuals at BNNR do not seem to be finding mates or forming new groups. Possible root causes are:

1. Familiarity between individuals possibly affecting mate selection and driving lack of mating.
2. Lack of suitable habitat into which gibbons can disperse and establish new territory.
3. Low population density leading to post-dispersal difficulties in locating potential mates.
4. Lack of availability and suitability of mates; as a comparison, captive gibbons of other species may require up to seven choices of mates before a successful pairing occurs (Aurelien Brulé, pers. comm.).

Possible Low Survivorship/Recruitment

From an estimated population of 13 Hainan gibbons in 2003 (Chan *et al*. 2005), the gibbon population at BNNR has increased to 23 individuals found in the 2013 survey. While the average inter-birth interval for this species and the number of breeding females recorded at BNNR are known, rates of mortality are harder to calculate given the uncertain fate of dispersing subadults; although there are no reports of known gibbon mortalities during the past decade, this observation is likely to be uninformative about true mortality rates in the BNNR population. Low survivorship was suspected in different age classes, especially in dispersing young adult individuals that are crucial for new group formation and recruitment. The root causes of low survivorship/recruitment could be:

1. High seasonality and low quality of habitat, making it difficult for young individuals to find enough food when dispersing.
2. Infant mortality due to nulliparous (inexperienced) females or females with poor body conditions (unable to feed infant).
3. Competitive exclusion of lone gibbons by social groups for access of food.
4. Aggressive contact of lone gibbons with territorial groups, leading to death of lone gibbons.
5. Potential inbreeding effects leading to increased mortality.
6. Sex ratio imbalance.

Lack of Space for Territories

Past reports (e.g. Liu *et al*. 1989; Chan *et al*. 2005; Zhang *et al*. 2010) indicate that the amount of connected habitat available to gibbons at BNNR is approximately 15 km^2, although BNNRMO reports that they can occupy a larger connected area of 30 km^2; irrespective of which estimate is preferred, the total amount of connected forest habitat currently available at BNNR, and therefore the regional carrying capacity for gibbons, is limited. This available habitat may also be suboptimal for gibbons (Chan *et al*. 2005), and low habitat quality may be associated with increased home range size (e.g. to enable foraging across a larger area in order to find sufficient food), leading to further lack of suitable habitats for the formation of new groups and to potential starvation of lone gibbons. How might the establishment of new groups in the BNNR landscape be assisted, if there is currently a restriction of suitable quality habitat as well as lack of space within that habitat? The group evaluated a number of options that could improve habitat connectivity to address lack of space for territories.

Stochastic Processes Resulting in Dramatic Population Decline

Stochastic processes can be genetic, environmental, demographic, and catastrophic. For this discussion, the group focused on monitoring and, if necessary, reacting to catastrophic declines in population size due to natural or human-driven catastrophes, environmental variation, or demographic stochasticity. Currently, there is no management action plan for

dealing with rapid decline in the BNNR gibbon population due to an unpredictable event; the reserve only has a fire management plan, which is not specific as to the gibbon population. The development of a formal BNNR Emergency Management Plan for the gibbon population should be considered, at least to monitor the population to determine the potential impact of catastrophes or other stochastic processes.

Due to the large number of participants and complexity of issues, the group was divided into three subgroups on the second day of workshop according to the major mechanisms identified. These were:

1. **Gibbon Group Formation Subgroup** (low rate of group formation)
2. **Habitat Availability and Connectivity Subgroup** (both low survivorship and habitat connectivity)
3. **Catastrophic Decline Subgroup** (potential future catastrophic declines in the gibbon population)

Summaries of the discussion of these three subgroups are given below and in Table 1.

Mechanism	*Long-term goals*	*Medium-term goals*	*Short-term goals*	*Data available*	*Assumption?*	*Research Priority*
Low rate of group formation	1) Increased population size; 2) Fate of dispersing individuals better understood; 3) Mortality rates better understood	1) Stop tapping pine resin; 2) Build new road so existing road through BNNR can be removed; 3) Increase monitoring capacity	1) Increased patrolling in adjacent forest to reduce human disturbance; 2) Improve monitoring data management; 3) More detailed habitat surveys			
Familiarity between individuals possibly driving lack of mating				No	Yes (based on other species)	No
Low population density leading to issues with dispersal and lack of available/suitable mates				Partial	Yes	Yes
Lack of suitable habitat into which gibbons can disperse				Partial	Yes	Yes
Possible low survivorship	Closer monitoring of all individuals, including behavioural data	1) Data needed on gibbon sleeping trees; 2) Habitat modelling with phenology data	1) Investigate new monitoring techniques, e.g. bioacoustic monitoring			
Highly-seasonal/low-quality habitat, leading to starvation of dispersing individuals				No	Low-quality habitat	Yes
Competitive exclusion of lone individuals by groups for access to food				No	Yes	??
Aggressive contact with territorial groups, leading to death of lone individuals				No	Yes	No
Inbreeding issues leading to mortality				No	Yes	No
Low recruitment into breeding population				Partial	Yes	Yes
Low habitat connectivity in the reserve limiting space for group territories	Larger area occupied by gibbons	Evaluate all habitat connectivity methods, e.g. rope bridges, reforestation	Better understanding of habitat (satellite data with ground-truthing)			
Forest canopy is discontinuous, which could limit gibbon movement				Yes	Yes	Yes

Table 1. Goals, data availability, assumptions, and research priority for mechanisms likely to regulate the status of the small gibbon population.

Gibbon Group Formation *and* Habitat Availability and Connectivity Subgroups

There proved to be considerable overlap of goals, concerns, and proposed actions between the Gibbon Group Formation Subgroup and the Habitat Availability and Connectivity Subgroup. Most of the goals and actions that were proposed by each subgroup are therefore treated together below in order to avoid repetition, with a clear statement of which subgroup proposed each action. There was also further overlap of goals and concerns between both subgroups (and in particular the Habitat Availability and Connectivity Subgroup) and the separate Habitat Constraints Working Group (see Section 5); some of the goals and actions proposed by these subgroups are therefore presented and discussed under the Habitat Constraints Working Group section, again with a clear statement of which group proposed each action, in order to streamline the structure of the report and clarify the overall recommendations for Hainan gibbon conservation that were proposed during the workshop.

Gibbon Group Formation Subgroup Problem Statement
Dispersing individuals (known to be of both sexes) are apparently not finding mates and thus not forming new groups.

Habitat Availability and Connectivity Subgroup Problem Statement
There is a lack of understanding of survivorship of dispersing individuals and lack of suitable quality habitat for new group formation.

ACTIONS 1.1 – 1.10

Gibbon Group Formation Subgroup, <u>GOAL 1</u>: Strengthen capacity to detect gibbons, to enable improved monitoring of the known gibbon population at BNNR, and potential detection of other surviving gibbon populations or lone individuals within and outside BNNR.

Habitat Availability and Connectivity Subgroup, <u>GOAL 1</u>: Improve understanding of the fate/survival of dispersing individuals.

(*Actions associated with these two goals are treated together below, due to the similarity between both goals and close overlap of recommended actions*)

ACTION 1.1: Improve monitoring of individuals in all social groups
Although each of the three gibbon social groups at BNNR is currently the focus of regular monitoring efforts by BNNRMO, there is considerably less clarity about the history, long-term social dynamics, or fate of almost any specific individuals within any of these groups. Increased information on these topics would be likely to assist in understanding and predicting changes in social group size, composition and dynamics, and potentially also in dispersal events and the likelihood of new social group formation. Additional information on specific aspects of gibbon behavioural ecology at BNNR, such as the location of gibbon sleeping trees (none are currently known), would also be extremely useful to collect through such improved monitoring. Although identification of most individual gibbons is difficult, direct behavioural observations should therefore be conducted and recorded on a regular basis for all groups, and also for lone gibbons if possible. It would be ideal if these observations could include reproductive and parental behaviours.

<u>Resources needed</u>: Not specified

Responsible party: BNNRMO
Collaborators/potential partners: ZSL, KFBG
Timeline: As soon as possible
Potential benefit: HIGH
Likelihood of success: HIGH
Priority: HIGH
(*Proposed by Gibbon Group Formation Subgroup*)

ACTION 1.2: Tracking of subadult individuals

Although the BNNR gibbon population still displays an apparently normal birth rate (Fellowes *et al*. 2008), individual gibbons (mainly young adults) dispersing from their natal group almost always fail to form new social groups. Instead they become extremely difficult to monitor once they have left the group and become solitary, when they typically fail to be detected on a regular basis by on-site monitoring efforts and are only encountered opportunistically. Existing monitoring activities should increase data collection on subadult individuals in all three social groups at BNNR, with monitoring of these individuals conducted on a monthly scale, in order to improve understanding of the fate of dispersing individuals. However, individual identification of subadult Hainan gibbons is likely to be a substantial challenge (see also Action 1.3 below).

Resources needed: Substantial time, funding (USD $10,000–50,000) and manpower
Responsible party: BNNRMO
Collaborators/potential partners: Not specified
Timeline: 6-12 month period, initiate as soon as possible
Potential benefit: HIGH
Likelihood of success: Moderate
Priority: HIGH
(*Proposed by Habitat Availability and Connectivity Subgroup*)

ACTION 1.3: Develop an individual identification guide/report

Monitoring of the BNNR gibbon population would be improved if BNNRMO staff, monitoring teams and researchers were able to visually identify individual gibbons. It would therefore be useful to try to develop a photographic and descriptive guide that can be learnt and used by all monitoring staff; it would also be useful if this guide could be supplemented with sound recordings of known individuals. However, visual identification of most Hainan gibbon individuals with certainty may not be possible, and such a guide will definitely require regular updating; an electronic guide may therefore be preferable to a printed guide, to facilitate these regular updates.

Resources needed: Not specified
Responsible party: BNNRMO
Collaborators/potential partners: Thomas Geissmann
Timeline: Three month period, initiate as soon as possible
Potential benefit: HIGH
Likelihood of success: Moderate
Priority: HIGH
(*Proposed by Habitat Availability and Connectivity Subgroup*)

ACTION 1.4: Possible habituation of Group C to enhance future monitoring of dispersing individuals

At present, Group B is the only habituated gibbon social group at BNNR, and this group has provided the great majority of all known data on Hainan gibbon ecology and behaviour. Of the other two existing social groups at BNNR, the newly-formed Group C appears to be slightly less sensitive to human presence than Group A, and it could therefore be possible to habituate Group C to provide further data on Hainan gibbon behavioural ecology. Habituation of Group C could potentially be achieved through a graduate student project. However, habituated gibbons are at much greater risk of being hunted, which could represent a particular threat to Group C, as its territory is currently relatively close to human settlements. In contrast, the working group explicitly suggested that Group A, which is highly sensitive to human presence, should not be habituated, so that some gibbons within BNNR retain their natural aversion to humans and may therefore remain less vulnerable to hunting and other anthropogenic disturbance. Given the tiny overall population size of the Hainan gibbon, the fact that nearly all data on the species comes from a single social group may ultimately be a limitation that we have to accept.

Resources needed: USD $50,000–100,000 to allow for university fees, stipend and field costs for three-year study
Responsible party: BNNRMO
Collaborators/potential partners: Jiang Xuelong
Timeline: three years, initiated after a graduate student can be recruited
Potential benefit: HIGH
Likelihood of success: HIGH
Priority: Moderately HIGH
(*Proposed by Habitat Availability and Connectivity Subgroup*)

Actions 1.5–1.7 describe different monitoring or survey techniques that may permit more accurate and systematic evaluation of the distribution and status of the BNNR gibbon population, including both the three social groups and lone individuals, and may also be of use in trying to detect further currently unknown gibbons outside the Futouling region of BNNR.

ACTION 1.5: Increase the frequency and area surveyed by fixed-point counts

At present, monitoring of the three gibbon social groups at BNNR is conducted using a combination of opportunistic follows and detection from a series of fixed high-elevation listening posts. Data from this combined ongoing survey effort are used to monitor changes in the location of each group within the BNNR landscape. The most basic enhancement of this current survey effort would be to increase the number of listening posts and the frequency of survey effort using these listening posts (although this is dependent upon Action 1.8 below). This could also enable more precise estimates of gibbon group occurrence and movement patterns if analysed within an appropriate statistical framework (e.g. triangulation). Formal census techniques using this framework could also be expanded to other areas outside the known Hainan gibbon distribution, in the hope of detecting other populations and/or lone individuals (although see comments under Action 1.7 below about the reduced likelihood of detecting rarely calling solitary individuals).

Resources needed: Team of monitoring staff/students
Responsible party: BNNRMO
Collaborators/potential partners: ZSL, KFBG, Susan Cheyne
Timeline: As soon as possible

Potential benefit: HIGH
Likelihood of success: HIGH
Priority: HIGH
(*Proposed by Gibbon Group Formation Subgroup*)

ACTION 1.6: Conduct playback experiments in unoccupied forest
Gibbons can be difficult to detect if they do not call regularly, making detection of lone individuals and isolated populations often labour-intensive or difficult using standard monitoring/census techniques. Detection of such individuals or groups may be increased through call playback, which can prompt investigation of the novel call. Previous field studies of other gibbon species suggest that call playback for at least a week is likely to attract new gibbon groups to investigate (Aurelien Brulé, pers. comm.). This approach needs to first be trialled in areas of BNNR currently occupied by gibbons, in order to assess its effectiveness for this species under available field conditions, but it is considered likely to represent a means to identify the presence of gibbon individuals in an area of interest. However, it may not necessarily encourage gibbons to become established in a new territory.

Resources needed: Audio recorder/player
Responsible party: BNNRMO
Collaborators/potential partners: ZSL, KFBG, Susan Cheyne, Aurelien Brulé, Kashmira Kakati
Timeline: As soon as possible
Potential benefit: HIGH
Likelihood of success: HIGH
Priority: HIGH
(*Proposed by Gibbon Group Formation Subgroup*)

ACTION 1.7: Employ new acoustic technologies to support monitoring efforts
The fact that gibbons call regularly forms the basis of traditional census techniques for these species, whereby researchers either listen opportunistically for calls or use a more formal sampling process, for example involving fixed-point counts from listening posts (see Action 1.5 above). This behavioural characteristic of gibbons also means that it should be possible to use novel approaches that have already been developed for other species and other systems (e.g. in two ongoing orang-utan studies; Susan Cheyne, pers. comm.), which involve placing passive bioacoustic recording devices in the landscape to record calls remotely. This approach can have two potential uses for Hainan gibbon survey work: to support ongoing monitoring of the currently known population at BNNR by providing an additional monitoring tool, and as a census technique to try to detect other currently unknown gibbon populations. This method should be initially trialled within the known range of the Hainan gibbon groups at Futouling to determine its effectiveness. It is more likely to be effective for detecting gibbon social groups rather than solitary individuals, which are likely to be more silent; however, solitary males are known to call periodically and solitary females can also vocalise, suggesting that it may also be useful for detecting solitary individuals at BNNR and potentially elsewhere. However, it should be noted that this method may not prove to be appropriate for the BNNR landscape, that false signals (not gibbon calls) may also be recorded, and that data processing is time intensive.

Resources needed: Audio recorders (recognise the potential risk of theft); USD $100,000–500,000 to allow for university fees, stipend and field costs for three-year study
Responsible party: BNNRMO

Collaborators/potential partners: ZSL, KFBG, Susan Cheyne, Aurelien Brulé, along with appropriate academic institutions specialising in bioacoustic monitoring techniques (e.g. Cornell Lab of Ornithology) to support student and train BNNR staff in techniques
Timeline: As soon as possible (to be initiated within 6-12 months)
Potential benefit: HIGH
Likelihood of success: HIGH
Priority: HIGH
(*Proposed by both subgroups*)

Once Actions 1.5–1.7 have been conducted, an assessment of their relative effectiveness should be carried out to determine which techniques and actions are most appropriate to use for Hainan gibbon surveys and monitoring.

ACTION 1.8: Increase survey effort on the ground at BNNR
The various survey methods described in Actions 1.5–1.7 above differ in terms of ease of implementation and impact. However, all of these methods, and in particular the currently employed strategies that rely on the use of listening posts and gibbon follows by the BNNR monitoring teams, are labour-intensive and require relatively substantial manpower. Increased staff capacity within the current BNNR monitoring team would therefore greatly increase the effectiveness and capacity of BNNRMO to monitor the known Hainan gibbon population. More patrolling by BNNRMO staff would also increase the likelihood of opportunistically encountering lone gibbons, and detecting and deterring illegal activities within the reserve.

Resources needed: Not specified
Responsible party: BNNRMO
Collaborators/potential partners: ZSL, KFBG, FFI
Timeline: Dependent upon availability of suitably trained and funded staff
Potential benefit: Moderate
Likelihood of success: HIGH
Priority: HIGH
(*Proposed by Gibbon Group Formation Subgroup*)

ACTION 1.9: Conduct community surveys within and outside BNNR to investigate reports of possible recent gibbon sightings
Several stakeholders (e.g. KFBG, FFI) have reported hearing from local forest users (villagers, hunters, park wardens) about possible recent sightings of lone gibbons or small gibbon groups in areas outside the known distribution of the species in the Futouling region of BNNR. These regions include both other areas of the BNNR landscape (the Yajia region to the west of Futouling), and also forest areas outside BNNR elsewhere across Hainan where gibbons are known to have occurred in past decades (e.g. Diaoluoshan, Jiaxi, Limushan, Wuzhishan, Yinggeling). Systematic collection and interpretation of such sighting reports through community-based surveys interviewing local forest users in each of these regions (using standard techniques developed in other projects) will permit better assessment of the plausibility of such reports, and may help to identify sites where further direct survey activities could be conducted to try to locate previously undetected gibbons.

Resources needed: Interview teams, funding for community-based fieldwork
Responsible party: Not specified
Collaborators/potential partners: ZSL, FFI, KFBG, BNNRMO, relevant management authorities of other protected areas across Hainan

Timeline: As soon as possible
Potential benefit: HIGH
Likelihood of success: HIGH
Priority: HIGH
(*Proposed by Gibbon Group Formation Subgroup*)

ACTION 1.10: Survey forest areas within and outside BNNR for other gibbon populations or individuals

Based on the recommendations of stakeholders with expert knowledge of Hainan's forests (e.g. BPL Chan, KFBG) and the results of the proposed community interview surveys investigating possible local gibbon reports (see Action 1.9 above), comprehensive and systematic field surveys should also be carried out to try to locate any surviving gibbon populations or lone individuals in forest areas across Hainan, including both areas of BNNR other than the Futouling region, and also other regions outside BNNR that may conceivably still contain gibbons (see Action 1.9 above). These surveys could utilise one or more of the methods detailed in Actions 1.5–1.7 above. If any gibbons are found during these surveys, appropriate management options will then have to be rigorously and systematically evaluated with input from all key stakeholders.

Resources needed: Not specified
Responsible party: Not specified
Collaborators/potential partners: ZSL, FFI, KFBG, BNNRMO, relevant management authorities of other protected areas across Hainan
Timeline: As soon as possible
Potential benefit: HIGH
Likelihood of success: HIGH
Priority: HIGH
(*Proposed by Gibbon Group Formation Subgroup*)

ACTIONS 2.1 – 2.4

Gibbon Group Formation Subgroup, GOAL 2: Facilitate new group formation.

ACTION 2.1: Increase habitat availability for new groups by investigating and removing local human disturbance

At present, gibbon social groups do not occupy the full extent of connected forest habitat in the Futouling region of BNNR, with a fairly substantial area of forest in the southwestern part of this forest patch (locally known as the Dongwu region or "Big Fig Valley" and the surrounding region) currently unoccupied. This area could conceivably support additional gibbon social group(s); part of the area was formerly within the home range of Group B several years ago, indicating that the forest is still likely to represent suitable gibbon habitat. It is unclear what has caused gibbons to abandon the southwestern part of the Futouling forest area, but it is considered possible that local disturbance from human activities may be responsible. It is therefore important to determine the magnitude and nature of any human disturbance within this region of forest, how it may be negatively affecting gibbons and preventing their recolonisation of the forest, and the best way to minimise or remove this disturbance. Further patterns of human disturbance in forest patches across the wider BNNR landscape, and how this disturbance might potentially affect gibbon populations present in these regions in the future, also needs to be better understood.

Resources needed: Not specified
Responsible party: BNNRMO
Collaborators/potential partners: ZSL, KFBG, FFI, Jiang Haisheng
Timeline: As soon as possible
Potential benefit: HIGH
Likelihood of success: HIGH
Priority: HIGH
(*Proposed by Gibbon Group Formation Subgroup*)

ACTION 2.2: Attract or encourage gibbons into new forest by provisioning
Provisioning represents a recommended low-risk strategy that could be employed as a potential step to attract gibbons into a new area of habitat, either into the connected southwestern part of the Futouling forest patch or elsewhere within the BNNR landscape if/when suitable habitat connectivity is established. Risks to gibbon behaviour are low if provisioning is conducted with wild food and for a short time only (e.g. 1-4 weeks). Provisioning could also represent a first step in possible translocation, if such an action were to be considered feasible and necessary for Hainan gibbon conservation (although see Actions 2.3 and 2.4 below).

Resources needed: Not specified
Responsible party: BNNRMO
Collaborators/potential partners: Not specified
Timeline: Not an immediate action
Potential benefit: HIGH
Likelihood of success: Unknown
Priority: Low
(*Proposed by Gibbon Group Formation Subgroup*)

Long-term recovery of the Hainan gibbon is likely to require intensive conservation management, which for many other species of extreme rarity (e.g. black-footed ferret *Mustela nigripes*; Mauritius kestrel *Falco punctatus*; California condor *Gymnogyps californianus*; Madagascar pochard *Aythya innotata*) has typically involved some kind of "hands-on" manipulation of the last surviving individuals of the species to try to maximise breeding success and/or population growth (May 1986; Groombridge *et al*. 2004; Bamford *et al*. 2015). In fact, the recovery of a Critically Endangered species from a handful of surviving individuals back to a reasonably healthy population has rarely occurred in the absence of intensive conservation manipulation; the Rodrigues Fody (*Foudia flavicans*) is an example of such a more 'natural' population recovery, associated only with habitat restoration (Groombridge *et al*. 2004), although examples of species that have become globally extinct due to delays in development and implementation of urgently-needed intensive conservation recovery programmes are also unfortunately easy to list (e.g. po'ouli *Melamprosops phaeosoma*, Yangtze River dolphin *Lipotes vexillifer*, Christmas Island pipistrelle *Pipistrellus murrayi*; Groombridge *et al*. 2004; Turvey 2008; Martin *et al*. 2012; Ng *et al*. 2014). However, such activities are inherently both high-risk and highly sensitive to stakeholders, and must be considered extremely carefully.

The only potential intensive recovery manipulations to encourage population growth that were thought to be worth considering for the Hainan gibbon at this stage of the species recovery process by participants at the workshop involved the possibility of wild-to-wild translocation of gibbons from the Futouling area of BNNR to an alternative protected

location within the BNNR landscape, where they might be more likely to establish new social groups and/or have greater reproductive success. Such translocations could be guided by the recently developed IUCN gibbon rehabilitation and translocation guidelines (Campbell *et al*. 2015), and with expert advice from a number of workshop attendees who have considerable experience in intensive conservation activities for gibbons in several range states. For the time being, it was felt that translocations were not an immediate priority activity to undertake for Hainan gibbon conservation. In particular, PVA modelling conducted prior to the workshop demonstrated that removal of any gibbon individuals from the existing BNNR population for translocation or other purposes would severely compromise the potential survival of the source population (Bryant 2014). However, feasibility studies to be conducted and/or advised by these stakeholders were recommended by the working group, to investigate whether translocations could be conducted safely in the BNNR landscape and with the resources and capacity available, and under what conditions translocations might become a future priority. It should also be noted that translocations and other intensive conservation management scenarios were considered in more depth as potential management strategies by the Catastrophic Decline Subgroup in the event of a sudden population decline of the BNNR gibbon population (see below).

Two different translocation scenarios were discussed by the working group, as follows:

ACTION 2.3: Translocate solitary individuals to form a new social group

It was suggested in working group discussions that solitary male and female gibbon individuals believed to be present in the northern part of the Futouling forest patch may be unable to form new social groups in this region due to the close proximity of established gibbon groups, but may also be unable to cross the territories of these groups to colonise the currently unoccupied southwestern region of the Futouling forest. One potential option that was discussed in the working group was therefore to consider the feasibility of wild-to-wild translocation of solitary individuals to the unoccupied southwestern forest region (or possibly to a separate forest patch within the wider BNNR landscape), to facilitate potential new social group formation. In addition to the other risks associated with any wild-to-wild gibbon translocations, the concern was raised that translocated gibbons may try to return to their previously occupied territories and could be killed when crossing the territories of established social groups.

Resources needed: Not specified
Responsible party: BNNRMO
Collaborators/potential partners: Not specified
Timeline: Not an immediate action
Potential benefit: Moderate
Likelihood of success: Low
Priority: Low
(*Proposed by Gibbon Group Formation Subgroup*)

ACTION 2.4: Translocate individuals from an existing social group to a new forest patch

An alternative translocation scenario also discussed by the working group was the possibility of translocating an entire social group to a different forest patch currently unoccupied by gibbons within the BNNR protected landscape. Such a management step could serve both to free up habitat within the Futouling forest patch for new social group formation by existing solitary individuals or individuals dispersing from their natal groups,

and also to provide further unoccupied habitat into which the offspring of the translocated social group could disperse and potentially form additional new groups. It was recognised that the safe capture and translocation of an entire gibbon social group, comprising multiple adults and offspring, may be considerably more risky than the capture and translocation of single gibbon individuals. However, translocations have been carried out for pairs and small family groups of eastern hoolock gibbons (*Hoolock leuconedys*) in Arunachal Pradesh into Mehao Wildlife Sanctuary (The Times of India 2012) and all individuals survived the initial translocation event, although the long-term success of this intensive management action has not yet been determined.

Resources needed: Not specified
Responsible party: BNNRMO
Collaborators/potential partners: Not specified
Timeline: Not an immediate action
Potential benefit: Moderate
Likelihood of success: Low
Priority: Not currently feasible
(*Proposed by Gibbon Group Formation Subgroup*)

Both subgroups also recognised that new group formation would also be facilitated by increased habitat connectivity and access to additional areas of forest habitat at BNNR. Actions related to this conservation requirement were also proposed by both subgroups, but these are detailed under the Habitat Constraints Working Group section below to avoid repetition.

Catastrophic Decline Subgroup

When populations of Critically Endangered species reach a population size of just a handful of individuals, the likelihood of population extinction via stochastic events, such as disease outbreak, fire or typhoon, becomes extremely high. In these instances there is often little time to react, and therefore contingencies have to be put in place in order to expedite action in the event that such stochastic events do occur. Some species, such as the Mauritius kestrel (*Falco punctatus*), Chatham Islands black robin (*Petroica traversi*), and Mauritius parakeet (*Psittacula echo*), have been successfully recovered from the brink of extinction when only a few individuals remained. Other species such as the po'ouli (*Melamprosops phaeosoma*, a Hawaiian honeycreeper endemic to Maui) have not been so fortunate, with extinction of the species following last-ditch attempts to conserve it, including a translocation attempt and capture of the last few remaining individuals for captive breeding (Groombridge *et al*. 2004). One way to reduce the chances of the Hainan gibbon facing a similar fate is to prepare an Emergency Management Plan (EMP), which ideally states at what point the plan should come into operation and what actions should be taken; such actions form a rapid response to a pre-decided set of circumstances. An EMP is intended to avoid an unnecessary delay in decision-making that can occur when a catastrophic event places an already highly threatened species at immediate risk of extinction.

Problem Statement
There is currently no EMP in place that would deal with a rapid decline in the gibbon population due to an unpredictable event.

Question 1: What is the threshold at which we would need to implement an EMP?
Both population and habitat parameters (e.g. quality/quantity of fruiting trees) should be used as metrics in a final EMP. Both specific thresholds in population state and predetermined population trends can constitute EMP triggers. In this working group session, only population measures and specific population state thresholds were discussed. Two different potential thresholds that could trigger the implementation of an EMP were considered using Vortex modelling:

A) 'Catastrophic' decline threshold: two males and three females remaining
This scenario assumes that all remaining individuals are young adults with a full reproductive life ahead of them, and that the gibbons are in two breeding groups such that all three females are breeding. Vortex models were run with various combinations of only a few adult males and females to determine the threshold at which the population was severely demographically challenged and unlikely to be able to recover sufficiently to persist in the long-term. These model scenarios included a low level of inbreeding impacts, i.e. less than the default value generally used for other vertebrates. Model results found that populations with fewer than two adult males and three adult females had a 92-99% chance of extinction in the long-term (150 years). A population crash to two males and three females has a 47% chance of extinction. The group therefore felt that an EMP should be enacted if the population declined to two males and three females, because if action were not taken at this point but after the population declined further, the probability of extinction would reach an unacceptable level.

B) 'Worrying' decline threshold: two males and four females remaining
A second, slightly less 'catastrophic' but still 'worrying' threshold of two males and four females was also considered, which represents a situation when more intensive management of the wild population would be required.

It was also acknowledged that the current Hainan gibbon population should not necessarily be used as a baseline on which to judge what an 'ideal' gibbon population should comprise. It was noted that although many stakeholders are positive about the current status of the Hainan gibbon population, this does not suggest that the current situation of only five females of breeding age in breeding positions is secure. As such, it is highly likely that the current situation might in fact be considered a highly 'worrying' situation to many conservationists, which has implications for whether more intensive conservation management should already be under consideration for the BNNR gibbon population.

Question 2: What EMP options could be employed?
The following, non-exhaustive list of potential options (listed in no specific order) were suggested during the group discussion, which should all be seriously considered during development of a formal EMP. These options could potentially be considered within the framework provided by the flowchart in Figure 4.

- Emergency monitoring team
- Food provisioning
- Intensive monitoring (satellite collaring/safe radioactive labelled isotopes)
- Disease screening
- Biosecurity measures (quarantine the reserve)
- Preventative health measures (vaccination)
- Translocation (managed moves via various methods)
- Establishment of captive population (maintained locally in Hainan)
- Artificial reproductive technologies
- Hybridization with another *Nomascus* species, e.g. its sister species *N. nasutus* (genetic augmentation)

Question 3: How would the data be collected on which to determine whether an EMP should be implemented or not?
The group discussed the need for increased monitoring, both continually and as a specific component of an EMP.

- Data need to be collected that are accurate, reliable and in real time of individually identified gibbons; these data need to be evaluated regularly to permit appropriate and timely management decisions to be made.
- Annual DNA-based sexing should be undertaken to determine the sex of young individuals, which are otherwise very difficult to sex at a distance on the basis of morphological characteristics alone.
- The fate of dispersing individuals should be tracked.
- Disease in and around the reserve should be investigated and monitored; this should include at least maintenance of a freezer for the storage of dead animals (both gibbons and other species) found in and around the reserve for post-mortem investigation. Gibbon carcasses should be prioritised for analysis. Local people from communities around BNNR, domestic animals and wild animals should all be considered as potential vectors of disease that could have an adverse impact on the BNNR gibbon population.

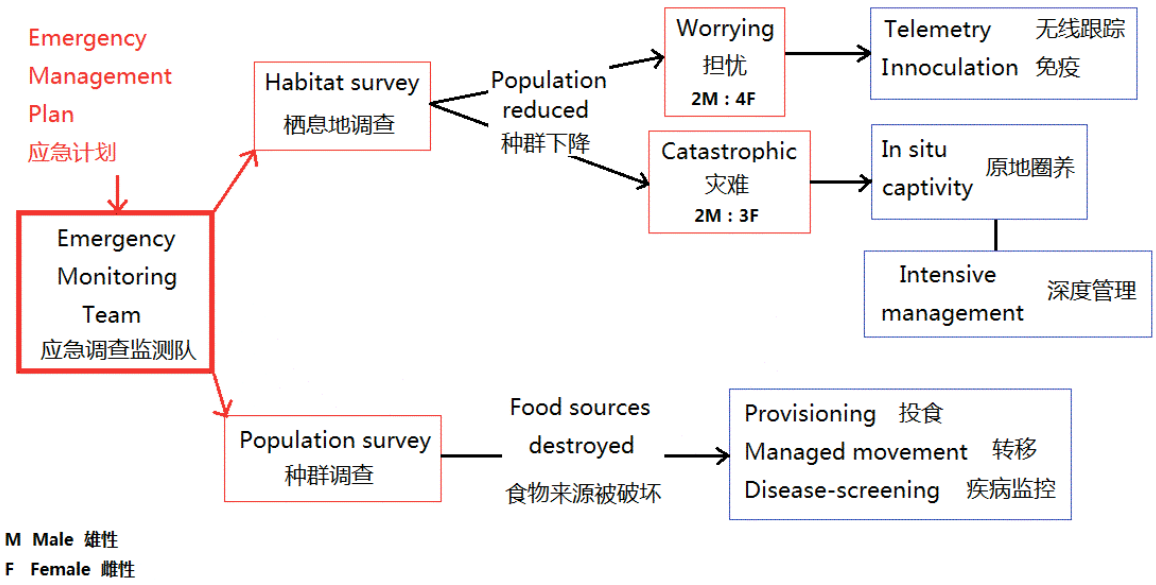

Figure 4. Flowchart providing a possible framework for making decisions about intensive management actions for the Hainan gibbon in response to different categories of sudden population decline, to inform a potential Emergency Management Plan for the species. As IUCN guidelines are available for some of these strategies, translating these guidelines into Chinese should be a priority, in particular the recently developed guidelines for gibbon rehabilitation, reintroduction and translocation (Campbell *et al*. 2015).

Question 4: What would be the approval process of the use of EMP?
Specific permits would be required to implement any of the activities likely to be included in a formal EMP; permit applications would need to be made first to the Hainan Gibbon Advisory Panel (see Action 10.1 below), who then would need to make a further application to the National Reserves Committee before permissions for specific intensive management activities at BNNR could be authorised. It was therefore suggested that all parties mandatory to the approval process be familiar with the EMP and approve it in advance in principle. Thus, as and when the threshold for implementing the EMP was reached, the necessary paperwork could be processed expediently to allow a faster response to gibbon population decline.

ACTIONS 3.1 – 3.2

<u>Catastrophic Decline Subgroup, GOAL 1</u>: Increase monitoring efforts to allow confirmation of when the "catastrophic decline threshold" has been reached, triggering implementation of the EMP.

ACTION 3.1: Increase monitoring, including health status and mortality in social groups and lone gibbons
In addition to the actions listed above that are associated with the urgent need for increased monitoring of the number, sex, and distribution of gibbon social groups and solitary individuals at BNNR (see Actions 1.1–1.3), which are of critical importance for making decisions about implementing an EMP, this group also recognised the need for close monitoring of the health status and cause of mortality of all gibbons, for example through

regular disease screening of faecal samples obtained from as many gibbon individuals as possible, to provide further important baseline data that may also trigger the implementation of an EMP. Regular disease screening of gibbons would also be critical for making decisions about appropriate worker health and safety if any gibbon individuals need to be handled by reserve staff or other people in the future, e.g. during potential wild-to-wild translocation activities.

Resources needed: Increased capacity of monitoring system, on-site freezer for sample storage, wildlife veterinarian
Responsible party: BNNRMO, Hainan Wildlife Conservation Centre
Collaborators/potential partners: NGOs, institutes
Timeline: As soon as possible
Potential benefit: HIGH
Likelihood of success: HIGH
Priority: HIGH

ACTION 3.2: Assess and write an EMP, and establish an approval mechanism
It is very important to prepare a formal EMP for the Hainan gibbon population at BNNR, which must allocate roles and responsibilities for different government departments and other stakeholders, state the triggering thresholds of the EMP, outline which strategies (including response timelines) are to be used under what circumstances, include evaluation processes, and specify under what circumstances alternative strategies should be used or considered. It is also necessary to gain endorsement of the EMP, and establish an appropriate approval/initiation mechanism with the collaboration of relevant experts and local or higher-level authorities.

Resources needed: Not specified
Responsible party: BNNRMO, Hainan Wildlife Conservation Centre
Collaborators/potential partners: NGOs, institutes
Timeline: As soon as possible
Potential benefit: HIGH
Likelihood of success: HIGH
Priority: HIGH

工作小组报告:种群现状

组员

家庭群组成亚组:

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灾难性种群衰退亚组:

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工作小组首先集中讨论了海南长臂猿种群现状的问题，包括它的分布、遗传性特征、生物特征以及这些方面的知识空缺。然后组员被分成三个亚组以针对种群三个不同方面的问题：长臂猿家庭群的组成问题、栖息地连通性的问题，以及种群可能遭遇灾难性事件的问题。

问题阐述

海南长臂猿保育最大的困难在于该物种已知只有一个二十几个个体的种群。多个内在因素（生存率低、补充量低、新家庭群组成率低）与外在因素（缺乏建立领地的空间、自然灾害）都可能致使种群数量低下。如果不能有效消除或降低这些威胁以促进种群的增长，种群可能会陷入“灭绝漩涡”，恢复越发困难。

主要问题

新家庭群组成率低

扩散的年轻个体未能找到合适的配偶，无法组成新家庭。可能原因包括：

1. 异性来自同一个家庭群，降低交配的可能性。
2. 独猿密度低，降低相遇的可能性。
3. 缺乏足够的栖息地建立家庭领域。
4. 异性独猿太少，降低找到合适配偶的几率；据了解，圈养的长臂猿一般需要多次配对才能够成功繁殖（奥瑞利安•布雷，个人交流）。

生存率/补充率可能较低

2003至2013年的调查结果显示，长臂猿数量从13上升至23只（陈辈乐等，2005）。虽然已知海南长臂猿的繁殖速度与繁殖母猿的数量，但是由于在野外无法发现动物尸体而无法确定其死亡率。根据过去的种群发展速度，估计海南长臂猿的生存率可能较低，尤其是独猿，因而大大限制了新家庭群的组成率与补充率。可能原因包括：

1．栖息地质量较低且有季节性，缺乏经验的独猿容易由于食物不足而死亡。
2．母猿经验不足或者身体状况欠佳容易造成幼猿的死亡。
3．独猿与家庭群存在食物竞争。
4．独猿侵略家庭群领地继而发生打斗与死亡。
5．近亲繁殖可能造成死亡率的增加。
6．性别比不平衡。

缺乏建立新领地的空间

过去调查显示保护区内连片的长臂猿栖息地面积仅15平方公里（刘振河等，1989；陈辈乐等，2005；张明霞等，2010），管理部门认为栖息地面积近30平方公里，两者均显示霸王岭保护区内长臂猿的承载量有限。而且，现有栖息地并不是长臂猿的最适宜栖息地（陈辈乐等，2005），栖息地质量低有可能令长臂猿活动范围扩大（以获取足够的食物），增加新家庭群组成的难度及独猿饥饿致死的风险。工作小组对不同增加栖息地连通性的策略进行了评估。

随机性事件的发生导致长臂猿数量严重下降

随机性事件有遗传性的、种群性的、环境性的和灾难性的。讨论就自然或人为灾难，包括疾病、台风、持续多年的不利天气或食物短缺，种群内在的随机变化，如性别比不平衡等订立监测和应变措施。至今，有关部门并没有为海南长臂猿可能要面对的突发灾难设计应变管理措施，仅有的林火应变措施并不包含长臂猿的种群管理。因此，应考虑订立一个针对长臂猿的紧急应变计划，至少评估不同灾难对种群的潜在影响。

由于工作小组成员众多而且讨论的问题复杂，所以于第二天分成三个亚组对三个方面进行针对性讨论。

1．家庭群组成亚组（新家庭群组成率低的问题）
2．栖息地可用性与连通性亚组（生存率低和栖息地连通性低两个问题）
3．灾难性种群衰退亚组（灾难性种群衰退的问题）。

表一 可能造成长臂猿的濒危机理以及相应的保护目标、数据可用性、假设与优先性。

机理	长期目标	中期目标	近期目标	数据可用性	假设	优先性
新家庭群组成率低	1) 种群增长, 2) 增加对独猿的了解, 3) 增加对死亡率的认知	1) 停止采松脂活动, 2) 修建新公路以停止使用东干线, 3) 巡护队能力建设	1) 加强监测以降低人为干扰, 2) 加强数据管理, 3) 对栖息地进行更详细的调查			
异性来自相同家庭群降低交配可能性				没有	根据其它物种	低
独猿密度低降低找到合适配偶的可能性				部分	有	高
缺乏足够的栖息地				部分	有	高
生存率/补充率低	加强对长臂猿的监测，尤其是对行为的监测	1) 收集夜宿树的数据, 2) 根据物候数据建立栖息地模型	发展新监测方法，如生物声学监测技术			
栖息地的低质量/季节性增加食物不足的风险				没有	栖息地质量低	高
独猿与家庭群之间的食物竞争				没有	有	??
独猿侵略家庭群领地继而发生打斗并造成独猿的死亡				没有	有	低
近亲繁殖可能导致的死亡率增加				没有	有	低
繁殖群体的补充率低				部分	有	高
栖息地连通性低导致缺乏建立新领地的空间	长臂猿分布区扩大	评估所有能增加栖息地连通性的手段，如人工廊道、森林恢复	增加对栖息地的了解 (卫星图像和实地考证)			
破碎的栖息地（出现如草甸和沟谷等）妨碍长臂猿的移动				有	有	高

家庭群组成亚组与栖息地可用性与连通性亚组

由于家庭群组成亚组与栖息地可用性与连通性亚组的建议行动非常相似，所以在这里集中描述以避免重复，并表明提出每项建议行动的亚组。另外，这两个亚组的保护目标也与栖息地的制约工作小组有重叠的部分，这些建议行动被纳入栖息地的制约工作小组报告内（第五章），并同样明确指出提出每项建议行动的工作小组/亚组。

家庭群组成亚组问题阐述

扩散的雌雄个体未能找到合适的配偶，导致无法组成新家庭群。

栖息地可用性与连通性亚组问题阐述

缺乏对扩散个体生存情况的基本了解，也缺乏能容纳新家庭群的栖息地。

行动1.1 – 1.10

家庭群组成亚组，<u>目标1</u>：加强对长臂猿的侦查能力，在霸王岭内外寻找其它种群/独猿，并对所有家庭群进行高度监测

栖息地可用性与连通性亚组，<u>目标1</u>：加强对独猿的跟踪研究

（以上两个目标的相关行动相似，因此合并处理）

行动1.1： 加强对所有家庭群每个个体的常规性监测力度

虽然对霸王岭保护区内的三个家庭群一直在进行常规性的监测，可惜对它们的历史、种群动态、个体的了解都非常有限。增加这些方面的认识能助于了解和预测种群变化及发展方向。加强监测力度也有利于长臂猿生态行为的研究。例如，长臂猿的夜宿地暂时还是未知。虽然辨认个体还存在一定的难度，加深对繁殖与哺育行为等的了解能揭示长臂猿种群恢复的问题所在。

<u>所需资源</u>：未明确
<u>负责单位</u>：霸王岭保护区管理局
<u>合作单位</u>：ZSL、KFBG
<u>时间</u>：尽快
<u>得益</u>：高
<u>成功率</u>：高
<u>优先性</u>：高
<u>（由家庭群组成亚组提出）</u>

行动1.2： 跟踪调查所有年轻个体

虽然在霸王岭的种群有正常的繁殖率 (Fellowes *et al*. 2008)，但是年轻个体在扩散后几乎都无法组成新家庭。扩散后的独猿很难被发现，以致无法对它们进行常规性监测。建议每月跟踪调查所有即将或已经扩散的个体，以研究它们的死亡率与威胁因素。但是个体的辨认还存在一定的难度（见行动1.3）。

所需资源：大量人力与调查时间，费用约六至三十万元
负责单位：霸王岭保护区管理局
合作单位：未明确
时间：为期六至十二个月，应尽快执行
得益：高
成功率：中
优先性：高
（由栖息地可用性与连通性亚组提出）

行动1.3：　编写海南长臂猿个体辨认指南或报告

准确辨认个体能大大提高保护区管理员、监测队和科研人员对种群监测的有效性。因此，建议以文字叙述和图片编制个体辨认指南，再者能以叫声的音频作为补充。以肉眼辨认存在较大的不确定性，辨认指南也需要进行定期更新，所以指南应为数值化形式。

所需资源：未明确
负责单位：霸王岭保护区管理局
合作单位：戈斯曼恩
时间：为期三个月，应尽快执行
得益：高
成功率：中
优先性：高
（由栖息地可用性与连通性亚组提出）

行动1.4：　使C群习惯人类近距离调查，以更有效进行监测

现在只有B群习惯人类近距离调查，因此人们对海南长臂猿的生态与行为的理解大多来自B群。在A群与C群两者中，新组成的C群对人的敏感性较低，因而被认为是合适的行为研究对象。建议以C群的生态行为作为研究生的研究课题。近距离调查能收集更丰富的行为数据，但是，降低长臂猿对人类的戒备心理可能会增加其遭受猎杀的风险，尤其是C群的分布相对靠近村庄。相反，A群不应被驯化以保持其自然生态行为，也为了降低其被猎杀的风险。

所需资源：学生三年的学费、生活补助与野外工作费用约三十至六十万元
负责单位：霸王岭保护区管理局
合作单位：蒋学龙
时间：为期三年，根据收生情况而定
得益：高
成功率：高
优先性：中高
（由栖息地可用性与连通性亚组提出）

行动1.5-1.7是关于能有效提高对家庭群与独猿监测的准确性和可比性的监测或调查方法，也可用于侦察在霸王岭斧头岭以外未知长臂猿的手段。

行动1.5： 增加长臂猿定点调查的频率和面积

现时对霸王岭三个长臂猿种群的监测方法结合机遇性跟踪和在固定监听点进行监听两种手段。所收集到的调查数据被用于分析各家庭群活动区域的变化。增加监听点的数量及调查频率，并结合合适的调查方法（如三角定位法）能有效提高调查力度与准确性，不过要视乎行动1.8的具体情况而定。这种调查手段也能用于侦察未知家庭群或独猿（见行动1.7对侦察独猿的评论）。

所需资源：监测/学生团队
负责单位：霸王岭保护区管理局
合作单位：ZSL、KFBG、車尤尼恩
时间：尽快
得益：高
成功率：高
优先性：高
（由家庭群组成亚组提出）

行动1.6： 在已知家庭群活动区域以外进行叫声回放实验

独猿不经常鸣叫，因此，要以传统劳动密集型的监测方法侦察独猿异常困难。叫声回放可以增加侦察独猿的效果，当记录到回应时再实施针对性的调查。过去其它长臂猿的研究显示，进行回放实验至少一星期能吸引长臂猿前来探索（奥瑞利安•布雷，个人交流）。必须首先在霸王岭已知种群分布区内进行实验，以证明此方法对于海南长臂猿的实施效果。叫声回放可能能帮助发现与辨认长臂猿，但不一定能引导长臂猿建立新领地。

所需资源：录音机/播放器
负责单位：霸王岭保护区管理局
合作单位：ZSL、KFBG、車尤尼恩、布雷、卡卡提
时间：尽快
得益：高
成功率：高
优先性：高
（由家庭群组成亚组提出）

行动1.7： 以新的声学技术来增加监测力度

长臂猿家庭群一般每天定时鸣叫，因此调查人员常以机遇性跟踪和在固定监听点进行监听作为主要调查手段（见行动1.5）。近年针对其它物种与地区研发的声学调查技术（如，两个正在进行的红毛猩猩研究，車尤尼恩，个人交流）也有望能提高海南长臂猿的监测效果。具体方法是在野外安装录音器材，收集长臂猿鸣叫音频数据。此方法能用作海南长臂猿的常规性监测手段，也可以应用于未知长臂猿的侦察。但必须首先在霸王岭已知种群分布区内进行实验，以证明此方法对于海南长臂猿的实施效果。此方法可能对家庭群的应用效果会更好，但是由于雄性或雌性的独猿也会偶尔鸣叫，所以也可能能应用于独猿的侦察工作。应注意的是，如果调查环境产生太多错误信号（杂音），或许此研究手段会由于数据处理过程太长而不被采用。

所需资源：录音器材（有被偷窃的风险），及研究生三年的学费、生活补助与野外工作费用约共六十至三百万元

负责单位：霸王岭保护区管理局
合作单位：ZSL、KFBG、車尤尼恩、布雷，以及在生物声学方面资历较深的科研机构，如美国康奈尔大学鸟类学实验室。
时间：尽快（建议在6-12个月内开展）
得益：高
成功率：高
优先性：高
（由两个亚组提出）

行动1.5-1.7完成后比较与评估行动的有效性，以选出采用最佳的调查手段。

行动1.8：　加强在霸王岭的长臂猿监测

以上行动1.5-1.7的调查方法有不同的实施要求与效果，但是所有调查方法，连同霸王岭长臂猿监测队常用的机遇性跟踪和固定监听点监听均需要更强大的监测队伍。因此，要增加长臂猿监测的有效性和能力必须要增加保护区的人力资源与投入。提高巡护力度能增加发现独猿的几率，并能更有效防止保护区内不法行为的发生。

所需资源：未明确
负责单位：霸王岭保护区管理局
合作单位：ZSL、KFBG、FFI
时间：视乎人员配置与培训情况而定
得益：中
成功率：高
优先性：高
（由家庭群组成亚组提出）

行动1.9：　通过社区问卷收集与分析长臂猿的目击事件

KFBG及FFI等的工作人员在过去多年都有听说有当地村民在斧头岭以外区域遇见或听见长臂猿的消息，包括霸王岭内的其它地区（如斧头岭以西的雅加地区），和霸王岭以外长臂猿的历史分布地区（如吊罗山、佳西、黎母山、五指山、鹦哥岭）。通过在这些地区向森林使用者进行问卷调查、系统地收集并分析这些信息，能为野外侦察工作提供依据。

所需资源：调查员及调查经费
负责单位：未明确
合作单位：ZSL、FFI、KFBG、霸王岭保护区管理局和其它保护区管理部门
时间：尽快
得益：高
成功率：高
优先性：高
（由家庭群组成亚组提出）

行动1.10：　在霸王岭以内及以外林地侦察未知长臂猿

根据利益相关者与专家（如，陈辈乐博士）建议，以及行动1.9的调查结果，再海南更大范围内展开全面而系统的野外调查侦察未知种群或独猿。调查方法可采用行动1.5-1.7的其中一个或以上。如在调查中发现未知长臂猿，即与所有利益相关者开展管理措施的系统评估工作，以尽快采取合适的管护措施。

所需资源：未明确
负责单位：未明确
合作单位：ZSL、KFBG、FFI、霸王岭保护区管理局和其它保护区管理部门
时间：尽快
得益：高
成功率：高
优先性：高
（由家庭群组成亚组提出）

行动2.1 – 2.4

家庭群组成亚组 目标2：促进新家庭群的组成

行动2.1：　调查并消除栖息地的人为干扰以增加栖息地的可用性

长臂猿的三个家庭群现今并不完全占据斧头岭地区所有连片的栖息地，未被利用的斑块，如东五或榕树沟，部分地区几年前属B群的分布区，所以应是长臂猿的适宜生境。长臂猿离开斧头岭西南部适宜生境的原因至今未明，可能是受到人为干扰的影响所致。因此，必须调查并消除长臂猿栖息地内的人为干扰。另外，建议在霸王岭更大范围内开展人为干扰的调查，以分析未来可能妨碍长臂猿种群发展和扩散的因素。

所需资源：未明确
负责单位：霸王岭保护区管理局
合作单位：ZSL、KFBG、FFI、江海声
时间：尽快
得益：高
成功率：高
优先性：高
（由家庭群组成亚组提出）

行动2.2：　以食物投放吸引长臂猿探索新栖息地

当霸王岭保护区内，如斧头岭西南坡的栖息地连通性达到合适水平时，可使用食物投放这低风险的手段，促使长臂猿使用新栖息地。如只投放当地野果和持续时间较短（一至四星期）则能减少影响长臂猿行为的风险。食物投放也可以用于迁地保护的第一步（见行动2.3及2.4）。

所需资源：未明确
负责单位：霸王岭保护区管理局
合作单位：未明确
时间：无需马上执行
得益：高
成功率：未知
优先性：低
（由家庭群组成亚组提出）

海南长臂猿这一珍稀物种的长远种群恢复可能需要高强度的管理手段，以便于提高最后这小种群的繁殖率和种群增长率。国外一些成功的案例如黑足雪貂（*Mustela*

nigripes）、毛里求斯隼（*Falco punctatus*）、加州神鹫（*Gymnogyps californianus*）和马岛潜鸭（*Aythya innotata*）（May 1986; Groombridge *et al*. 2004; Bamford *et al*. 2015）。事实上，一个极度濒危的物种要恢复到一个健康的种群数量一般需要人为的、高强度的保育计划。罗德里格斯织布鸟（*Foudia flavicans*）是少数中的一个只通过栖息地恢复来达到种群恢复的物种（Groombridge *et al*. 2004）；可是，由于缺乏或未能及时实施高强度保育计划因而灭绝的案例比比皆是, 如夏威夷蜜旋木雀（*Melamprosops phaeosoma*）、白暨豚（*Lipotes vexillifer*）和圣诞岛伏翼（*Pipistrellus murrayi*; Groombridge *et al*. 2004; Turvey 2008; Martin *et al*. 2012; Ng *et al*. 2014）。由于高强度保育手段的投入和风险都较高，因此必须谨慎对待。

在论坛上，与会人员认为在海南长臂猿保护上暂时唯一可以考虑的高强度保育行动是把斧头岭的部分种群迁移到霸王岭保护区内其它更合适的栖息地，以增加新家庭群形成和繁殖的成功率。任何迁地保护必须按照世界保护联盟长臂猿恢复与迁地保护指引（Campbell *et al*. 2015）以及一些有丰富长臂猿保育经验的专家建议严格执行。与会人员认为迁地保护并不是当前的优先行动，除了还没有数据证实现有栖息地对新家庭群组成造成障碍外，漩涡模型指出主要种群任何一个个体的调动/丧失都会对其遗传多样性造成负面的影响（Bryant 2014）。但是，工作小组认为该就迁地保护的可行性、可操作性，以至什么情况下该让它成为优先行动等进行讨论与评估。灾难性种群衰退亚组对高强度保育行动有更深入的讨论（见下）。

以下是工作小组分别讨论过的两种迁地保护手段：

行动2.3：　迁移独猿以促进新家庭群的组成

组员认为，已知斧头岭种群以北出现过的雄性与雌性独猿可能由于栖息地资源不足导致无法形成新家庭群。因此可以通过迁移独猿到斧头岭西南坡或霸王岭范围内其它合适的栖息地来促进新家庭群的组成。迁移任何野生动物都会产生一定程度的风险，另外，被迁移后的长臂猿也有可能尝试回到原来的活动区，在经过其它家庭群领地时因发生打斗而死亡。

所需资源：未明确
负责单位：霸王岭保护区管理局
合作单位：未明确
时间：无需马上执行
得益：中
成功率：低
优先性：低
（由家庭群组成亚组提出）

行动2.4：　迁移现有家庭群到新的栖息地

迁移整个现有家庭群到斧头岭以外的栖息地能使在斧头岭的独猿有更多的可用栖息地组成新家庭群，也能让迁移家庭群以后有更大的扩散空间。专家指出，迁移家庭群比迁移独猿存在更高的风险。虽然在印度曾成功迁移东白眉长臂猿的小家庭群（The Times of India 2012），但是这些行动的长期影响还有待研究。

所需资源：未明确
负责单位：霸王岭保护区管理局
合作单位：未明确
时间：无需马上执行

得益：中
成功率：低
优先性：现时不可行
（由家庭群组成亚组提出）

两个亚组都认为增加栖息地连通性和面积能有效提高新家庭群组成的几率，但是为了避免重复，被置于栖息地的制约工作小组报告（第五章）中。

灾难性种群衰退亚组

当种群数量减少到一个极为濒危的水平，种群会更容易遭受随机事件，如疾病暴发、林火、台风等的严重威胁。遇到这些突发情况时，需要在很短的时间内做出很重要的抉择。因此，有需要在突发事件发生以前做好紧急应变计划，以确保能快速、合理地处理重大危机。有些濒危物种在只剩下最后几个个体的情况下被成功拯救过来，如毛里求斯红隼（*Falco punctatus*）、查岛鸲鹟（*Petroica traversi*）和回声鹦鹉（*Psittacula echo*）等。其它一些物种则由于未能及时实施保育措施而惨遭灭绝，如夏威夷蜜旋木雀（*Melamprosops phaeosoma*），在最后仅剩三只的时候才开始尝试实施人工圈养繁殖，最后以失败告终（Groombridge *et al*. 2004）。要避免海南长臂猿遭受同样的厄运，建议编写海南长臂猿紧急应变计划，表明如何及何时该实施高强度的保育措施，以在小种群遇到灭绝风险时及时做出适当的拯救行动。

问题阐述
缺乏能应对突发性灾难造成的种群衰退的紧急应变计划。

问题1：在什么情况下需要启动紧急应变计划？

当某些种群或栖息地特征（如，果树数量）达到预设的临界值时则马上启动紧急应变计划。某个种群状态或种群变化趋势均可作为应变计划的触发点。在论坛上，只针对种群特征方面的触发点进行了讨论，并以漩涡模型模拟两个不同种群触发点所产生的效应。

A）灾难性种群衰退临界点：长臂猿仅剩两雄三雌

假设最后长臂猿仅剩五头（两雄三雌），它们皆年青、健康，分两个家庭群因此三头母猿都能以正常生育率生育。以漩涡模型模拟种群以辨别能长远恢复健康种群数量的最少个体数。模型中运用了较低的近亲繁殖影响水平（低于脊椎动物的一般水平）。模拟结果显示，当种群数量少于两雄三雌的时候，物种在150年内的灭绝机会达92-99%。当种群数量在两雄三雌的时候，灭绝机会为47%。因此，组员认为当长臂猿数量下降到两雄三雌的时候必须采取紧急应变措施，以免种群衰退达至不可能恢复的境地。

B）威胁性种群衰退临界点：长臂猿仅剩两雄四雌

威胁性临界点没有灾难性临界点那么紧急，但是也认为是个令人担忧的水平。组员认为在长臂猿数量仅剩两雄四雌的时候，须加大种群的管护力度。

组员提出，不应以现有种群状态（五头繁殖雌性）作为种群的理想状态。虽然一些利益相关者对现有种群状态抱乐观态度，种群也未必处于“安全”状态，而是可能已经处于“威胁性”状态。为了确保海南长臂猿种群的持续增长，现在就必须加大种群的管护力度。

问题2：有哪些不同的紧急应变手段？

以下是组员提出的所有潜在应变措施（不分先后次序），应该在应变计划的设计时加以考虑，也应纳入图4流程图的考虑因素之列。

- 紧急监测队
- 投食
- 高强度监测技术（如，卫星追踪项圈或放射性同位素标记）
- 疾病排查
- 生物安全措施（如，保护区隔离检疫）
- 疾病预防措施（如，疫苗注射）
- 不同方法的迁地保护
- 在海南建立圈养种群
- 人工繁殖技术
- 与同属（*Nomascus*）长臂猿，如东黑冠长臂猿（*N. nasutus*）进行杂交以提高遗传多样性

问题3：如何收集启动紧急应变计划所需的数据？

亚组对加强对长臂猿的常规性和紧急性监测进行了深入讨论。

- 数据必须准确、可信、及时，必须准确到个体上（个体辨认），并需要定时更新以进行有效管理。
- 凭外观辨别性别困难，建议每年对年轻个体进行遗传性分析以准确辨别个体的性别。
- 应对扩散个体进行跟踪监测。
- 应掌握保护区内的疾病发生情况。最基础的手段是对所有被发现的动物尸体，尤其是长臂猿，进行解剖分析（需设置冷冻储存设备）。同时，应视当地居民、禽畜和其它野生动物为疾病媒介被纳入检测范围。

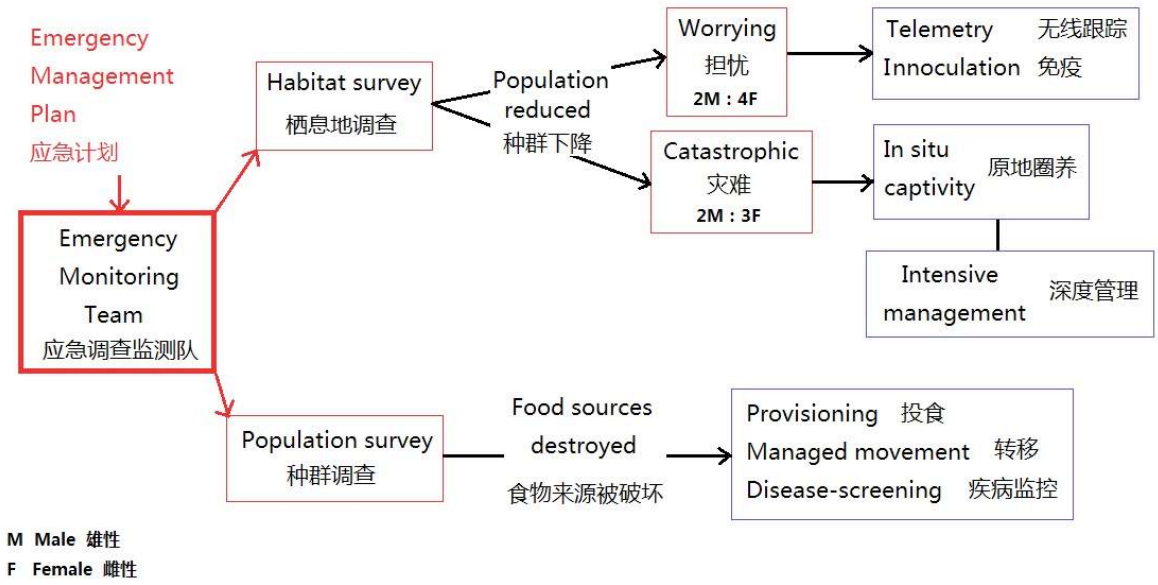

图4 海南长臂猿种群发生紧急情况时的应急流程图，显示当发生不同程度的种群下降时应相应作出不同的管护措施。世界保护联盟已出版相关的技术指引，包括《长臂猿种群恢复、再引入与迁地保护指引》（Campbell *et al*. 2015），应尽快翻译成中文版供有关部门参考。

问题4：如何启动紧急应变计划？

紧急计划所涉及的行动必须获得有关部门的许可，申请程序应先通过海南长臂猿专家委员会（行动10.1）进行审批，再由专家委员会向国家自然保护区管理部门提出许可申请。设计紧急应变计划时必须确立紧急应变计划的启动机制，并且得到所有相关部门的理解与接纳。这样在种群达到临界点时，有关人员便能即时准备所需文件办理相关手续。

行动3.1-3.2

灾难性种群衰退亚组，目标1：增加监测力度，以在种群达到“灾难性种群衰退临界点”时及时启动紧急应变计划

行动3.1： 加强对家庭群和独猿的跟踪监测与健康分析

除了对家庭群与独猿的数量、性别与分布进行监测（行动1.1-1.3）外，组员还建议对长臂猿的健康情况和致死因素进行更全面的分析。例如，对长臂猿的排泄物进行定期的疾病排查可以为紧急应变计划提供重要依据。定期的健康排查对以后进行近距离管护工作（如迁地保护）提供重要的信息。

所需资源：更完善的监测系统、冷藏设备、野生动物兽医
负责单位：霸王岭保护区管理局、野生动植物保护管理局
合作单位：非政府组织、科研单位
时间：尽快

得益：高
成功率：高
优先性：高

行动3.2： 编制海南长臂猿紧急应变计划，并确立启动机制

为海南长臂猿编制紧急应变计划非常重要。计划内必须明确部门和利益相关者的职责，陈述触动应变措施的临界点，明细不同情况下使用的不同管护策略（时间表），包括计划实施后的评估机制，以及在什么情况下须改变管护策略等。应变计划必须得到有关部门的接纳，并与有关专家共同设立申请和启动机制。

所需资源：未明确
负责单位：霸王岭保护区管理局、野生动植物保护管理局
合作单位：非政府组织、科研单位
时间：尽快
得益：高
成功率：高
优先性：高

International Conservation Planning Workshop for the Hainan Gibbon

Bo'ao, Hainan, China
18 – 20 March 2014

Final Report

海南长臂猿保护博鳌国际论坛

中国海南省博鳌镇
2014年3月18至20日

总结报告

SECTION 5

Habitat Constraints
Working Group Report

第五章　工作小组报告:栖息地的制约

Working Group Report: Habitat Constraints

Participants

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This working group addressed issues related to habitat within BNNR that may act as constraints to the gibbon population and its viability.

There proved to be considerable overlap of goals, concerns, and proposed actions between this group and the Habitat Availability and Connectivity Subgroup of the Population Status Constraints Group (see previous section). In order to clarify the recommendations for Hainan gibbon conservation proposed during the workshop, several of that subgroup's goals and actions are presented and discussed below rather than in the previous section, with a clear statement of which group proposed each action.

General Problem Statement

Hainan gibbon habitat constraints within the BNNR landscape include both natural and anthropogenic factors that reduce the connectivity and quality of suitable forest. These factors not only limit the spatial distribution of Hainan gibbons, but also increase the risk of food shortage. It is therefore necessary to reconnect suitable habitat fragments within the BNNR landscape through both immediate-term processes, such as rope bridges across small canopy gaps, and long-term processes such as reforestation.

Major Issues Identified

Low Habitat Quality and Connectivity

The current forest structure at BNNR is not suitable for supporting a large population of gibbons. Forest within the reserve that is likely to represent good-quality gibbon habitat (cf. Chan *et al*. 2005) is currently fragmented into discrete, non-connected patches within a matrix of anthropogenically modified vegetation types, and it is possible that these forest patches may contain insufficient food resources for gibbons during the dry season. The gibbon population at BNNR is isolated from further potentially good-quality forest within the wider BNNR landscape by man-made gaps in the canopy, preventing dispersal of individuals into other neighbouring forest areas to establish new social groups. The working group considers that the potential impact of the current habitat structure across the BNNR landscape on the surviving gibbon population is likely to be low in the short term (i.e. it will not cause immediate loss in numbers or population extinction) but high in the long term (i.e. it is very likely to affect gibbon population recovery). Gibbons are also not utilising all available connected forest habitat in the Futouling region of the reserve, and in particular are currently absent from seemingly good-quality habitat in the southwestern Dongwu area; more research

is necessary to understand the factors determining the current distribution of gibbons and their habitat preferences at BNNR.

Physical Barriers to Gibbon Dispersal

Habitat connectivity within BNNR is limited both by conversion of potential gibbon habitat into unsuitable anthropogenically modified vegetation types, and by construction of physical barriers to gibbon movement across the landscape. A paved road (Dongganxian) also currently bisects a major area of potentially suitable gibbon habitat, and although there is intermittent connection of forest canopy across the road, this structure may act as a barrier to gibbon movement between the Futouling forest patch and adjacent forest areas within the reserve (see Fig. 2). There are two power lines running through areas of forest within BNNR; the power line that bisects the forest close to Dongganxian has recently had a section near Dong'er buried, although a gap remains in the forest canopy where the line used to stand, and there are no specific plans to reforest this gap.

Tourism Development

Tourist trails were built in the Dong'er and Dongsan areas of the Futouling forest patch in 2006 (see Fig. 2). Gibbon social groups were formerly located in these areas, but have now shifted their distribution to other parts of the Futouling region. BNNRMO has since closed some parts of these trails. The potential impacts of tourism development and associated construction activities on BNNR's forest habitat is high, although the likely specific impact of tourists on the BNNR gibbon population and its distribution have not been studied and are difficult to determine.

Impacts of Local Communities

Local villagers often go into the forest in BNNR to collect non-timber forest products (NTFPs). Hunting of gibbons is strictly prohibited, but locals sometimes hunt other wild animals within the reserve using both snares and guns (see Impacts of Human Activities Working Group below for further details). It is suggested that the impact of these activities on the BNNR gibbon population is low because these activities do not target the gibbons directly. However, the magnitude and spatial pattern of disturbance within the Futouling forest region caused by these activities, and their potential effects on gibbon distribution within the reserve, are unclear and warrant further study. Additional indirect impacts on forest habitat associated with local communities, such as wildfires and livestock grazing, are also known to have degraded vegetation within BNNR during recent decades (Zhang *et al*. 2010), although the potential impacts of these factors are considered low within the area of forest currently occupied by gibbons.

Plantations

Plantations have replaced almost all lowland rainforest within the reserve, as well as more widely across Hainan. Removal of low-elevation forest habitat has therefore forced the BNNR gibbon population to occupy higher-elevation forest, which may contain less food for gibbons. The impact of plantations at BNNR is therefore high. These plantations are all 10-15 years old, and date from before the expansion of the reserve.

Rubber plantations cover 6 km^2 of the nature reserve, near villages in Qingsong Township. Pine plantations cover more than 80 km^2 of the nature reserve; these comprise Tenasserim pine plantations (*Pinus latteri*, c.62 km^2) and Caribbean pine plantations (*Pinus caribaea*, >18 km^2). The former is a native Hainan species widely planted for resin production, and the latter was introduced to Hainan for timber production. Pine plantations

are distributed across different areas of the reserve, and cover most of the Zizhai area (in the southeast of the reserve, south of Dongliu; Fig. 2). Pine plantations are present within the current area of gibbon habitat, near Nanchahe on the north side of Futouling. This area is intermixed with lowland forest habitat that is potentially suitable for gibbons, and so it has been a focal area for KFBG's restoration efforts. However, resin is still tapped in the Nanchahe and other plantations on a regular basis, so the level of human disturbance in these areas could potentially prevent gibbons from using these recovering habitats. Management of all plantations within BNNR has been contracted by the Bawangling Forestry Bureau and BNNRMO to individuals/private companies, so pine resin harvesting does not contribute to the income of local communities.

Natural Disasters

Typhoons occur every year at BNNR, causing treefalls and landslides to varying degrees. One local representative at the working group considered that typhoons are unlikely to cause significant impacts on the gibbons, while another thought that they may influence gibbon distribution within the Futouling forest region, as gibbons no longer occupy areas in which forest structure has been significantly damaged by typhoons (e.g. Dongsan). Further research is therefore warranted to investigate the likely impact of typhoons on gibbons at BNNR.

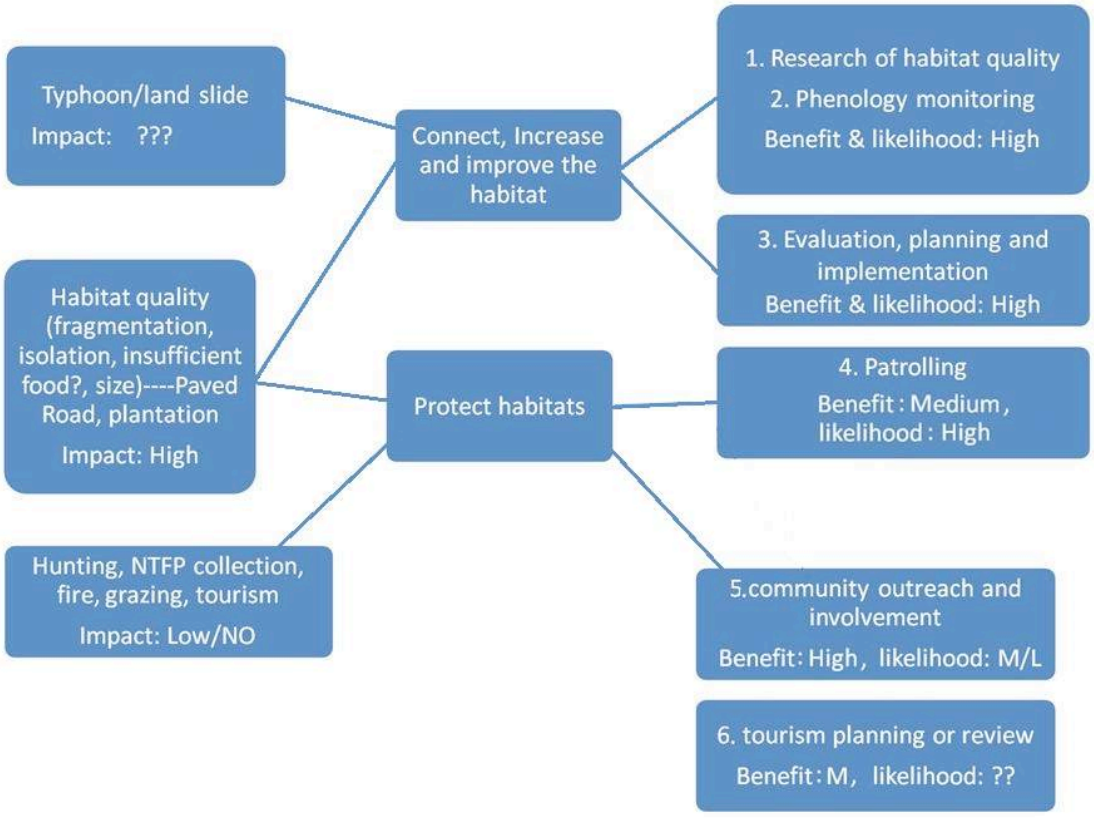

Figure 5. External threats identified for Hainan gibbon habitats, and the respective conservation approaches and actions recommended.

Goals and Recommended Actions

ACTIONS 4.1 – 4.3

Habitat Availability and Connectivity Subgroup, GOAL 2: Evaluate the extent, quality and connectivity of suitable gibbon habitat in the BNNR landscape.

ACTION 4.1: Establish fine-scale forest plots within current gibbon habitat to assess plant species composition and phenology

Whereas the spatial distribution of gibbon social groups within the Futouling forest patch is understood relatively accurately as a result of ongoing monitoring by BNNRMO and visiting researchers, gibbon habitat preferences and the wider environmental correlates of their past and present distribution are much more poorly understood. In the absence of robust baseline data on this component of gibbon spatial ecology, it is difficult to determine whether other areas of forest across the BNNR landscape and beyond may also constitute suitable gibbon habitat. It is therefore necessary to set up a series of botanical plots within areas of forest occupied by gibbons using a standardised and repeatable sampling protocol, and record data for a series of ecologically relevant variables including canopy height and cover, and tree diameter at breast height (DBH), distribution, species composition, growth and phenology (for trees >10cm DBH), paying special attention to known gibbon food tree species.

Resources needed: USD $1,000–10,000; time intensive
Responsible party: BNNRMO
Collaborators/potential partners: Chinese Academy of Forestry, Guizhou Normal University, Dali University, Jiang Haisheng, Warren Brockelman
Timeline: 6-12 months (up to three years for longer-term habitat monitoring), initiated within 6 months
Potential benefit: HIGH
Likelihood of success: HIGH
Priority: Moderately HIGH
(*Proposed by both groups*)

ACTION 4.2: Evaluate distribution and connectivity of suitable gibbon habitat across BNNR using satellite imagery and ground-truthing

While BNNRMO has some knowledge of possible barriers to the movement of existing gibbon groups in the vicinity of the area in which these groups presently range, it is crucial to gain a better understanding of the level of connectivity across the wider landscape within BNNR. Up-to-date, high-resolution satellite data could be used to map the size, distribution, and connectivity of primary forest patches across the BNNR landscape, as well as the structure of the surrounding modified habitat matrix and the location of natural and artificial physical barriers to gibbon movement (e.g. ravines, roads) across this landscape. A further large-scale series of botanical plots, sampled using the same standardised and repeatable sampling protocols and ecological/habitat quality indices used in Action 4.1, should then be surveyed in each of the other major forest patches that have been identified using remote sensing data, in order to assess their potential suitability to support gibbons. Suitability of other forest patches for gibbons could be further investigated through habitat suitability modelling for the species, which could combine these up-to-date habitat data for

the Futouling forest patch and other forest areas across BNNR with independent gibbon spatial ranging data available for the Futouling region.

Resources needed: USD $50,000–100,000; time intensive
Responsible party: BNNRMO
Collaborators/potential partners: KFBG
Timeline: 12 months, initiate as soon as possible
Potential benefit: Moderate
Likelihood of success: HIGH
Priority: HIGH
(*Proposed by both groups*)

Any attempts to expand the geographic distribution and population size of the BNNR Hainan gibbon population – an essential requirement for any long-term recovery programme for the species, to be conducted in tandem with efforts to maintain the survival of this population – will likely first focus on expanding gibbons into areas of habitat that are immediately adjacent to the area in which they are currently distributed at BNNR. As such, habitat evaluation could be conducted according to a two-step plan, as follows:

1) *Evaluate the habitat in the area immediately surrounding the existing population in terms of canopy connectivity and food species composition.*

Resources needed: USD $1,000–10,000
Responsible party: BNNRMO
Collaborators/potential partners: KFBG
Timeline: 3 months, within the next year
Potential benefit: HIGH
Likelihood of success: HIGH
Priority: HIGH

2) *Expand the connectivity evaluation to the entire reserve.*

Resources needed: USD $10,000–50,000
Responsible party: BNNRMO
Collaborators/potential partners: KFBG
Timeline: 6 months, within the next year
Potential benefit: Moderate
Likelihood of success: HIGH
Priority: Moderately HIGH

ACTION 4.3: Create new high-resolution maps of habitat quality and connectivity across BNNR

Detailed habitat maps of BNNR, which are essential for making informed decisions about gibbon conservation management within the reserve, are currently unavailable to most stakeholders. Data on the distribution and habitat composition of forest areas across the BNNR landscape generated in Action 4.2 should therefore also be used to produce high-resolution maps of BNNR forest cover and gibbon habitat suitability, which should be shared freely amongst BNNR staff, researchers and other stakeholders. However, it is recognised that attempts to develop and distribute such maps may be met with concerns about data sharing from some parties.

Resources needed: USD $10,000–50,000
Responsible party: BNNRMO
Collaborators/potential partners: KFBG
Timeline: 6 months, initiate within the next year
Potential benefit: HIGH
Likelihood of success: HIGH
Priority: Moderately HIGH
(*Proposed by Habitat Availability and Connectivity Subgroup*)

ACTIONS 5.1 – 5.5

Habitat Constraints Group, GOAL 1: Connect fragmented habitats, increase their size, and improve quality of habitats.

Habitat Availability and Connectivity Subgroup, GOAL 3: Enhance the connectivity of the habitat immediately surrounding the existing gibbon population.

ACTION 5.1: Evaluate connectivity of habitat at BNNR in terms of the necessity and feasibility of artificially connecting gaps in the landscape
The detailed data on habitat quality and connectivity across BNNR generated in Actions 4.1–4.3 above, together with other available habitat data (e.g. see Zhang *et al*. 2010) and existing expertise in landscape restoration at BNNR by BNNRMO and KFBG, should be used to identify a series of key localities across the reserve where habitat restoration efforts can be conducted to increase connectivity, size and quality of forest areas for gibbons. Habitat restoration efforts should be considered for these localities in terms of both immediate-term processes (e.g. rope bridges across small canopy gaps; see Actions 5.2–5.3 below) and longer-term forest restoration (see Action 5.4 below). These identified restoration sites should then be prioritised according to factors such as estimated cost of restoration, logistical/practical considerations, estimated time to restoration, and likely benefit to gibbons over both the short-term and longer-term. The potential impacts on gibbon dispersal and movement of discrete anthropogenic landscape features within the reserve should also be independently assessed, and appropriate management approaches identified to minimise the effect of such features (e.g. burial of all existing powerlines within the reserve boundary as a possible strategy).

Resources needed: USD $1,000
Responsible party: BNNRMO
Collaborators/potential partners: Chinese Academy of Forestry, Guizhou Normal University, Dali University, KFBG, ZSL, Susan Cheyne
Timeline: 3 months, initiate within 6 months
Potential benefit: HIGH
Likelihood of success: HIGH
Priority: HIGH
(*Proposed by both groups*)

ACTION 5.2: Trial canopy bridges to reconnect existing small-scale gaps in canopy
Canopy bridges are increasingly recognised as an effective conservation management innovation that can provide rapid functional habitat connectivity for target arboreal species in fragmented landscapes. They have now been successfully used to establish direct

arboreal connections between habitat patches and food resources for several primate species (e.g. Teixeira *et al*. 2013), including hoolock gibbons in Assam, India (Das *et al*. 2009), and they are considered to represent a potentially suitable management strategy for rapid reconnection of isolated forest patches to increase available habitat for gibbons at BNNR. Canopy bridges could be constructed at BNNR using either bamboo threaded with high-quality rope for increased strength and support, and/or silicon or metal cables disguised to resemble lianas. Multiple crossing points should be constructed to support natural gibbon traffic. Priority sites for trialling canopy bridges at BNNR could include the deep ravine to the south of Group A's current territory, which apparently acts as an almost complete barrier to a further large forest patch to the south. However, it should be noted that there is no guarantee that the gibbons will use the canopy bridges, if they do it may take several months for gibbons to start using them, and the bridges may degrade if not routinely checked and replaced, which could endanger gibbon safety.

Resources needed: USD $1,000–10,000
Responsible party: BNNRMO
Collaborators/potential partners: Jessica Bryant, Susan Cheyne, HUTAN (Kinabatangan Orang-utan Conservation Programme), Singapore Zoo
Timeline: 6 months, initiate within a year
Potential benefit: Moderate
Likelihood of success: Moderate
Priority: HIGH
(*Proposed by Habitat Availability and Connectivity Subgroup*)

ACTION 5.3: Monitor use of canopy bridges by gibbons

The installation of canopy bridges must be followed by systematic and time-intensive monitoring of their use, in order to evaluate their effectiveness and assist in their management (Teixeira *et al*. 2013). Camera traps installed at each bridge may represent a suitable method for monitoring bridge use by gibbons, although their success has been low at some other sites; for example, timing of cameras may be an issue when monitoring relatively fast-moving primates in arboreal conditions. Other technologies may therefore be required for successful monitoring of canopy bridge use.

Resources needed: USD $1,000–10,000; requires c.10-20 cameras to monitor all bridges
Responsible party: BNNRMO
Collaborators/potential partners: Jessica Bryant, Susan Cheyne, HUTAN
Timeline: 1 year, initiate within a year
Potential benefit: HIGH
Likelihood of success: Moderate
Priority: HIGH
(*Proposed by Habitat Availability and Connectivity Subgroup*)

ACTION 5.4: Conduct habitat restoration and forest corridor establishment

In tandem with rapid reconnection of forest patches using artificial canopy bridges and/or other techniques, it is also imperative to increase forest cover across BNNR for gibbon conservation over the longer-term through habitat restoration. This process should involve two components:

(1) Overall expansion of the existing area of contiguous forest in the Futouling region to which gibbons are currently restricted;

(2) Establishment of forest corridors suitable to be used by gibbons, which link the Futouling patch to other nearby forested areas across the BNNR landscape that have also been identified as capable of supporting gibbons (see Actions 4.1–4.3 above).

Habitat restoration should involve an initial phase of small-scale restoration trials and consultation (with botanical experts, local people, and other key stakeholders such as KFBG), which should result in development of a technical guide and comprehensive restoration plan including a timeline. All restoration efforts should be conducted using native tree/vine species, and will require long-term monitoring and evaluation. Corridors should aim initially to connect the current patch of gibbon habitat in the Futouling region to other potentially suitable adjacent forest patches, and should then gradually be extended to include further forest patches distributed more widely across the BNNR landscape. Ultimately, forest restoration at BNNR will also necessitate the removal of plantations that currently exist within the boundary of the protected area, in order to create optimal contiguous habitat for gibbons. However, it should be noted that administrative national nature reserve regulations currently prohibit any removal of trees from protected areas, including plantations.

Resources needed: Not specified
Responsible party: BNNRMO, HFB
Collaborators/potential partners: KFBG, FFI, local communities
Timeline: Long-term
Potential benefit: HIGH
Likelihood of success: HIGH
Priority: HIGH
(*Proposed by Habitat Constraints Group*)

ACTION 5.5: Fade out pine resin production in/near gibbon habitat

Pine resin tapping needs to be reduced and ultimately eradicated in areas of the reserve that represent priority areas for gibbon conservation. This process will require non-tapping sites across the reserve to be clearly defined and marked, and economic alternatives to be identified for stakeholders currently dependent upon resin tapping. As for Action 5.4, this conservation action will require effective communication and collaboration between BNNRMO and HFB. Although removal of any trees, including plantations, is prohibited within nature reserves, an appeal should be made to the local government for special consideration to allow pine plantations and any other economic forests located in areas immediately surrounding the current distribution of the BNNR gibbon population to be rehabilitated into native forest suitable for gibbons.

Resources needed: Not specified
Responsible party: BNNRMO, HFB
Collaborators/potential partners: KFBG, FFI
Timeline: Short to mid-term
Potential benefit: HIGH
Likelihood of success: Medium
Priority: HIGH
(*Proposed by Habitat Constraints Group*)

ACTION 6

Habitat Constraints Group, GOAL 2: Strengthen BNNRMO's capacity to protect habitats.

ACTION 6.1: Enhance patrolling and monitoring capacity at BNNR

The current system of patrolling in place at BNNR should be substantially strengthened through a series of activities:

1) *Use of improved patrolling tools*

BNNRMO staff should be trained in the use of established tools that are widely employed in other protected areas to monitor, evaluate, and adaptively manage patrolling activities. In particular, they should receive training in the use of software such as SMART (Spatial Monitoring and Reporting Tool; see www.smartconservationsoftware.org). Adoption of SMART or related tools at BNNR would improve the ability and effectiveness of wardens to combat illegal activities associated with forest disturbance at BNNR, as well as providing further benefits for improved monitoring of gibbon social groups and solitary individuals (see Action 1.1 above).

Resources needed: Funds, trainers, equipment
Responsible party: BNNRMO, HFB
Collaborators/potential partners: KFBG, FFI, ZSL and other institutes
Timeline: Not specified
Potential benefit: Medium
Likelihood of success: HIGH
Priority: Medium
(*Proposed by Habitat Constraints Group*)

2) *Increased support and collaboration*

Patrolling at BNNR should also be strengthened through access to increased financial support and associated resources and increased staffing of patrol teams. Greater communication and collaboration between BNNRMO staff and local communities (including regular meetings, public awareness and educational activities, and co-management) should also be established, in order to identify potential solutions to conflicts over utilisation of forest resources and ongoing disturbance of forested areas within BNNR by local community members.

Resources needed: Not specified
Responsible party: BNNRMO, HFB
Collaborators/potential partners: KFBG, FFI
Timeline: Not specified
Potential benefit: HIGH
Likelihood of success: Low
Priority: Medium
(*Proposed by Habitat Constraints Group*)

ACTION 7

Habitat Constraints Group, GOAL 3: Improve understanding of human and environmental disturbance.

ACTION 7.1: Investigate potential impacts of human and environmental disturbance

Even if the Futouling forest patch is expanded and connected to areas of adjacent gibbon habitat across the BNNR landscape, gibbons may still avoid some forested areas due to potential disturbance to this habitat. Such disturbance may either be anthropogenic (caused by local community members or tourists) or natural (e.g. damage to vegetation caused by typhoons or other severe weather events). Indeed, it is possible that current levels of forest usage by local community members in the Futouling forest patch have caused gibbons to move away from the Big Fig Valley area, and that recent tourism activities have caused gibbons to move away from the Dong'er and Dongsan areas. It is therefore necessary to evaluate the potential impacts on gibbons of current tourism strategies and associated construction activities, current forest usage by local communities, and natural disturbances, and to regulate patterns of forest usage by different user groups accordingly.

Resources needed: Not specified
Responsible party: BNNRMO, HFB
Collaborators/potential partners: Institutes or universities
Timeline: Not specified
Potential benefit: Low
Likelihood of success: Medium
Priority: Low
(*Proposed by Habitat Constraints Group*)

工作小组报告：栖息地的制约

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工作小组对海南长臂猿种群生存力可能受到的栖息地的制约进行了讨论。

由于此工作小组的目标、考虑问题和建议行动与种群现状工作小组的栖息地可用性与连通性亚组出现重叠，所以该亚组的部分讨论内容被置于本章，并清楚标明建议的组别。

问题阐述

海南长臂猿所受的栖息地的制约来自于多种自然与人为干扰导致森林的连通性与质量的下降，这些问题不但影响长臂猿的分布，还增加长臂猿遭受食物短缺的风险。建议通过短期与长期的不同手段来连接栖息地板块，同时增加栖息地的面积与质量，如利用绳桥连接小林窗和造林等。

主要问题

栖息地质量较低

现在霸王岭的森林结构并不能支持长臂猿的长远增长，较好的栖息地都存在林斑，破碎化及被人工林分隔等的问题，很可能造成长臂猿在旱季的食物短缺。另外，人工的物理阻隔也妨碍种群往其它质量较好的栖息地扩散。工作小组认为霸王岭的栖息地问题对海南长臂猿种群的近期影响不大（不会直接导致个体死亡或物种灭绝），长远影响却可能很大（可能影响种群恢复）。也发现现有种群没有充分利用质量较高的生境，如东五片区，所以建议对长臂猿的分布因素和栖息地要求进行更深入研究。

长臂猿扩散的物理阻隔

霸王岭长臂猿栖息地的连通性主要受人工林和建筑物影响。例如，保护内的主要道路——东干线，就把保护区核心区的适宜生境一分为二。虽然沿路两边的林冠在某些位置已慢慢产生连接，但它仍是长臂猿从斧头岭往附近潜在栖息地迁移的主要障碍（见图2）。在霸王岭保护区范围内现有两条电缆穿越，虽然在东干线近东二有部分电缆已经被埋入地下，遗留的林隙依然明显，而且并没有实施造林计划。

旅游开发

自从2006年在斧头岭东二与东三地区修建了旅游栈道（见图2），那里原有的家庭群从此往斧头岭其它地区迁移。有关当局在稍后已经把部分栈道封闭。可见，栈道的修建工程及旅游发展对长臂猿生境影响明显，然而旅游对长臂猿种群与其分布的影响则有待研究。

当地居民的直接干扰

当地居民有到森林采集非木质林产品的习惯。长臂猿已被严禁猎杀，但是针对其它野生动物的捕猎行为还是偶有发生（见人类活动影响工作小组报告）。与会人员初步认为这些捕猎活动未直接针对长臂猿所以不会对长臂猿产生直接的影响。因为，对在斧头岭的人类活动的强度与地理分布，及其可能对长臂猿分布造成的影响暂时还没有进行过比较全面的分析研究。也有研究认为其它人为干扰，如林火和放牧，是导致霸王岭地区植被在近几十年退化的间接原因（张明霞等 2010），不过认为这些因素对现有长臂猿栖息地的影响较低。

经济林

全省范围，包括保护区内，几乎全部低地雨林都被改造成经济林。低海拔森林生境的丧失致使长臂猿往较高海拔地区（食物来源减少）活动。霸王岭保护区内有大面积的经济林，树龄为10-15年，在保护区范围扩大时被划到保护范围内。

橡胶林在保护区内的面积约为6 km^2，靠近青松镇的部分村子。松树林的面积超过80 km^2，其中约62 km^2是南亚松（*Pinus latteri*），加勒比松（*Pinus caribaea*）至少有18 km^2。南亚松是海南的原生种，被广泛种植用于松脂生产；加勒比松则是用于木材生产的外来种。经济林分布于保护区内不同的区域，覆盖子宰的大部分地区（保护区东南部，东六以南，见图二）。在长臂猿活动范围内也有松树林的分布，位置在斧头岭以南南叉河附近。这些松树林混杂于长臂猿喜欢的低地雨林当中，是KFBG栖息地恢复项目的重点区域。但是由于采松脂活动在南叉河与其它区域的松树林内依然活跃，长臂猿也可能因此而放弃这片恢复中的栖息地。所有保护区内的经济林由霸王岭林业局和保护区管理局承包给私人公司经营，因此采松脂等活动的经济收益对改善当地社区的民生帮助极少。

自然灾害

每年的台风季节都会发生某程度的倒木和滑坡。会上，一名社区代表认为自然灾害对长臂猿及其栖息地不会产生明显的影响，但是另一名社区代表却认为台风对斧头岭，如东三地区，造成的森林结构的变化可能已导致长臂猿的迁离，所以有必要对台风的生态响应开展系统的调查。

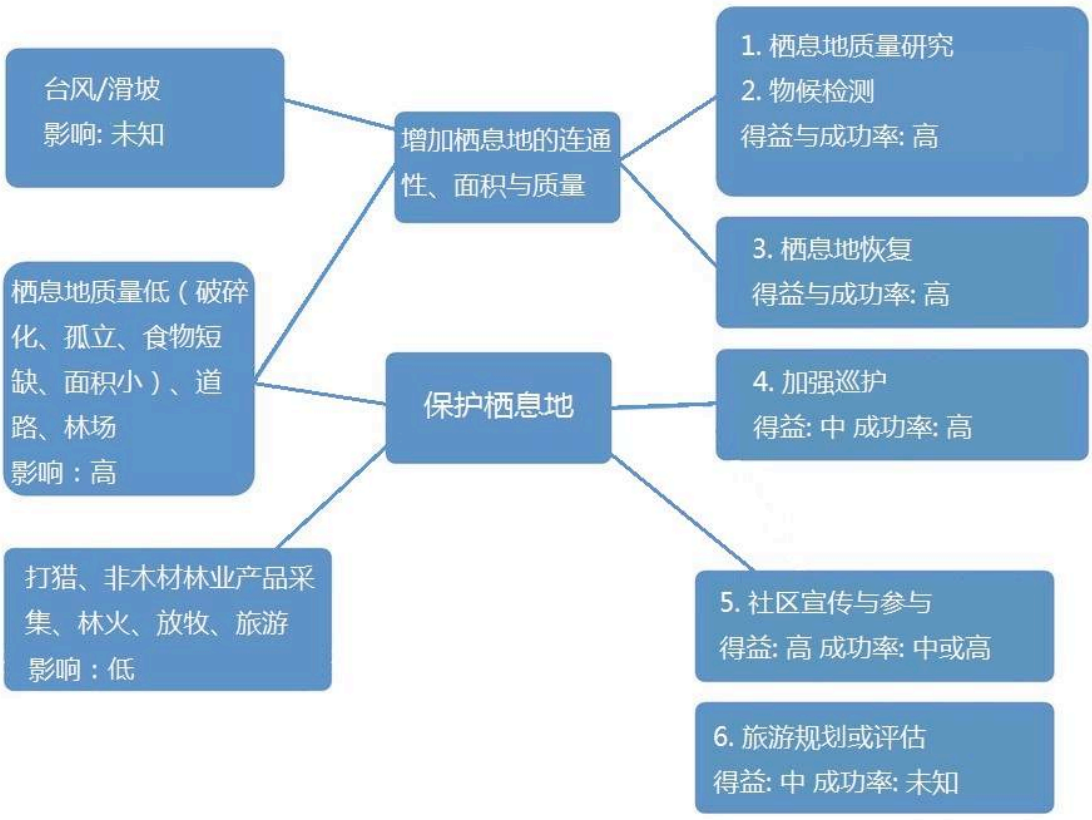

图5 海南长臂猿来自栖息地的威胁，以及对应的策略与建议行动。

保护目标与建议行动

行动4.1-4.3

栖息地可用性与连通性亚组，目标2：对霸王岭保护区内长臂猿适宜栖息地的面积、质量与连通性进行详细的评估

行动4.1： 在长臂猿的主要分布区对植物组成和物候进行详细的样方调查

通过保护区管理局与科研人员持续的监测，对斧头岭种群的现时分布已有很好的掌握，但是，对于长臂猿的栖息地选择以及其它环境变量对长臂猿的历史和现在分布的作用至今还是未明。缺乏长臂猿这方面的生态知识，要了解长臂猿适宜生境在霸王岭以内及以外的分布非常困难。因此，必须在长臂猿分布区域内系统地建立植物样方，并以标准的、可重复的调查手段对树冠高度与盖度、胸径，对胸径大于10厘米的树种、分布、物候进行调查，特别关注已知的猿食树种。

所需资源：六千至六万元，所需人力资源较大
负责单位：霸王岭保护区管理局
合作单位：林业科学院、贵州师范大学、大理学院、江海声、博瑞查克曼

时间：为期六至十二个月（栖息地监测时间应达到三年），在六个月内执行
得益：高
成功率：高
优先性：高
（两组均提出）

行动4.2： 利用卫星图像与地面调查评估保护区内长臂猿适宜生境的分布和连通性

虽然保护区对种群活动所受的限制（移动障碍）有一定程度的了解，但是对整个保护区范围的栖息地连接度了解却很有限。最新的、高精度的卫星图像数据能用于准确辨认原始森林斑块的分布、面积与连通性，退化栖息地的结构，以及妨碍长臂猿迁移的物理障碍的具体位置。另外，采用以上行动4.1的调查方法，在卫星图像显示的每个主要森林斑块进行样方调查，利用预设的生态和栖息地质量指标评估栖息地的适宜性。更可以结合卫星图像数据和长臂猿活动数据建立长臂猿栖息地适宜性模型，进一步分析整个区域的栖息地适宜性分布情况。

所需资源：三十万至六十万元 ，所需人力资源较大
负责单位：霸王岭保护区管理局
合作单位：KFBG
时间：为期十二个月，尽快执行
得益：中
成功率：高
优先性：高
（两组均提出）

长远的种群恢复计划必须结合现有种群的保护与种群数量和分布的增加。种群分布区域的扩张应从现有活动范围的周边地区开始，因此，栖息地评估工作也应分两个阶段进行：

1）*对长臂猿现有活动范围的周边地区进行林冠连通性和猿食树种的调查*

所需资源：六万元以内
负责单位：霸王岭保护区管理局
合作单位：KFBG
时间：为期三个月，一年内执行
得益：高
成功率：高
优先性：高

2）*把栖息地连通性和猿食树种的调查伸延至整个保护区*

所需资源：六万至三十万元
负责单位：霸王岭保护区管理局
合作单位：KFBG
时间：为期六个月，一年内执行
得益：中

成功率：高
优先性：中高

行动4.3：　为保护区制作高精度栖息地质量与连通性分布图

详细的栖息地分布图能为管理人员提供栖息地恢复和种群管理的必要信息。因此，应利用行动4.2所获得的空间数据制作高精度的植被分布图和长臂猿栖息地适宜性分布图，并免费提供给保护区人员、科研人员和其它利益相关者使用。信息共享的忧虑可能会对行动构成障碍。

所需资源：六至三十万元
负责单位：霸王岭保护区管理局
合作单位：KFBG
时间：为期六个月，一年内执行
得益：高
成功率：高
优先性：中高
（由栖息地可用性与连通性亚组提出）

行动5.1-5.5

栖息地的制约工作小组，目标1：增加栖息地连通性、面积与质量

栖息地可用性与连通性亚组，目标3：提高长臂猿分布区周边栖息地的连通性

行动5.1：　评估人工连通栖息地的必要性和可行性

根据行动4.1-4.3所产生的栖息地质量与连通性数据，其它现有栖息地数据（如，Zhang *et al*. 2010），以及保护区管理局和KFBG在霸王岭的栖息地恢复经验，选择栖息地恢复优先区域以增加长臂猿栖息地的连通性、面积与质量。应同时考虑使用中期（见行动5.2-5.3）和长期（见行动5.4）的恢复手段。然后应根据恢复这些区域的可行性、所需经费、所需时间与对长臂猿的正面影响进行优先性排序。同时，评估现有各种建筑物对长臂猿移动的影响，以及如何降低其影响（如，把保护区内的架空电缆买入地下）。

所需资源：六千元以内
负责单位：霸王岭保护区管理局
合作单位：中国林业科学院、贵州师范大学、大理学院、KFBG、ZSL、車尤尼恩
时间：为期三个月，六个月内执行
得益：高
成功率：高
优先性：高
（两组均提出）

行动5.2：　测试以树冠桥梁连通林窗的可行性

树冠桥梁越来越广泛被应用于连通破碎的树冠层动物生境。在国外，这手段已被成功应用于几种灵长类的保护工作（如，Teixeira *et al*. 2013），包括印度北部的白眉

长臂猿（Das *et al*. 2009）。专家认为这手段也适合在霸王岭应用，以快速增加现有家庭群的栖息地面积。树冠桥梁可以用竹竿与麻绳等当地自然材料搭建，也可以用硅胶或金属绳索（以攀藤作掩饰）增加其韧性和耐用性。树冠桥梁的密度和位置应取决于长臂猿家庭群的移动特征，不妨考虑A群以南的沟谷作为试点(已知该沟谷妨碍长臂猿往南边大片合适生境中扩散)。值得注意的是，第一不能保证长臂猿会利用这些树冠桥梁，其次可能需要数个月的适应期后方会使用，另外必须要对所有设施进行定期检查与维修。

所需资源：六千到六万元
负责单位：霸王岭保护区管理局
合作单位：布赖恩、車尤尼恩、HUTAN、新加坡动物园
时间：为期六个月，一年内执行
得益：中
成功率：中
优先性：高
（由栖息地可用性与连通性亚组提出）

行动5.3： 对树冠桥梁进行监测

树冠桥梁建成后必须对其的有效性进行系统监测评估（Teixeira *et al*. 2013）。在桥梁上安装自动感应摄像机可以记录长臂猿对桥梁的使用，但是由于摄像机定时设置等的问题，应配合使用其它监测手段。

所需资源：六千至六万元，十至二十台摄像机
负责单位：霸王岭保护区管理局
合作单位：布赖恩、車尤尼恩、HUTAN
时间：为期一年，一年内执行
得益：高
成功率：中
优先性：高
（由栖息地可用性与连通性亚组提出）

行动5.4： 栖息地恢复与廊道建设

在运用树冠桥梁的同时，必须进行长期的栖息地恢复计划：

（1）以增加斧头岭现有栖息地的面积；

（2）建立生态廊道连接斧头岭与其它适宜生境（见行动4.1-4.3）。

初步阶段需进行试验及专家咨询会（邀请专家和关键利益相关者参加），以编制技术指南和栖息地恢复计划。栖息地恢复与廊道建设必须使用原生种，并需进行长期的监测与评估。生态廊道应连接现有与附近的潜在栖息地，并逐步往保护区内其它区域延伸。最终，栖息地全面的恢复还是需要移除妨碍长臂猿扩散的人工林，虽然现在法规并不允许在保护区范围内移除任何树木，包括人工种植的树木。

所需资源：未明确
负责单位：霸王岭保护区管理局、海南省林业厅
合作单位：KFBG、FFI、当地社区

时间：长期
得益：高
成功率：高
优先性：高
（由栖息地的制约工作小组提出）

行动5.5： 在长臂猿栖息地逐步取缔采松脂

在主要长臂猿活动区域必须逐渐减少并最终停止采松脂等林业活动。订立管辖制度后需竖立清晰的管辖范围指示牌，并为受影响的部门提供经济补偿。如行动5.4，此行动也要求保护区管理局和林业厅的有效沟通与合作。虽然现在法规并不允许在保护区范围内移除任何树木，但应尝试以法律途径解决当前长臂猿栖息地恢复所面临的障碍。

所需资源：未明确
负责单位：霸王岭保护区管理局、海南省林业厅
合作单位：KFBG、FFI
时间：短至中期
得益：高
成功率：中
优先性：高
（由栖息地的制约工作小组提出）

行动6

栖息地的制约工作小组，目标2：提高保护区管理局保护栖息地的能力

行动6.1： 巡护与监测队的能力建设

1）巡护工具的使用

为保护区管理局的巡护与监测队人员提供巡护工具和技术的培训，如SMART（空间监测与汇报工具，http://www.smartconservationsoftware.org），以提高巡护、监测与管理效率。SMART等工具能有助提高保护区巡护人员打击非法活动的能力与效率，同时能加强长臂猿的监测效率（见行动1.1）。

所需资源：经费、培训员、培训工具
负责单位：霸王岭保护区管理局、海南省林业厅
合作单位：KFBG、FFI、ZSL以及其它机构
时间：未明确
得益：中
成功率：高
优先性：中
（由栖息地的制约工作小组提出）

2）*加大投入与合作力度*

增加对保护区巡护与监测的经费与人力资源投入，并通过会议、社区宣传、社区共管加强管理局与社区之间的沟通与合作，以缓解在森林资源利用上的冲突。

所需资源：未明确
负责单位：霸王岭保护区管理局、海南省林业厅
合作单位：KFBG、FFI
时间：未明确
得益：高
成功率：低
优先性：中
（由栖息地的制约工作小组提出）

行动7

栖息地的制约工作小组，目标3：增加对人为与自然干扰的理解

行动7.1： 评估人为和自然干扰对长臂猿及其栖息地的影响

即使栖息地的质量与连通性有所改善，某些适宜生境也可能由于人为或自然干扰不能成为长臂猿的栖息地。人为干扰包括当地居民的进山活动、林业活动和旅游活动；自然干扰包括台风或其它极端气候所造成的植被破坏。据了解，人为活动可能已导致长臂猿离开斧头岭的榕树沟，而旅游开发可能是导致长臂猿离开东二及东三区域的原因。因此，评估现有旅游发展计划、森林利用、自然灾害等对海南长臂猿的潜在效应评估，以促进管理。

所需资源：未明确
负责单位：霸王岭保护区管理局、海南省林业厅
合作单位：科研单位或大学
时间：未明确
得益：低
成功率：中
优先性：低
（由栖息地的制约工作小组提出）

International Conservation Planning Workshop for the Hainan Gibbon

Bo'ao, Hainan, China
18 – 20 March 2014

Final Report

海南长臂猿保护博鳌国际论坛

中国海南省博鳌镇
2014年3月18至20日

总结报告

SECTION 6

Impacts of Human Activities
Working Group Report

第六章　工作小组报告:人类活动的影响

Working Group Report: Impacts of Human Activities

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This working group addressed issues related to potential impacts that human activities may have on the Hainan gibbon population and its viability.

General Problem Statement

Gibbons occur in a fragmented forest mosaic landscape at BNNR that is also utilised by local villagers, mostly Li and Miao ethnic minorities, who have lived in close association with the region's forests for generations. Gibbons and humans are likely to come into close contact as a result of this shared habitat use, and the current range of the newly formed Group C is very close to settlements in Qingsong Township. The livelihoods of local communities around BNNR have been substantially affected by the establishment of the reserve, leading to local tensions and reduced economic opportunities, and many villagers continue to use the forests for a range of activities. The group discussed the potential threats that local communities could impose on the gibbons and what actions are required to mitigate these threats.

Major Issues Identified

Collecting Non-Timber Forest Products (NTFPs)

Local people continue to enter the reserve regularly to collect medicinal plants and fungi, which have a relatively high market value. The spatial pattern and intensity of NTFP collection by local people is not clearly understood, but is likely to be widespread. Although NFTP collectors reportedly do not have direct contact with gibbons, and may only create minimal disturbance to habitats, their activities may still constitute sufficient disturbance to cause gibbons to avoid certain areas of forest and may degrade individual areas substantially over time (cumulative effects).

Hunting

Hunting of forest mammals is a traditional subsistence activity carried out by the Li and Miao communities around BNNR. Past hunting is known to have targeted the BNNR gibbon population directly, and is one of the primary factors responsible for the disappearance of gibbons across Hainan during the twentieth century (Chan *et al*. 2005). Gibbons are reportedly no longer targeted by local hunters, but hunting of other mammal species continues within the reserve (Lau *et al*. 2010), and is likely to impact the BNNR gibbon population directly by causing substantial disturbance. Accidental killing of gibbons by

hunters targeting arboreal species such as giant flying squirrels (*Petaurista philippensis* and *Ratufa bicolor*) remains a possibility, as does potential deliberate killing of gibbons, and even the loss of a single gibbon individual to hunters would represent a catastrophic event for the sole remaining population.

Logging
Commercial logging ceased in BNNR in 1992, but local communities continue to use forests within the reserve as a source of construction materials for houses. Such timber extraction activities will disturb and damage gibbon habitats directly.

Poverty
Local communities situated around BNNR are low-income subsistence communities, and four townships in this region (Jinbo and Qingsong townships in Baisha County, and Qicha and Wangxia townships in Changjiang County) are designated as poverty townships at the provincial level and are the subject of poverty alleviation programmes. Baisha County is in fact recognised as one of China's poorest counties (FFI China Programme 2005).

There are three major causes of poverty in local communities around BNNR:
1. Local communities are no longer permitted to conduct various activities in areas now within the boundaries of the reserve, which has expanded its boundaries into areas traditionally used by local people over the past few decades. Since BNNR was established as a protected area, planting of rubber trees has been prohibited within the reserve boundary; rubber trees die after 20-30 years, and the loss of local rubber plantations has drastically reduced the income of some villages.
2. Continued human population growth in the area, although this is relatively low (15% between 2000 and 2010).
3. Lack of alternative livelihoods, partly due to poor education, which leaves many local communities no choice but to continue to rely on BNNR's forests to provide food, materials and income.

Continued exploitation of forest resources by local communities leads to conflicts and resentment with BNNRMO, and creates major challenges for effective reserve management. It is suggested that poverty is the root cause of all human-gibbon conflicts (Figure 6).

Other Low-Impact Threats
Additional issues were also raised and discussed by the group, but these are not described in detail here because they were not considered to constitute significant concerns for gibbon conservation by the working group. These issues include: 1) traditional beliefs and attitudes towards gibbons in local communities; 2) competition for resources between gibbons and local forest users; 3) low awareness of gibbon conservation in local communities; 4) tourism; 5) domestic animals; 6) zoonoses (potential for disease transmission from humans to gibbons); and 7) lack of incentives to protect gibbons or support conservation.

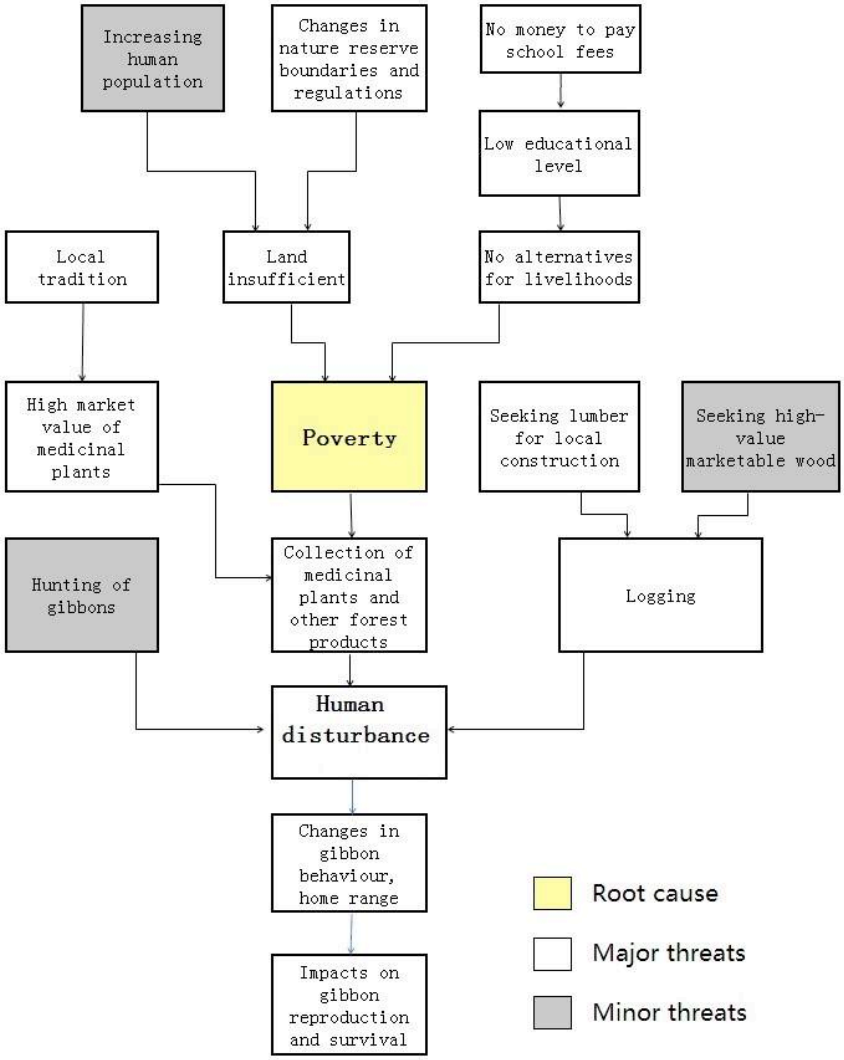

Figure 6. Causes of major threats from local communities to the survival of the Hainan gibbon.

Goal and Recommended Actions

ACTIONS 8.1 – 8.6

<u>Impacts of Human Activities Group, GOAL 1</u>: Use local knowledge and resources to increase local income.

ACTION 8.1: Improve education

In order to provide the next generation of local community members around BNNR with greater economic opportunities that will reduce their dependency on forest resources from within the reserve in the long-term, it it necessary to strengthen the level of education provided by local schools. This will necessitate both improvements in the quality of primary school teaching, and also providing stipend support to enable more children to also go on to secondary school.

Resources needed: Not specified
Responsible party: Ministry of Education of Baisha and Changjiang counties
Collaborators/potential partners: NGOs and donors
Timeline: Not specified
Potential benefit: HIGH, but long-term
Likelihood of success: HIGH
Priority: HIGH

ACTION 8.2: Develop agroforestry

Whereas current forest production practices carried out by local communities around BNNR (pine resin tapping, rubber tapping) have detrimental impacts on primary forest environments and therefore on gibbon habitats within the reserve, alternative agroforestry approaches may potentially be more sustainable and could therefore represent viable economic alternatives for communities. Ecologically appropriate and locally suitable agroforestry practices, and potentially also medical crop systems and other farming practices that could benefit local communities and be established sustainably around BNNR, should therefore be identified. These activities should be explored in areas surrounding the reserve, rather than within the protected area.

Resources needed: Not specified
Responsible party: Not specified
Collaborators/potential partners: Forestry organisations, e.g. APFNet (Asia-Pacific Network for Sustainable Forest Management and Rehabilitation)
Timeline: Not specified
Potential benefit: HIGH
Likelihood of success: Moderate
Priority: HIGH

ACTION 8.3: Provide vocational training and technical support

To further improve educational capacity and opportunities for local communities around BNNR, and ensure that potential sustainable agroforestry alternatives can be successfully developed to improve local livelihoods, vocational training should be provided to develop relevant key livelihood skills. Training needs should be identified through appropriate consultation with local communities. In particular, if sustainable agroforestry strategies suitable for the BNNR landscape can be identified, it will be necessary to provide relevant training and equipment to local communities to enable effective agroforestry production.

Resources needed: Not specified
Responsible party: Local Poverty Alleviation Office
Collaborators/potential partners: NGOs, BNNRMO
Timeline: Not specified
Potential benefit: HIGH
Likelihood of success: Moderate
Priority: HIGH

ACTION 8.4: Develop agroforestry sales strategies and marketing channels

If sustainable agroforestry strategies suitable for the BNNR landscape can be identified and developed to improve local community livelihoods, it will also be necessary to identify appropriate marketing strategies that will enable agroforestry products to be distributed to both local and larger markets, to ensure the long-term economic sustainability of such ecologically appropriate environmental management.

Resources needed: Not specified
Responsible party: Local poverty alleviation offices
Collaborators/potential partners: NGOs, BNNRMO
Timeline: Not specified
Potential benefit: HIGH
Likelihood of success: Moderate
Priority: HIGH

ACTION 8.5: Investigate potential for developing cultural tourism

Infrastructure for relatively small-scale ecotourism is already established in parts of BNNR; local accommodation is available for tourists (almost entirely Chinese nationals) who are interested in visiting the forest (non-core areas), and access to certain peripheral areas of forest is facilitated by several boardwalks and trails. It was suggested by some members of the working group that it may also be appropriate to develop community-based tourism in villages around BNNR. A responsible and respectful tourism industry based on the cultural heritage within the communities around BNNR may constitute a means of improving economic opportunities for these local communities surrounding the reserve, and may also create wider awareness among both community members and visitors about gibbon conservation at BNNR and the wider link between forests and gibbons on Hainan. Such tourism may also provide local communities with greater involvement in (and indirect benefits from) gibbon conservation activities taking place in the reserve, thus creating more positive attitudes towards gibbons in these communities. Whilst such tourism may provide benefits for the economy of local communities, however, any increase in tourist activities is also likely to increase anthropogenic disturbance in the reserve and surrounding areas, and so should be assessed extremely carefully and critically. For example, the presence of tourists in the Dong'er and Dongsan areas of the Futouling region of the reserve are considered likely to have disturbed gibbons away from these areas and caused the animals to stop using parts of the forest. Any consideration of further tourism development either within BNNR or in areas surrounding the reserve should therefore involve formal consultation with all stakeholders associated with Hainan gibbon conservation, and should not proceed until the concerns of these stakeholders about any potential negative impacts on gibbons have been fully addressed. In particular, gibbon Group C currently occupies an area of forest closely adjacent to a Miao minority village in Qingsong Township, and so this area should not be considered for any kind of community-based tourism due to specific concerns about the likely negative effects of any increase in local human disturbance.

Resources needed: Not specified
Responsible party: Not specified
Collaborators/potential partners: NGOs
Timeline: Not specified
Potential benefit: Moderate
Likelihood of success: Moderate
Priority: Moderate

ACTION 8.6: Establish communication channels between local communities, authorities and reserve management

Tensions existing between communities across the BNNR landscape and regional reserve management staff and other authorities have had a negative impact on attitudes towards gibbon conservation held by many local communities. In order to attempt to build a more positive relationship between BNNRMO and local officials and these communities, and therefore to generate more positive attitudes about gibbon conservation among forest users

and other local stakeholders, it was proposed that regular meetings should be scheduled between reserve staff and representatives from local communities. These meetings should be used as a forum for local people to air any grievances they have about specific reserve management issues that affect their livelihoods, and as a means to identify mechanisms for BNNRMO and other authorities to respond appropriately to the needs of local communities.

Resources needed: Not specified
Responsible party: BNNRMO
Collaborators/potential partners: NGOs
Timeline: As soon as possible
Potential benefit: HIGH
Likelihood of success: Moderate
Priority: HIGH

工作小组报告：人类活动的影响

组员

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工作小组对海南长臂猿种群生存力可能受到的人类活动影响进行了全面的讨论。

问题阐述

当地村民，主要是黎族与苗族，世世代代靠山吃山，与长臂猿共用自然资源，使得海南长臂猿活动区域内森林破碎化越发明显，而且新组成的C群也离青松乡民居非常近。由此可见，保护区的建立对周边村民的生活影响甚大，特别是他们经济收入的减少，使之与管理部门之间的关系也变得逐渐紧张。工作小组对村民生活可能对长臂猿造成的影响及对应措施进行详细的讨论。

主要问题

采集林副产品，主要是药用植物

多种药用植物和菌类具可观的经济价值，吸引村民进入保护区内进行采集。至今还没有确切的数据说明林副产品采集活动的空间分布与强度，但是相信分布甚广。采集者虽人为采集活动对长臂猿不会产生直接的影响，但是实际上所产生的干扰也可能促使长臂猿改变其活动范围，也可能导致栖息地质量逐渐地下降。

捕猎

捕猎是当地苗族与黎族的传统生活活动。以前，长臂猿是捕猎活动的主要目标之一，从而造成二十世纪海南长臂猿种群的快速消亡（Chan *et al*. 2005）。虽然现在长臂猿已非猎人的主要目标，但是由于保护区内偷猎仍然时有发生（Lau *et al*. 2010），在捕猎树冠层动物，如鼯鼠（*Petaurista philippensis*，*Ratufa bicolor*）时可能会误杀长臂猿。对现在海南长臂猿的种群而言，一头长臂猿的杀害也可能对种群产生灾难性的后果。

伐木

自1992年，在霸王岭保护区内的所有商业砍伐活动已被制止，但是这里依然是周边居民建筑用材的来源。伐木活动对长臂猿栖息地造成直接的干扰及破坏。

贫困

霸王岭保护区周边社区主要是低收入家庭；其中四个乡，白沙县的金波和青松乡，昌江县的七差和王下乡，是海南省贫困乡，白沙县更是我国贫困县之一（FFI China Programme 2005）。

当地贫困的三个主要原因：

1. 保护区的建立使得传统依赖森林资源的原著居民收入大幅减少，而保护区的范围自成立后先后扩大了两次。保护区内严禁栽种新的橡胶树，已种植的橡胶树在20至30年后便会死去，村民便失去主要的经济来源。
2. 当地人口的增加，虽然增长率并不高（2000至2010年增长15%）。
3. 教育水平低，缺乏替代生计，迫使村民继续从保护区取得其所需的食物、材料和经济来源。

村民持续对森林资源的依赖，致使社区与管理部门之间产生矛盾与冲突，不利于保护区的有效管理。贫困是人类与长臂猿之间发生冲突的首要因素。

其它威胁

工作小组还提出了其它的潜在威胁，但是由于组员认为这些威胁对长臂猿的影响不大所以没有进行更深入的讨论，这些威胁包括：(1) 对长臂猿的传统观念 (2) 人与长臂猿的自然资源竞争 (3) 公众保护意识薄弱 (4) 旅游开发 (5) 家养动物 (6) 人畜共患病的传染 (7) 当地社区缺乏保护长臂猿的动机。

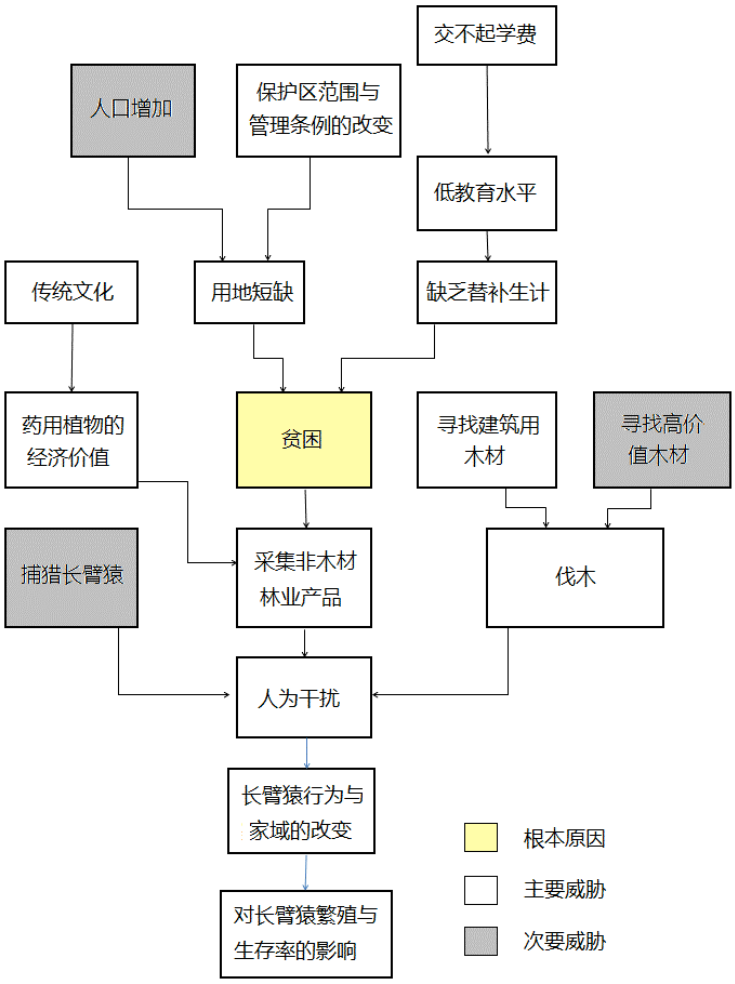

图6 社区对海南长臂猿的主要威胁与成因。

保护目标与建议行动

行动8.1-8.6

人类活动的影响工作小组，目标1：以传统知识和当地资源增加社区经济收入

行动8.1： 提高教育水平

为了提高下一代的教育水平，从长远角度减少原著居民对保护区内自然资源的依赖，必须提高当地学校的教学质量。行动内容包括改善当地小学的教学条件，提供助学金鼓励更多的学生升读中学。

所需资源：未明确
负责单位：县教育部
合作单位：非政府组织和捐款者
时间：未明确
得益：高（长期）

成功率：高
优先性：高

行动8.2： 发展混农林业

保护区内现有的林业生产活动（采松脂，割胶等）严重破坏海南长臂猿栖息地；发展混农林业可以提供可持续性的替代生计。因此应为保护区外的霸王岭地区开展混农林业调研，开发适合当地生态环境和市场状况的新农林系统，如林下种植药用植物等。

所需资源：未明确
负责单位：未明确
合作单位：林业组织，如亚太森林网络
时间：未明确
得益：高
成功率：中
优先性：高

行动8.3： 提供林业相关的技能培训

为保护区周边社区提供相关的技能培训，以提升其教育与技能水平，确保混农林业等替代生计的顺利发展。培训内容应根据不同社区特点以及混农林业发展方向而定。

所需资源：未明确
负责单位：当地扶贫办
合作单位：非政府组织，海南霸王岭保护区管理局
时间：未明确
得益：高
成功率：中
优先性：高

行动8.4： 为混农林业设计营销策略和开发销售渠道

为混农林业设计营销策略并开发销售渠道，促进林业产品在本地以至更大市场的销售，确保其持续性发展。

所需资源：未明确
负责单位：当地扶贫办
合作单位：非政府组织，海南霸王岭保护区管理局
时间：未明确
得益：高
成功率：中
优先性：高

行动8.5： 研究发展文化特色旅游的可行性

在霸王岭保护区内已建有一些生态旅游的基础设施，包括住宿和观光栈道。有组员提议可在保护区周边社区发展文化旅游。合理开展文化旅游不但能提高社区居民和游客的保护意识，还可以为社区提供经济收入以缓解社区和管理部门之间的冲突。但

是，旅游活动的增加会增加保护区内的人为干扰，必须正确评估开发文化旅游的可行性与影响。例如，过去在斧头岭东二与东三地区的旅游发展被认为是促使长臂猿弃用这些区域的原因。因此，任何旅游发展必须得到所有利益相关者的同意，并确保所有可能对长臂猿产生的威胁都得到充分的考虑。长臂猿C群的活动范围靠近青松乡的苗村，因此这里不适宜发展任何旅游开发项目。

所需资源：未明确
负责单位：未明确
合作单位：非政府组织
时间：未明确
得益：中
成功率：中
优先性：中

行动8.6： 建立林业部门、管理单位与社区之间的沟通渠道

林业部门、管理单位和社区之间的紧张关系会影响社区保护长臂猿的观念。建立健康的沟通渠道，促进良性互动，建议定期举行会议使得村民对保护区管理意见有申诉的渠道，有助保护区采取适当的措施缓解矛盾。

所需资源：未明确
负责单位：海南霸王岭保护区管理局
合作单位：非政府组织
时间：尽快
得益：高
成功率：中
优先性：高

International Conservation Planning Workshop for the Hainan Gibbon

Bo'ao, Hainan, China
18 – 20 March 2014

Final Report

海南长臂猿保护博鳌国际论坛

中国海南省博鳌镇
2014年3月18至20日

总结报告

SECTION 7

Policy and Communication Issues
Working Group Report

第七章　工作小组报告:政策与管理

Working Group Report: Policy Constraints

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This working group addressed issues related to policy and communication among stakeholders that may impact the effectiveness of Hainan gibbon conservation.

General Problem Statement

The key problem that hinders effective management, action and policy-making for Hainan gibbon conservation is the general lack of effective communication or collaboration among stakeholders. Four levels of communication problems were identified by the working group:

Lack of Communication among Authorities
Lack of horizontal communication between government departments (for example between BNNRMO and provincial government departments on Hainan), and lack of vertical communication between levels of government hierarchy (for example between provincial and national governments), in both cases leading to lack of action.

Lack of Communication between Authorities and Communities
Lack of effective communication or collaboration between authorities and local communities around BNNR, leading to conflicts of interest (e.g. over issues such as forest use).

Lack of Communication between Authorities and Academics
Lack of effective communication or collaboration between authorities and researchers, leading to relevant scientific data, techniques, funding and ideas not being shared.

Lack of Communication between Stakeholders and the Public
General lack of communication between academics, NGOs, authorities and the public, leading to low wider awareness of Hainan gibbon conservation issues and further lack of action.

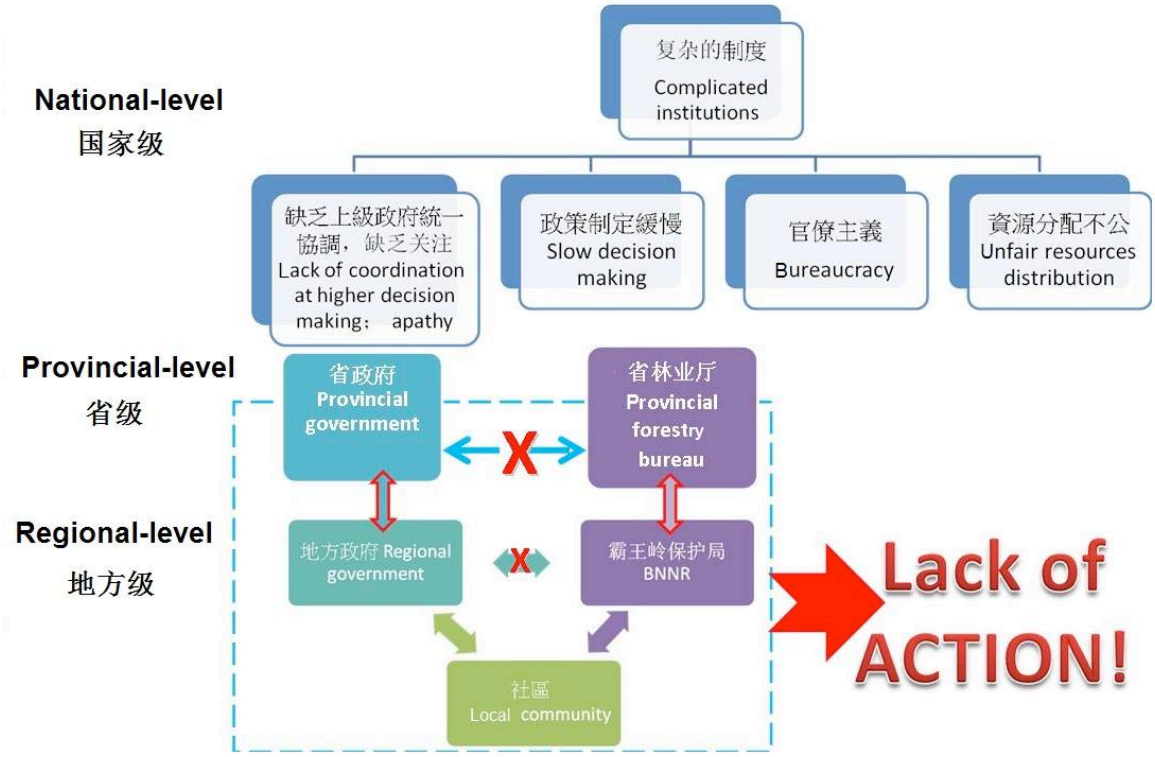


Figure 7. Political issues that hinder effective conservation of the Hainan gibbon.

Goals and Recommended Actions

ACTIONS 9.1 – 9.4

<u>Policy and Communication Issues Group, GOAL 1</u>: Enhance horizontal and vertical communication among authorities.

ACTION 9.1: Draft and sign Letter of Intent for Hainan gibbon conservation
In order to promote awareness of the plight of the Hainan gibbon and galvanise action for its conservation at the regional and national levels within China, a formal open letter was prepared describing the initial conservation recommendations made at the workshop. This letter was signed after working group discussions had concluded on 20 March 2014 by Chinese and international participants representing the main collaborating institutions attending the workshop, and was distributed to BNNRMO and the national Chinese media immediately following the workshop.

<u>Resources needed</u>: None
<u>Responsible party</u>: PSG, ZSL
<u>Collaborators/potential partners</u>: All workshop participants
<u>Timeline</u>: 20 March 2014
<u>Potential benefit</u>: HIGH
<u>Likelihood of success</u>: HIGH
<u>Priority</u>: HIGH

ACTION 9.2: BNNRMO reports workshop findings and presents Letter of Intent to HFB

To ensure increased understanding regarding the current highly threatened status of the Hainan gibbon, and increased support for key actions required for its conservation from relevant province-level authorities, it is essential that BNNRMO must communicate proactively with the directors of HFB. Therefore, a first step in this direction is for BNNRMO to disseminate the Letter of Intent to HFB together with a detailed summary of the key outputs of the workshop as presented in the workshop report.

Resources needed: Workshop findings, Letter of Intent, necessary funds for logistics
Responsible party: Directors of BNNRMO
Collaborators/potential partners: Workshop participants, FFI, KFBG, ZSL
Timeline: No later than one month after workshop report publication
Potential benefit: HIGH
Likelihood of success: HIGH
Priority: HIGH

ACTION 9.3: Conduct meeting between HFB and Provincial Government

The political landscape of Hainan dictates that BNNRMO is unable to meet directly with provincial-level government bodies and departments. Therefore, following the presentation of the Letter of Intent and principal workshop findings by BNNRMO to HFB (see Action 9.2 above), it is necessary that these documents, together with all associated communications and decisions made by local governmental bodies arising from the workshop report and its contents, should then be submitted by HFB to the Hainan provincial government.

Resources needed: Workshop findings, Letter of Intent, necessary funds for logistics
Responsible party: BNNRMO Administrative Officer (Mr. Cai)
Collaborators/potential partners: FFI, KFBG, ZSL
Timeline: No later than one month after BNNRMO meets with HFB
Potential benefit: HIGH
Likelihood of success: HIGH
Priority: HIGH

ACTION 9.4: Conduct regular meetings between BNNRMO and County Governments

Effective conservation of the Hainan gibbon will require sustained long-term official support from all relevant levels of government hierarchy within Hainan. Therefore, in addition to improved and increased communication between BNNRMO, HFB and the Hainan provincial government (Actions 9.2–9.3), the Letter of Intent and workshop report must also be disseminated to the local county governments of both Baisha and Changjiang counties. We envisage that this initial step should then facilitate regular ongoing communication between BNNRMO and representatives of both county governments, ideally with meetings arranged on a quarterly basis to discuss gibbon and other species conservation and reserve management issues.

Resources needed: Workshop findings, Letter of Intent, necessary funds for logistics
Responsible party: BNNRMO
Collaborators/potential partners: FFI, KFBG, ZSL, local community representatives
Timeline: Quarterly
Potential benefit: Medium
Likelihood of success: Medium
Priority: Medium

ACTION 9.5: Draft and ratify an up-to-date formal Species Action Plan

A Hainan gibbon Species Action Plan, which can be used to request governmental funding for activities outlined for gibbon conservation at BNNR, was published in 2005 in collaboration with the HFB (Chan *et al*. 2005). However, this action plan is based on data about the status of the Hainan gibbon population, environmental and management conditions at BNNR, and potential conservation approaches that are over a decade old. There is therefore a pressing need to develop a new, up-to-date species action plan that should be recognised and ratified by the appropriate authorities, to make sure that the recommendations from this workshop are realised in the future.

Resources needed: USD ~$40,000 for meetings, consultancy fees etc
Responsible party: BNNRMO
Collaborators/potential partners: HFB, PSG, other Chinese governmental stakeholders, NGOs
Timeline: 12-18 months after workshop
Potential benefit: HIGH
Likelihood of success: HIGH
Priority: HIGH

ACTIONS 10.1 – 10.2

Policy and Communication Issues Group, GOAL 2: Enhance communication and collaboration between authorities and academics.

ACTION 10.1: Form Hainan Gibbon Advisory Panel consisting of national and international experts

The 2014 Hainan gibbon workshop brought together a wide range of stakeholders with differing backgrounds, expertise and investment (including government offices, universities, conservation NGOs, zoos and rescue centres, and local communities). The workshop process provided a platform for direct and productive exchange of information and ideas between these stakeholders, and in particular between government/reserve management authorities and conservation researchers with novel data on the Hainan gibbon or other relevant conservation scenarios. This was the first time in over a decade that this level of discussion and knowledge exchange between these two stakeholder groups had been able to take place. In order to maintain the momentum from the workshop and continue drawing on the different and complementary expertise and perspectives of these various stakeholder groups, and to establish a more formal mechanism for continued productive information transfer and decision-making, it is recommended that a Hainan gibbon advisory panel should be established. The primary aim of this advisory panel should be to provide ongoing consultation to BNNRMO regarding technical, scientific and conservation management decisions.

Resources needed: Experts, especially experienced funding proposal writers
Responsible party: PSG, ZSL
Collaborators/potential partners: BNNRMO, FFI, KFBG, DWCT, PSG, relevant institutes
Timeline: No more than one year from 20 March 2014
Potential benefit: HIGH
Likelihood of success: Medium
Priority: HIGH

ACTION 10.2: Provide training to officials and monitoring team

At present, the members of the Hainan gibbon monitoring team along with other BNNRMO staff at various levels have a limited level of expertise in several of the skills and techniques required to successfully monitor and effectively manage the Hainan gibbon population for long-term conservation of the species. During the 2014 workshop, representatives from BNNRMO specifically requested support to strengthen their capacity in these areas. It is therefore necessary to provide training for BNNRMO management and monitoring staff in areas including relevant conservation research approaches, management and monitoring techniques, and awareness-raising.

Resources needed: Trainers and necessary funds for logistics
Responsible party: Not specified
Collaborators/potential partners: BNNRMO, ZSL, FFI, KFBG, and other institutes
Timeline: Not specified
Potential benefit: Medium
Likelihood of success: Medium to low
Priority: Low

ACTIONS 11.1 – 11.4

Policy and Communication Issues Group, GOAL 3: Enhance understanding, communication and collaboration between authorities and communities.

ACTION 11.1: Analyse socio-economic needs, benefits and issues of local communities

The establishment and expansion of BNNR as a protected area, and further gibbon-specific conservation management activities conducted by BNNRMO, have had economic impacts on local communities surrounding the reserve. However, there is still only limited information available with which to either ascertain the nature and magnitude of specific impacts of the reserve upon these communities, or to determine appropriate alleviation mechanisms that would address these issues and provide benefits to communities. Therefore, formal (preferably quantitative) evaluation of the socio-economic state and needs of these communities should be conducted to provide the necessary baseline for evaluating possible solutions for local poverty alleviation.

Resources needed: Not specified
Responsible party: Not specified
Collaborators/potential partners: BNNRMO, FFI, KFBG, and other institutes
Timeline: Not specified
Potential benefit: Medium
Likelihood of success: HIGH
Priority: Medium

ACTION 11.2: Develop sustainable alternative livelihoods for local communities

Representatives from local communities around BNNR who attended the 2014 workshop specifically highlighted the need to identify sustainable alternative livelihoods that do not conflict with the reserve's conservation management aims. It is therefore necessary to identify and evaluate the best available alternative livelihood options that are suitable for the Bawangling landscape (see Actions 8.2–8.5 above).

Resources needed: Not specified
Responsible party: Not specified

Collaborators/potential partners: BNNRMO, FFI, KFBG, and other institutes
Timeline: Not specified
Potential benefit: Medium
Likelihood of success: Medium
Priority: Medium

ACTION 11.3: Improve co-management between authorities and local communities
Community co-management (whereby local communities participate in the process of planning, decision-making, implementation and evaluation of reserve management measures with the aim of combining and balancing needs of biodiversity conservation and sustainable development) has been proposed as a potential reserve management approach at BNNR since 2004. Previous actions toward co-management at BNNR have focused on integrating the needs of local communities in Qingsong Township into official management of local resource utilisation and conservation, with production of an FFI-led action plan to assist in implementation of co-management by these communities (FFI China Programme 2005), although this initiative has not yet led to an effective co-management framework being established at BNNR. Based on experience and lessons learnt from FFI's past co-management project, it is necessary to design and implement a more comprehensive co-management scheme for the reserve, incorporating communities around BNNR that utilise resources in areas of forest suitable for gibbons, and which can effectively improve reserve management by providing incentives for local communities to conserve forest resources.

Resources needed: Not specified
Responsible party: BNNRMO
Collaborators/potential partners: FFI and KFBG
Timeline: Not specified
Potential benefit: Medium
Likelihood of success: Medium
Priority: Medium

ACTION 11.4: Conduct communication, education and public awareness-raising in local communities
Reducing conflicts of interest and competing demands upon landscapes within and around BNNR requires greater mutual understanding between stakeholders of the respective needs and challenges both of BNNRMO's mandate to manage the reserve, and of the needs of local communities to maintain sustained livelihoods. It is therefore necessary to establish an improved mechanism for sharing the respective viewpoints and needs of each of these key stakeholder groups on a regular basis. Enhanced mutual understanding between management authorities and local communities will improve reserve management in the long-term by promoting community engagement with gibbon conservation, by providing a further process for investing community members in the future of the reserve, for example through activities such as maintaining tree nurseries and conducting tree planting for habitat restoration.

Resources needed: Not specified
Responsible party: Not specified
Collaborators/potential partners: BNNRMO, FFI and KFBG
Timeline: Not specified
Potential benefit: Medium
Likelihood of success: HIGH
Priority: Medium

ACTION 12.1

Policy and Communication Issues Group, GOAL 4: Enhance public awareness for Hainan gibbon conservation.

ACTION 12.1: Publicise Letter of Intent, workshop output, and species action plan
Raising awareness at the local, national and international levels of the urgent need for immediate and ongoing conservation actions for the Hainan gibbon should be conducted through contacting relevant media to publicise the workshop output, species action plan and Letter of Intent, as well as any further achievements and milestones associated with the species recovery programme.

Resources needed: News media, websites
Responsible party: Hainan Gibbon Advisory Panel
Collaborators/potential partners: BNNRMO, FFI, KFBG, ZSL, DWCT, PSG
Timeline: Ongoing
Potential benefit: HIGH
Likelihood of success: Medium
Priority: HIGH

工作小组报告：政策与管理

组员

陈姝 女士（英国伦敦动物学会）
胡庆如 先生（中国海南师范大学）
戈登•亨特 先生（英国达雷尔野生动物保护信托）
林思吟 女士（英国森林协会）
蒙秉波 先生（野生动植物保护国际）
齐旭明 先生（中国海南霸王岭国家级自然保护区管理局）
周照骊先生（中国海南霸王岭国家级自然保护区管理局）

工作小组对可能影响海南长臂猿保护的政策与利益相关者之间的沟通问题进行了全面的讨论。

问题阐述

由于利益相关者之间缺乏有效沟通与合作，阻碍了海南长臂猿的有效管理、保护行动的实施及保护政策的制定。利益相关者之间的沟通有以下四个方面：

政府部门之间缺乏沟通

政府部门之间缺乏有效的横向与纵向沟通，如，保护区管理局与省级部门之间，省级与国家级部门之间等，妨碍保护或管理行动的有效实施。

管理部门和社区之间缺乏沟通

管理部门和社区之间缺乏有效沟通与合作，导致误解和利益冲突（主要表现在森林资源利用方面）。

管理部门和学术界之间缺乏沟通

管理部门和学术界之间缺乏有效沟通与合作，妨碍科研资源、数据、成果、技术等的共享。

利益相关者与公众之间缺乏沟通

管理部门、学术界、非政府组织与公众之间的缺乏沟通，导致海南长臂猿保护意识薄弱，更加不利于保护行动的实现。

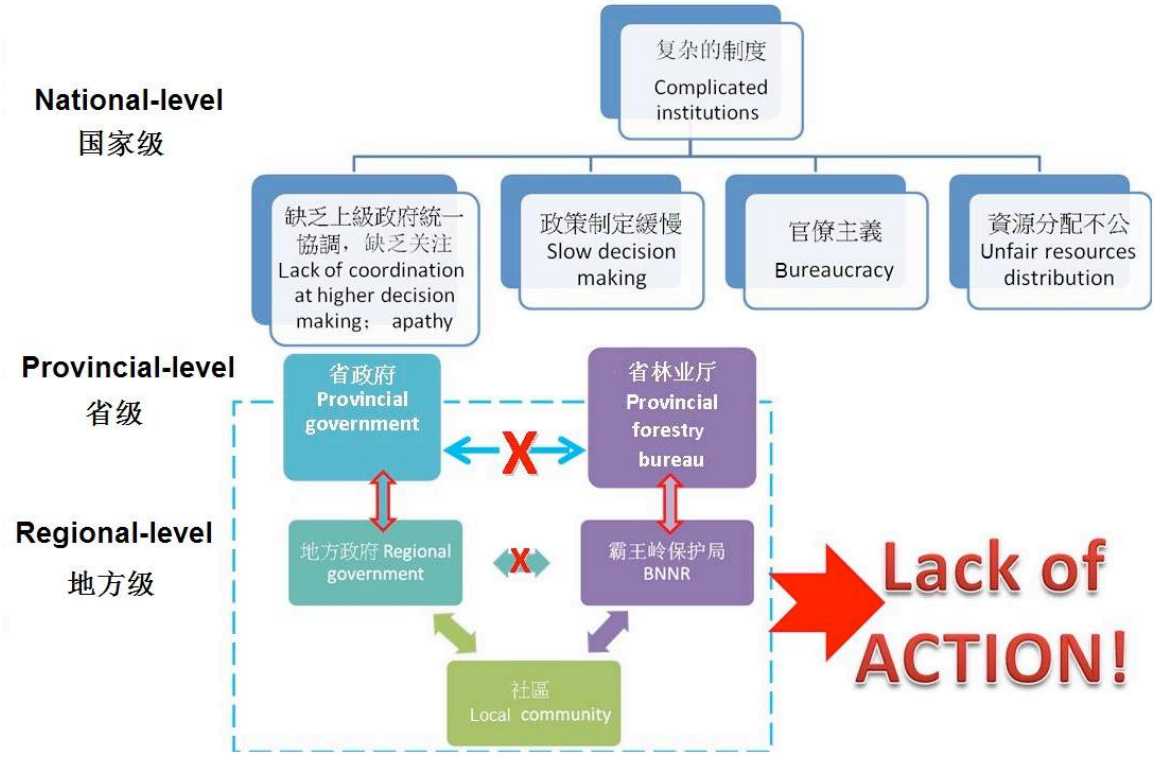


图7 妨碍海南长臂猿有效保护的政策与管理问题。

保护目标与建议行动

行动9.1-9.4

政策与管理工作小组，目标1：加强政府部门之间的纵向与横向沟通

行动9.1： 草拟并签署海南长臂猿保护联名倡议书

为进一步提高公众对海南长臂猿保护意识，推动保护行动的实施，建议草拟并签署联名信宣传本论坛的成果并呼吁保护海南长臂猿。倡议书在论坛的最后一天，二〇一四年三月二十日由参与论坛的国内外专家签署，交予霸王岭保护区管理局保管，并通过媒体进行了全国即时发布。

所需资源：零
负责单位：灵长类专家组、伦敦动物学会
合作单位：所有参会人员
时间：2014-3-20
得益：高
成功率：高
优先性：高

行动9.2： 保护区管理局向省林业厅汇报论坛情况和产出

为了加强省级管理部门对海南长臂猿的重视与保护行动的支持，保护区管理局必须向省林业厅递交论坛报告与联名倡议书，主动向省林业厅领导汇报并与之沟通。

所需资源：论坛报告、联名倡议书、交通费
负责单位：海南霸王岭保护区管理局领导
合作单位：所有参会人员、FFI、KFBG、ZSL
时间：论坛报告完成后一个月内
得益：高
成功率：高
优先性：高

行动9.3： 省林业厅向省政府办公室汇报论坛情况和产出

为了加强省级部门对海南长臂猿的重视与保护行动的支持，行动9.2之后，省林业厅办公室必须到省政府办公室汇报论坛情况，并递交论坛报告与联名倡议书。

所需资源：论坛报告、联名倡议书、交通费
负责单位：海南霸王岭保护区管理局
合作单位：FFI、KFBG、ZSL、社区代表
时间：季度
得益：中
成功率：中
优先性：中

行动9.4： 保护区管理局定期与县政府进行沟通

海南长臂猿的有效保护必须基于政府不同层面的长期支持，因此，除了改善保护区管理局、省林业厅和省政府的沟通（行动9.2-9.3）外，联名倡议和论坛报告也必须提交给昌江和白沙县政府。以这些文件为基础，通过季度的常规性会议，加强保护区管理局与县政府在海南长臂猿保护与保护区管理工作上的沟通与合作。

所需资源：论坛报告、联名倡议书、交通费
负责单位：海南霸王岭保护区管理局
合作单位：ZSL、KFBG、FFI、社区代表
时间：季度
得益：中
成功率：中
优先性：中

行动9.5： 草拟并认可最新的海南长臂猿保护行动计划

第一份海南长臂猿保护行动计划于2005年编制，为海南长臂猿管护争取政府经费支持。但是，历经九年之后长臂猿种群、自然与管理环境都已经发生了变化，该行动计划已不合时宜。因此，必须根据论坛产出编写一份最新的海南长臂猿保护行动计划，并争取有关部门的认可与接纳，以促使论坛上所有建议行动能得以实现。

所需资源：二十至三十万元，用于会议费和顾问费等。
负责单位：海南霸王岭保护区管理局
合作单位：海南省林业厅、灵长类专家组、相关政府部门、非政府组织

时间：论坛后12-18个月
得益：高
成功率：高
优先性：高

行动10.1-10.2

政策与管理工作小组，目标2：加强主管单位和学术界之间的沟通与合作

行动10.1： 组建海南长臂猿专家顾问团

本次海南长臂猿保护论坛集中了国内外不同背景和专业的利益相关者，包括政府部门、大学、非政府组织、动物园、救护中心、社区等。论坛为利益相关者提供了一个直接交流的平台，促进相关知识与理念的交流，特别是保护区管理部门与科研人员之间对海南长臂猿信息的公开讨论与分享，是在近十年内绝无仅有的。为了延续这交流平台，使不同专业与立场的人士能继续支持海南长臂猿的保护工作，建议组建海南长臂猿专家顾问团，为霸王岭保护区管理局提供相关支持。

所需资源：专家，尤其是善于筹募经费的专家
负责单位：PSG、ZSL
合作单位：海南霸王岭保护区管理局、FFI、KFBG、DWCT、PSG 以及其它科研单位
时间：论坛后一年内
得益：高
成功率：中
优先性：高

行动10.2： 主管部门员工与监测队员的能力培训

海南长臂猿监测队以及保护区其他管理员的长臂猿管护技术有限，对长臂猿种群的有效监测与管理造成障碍。在本次论坛上，一些保护区代表希望得到管护技术上的培训与支持。因此，建议为保护区人员提供调查手段、管理和监测技术和保护意识等的相关培训。

所需资源：专家和培训行程所需费用
负责单位：未明确
合作单位：海南霸王岭保护区管理局、ZSL、FFI、KFBG以及其它科研单位
时间：未明确
得益：中
成功率：中/低
优先性：低

行动11.1-11.4

政策与管理工作小组，目标3：加强管理部门和社区之间的沟通与合作

行动11.1： 开展社区经济发展专项调查了解社区需求

保护区的建立、扩展，其管理活动都对当地社区的经济带来影响。可惜，对这些影响的性质与强度，以及能缓解这些影响的有效方法等的掌握还是有限。因此，建议针对社区经济发展的现状与需求展开系统评估，以评估不同扶贫计划的有效性。

所需资源：未明确
负责单位：未明确
合作单位：海南霸王岭保护区管理局、FFI、KFBG以及其它科研单位
时间：未明确
得益：中
成功率：高
优先性：中

行动11.2： 发展社区可持续替代生计

参会的社区代表特别看重开发适合霸王岭地区的替代生计（见行动8.2-8.5），以减少社区对森林的依赖，并促进当地经济发展。

所需资源：未明确
负责单位：未明确
合作单位：海南霸王岭保护区管理局、FFI、KFBG以及其它科研单位
时间：未明确
得益：中
成功率：中
优先性：中

行动11.3： 加强社区共管

社区公管是通过社区参与保护区的决策、管理及评估，达到平衡自然保护与社区发展的双赢目标。霸王岭的社区公管项目始于2004年，由FFI进行策划与牵头，目的是让青松乡的社区代表参与当地自然资源利用与保护的工作中（FFI China Programme 2005）。可惜，这项工作并未能为当地建立一个持续有效的公管机制。因此，建议借鉴以往FFI的共管经验，为所有利用长臂猿适宜生境的社区设计并推行更有效的共管机制，以促进森林资源的保护。

所需资源：未明确
负责单位：海南霸王岭保护区管理局
合作单位：FFI、KFBG
时间：未明确
得益：中
成功率：中
优先性：中

行动11.4： 开展社区交流、教育、公众意识提升活动

霸王岭保护区的有效管理需要各利益相关者的彼此理解，以缓解保护区管理与社区生计之间的冲突。建立管理部门与社区之间有效的沟通机制有助于当地居民参与长臂猿保护、栖息地恢复等管理工作，长远促进社区积极参与环保事业。

所需资源：未明确

负责单位：未明确
合作单位：海南霸王岭保护区管理局、FFI、KFBG
时间：未明确
得益：中
成功率：高
优先性：中

行动12.1

政策与管理工作小组，目标4：提高公众的海南长臂猿保护意识

行动12.1： 接洽相关媒体，发布论坛产出、倡议书和保护行动计划

接洽相关媒体，发布论坛产出、倡议书和保护行动计划，提高本地、国内，乃至国际社会对海南长臂猿的关注和保护意识，提升公众对海南长臂猿保护的支持。

所需资源：媒体、网站
负责单位：海南长臂猿保护顾问团
合作单位：海南霸王岭保护区管理局、FFI、KFBG、ZSL、DWCT、PSG
时间：持续性
得益：高
成功率：中
优先性：高

International Conservation Planning Workshop for the Hainan Gibbon

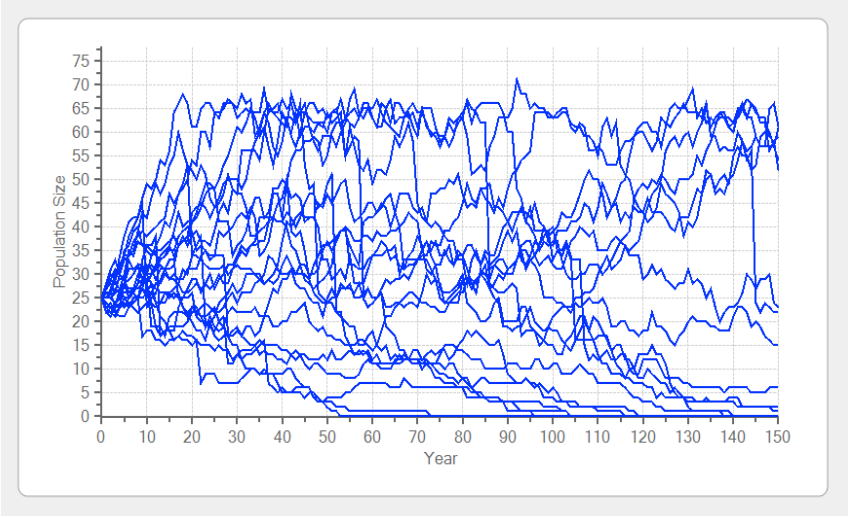
Bo'ao, Hainan, China
18 – 20 March 2014

Final Report

海南长臂猿保护博鳌国际论坛

中国海南省博鳌镇
2014年3月18至20日

总结报告



SECTION 8

Vortex Modelling Report

第八章　漩涡模型结果

Vortex Modelling Report for the Hainan Gibbon

Modellers
Kathy TRAYLOR-HOLZER, IUCN SSC Conservation Breeding Specialist Group, USA
Jessica BRYANT, Zoological Society of London/University College London, UK

A population simulation model was developed to assess the projected future viability of the Hainan gibbon population under current conditions, determine those factors that have the greatest impact on population viability, and guide management recommendations that will promote population growth and persistence of this species. A preliminary model was developed prior to the workshop and revised during a pre-workshop discussion with field biologists, BNNR staff, and others knowledgeable about Hainan gibbon biology and management. The final results of this modelling exercise are presented here.

Vortex Model Description

Computer modelling is a valuable and versatile tool for quantitatively assessing risk of decline and extinction of wildlife populations. Complex and interacting factors that influence population persistence and health can be explored, including natural and anthropogenic causes. Models can also be used to evaluate the effects of alternative management strategies to identify the most effective conservation actions for a population or species and to identify research needs. Such an evaluation of population persistence under current and varying conditions is commonly referred to as a population viability analysis (PVA).

A stochastic, individual-based population model was developed for the Hainan gibbon using the Vortex 10.0 (Lacy and Pollak 2014) software program. Vortex is a Monte Carlo simulation of the effects of deterministic forces as well as demographic, environmental, and genetic stochastic events on wild populations. For a more detailed explanation of Vortex and its use in population viability analysis, see Lacy (1993, 2000) and Lacy *et al*. (2014).

Reproduction, survival and other demographic rates were estimated (using data from the Hainan gibbon population, other wild gibbon populations, captive gibbon data, and expert opinion) to represent a healthy gibbon population with normal demographic rates and the ability to grow in the absence of threats. The base model (representing the current situation) assumes a fairly stable environment with the habitat capacity to support 65 gibbons, an estimate of the present carrying capacity of the gibbon-suitable habitat within BNNR agreed upon by stakeholders in the pre-workshop discussion. Low to moderate (average) levels of risk due to catastrophes and inbreeding were included based on data trends across a range of wild vertebrate populations.

The analyses reported here assume *no* further loss or fragmentation of gibbon habitat and *no* hunting or similar human-caused sources of gibbon mortality (except where specifically modelled). The model was initiated with a population of 25 gibbons of the approximate age and sex structure of the current wild population (based upon field observations by Bryant 2014 and confirmed by BNNRMO) and with some degree of average relatedness (estimated from modelling and direct molecular genetic analysis by Bryant 2014). The model was run for 150 years into the future (which represents about nine gibbon generations), with 1000 iterations (runs) per scenario. Further details on model input parameters are given below.

Model Input Values

Reproduction
Gibbons are generally considered to live in monogamous pairs, with the females of most species giving birth about every three years (Tunikorn *et al*. 1994; Molur *et al*. 2005; Chivers *et al*. 2013). However, Hainan gibbons have been observed with two breeding females in a family (breeding) group and to produce infants every two years (Liu *et al*. 1989; Chan *et al*. 2005; Zhou *et al*. 2008). It is unknown whether this higher reproductive rate and social structure is typical for the species or is in response to low population size/density.

For this model, Hainan gibbons were modelled as having a long-term bigamous breeding system, with up to two adult breeding females paired with each adult breeding male. All adults were considered to be potential breeders. Reproductive lifespan for males was modelled from 10 to 35 years of age; reproductive ages for females were from 8 to 30 years of age. In the model, each year about 46% of adult females produce an infant, which gives an inter-birth interval (IBI) of 2.17 yrs. This reflects a situation in which almost all adult females give birth every two years. All births are single births (no twins). These reproductive rates were used independent of population size or density (i.e., no density-dependent reproduction).

Mortality Rates
Some field data exist for survival rates of Hainan gibbons (Liu *et al*. 1989). However, these data must be used with caution, as: 1) they were collected over a relatively short time period for a long-lived species; 2) the fate of all individuals could not be determined; and 3) sample size (number of gibbons observed) was small and therefore observed rates were subject to sampling error and demographic variation expected in small populations. Mortality rates used in the model were therefore derived from data used to model other gibbon populations in Thailand (Tunhikorn *et al*. 1994) and expert opinion, and are lower than those suggested for wild Javan gibbon populations (Supriatna *et al*. 1994). Maximum age was set at 40 years, and age-specific rates were used as given in Table 2 (same rates were used for both males and females). These mortality rates result in the survivorship curve seen in Figure 8.

Age class (years)	Annual mortality rate
0–1 yr	10%
1–3 yrs	5%
3–7 yrs	3%
7–8 yrs	10%
8–30 yrs	5%
31–35 yrs	25%
36–40 yrs	50%

Table 2. Age-specific mortality rates used in the Hainan gibbon Vortex model.

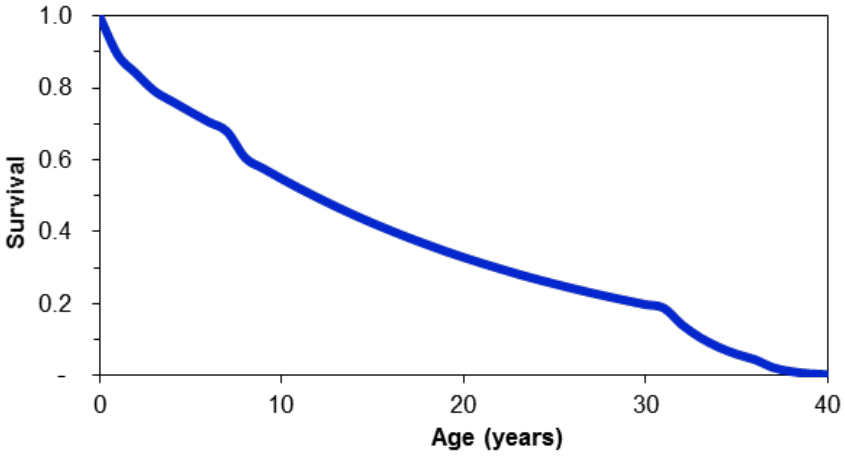


Figure 8. Survivorship curve based on age-specific mortality rates used in the model.

Model Validation (Deterministic Results)

The demographic rates given above result in a population with the age and sex structure as shown in Figure 9. This results in a deterministic positive growth rate ($\lambda = 1.042$; $r = 0.041$) and a generation time (T) of 16.8 years. This is a higher growth potential (4% annual growth) than has been estimated for some other gibbon populations due to a higher reproductive rate but was considered reasonable. These rates would lead to about 41% of the population represented by juveniles and subadults (0-7 yrs old), about 55% by breeding age adults (8-30 yrs old), and 4% by older, post-reproductive animals (31-40 yrs old).

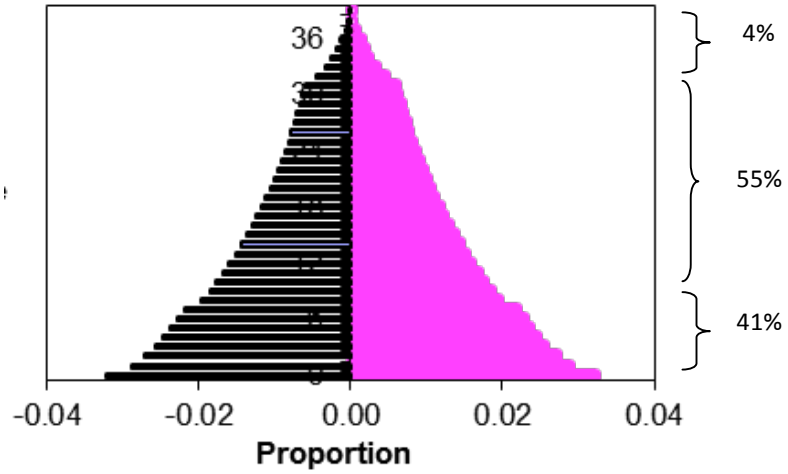


Figure 9. Age and sex structure of a stable age distribution resulting from the demographic rates used in the base model.

Variability in Demographic Rates

Survival and reproductive rates vary, particularly in small populations. Demographic variation (random differences from the 'average' rate due to sample size) is inherently built into the model. Environmental variation (EV) (differences in rates between 'good', 'average' and 'bad' years) was modelled with a coefficient of variance = 0.20, representing a fairly stable environment from year to year. EV for survival and reproduction were linked in the model, so that good years for survival were also good years for reproduction and vice versa.

Catastrophic Events
Catastrophes are relatively rare events that affect survival and/or reproduction. These can be natural events (e.g. disease epidemic, drought) or human-related events (e.g. political instability, loss of funding). Reed *et al*. (2003) analyzed 88 wild vertebrate species and documented the rate and severity of all catastrophe types, and found an overall 14% risk per generation of a catastrophe that reduces the population by 50%. This default setting in Vortex was included in the gibbon model (annual risk = 0.83% per year, meaning that this type of catastrophic event occurs approximately once every 120 years). A second catastrophe was included to represent a disease outbreak, based upon outbreaks observed in wild chimpanzee populations (2% risk per year, occurring once about every 50 years; 80% of normal survival).

Inbreeding Impacts
Mating between related individuals (inbreeding) leads to lower genetic variation and increases the chance that individuals will inherit two copies of deleterious or lethal alleles and be subject to inbreeding depression. Inbreeding depression has been documented widely among animal species and can result in a wide range of effects, including high infant mortality, skewed sex ratio, reduced adult survival, increased health problems, and infertility. All of these effects reduce population growth and can lead to decline and extinction. Inbreeding effects are difficult to document in the wild; however, disregarding inbreeding impacts on extinction risk can lead to serious overestimates of viability and survival for threatened mammal and bird species (O'Grady *et al*. 2006).

Each species and each population is different with respect to the level of impact that inbreeding will impose upon that population. The degree of inbreeding impact is measured as the number of 'lethal equivalents' (LE), which is the genetic load of recessive genes in a heterozygous state that if in a homozygous state would cause death or carry a risk of death. No data are available for LEs for Hainan gibbons; however, it is very unlikely that there will be no effects at all. In the absence of better data, inbreeding sensitivity was modelled as 6.29 LEs in the Vortex model, with inbred offspring having a slightly higher mortality rate in the first year. This was taken as a conservative measure of inbreeding based on the average LE = 12.29 found by O'Grady *et al*. (2006) for a variety of wild mammalian and avian populations. Two other levels of inbreeding sensitivity were also modelled: a) low inbreeding effects (3.14 LEs, based on captive population data for mammalian species, from Ralls *et al*. 1988); and b) no inbreeding effects (i.e., inbred gibbons have the same survival as non-inbred gibbons).

Initial Population
The model begins with an initial population of 25 gibbons (13 males, 12 females) of similar age and sex structure to the current population, as follows:

Males (ages, in years):	1, 1, 3, 3, 3, 7, 8, 8, 9, 11, 13, 18, 19
Females (ages, in years):	1, 5, 5, 6, 7, 7, 9, 11, 17, 20, 22, 32

The Hainan gibbon population has been isolated and small for decades, and many of the remaining individuals are related. Molecular analysis of historical specimens and a substantial proportion (36%) of the current gibbon population by Bryant (2014) found a significant temporal decline in genetic diversity (heterozygosity and allelic richness) and an average relatedness of 0.34 in the current population. Vortex modelling to simulate the reported bottleneck (starting with a population of eight *unrelated* gibbons modelled for 35 years to simulate today's current population) provided a conservative estimate of relatedness of 0.20. Based on these results, all inbreeding coefficients and kinships were set at 0.2 in the model as a conservative estimate of relatedness in the current Hainan gibbon population.

Habitat and Carrying Capacity

The base model was run with a carrying capacity of 65 gibbons starting today and remaining at K = 65 over the projected 150 years. This assumes no fragmentation or loss of habitat area or quality in the future. This also assumes that gibbons can and will move beyond their current area of occupancy of approximately 15 km^2 into additional currently disconnected forest fragments of gibbon-suitable habitat within BNNR.

MODEL SUMMARY:

The base Vortex model represents a healthy population of 25 gibbons with positive deterministic growth rates, in stable habitat that can support 65 gibbons, with modest risk of catastrophic events and inbreeding effects, and no loss of habitat or loss of gibbons through hunting or other human activities.

Model Results

Base Results

Model results indicate that the Hainan gibbon population is at relatively low risk over the next 15-20 years (one generation), *provided that no habitat loss, hunting, or severe catastrophes occur and the population can expand into further forested areas beyond the 15 km^2 currently occupied*. Although the population is projected, on average, to grow in the short-term, these results are highly variable due to the vulnerability of small populations to stochastic (chance) processes. Figure 10 shows a sample of 20 iterations of the base model (blue lines). As can be seen, in some iterations the population reaches the carrying capacity of 65 gibbons, while at other times the population goes extinct. The full results (1000 iterations) project a population size of about 37 (18-57) gibbons after 40 years (red line). After that, the population is projected to decline, combined with an increasing risk of extinction and loss of genetic variation over time. The probability of extinction (PE) in 150 years is 45%.

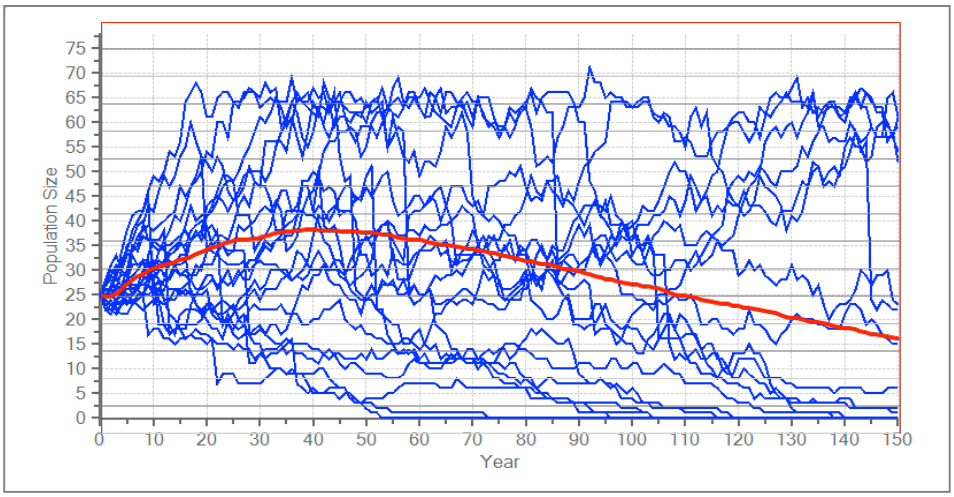


Figure 10. Base model results for 20 sample iterations. Each blue line represents the number of gibbons over 150 years (K = 65). The red line represents the mean projected number of gibbons over 1000 simulations (including extinctions).

Because of these highly variable results, an accurate and exact long-term projection for the Hainan gibbon population is not possible. This suggests that *careful monitoring of the gibbon population will be important in order to identify situations in which management actions will need to be adapted or changed*. While the precise future of the Hainan gibbon population is uncertain, the Vortex model is useful to identify those factors that have the greatest impact on population growth and viability, to identify important data gaps and priority research needs, and to help target management actions that will benefit the population.

Potential Impact of Inbreeding

Inbreeding effects can be potentially damaging to small, genetically isolated populations. We do not know the degree of impact ('genetic load') of the Hainan gibbon population. Survival and reproduction currently appear to be good. However, the population has gone through only about two generations at extreme small population size so far, and so it is difficult to estimate this impact. The base model was developed using an average (default) level of impact of inbreeding for this population (LE = 6.29). Additional modelling with low (LE = 3.14) and zero levels of impact indicate that inbreeding depression has the potential to play a significant role in the future viability and survival of this population.

Figure 11 shows that the gibbon population is projected, on average, to grow to near carrying capacity if no inbreeding effects are included in the model (green line). Low and moderate levels of inbreeding depression increasingly lower average growth rate and population size and are associated with greater risk of extinction. PE_{150yrs} is 45% under moderate inbreeding, 13% under low inbreeding impact, and 3% if inbreeding has no impact. *Inbreeding impacts have the potential to be a significant threat to the long-term viability of the Hainan gibbon population. Close monitoring of the situation is advised to detect potential effects.*

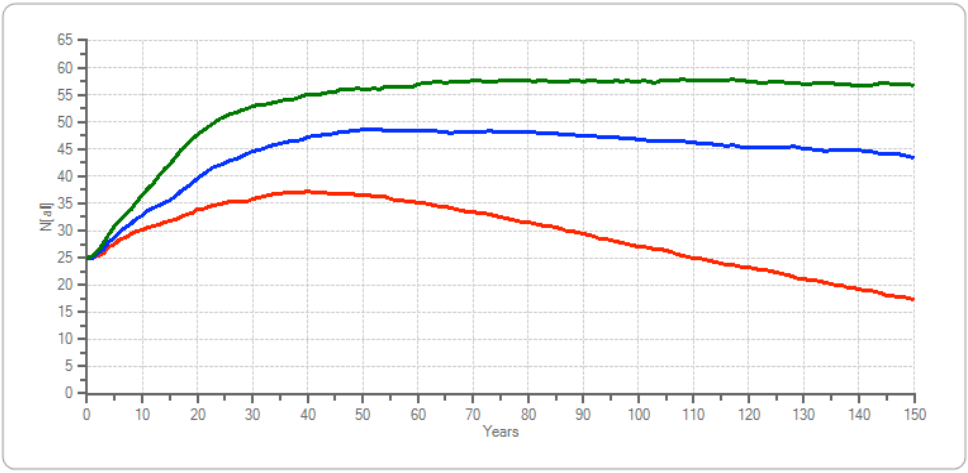


Figure 11. Model results for Hainan gibbons with K = 65. Lines indicate mean population size over 150 years. Red line represents average level of inbreeding impacts (LE = 6.29); blue line represents low impact (LE = 3.14); green line represents no inbreeding effects.

Sensitivity to Demographic Rates

Mortality and reproductive rates combine to determine the potential growth rate of the population. Reproductive factors (e.g. breeding system, age of first reproduction, inter-birth interval) are relatively well understood for the Hainan gibbon population. Age-specific mortality rates are less well documented, due to the difficulty in observing gibbons directly, the long lifespan of this species, the small sample size (few individuals over a relatively short time span), and the inability to confirm the fate of each individual, particularly dispersing subadults. Sensitivity testing was conducted to determine which of these factors have strong influences on population growth rate and viability. The input values given in Table 3 below were explored, both under inbreeding impacts (LE = 6.29) and under no inbreeding impacts.

Figure 12 shows the results of these scenarios on the stochastic growth rate of the population under moderate inbreeding sensitivity (a) and no inbreeding effects (b). The steeper the slope of the line, the greater the influence of that parameter. While the population growth rate is different under inbreeding depression than no inbreeding effects, the pattern is the same in terms of those demographic factors that most affect population growth. Similar trends were reflected in other measures of population viability (population size, genetic variation, and probability of extinction).

Model results indicate that minor variations in male mortality rates and reproductive lifespan have relatively little effect on population growth rate and probability of extinction under a bigamous breeding system. If family groups can include two adult females, then males are not a limiting factor for reproduction as long as sex ratios do not become too skewed. In contrast, female mortality rates do impact reproductive rates and population growth.

Adult females are the key to population growth, and therefore relatively small differences in mortality can have significant effects. Likewise, changes in reproductive lifespan (first and maximum age of reproduction) also impact population growth. *The loss of any adult females from this small gibbon population will reduce the effective number of breeders and may result in population decline, greater loss of genetic diversity, and increased risk of extinction.*

Parameter	**Low**	**Base**	**High**
Breeding system	--	Bigamy	Monogamy
Inter-birth interval (% females breeding/yr):	--	2yrs (46%)	3yrs (31%)
Age of first reproduction (females):	7	8	9
Age of first reproduction (males):	9	10	11
Maximum age of reproduction (females):	25	30	35
Maximum age of reproduction (males):	30	35	40
Juvenile mortality (0-7yrs) (females):	80% * base	See Table 2	120% * base
Juvenile mortality (0-7yrs) (males):	80% * base	See Table 2	120% * base
Subadult mortality (7-8yrs) (females):	8%	10%	12%
Subadult mortality (7-8yrs) (males):	8%	10%	12%
Adult mortality (8-30yrs) (females):	4%	5%	6%
Adult mortality (8-30yrs) (males):	4%	5%	6%

Table 3. Input values used in sensitivity testing of demographic rates. The column "Base" indicates the values used in the base model.

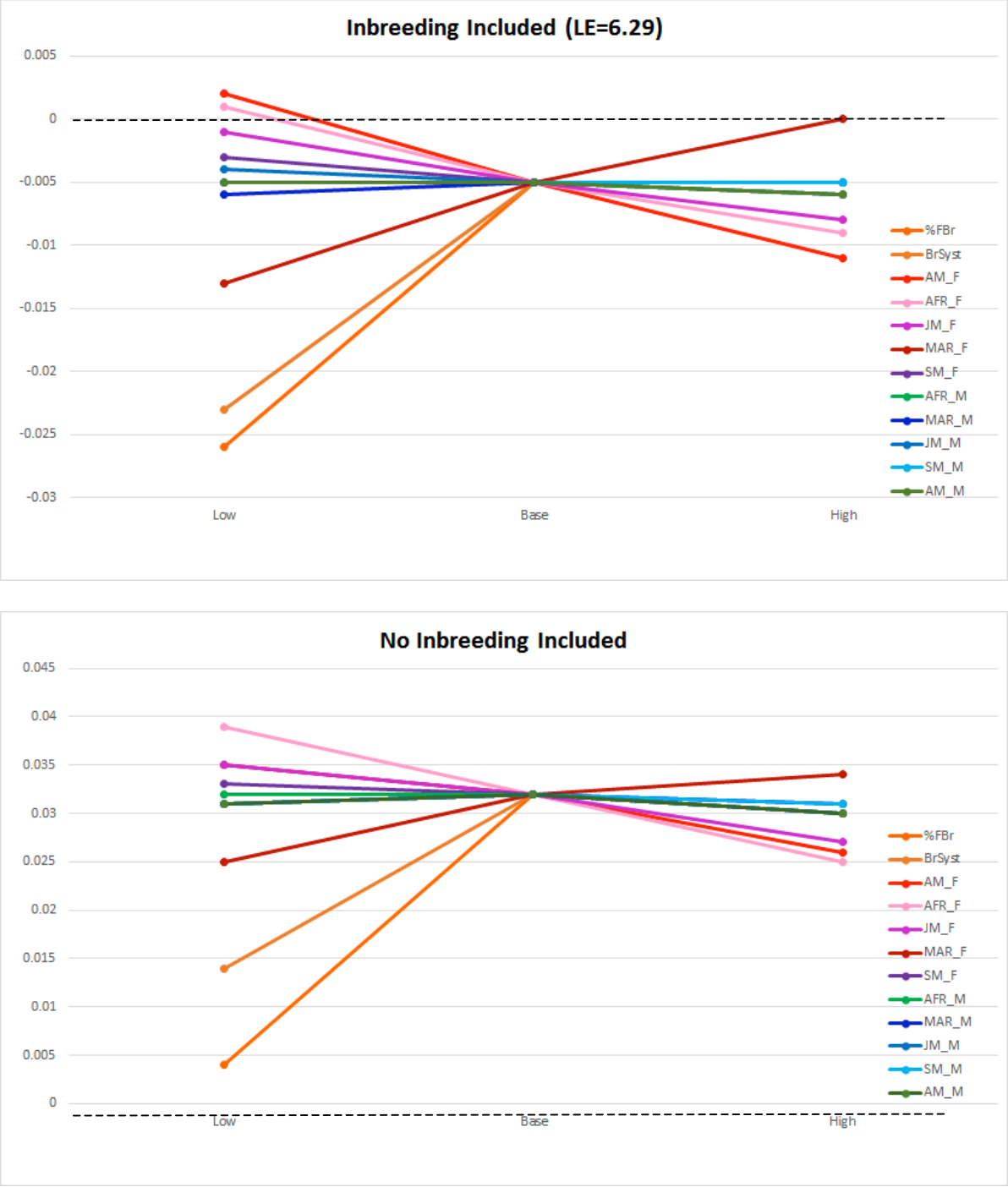


Figure 12. Sensitivity testing results indicating stochastic growth rate for low, high, and base model values for several demographic rates, under moderate inbreeding sensitivity (top) and no inbreeding effects (bottom). Dashed line = zero population growth (r = 0). Variables listed top to bottom in approximate descending order of impact on model results. Legend: %FBr, % females breeding/year; BrSyst, breeding system; AM_F, adult mortality (females); AFR_F, age of first reproduction (females); JM_F, juvenile mortality (females); MAR_F, maximum age of reproduction (females); SM_F, subadult mortality (females); AFR_M, age of first reproduction (males); MAR_M, maximum age of reproduction (males); JM_M, juvenile mortality (males); SM_M, subadult mortality (males); AM_M, adult mortality (males).

The factors that have the greatest impact on population growth are the breeding system and rate that has been observed in Hainan gibbons. The ability to have two breeding females in a family group means that growth is not limited if the population becomes female-biased by chance, and the production of offspring every two years versus every three years greatly increases the reproductive rate. *Any factors that influence the formation of breeding groups and the reproductive rate of those groups (e.g. habitat quality, food availability, human disturbance) may have significant influences on the viability of the population.*

Vulnerability to Loss of Individuals

The loss of adult female gibbons is especially harmful to the Hainan gibbon population, as this directly reduces the reproductive potential and therefore growth rate of the population. Modelling indicates that the loss of only one additional adult female once every five years may lead to population decline and eventual extinction (90% risk in 150 years) (Figure 13). While this effect is less dramatic at lower levels of inbreeding sensitivity, there is still a significant risk of extinction with the periodic loss of females even under the optimistic scenario of no inbreeding effects (PE_{150}=0.23 for 1 per 5 yrs; PE_{150}=0.87 for 1 per 2 yrs). *The loss of any gibbons, particularly adult females, from the population (for example, through accidental shooting by hunters or other accidents) is likely to negatively impact population size and viability. Actions to protect gibbons from incidental mortality are recommended.*

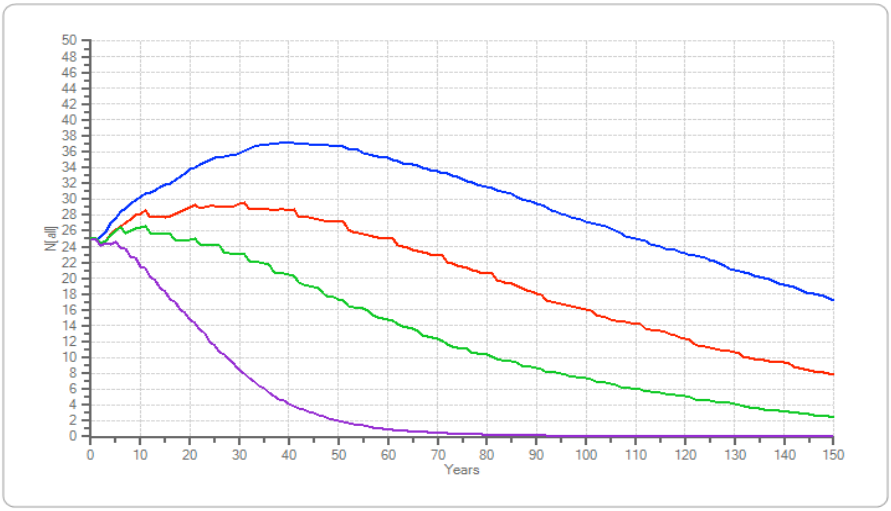


Figure 13. Mean population size over time for the base model and with the additional loss of one adult female gibbon every 10, 5 or 2 years. Key: blue, no additional losses of gibbon individuals; red, one gibbon loss per 10 years; green, one gibbon loss per 5 years; purple, one gibbon loss per 2 years.

Vulnerability of Small Population Size

Small populations are at greater risk of extinction due to stochastic demographic and genetic processes. To illustrate the impact of population size, several model scenarios were run with starting gibbon populations of different sizes (at carrying capacity) but using the same demographic rates, age and sex structure, genetic relatedness, and sensitivity to inbreeding (LE=6.29) as the base model. Model results (Figure 14) suggest that if the gibbon population

were larger *today*, the risk of extinction would be much less. A current population of 150 gibbons would have PE = 1.4% over 150 years (instead of 45%) and retain more genetic variation. These results do not apply direct to Hainan gibbons, because the current small population is still at high risk until it can be increased. However, *this analysis supports the critical importance of preventing further habitat loss and fragmentation and promoting rapid population growth through habitat improvement and expansion as well as other management actions*.

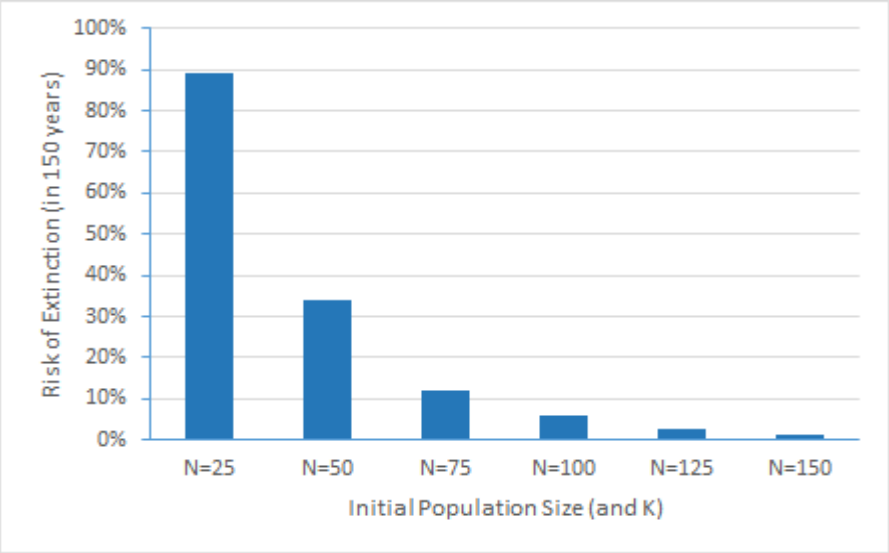


Figure 14. Model results for gibbons with different starting population sizes of 25 to 150 gibbons. Blue bars indicate the probability of populations of different sizes going extinct in 150 years.

Potential Impacts of Habitat Expansion

Expanding available habitat will be beneficial only if the gibbon population can grow to a larger size to fill that habitat. The faster the gibbon population growth rate, the more viable the population will be. Growth depends on good survival and good reproduction.

The accumulation of inbreeding in this population has the potential to significantly impact population growth. Even moderate (average) levels of inbreeding sensitivity may prevent the gibbon population from growing despite increased habitat availability (Figure 15). *Therefore, expansion of habitat alone will not be sufficient to significantly increase Hainan gibbon populations unless survival and reproduction remain high to produce positive population growth*.

Human activities that lead to the death or loss of gibbons (especially adult females) from the population (e.g. hunting) or lower reproduction (e.g. disturbance) should be minimised. Intensive population management strategies may need to be considered if inbreeding or other stochastic processes result in a critically low population viability status.

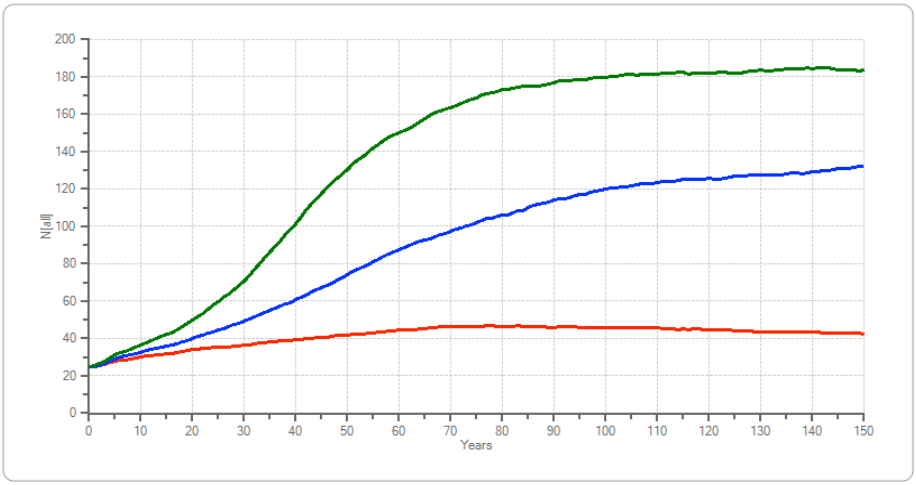


Figure 15. Mean population size over time with current population of 25 gibbons and K = 200. Red line represents average level of inbreeding impacts (LE = 6.29); blue line represents low impact (LE = 3.14); and green line represents no inbreeding effects.

Vulnerability of a Single Population

The persistence of only a single population of Hainan gibbons in a single location leaves the population extremely vulnerable to an unforeseen disaster – for example, a severe disease epidemic or reserve forest fire. While it is desirable to establish a second population as insurance against loss of the BNNR population, caution must be used to ensure that population viability is not jeopardised by splitting an already small population. The benefits (as well as the risks) of establishing a second population should be weighed against the risks of having only a single population for the species. If population division is considered in the future (e.g. translocation of part of the population to a new site), modelling can help to explore the potential benefits versus risks of different translocation scenarios, such as age, sex and number of individuals to transfer.

Conclusions

The Hainan gibbon population is small and genetically impoverished, making it vulnerable to population decline and eventual extinction. Protection of the gibbon population and its habitat, in concert with good reproduction and survival, has stabilised this population. Continued protection and eventual population and habitat expansion will be essential in the future if Hainan gibbons are to persist as a viable population in the long-term.

Due to the numerous stochastic processes that can significantly impact small populations, the precise future of the Hainan gibbon population is difficult to predict. However, modelling efforts suggest the following management considerations:

1. Stochastic events can lead rapidly to population decline. Monitoring of the Hainan gibbon population is recommended so that critical situations are recognised and any appropriate management actions can be implemented quickly.

2. Monitoring efforts should document pedigree relationships when possible, and include assessment of evidence of inbreeding impacts (e.g. increased infant mortality, infertility).

3. Human activities that lead to the death or loss of gibbons (especially adult females) from the population (e.g. hunting) should be minimised.

4. Human activities that inhibit breeding group formation or lower reproduction (e.g. human disturbance, reduced habitat quality) should be minimised.

5. Current efforts to prevent active poaching and protect gibbon habitat from conversion or loss are essential to Hainan gibbon persistence.

While essential, *habitat protection and expansion alone will not ensure the long-term survival of Hainan gibbons*. An unexpected catastrophe, disease outbreak, poaching event, inbreeding depression, or even bad luck can lead to population decline and even extinction. The smaller the population, and the longer it remains small, the greater the risk and the faster it will lose genetic variation and accumulate inbreeding.

For long-term viability, the Hainan gibbon population needs to increase in terms of number of gibbons and breeding groups, geographic range, and the number of distinct, separated populations. The long lifespan of this species and the evidence of good reproduction and survival in recent years under effective protection encourage hope that this population can be expanded and made more secure. However, the genetic bottleneck experienced by this population makes it highly vulnerable to inbreeding depression depending upon the genetic characteristics of this population, and it should be noted that if we have been overoptimistic in our assumptions about levels of available habitat or inbreeding, then our results may underestimate the vulnerability of the population in terms of risk of extinction and feasible population growth. Managers should be prepared to take quick action if the status of the population suddenly declines and/or if new threats emerge. Population and habitat monitoring and management may be critical to ensure long-term population persistence for this species.

Appendix. Model scenario results (LEs = lethal equivalents; stoch-r = stochastic r (i.e. population growth rate when stochastic processes are included); PE = probability of extinction; Nall = mean population size (all iterations); SDall = standard deviation of N (all iterations); GeneDiv = gene diversity.

Scenario	*LEs*	*stoch-r*	*PE*	*N-all*	*SD(Nall)*	*GeneDiv*
Inbreeding						
Base (mod inbr)	6.29	-0.005	0.450	17	22	0.759
Low inbreeding	3.14	0.013	0.129	44	23	0.793
No inbreeding	0	0.031	0.032	57	15	0.798
Loss of females						
Harv1F_10y	6.29	-0.012	0.724	8	16	0.768
Harv1F_5y	6.29	-0.021	0.901	2	9	0.778
Harv1F_2y	6.29	-0.043	1.000	0	0	0.000
Harv1F_10y	3.14	0.006	0.325	32	27	0.780
Harv1F_5y	3.14	-0.002	0.581	19	26	0.781
Harv1F_2y	3.14	-0.031	0.987	1	6	0.811
Harv1F_10y	0	0.026	0.083	53	20	0.792
Harv1F_5y	0	0.020	0.230	44	27	0.786
Harv1F_2y	0	-0.011	0.870	7	18	0.790
Pop size						
N=K=25	6.29	-0.012	0.893	1	3	0.598
N=K=50	6.29	-0.003	0.338	17	17	0.759
N=K=75	6.29	0.003	0.121	40	26	0.833
N=K=100	6.29	0.006	0.060	62	33	0.877
N=K=125	6.29	0.007	0.028	85	39	0.896
N=K=150	6.29	0.008	0.014	107	45	0.913
K = 200						
Base _K200	6.29	-0.003	0.420	43	59	0.802
Low Inbr _K200	3.14	0.014	0.118	132	76	0.844
No Inbr_K200	0	0.034	0.014	184	37	0.879
Demographic ST (with inbreeding)						
FirstRepro_F7	6.29	0.001	0.328	25	24	0.779
FirstRepro_F9	6.29	-0.009	0.576	11	17	0.758
FirstRepro_M9	6.29	-0.005	0.438	17	21	0.749
FirstRepro_M11	6.29	-0.006	0.488	15	20	0.754
MaxRepro_F25	6.29	-0.013	0.712	7	14	0.729
MaxRepro_F35	6.29	0.000	0.338	24	24	0.775
MaxRepro_M30	6.29	-0.006	0.472	16	21	0.754
MaxRepro_M40	6.29	-0.005	0.464	17	21	0.767
%Br31 (IBI=3)	6.29	-0.026	0.984	0	1	0.682
Monogamy	6.29	-0.023	0.916	2	7	0.758
JuvM_F_Low	6.29	-0.001	0.358	24	24	0.778
JuvM_M_Low	6.29	-0.004	0.454	18	22	0.771
JuvM_F_High	6.29	-0.008	0.520	13	18	0.750
JuvM_M_High	6.29	-0.005	0.468	17	21	0.767
SubM_F_Low	6.29	-0.003	0.392	20	22	0.773
SubM_M_Low	6.29	-0.005	0.470	17	22	0.764
SubM_F_High	6.29	-0.006	0.482	16	20	0.759
SubM_M_High	6.29	-0.005	0.476	16	20	0.766
AdM_F_Low	6.29	0.002	0.312	29	25	0.795

AdM_M_Low	6.29	-0.005	0.446	18	22	0.768
AdM_F_High	6.29	-0.011	0.638	9	15	0.737
AdM_M_High	6.29	-0.006	0.498	15	20	0.754
Demographic ST (no inbreeding)						
FirstRepro_F7	0	0.039	0.012	59	13	0.806
FirstRepro_F9	0	0.025	0.056	55	18	0.794
FirstRepro_M9	0	0.032	0.010	58	13	0.797
FirstRepro_M11	0	0.030	0.030	55	16	0.801
MaxRepro_F25	0	0.025	0.064	54	19	0.787
MaxRepro_F35	0	0.034	0.008	60	11	0.804
MaxRepro_M30	0	0.031	0.016	58	14	0.798
MaxRepro_M40	0	0.031	0.032	58	14	0.805
%Br31 (IBI=3)	0	0.004	0.262	34	27	0.745
Monogamy	0	0.014	0.208	42	27	0.801
JuvM_F_Low	0	0.035	0.018	59	13	0.804
JuvM_M_Low	0	0.031	0.026	58	14	0.802
JuvM_F_High	0	0.027	0.034	56	17	0.795
JuvM_M_High	0	0.030	0.014	57	15	0.793
SubM_F_Low	0	0.033	0.010	58	12	0.801
SubM_M_Low	0	0.031	0.026	57	15	0.801
SubM_F_High	0	0.030	0.030	57	15	0.799
SubM_M_High	0	0.031	0.024	58	15	0.805
AdM_F_Low	0	0.035	0.018	58	13	0.801
AdM_M_Low	0	0.031	0.028	58	15	0.801
AdM_F_High	0	0.026	0.032	56	16	0.788
AdM_M_High	0	0.030	0.038	57	16	0.789

海南长臂猿的漩涡模型结果

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利用海南长臂猿的现存情况建立种群模型，以分析影响种群生存力的主要因素，预测种群未来的生存力情况，为物种保护提供科学依据。在论坛举行之前，经相关专家和保护区管理者等商议后形成了基础模型。以下是模型的参数与结果。

漩涡模型简介

计算机模型能对野生动物种群的威胁进行有效的量化评估，并且能用于探讨大量而复杂的因子对种群状态的影响，其中包括自然与人为的影响因子。模型也能用于评估不同管理策略的效果，以提出较有效的保护行动或研究需要。这种针对种群现在与不同情景下的模拟分析称为“种群生存力分析”。

利用计算机程式Vortex（漩涡模型）10.0 （Lacy and Pollak 2014）为海南长臂猿建立模型；此软件通过蒙特卡罗模拟分析决定性因子的影响，并能模拟种群内在的、环境性的、遗传性的随机事件。关于漩涡模型的更多介绍和案例，见Lacy （1993, 2000）和Lacy *et al*.（2014）。

建模时需要输入多个参数以显示海南长臂猿的生物特征，如繁殖率和生存率，这些参数均须经过专家确认。在欠缺海南长臂猿的数据时，也可用其它野生长臂猿或圈养长臂猿的数据作为参考。基础模型（代表种群现在的状态）假设一个相对稳定、能容纳65头长臂猿的栖息地，并假设种群承受着低至中等（平均）水平的自然灾害风险与近亲繁殖风险（参照野生脊椎动物种群的一般情况）。

以下模拟分析均假设长臂猿栖息地不会被进一步破坏，也不存在偷猎或其它人为致死的威胁（除非特别说明）。模型的初始状态有25个个体，其年龄、性别比与亲缘度均以海南长臂猿的最新数据（布莱恩特2014和BNNRMO）作为依据。模型模拟未来150年（约9个长臂猿世代），每个情境模拟1000次。其它输入参数如下。

模型输入参数

繁殖率

其它长臂猿家庭群一般由一雄一雌组成，雌性一般每两至三年生产一次（Tunikorn *et al*. 1994; Molur *et al*. 2005; Chivers *et al*. 2013）。不过根据观察，海南长臂猿组成一雄两雌的家庭，而雌性每两年生产一次（Liu *et al*. 1989; Chan *et al*. 2005; Zhou *et al*. 2008）。暂时还未能确定这现象是物种的固有生物特征还是其它因素所致。

基础模型中，种群被设定为一雄两雌的繁殖模式，所有成年个体均有繁殖能力。雄性的繁殖年限被设定为25年（10-35岁），雌性的繁殖年限为22年（8-30岁）。每年约有46%成年雌性会生产幼崽，繁殖周期（IBI）为2.17年，这意味着几乎所有成年雌性均两年产崽一次，每次一只（无双胞胎），种群数量或密度的变化并不会对繁殖率造成影响。

年龄	年死亡率
0 – 1	10%
1 – 3	5%
3 – 7	3%
7 – 8	10%
8 – 30	5%
31- 35	25%
3 – 40	50%

表2 海南长臂猿漩涡模型所采用的死亡率。

死亡率

对海南长臂猿的生存率与死亡率已有一定的认知（Liu *et al*. 1989），但是由于：1）相对于长臂猿的寿命而言，收集这些数据的时间尺度太短　2）没有办法确认个体消失的原因是离群或是死亡　3）观察数据太少，意味着发生抽样误差或种群差异的几率会更高。因此，模型采用的死亡率主要是根据其它长臂猿的种群模型（Tunhikorn *et al*. 1994）以及专家建议。在模型里，海南长臂猿的死亡率要比爪哇长臂猿的要低（Supriatna *et al*. 1994），最大寿命为40，不同年龄级别的死亡率见表2（雄雌类同）。死亡率所产生的生存曲线见图8。

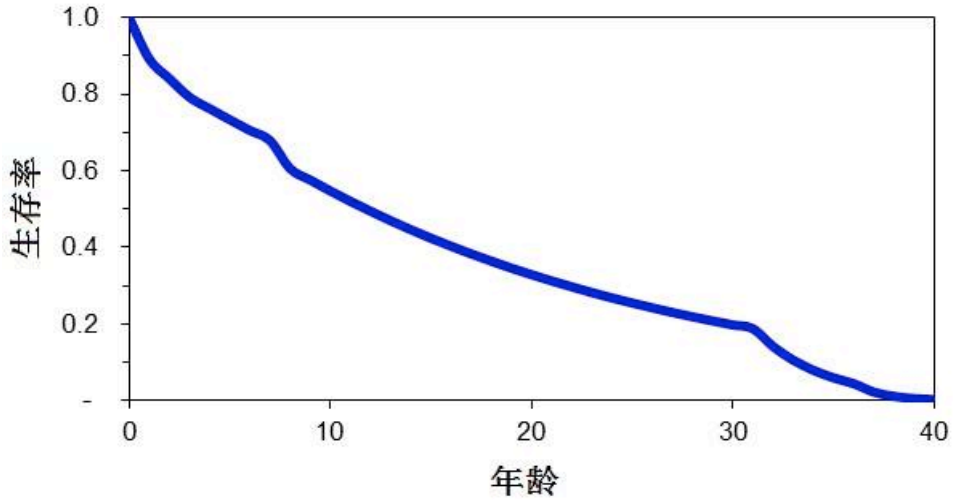


图8 海南长臂猿漩涡模型产生的生存曲线。

模型检验（确定性结果）

以上的种群特征产生了图9所示的年龄与性别结构，种群增长率4%（λ = 1.042; r = 0.041）和16.8年的世代时间。该种群增长率比一些其它的长臂猿种群略高，不过专家认为是合理的。设定的种群参数最终产生的种群含41%年幼、年轻个体（0-7岁），55%成年个体（8-30岁），和4%的年老个体（31-40岁）。

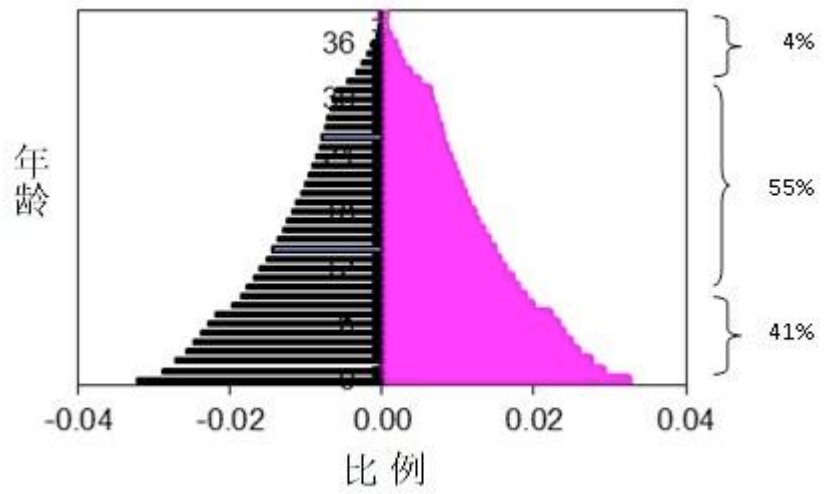


图9海南长臂猿漩涡模型（基础）产生的种群结构，显示在不受任何干扰情况下，不同年龄与性别的正常比例。

种群特征的差异

生存率与繁殖率的差异性在极小种群尤为明显（由于样本量少导致与平均水平存在随机性的差异），因此，模型包含了种群差异性的有关设置。环境变异性（EV，环境条件分高、中、低等）的变异系数为0.20，反映环境条件相对稳定。EV能直接影响当年的生存率与繁殖率，在环境条件较好时长臂猿的生存率与繁殖率普遍较高。

灾难性事件

偶尔发生的灾难性事件会影响种群的生存与繁殖。其中包括自然灾难（如，流行病疫，干旱等）或是人为灾难（如，政治不稳定，管理经费减少等）。过去一个针对88种野生脊椎动物的研究分析，每个世代遇到重大灾难性事件（毁灭种群的50%）的几率是14%（Reed *et al*. 2003）。漩涡模型以此作为灾难性事件发生几率的依据，每年发生几率为0.83%，约每120年发生一次。另外一种灾难来自于疾病，参照野生黑猩猩的情况设定发生几率为每年2%，每50年发生一次，种群存活率为80%。

近亲繁殖的影响

近亲繁殖可能会造成遗传多样性的降低和增加遗传病的发生机会。近亲繁殖可能对种群的生存率、繁殖能力、健康、表征、行为、性别比等产生影响，最终导致种群衰亡。有不少物种都有过近交衰退的记载，不过由于这种研究在野外很难实现，所以缺乏实际数据。因此，忽略近亲繁殖对物种灭绝的影响会严重高估濒危物种的种群生存力（O'Grady *et al*. 2006）。

近亲繁殖对不同物种和种群的作用各有不同。近亲繁殖影响力的指标称为"致死当量（LE）"，意思是同型结合时可能致命的基因，在异型（隐性）时产生的遗传负荷。虽然暂时缺乏海南长臂猿遗传负荷的数据，但是不能完全排除近亲繁殖的作用。在模型中，LE被设定为6.29，反映近亲繁殖的第一代出生后第一年的死亡率会稍为增加。参考O'Grady *et al*.（2006）对多种野生哺乳类动物和鸟类的LE分析（平均值为12.29），适当下调海南长臂猿的LE值以作保守推测。另外，还分别模拟比较在1）低

近亲繁殖作用（LE 3.14，基于圈养哺乳类动物种群数据）与2）没有近亲繁殖作用对长臂猿种群生存力的影响。

初始种群

以实际现存种群的年龄与性别构建初始种群，共25只（13雄，12雌）。

雄性年龄：1, 1, 3, 3, 3, 7, 8, 8, 9, 11, 13, 18, 19
雌性年龄：1, 5, 5, 6, 7, 7, 9, 11, 17, 20, 22, 32

海南长臂猿的数量近几十年来一直维持在30只以下，因此，大部分个体之间有着亲缘关系。根据对海南长臂猿的标本和活体（种群的36%）的遗传性分析（Bryant 2014），物种的遗传多样性（杂合性和等位基因丰度）有下降的趋势，平均亲缘度为0.34。已知，现存种群在80年代只有8只。以漩涡模型模拟8只亲缘度为0的种群35年，得到亲缘度0.20。因此，漩涡模型中保守估计初始种群的亲缘指数为0.20。

栖息地与其承载量

基础模型假设栖息地的面积与质量在未来不会下降，其现在与未来150年的承载量为65只。这意味着种群能在未来从现时的15平方公里栖息地范围往其它适宜生境扩散。

模型摘要:
漩涡基础模型是一个拥有25只，能健康增长的长臂猿种群。种群的栖息地承载量为65只，环境相对稳定，种群受到适度的灾难风险与近亲繁殖风险，栖息地或长臂猿均不受到人为的直接破坏或杀害。

模拟结果

基础模型

模型结果显示，在没有栖息地破坏、偷猎或严重灾难、物种能正常扩散的情况下，海南长臂猿在未来15-20年内（下一代）的种群威胁较低。在短期内，种群数量应该会有所增长，但是由于小种群容易受到随机性过程的影响，运算结果之间差异较大。图10显示基础模型20次的模拟结果（蓝线），可以看到种群有机会达到最大承载量的65，也有可能完全灭绝。在模拟1000次以后， 40年后的平均个体数量（红线）为37只（18至57只）。伴随着遗传多样性的降低和种群数量的减少，灭绝几率会逐渐上升。150年后海南长臂猿的灭绝几率为45%。

由于各种运算结果之间差异较大，因此不可能准确地模拟海南长臂猿的长远发展情况。有效的保护与管理有赖系统的监测，并在指定的情况下调整管理措施。虽然无法肯定海南长臂猿的未来发展趋势，漩涡模型指出了影响种群生存力和增长速度的主要因素，提出了调查与研究的需要，并有助于设计更有效的管理方案。

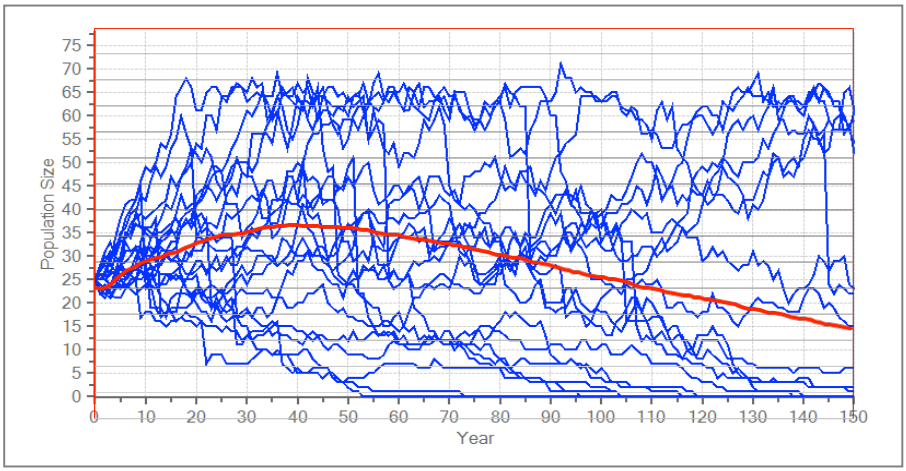


图10 基础模型20次运算结果。蓝线显示150年内的长臂猿种群数量，承载量为65。红线为1000次运算结果的平均（含物种灭绝）。

近亲繁殖的潜在风险

近亲繁殖可能会严重威胁小而孤立的种群。虽然缺乏有关海南长臂猿种群遗传负荷的数据，但是多年的监测数据反映其生存与繁殖状况暂时良好。不过，由于种群经过“瓶颈”（极小种群）仅两代，因此还不能对近亲繁殖情况作出准确评价。基础模型设定LE为6.29，代表近亲繁殖的影响为中度水平。稍后还模拟了LE=3.14与LE=0以探索不同水平的近亲繁殖对种群的长远影响。

图11显示在无近亲繁殖的作用下，长臂猿的平均种群数量会增长至接近最大承载量65只（绿线）。在低度与中度的近亲繁殖作用下，种群的数量与增长速度明显减少，灭绝的风险相应增加。海南长臂猿150年后的灭绝几率：中度近亲繁殖的为45%；低度近亲繁殖的为13%；无近亲繁殖的为3%。结果说明，近亲繁殖造成的遗传负荷会对海南长臂猿的长远发展构成障碍，因此，必须实行密切监测，以便即时发现并应对任何潜在效应。

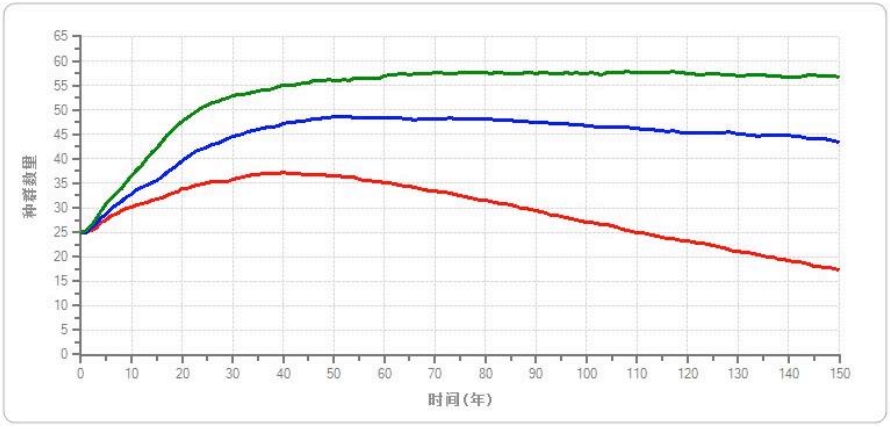


图11 不同强度的近亲繁殖对种群数量的影响。模型设置为承载量65，时间为150年。红线显示中度近亲繁殖（LE = 6.29）下的平均种群数量；蓝线为低度近亲繁殖（LE = 3.14）；绿线代表无近亲繁殖。

种群特征的敏感度测试

种群增长的潜力取决于死亡率与繁殖率。现今对海南长臂猿的繁殖特征，如配偶系统、首次生育年龄、繁殖周期等的了解比较多，但是由于监测困难，物种寿命较长，调查样本量少（种群小，调查时间短），和未能确认扩散个体的去向，导致对不同年龄的死亡率缺乏了解。测试种群特征的敏感度是辨别种群增长率和生存力最主要的因素，能提高对模型准确度的认知。表3列出了所有测试的参数，包括中度近亲繁殖与无近亲繁殖两个情景。

图12显示中度近亲繁殖（上）与无近亲繁殖（下）的测试结果。图中的直线越倾斜，代表其因子作用越强。虽然近亲繁殖强度影响种群增长速度，但是在不同近亲繁殖强度下各种繁殖因子的作用规律是相同的。近亲繁殖强度对种群的其它生存力指标（种群数量、遗传多样性、灭绝几率）的影响也是一样。

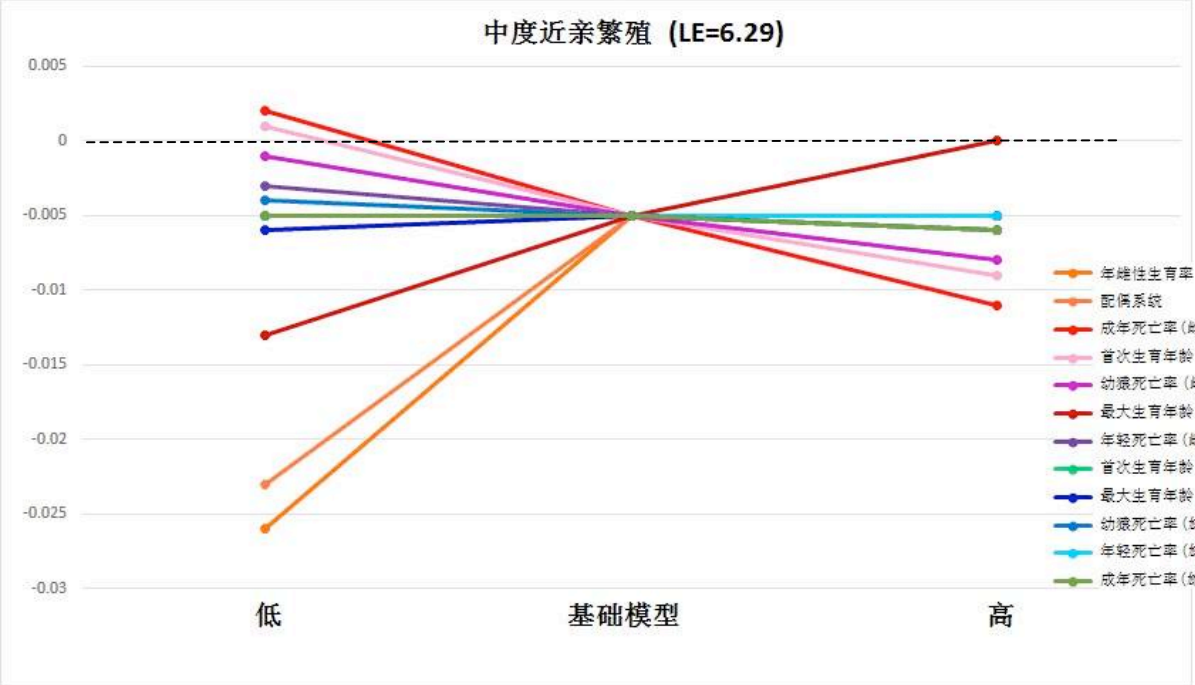
测试结果显示，在一雄两雌的配偶系统下，雄性死亡率和繁殖年限轻微的变化不会对种群的增长速度和灭绝几率产生明显的影响。只要每个家庭能容纳两只成年雌性，并且性别比正常，雄性就不会对种群发展造成限制。相反，雌性的死亡率对繁殖率甚至种群发展却有着决定性的作用。

由于雌性数量与生育状况是种群发展的关键，因此死亡率的轻微变化都会产生明显的后果。同样，改变雌性的繁殖年限（首次繁殖与最大繁殖年龄）也能对种群发展产生严重的影响。所以，*在海南长臂猿种群里，雌性充当着生育者的角色，任何雌性的死亡都意味着种群的萎缩，遗传多样性的流失，与灭绝风险的增加。*

影响海南长臂猿种群发展的主要因素是其配偶系统和繁殖速度。一个家庭能容纳两只成年雌性意味着种群性别比在趋于雌性的时候不会对种群发展构成威胁；而两年一胎的生育周期比三年一胎大大提高了种群总体的繁殖率。所以，*任何影响家庭群组成和生育周期的不利因素（如，栖息地质量，食物可利用性，人为干扰）均会对长臂猿的种群生存力构成严重的危害。*

表3 种群特征敏感度测试的测试参数。

参数	**低**	**基础模型水平**	**高**
配偶系统	--	一雄两雌	一雄一雌
繁殖周期 (每年雌性繁殖百分比):	--	两年 (46%)	三年 (31%)
首次生育年龄 (雌性):	7	8	9
首次生育年龄 (雄性):	9	10	11
最大生育年龄 (雌性):	25	30	35
最大生育年龄(雄性):	30	35	40
幼猿死亡率 (0-7岁) (雌性):	80% * 基础水平	见表2	120% *基础水平
幼猿死亡率 (0-7岁) (雄性):	80% * 基础水平	见表2	120% *基础水平
年轻个体死亡率 (7-8岁) (雌性):	8%	10%	12%
年轻个体死亡率 (7-8岁) (雄性):	8%	10%	12%
成年个体死亡率 (8-30岁) (雌性):	4%	5%	6%
成年个体死亡率 (8-30岁) (雄性):	4%	5%	6%



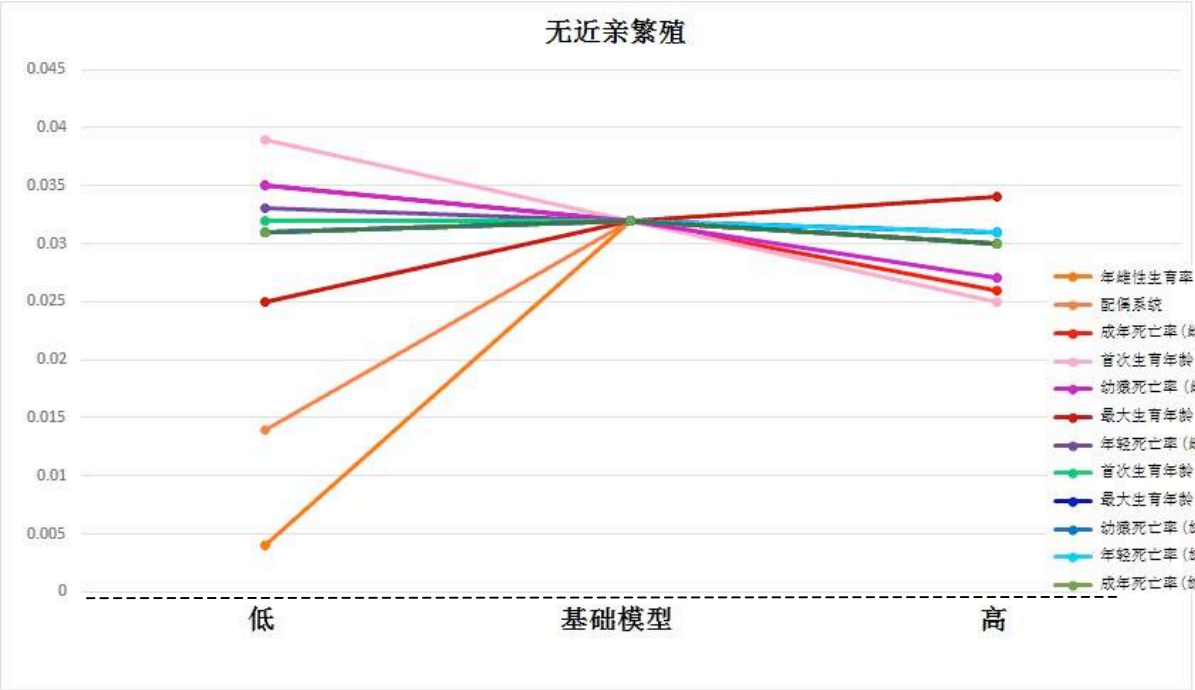


图12 种群特征敏感度测试结果：种群特征在基础模型、低与高水平时，种群在中度近亲繁殖（上），和无近亲繁殖（下）情况下的随机性增长速度。虚线表示种群增长率为零。参数的排序基本是以其影响力从高至低排列。

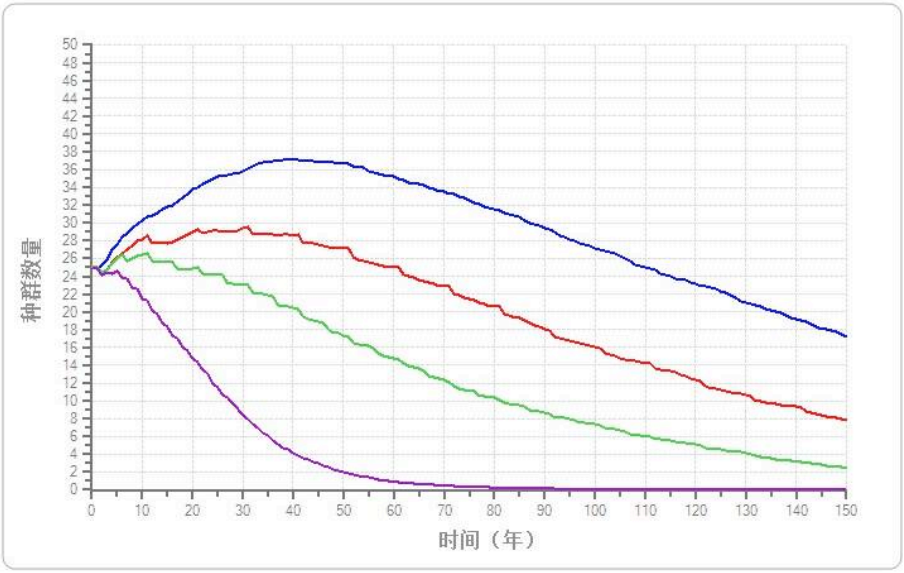


图 13 基础模型（蓝）以及每10年（红）、5年（绿）和2年（紫）丧失一只成年雌性长臂猿对平均种群数量所产生的影响。

个体死亡的风险

任何雌性长臂猿的死亡会直接降低繁殖速度和种群增长率，对长臂猿种群发展造成严重的危害。模型结果显示，每五年丧失一只成年雌性足以令种群生存力下降，最终致使物种灭绝（150年后90%）（图13）。虽然减少近亲繁殖指数有助于降低灭绝风险，但是就算在无近亲繁殖的情景下，偶尔减少成年雌性的数量还是能增加物种灭绝的风险（每5年减少一只，PE_{150}=0.23; 每2年减少一只，PE_{150}=0.87）。因此，*由于误猎或意外等丧失任何个体，尤其是成年雌性个体，都会对长臂猿的种群数量和生存力产生严重的后果，建议加强种群保护以免意外发生。*

小种群的风险

小种群容易受到种群随机性或遗传过程的影响，增加灭绝风险。为了显示种群数量所产生的风险，在基础模型的基础上（相同的种群发展速度、年龄结构和性别比、遗传亲缘性、近亲繁殖指数），模拟不同初始种群数量（和种群承载量）对150年后灭绝风险的影响。结果显示，当初始种群数量大于25，灭绝风险会显著减少（图14）。假设初始种群数量达150，150年后灭绝几率只有1.4%，而不是45%，并且拥有更高的遗传多样性。因此，*分析结果说明，必须防止栖息地破坏并进行栖息地恢复以在最大程度上促进种群的快速增长。*

图 14 初始种群数量为25至150时150年后的灭绝几率。

栖息地面积增加的潜在影响

种群的增长有赖于高生存力与高繁殖率；种群的增长速度越快，生存力越高。在长臂猿种群的数量几乎足够利用所有现有栖息地时，增加栖息地面积才会产生影响。

分析结果显示，近亲繁殖的叠加效应可能是妨碍海南长臂猿种群增长的一个重要因素。就算栖息地可利用性在未来可望增长，中等的近亲繁殖指数足以令种群数量停止增加（图15）。因此，*栖息地面积扩大并不能保证海南长臂猿种群的增长，而必须首先保证种群有较高的生存率与繁殖率致使种群数量的不断增长。*

必须尽可能避免任何能伤害长臂猿（尤其是雌猿）和降低其繁殖率的人类活动，如打猎和滋扰等等。当发生种群衰退或生存力下降时有可能需要考虑采取特殊的应变管理措施。

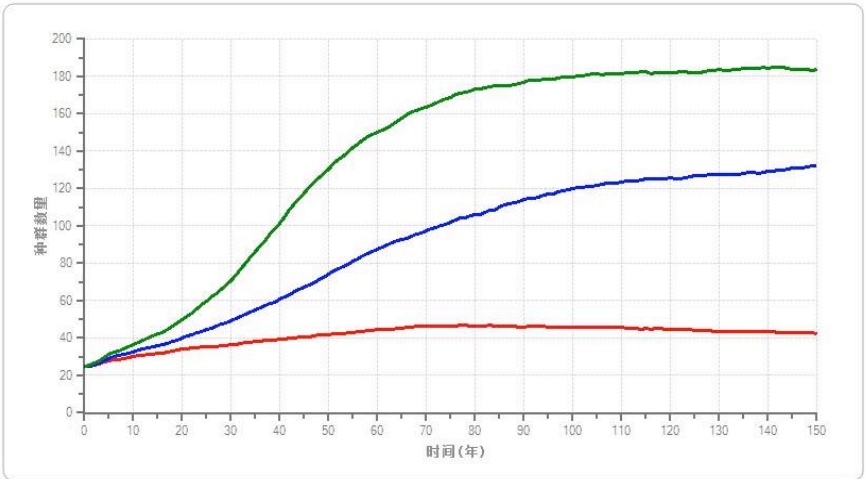


图15近亲繁殖强度对种群数量的影响。栖息地承载量设置为200。红线显示中度近亲繁殖（LE = 6.29）；蓝线为低度近亲繁殖（LE = 3.14）；绿线代表无近亲繁殖。

单个种群的风险

由于所有已知长臂猿同属一个种群，且共同栖息于一个地区内，使其更容易受到不可预知的灾难，如流行病害或林火的危害。理论上，帮助长臂猿建立第二个种群能有效降低物种灭绝的风险。但是由于种群已经很小，把其分为两群会妨碍基因流通，进一步降低种群的生存力。因此，必须把建立第二个种群与保持单个种群两个情况所产生的风险之间作出衡量。若在未来需要考虑建立第二个种群（如，把部分长臂猿迁移到新栖息地），能运用漩涡模型分析不同迁移手段（如迁移长臂猿的年龄、性别和数量），以评估不同效果与风险。

结论

海南长臂猿种群小，遗传多样性低，在未来容易发生衰退，甚至灭绝。在过去三十年间，对海南长臂猿及其栖息地实施了大量的管护工作，种群也体现了正常的存活率与生育率，种群发展比较稳定。要确保种群长远的、可持续的增长，必须继续种群的有效管护，以及栖息地的恢复工作。

由于小种群容易受到多种随机因素的影响，模型难以准确地预测海南长臂猿的未来状况。但是，模拟结果还是能对海南长臂猿的管护提供一些建议：

1. 随机事件能使海南长臂猿种群快速衰落。因此，管护部门必须对种群保持密切监测，以确保实时掌握种群状况，并在紧急情况时能迅速作出应变措施。

2. 应尽量识别并记录个体之间的亲缘关系，及评价分析任何近亲繁殖的影响（如，幼猿死亡率增加，不孕不育等）。

3. 应有效防止任何能导致长臂猿（尤其是雌猿）死亡或消失的人类活动。

4. 应有效防止任何能影响长臂猿家庭群组建和繁殖的人类活动。

5. 即时实行的反偷猎与栖息地保护工作对海南长臂猿的生存非常重要。

虽然栖息地的保护与恢复是必须的，但是单靠这些并不能保证海南长臂猿的生存与持续繁衍。自然灾害、疾病、偷猎、近交衰退等都会导致海南长臂猿种群的衰落甚至灭亡。种群越小，维持小种群的时间越长，近亲繁殖的机会就会越高；近亲繁殖会导致遗传多样性流失，近交衰退的作用因此会逐渐累积。

为了实现海南长臂猿种群的长远增长，其个体数量以及家庭群数量都必须要增加，多个不同的种群必须有更广阔的分布。近年的观察发现，霸王岭的海南长臂猿寿命较长、繁殖率高、存活率高，说明要以有效管护达到长臂猿种群的保护与数量长远增长是有可能的。由于种群曾经发生过遗传瓶颈效应（种群数量小于10），所以对其遗传负荷还是存在不确定性。如果漩涡模型高估了长臂猿的栖息地可利用性或低估了近亲繁殖的威胁，模型结果就会低估了其灭绝几率。因此，管理者必须对突如其来的情况（包括种群数量锐减或不能预测的威胁发生）做好充分的准备以作应变。有效的种群与栖息地监测及管理对海南长臂猿的持续发展至关重要。

附件 漩涡模型结果 (LEs = 致命当量; stoch-r = 随机性r（含随机性事件发生率的种群增长率）; PE = 灭绝几率; Nall = 所有运算结果的平均种群数量; SDall = 种群数量的标准差; GeneDiv = 基因多样性

情景	LEs	stoch-r	PE	N-all	SD(Nall)	GeneDiv
近亲繁殖						
基础模型 （中强度近亲繁殖）	6.29	-0.005	0.450	17	22	0.759
低强度近亲繁殖	3.14	0.013	0.129	44	23	0.793
无近亲繁殖	0	0.031	0.032	57	15	0.798
雌性死亡						
10年一只	6.29	-0.012	0.724	8	16	0.768
5年一只	6.29	-0.021	0.901	2	9	0.778
2年一只	6.29	-0.043	1.000	0	0	0.000
10年一只	3.14	0.006	0.325	32	27	0.780
5年一只	3.14	-0.002	0.581	19	26	0.781
2年一只	3.14	-0.031	0.987	1	6	0.811
10年一只	0	0.026	0.083	53	20	0.792
5年一只	0	0.020	0.230	44	27	0.786
2年一只	0	-0.011	0.870	7	18	0.790
初始个体数量						
初始数量=承载量=25	6.29	-0.012	0.893	1	3	0.598
初始数量=承载量=50	6.29	-0.003	0.338	17	17	0.759
初始数量=承载量=75	6.29	0.003	0.121	40	26	0.833
初始数量=承载量=100	6.29	0.006	0.060	62	33	0.877
初始数量=承载量=125	6.29	0.007	0.028	85	39	0.896
初始数量=承载量=150	6.29	0.008	0.014	107	45	0.913
承载量 K = 200						
基础模型 _K200	6.29	-0.003	0.420	43	59	0.802
低强度近亲繁殖 _K200	3.14	0.014	0.118	132	76	0.844
无近亲繁殖_K200	0	0.034	0.014	184	37	0.879
种群的人口特征 （有近亲繁殖）						
雌性首次生育年龄= 7	6.29	0.001	0.328	25	24	0.779
雌性首次生育年龄= 9	6.29	-0.009	0.576	11	17	0.758
雄性首次生育年龄= 9	6.29	-0.005	0.438	17	21	0.749
雄性首次生育年龄= 11	6.29	-0.006	0.488	15	20	0.754
雌性最大生育年龄= 25	6.29	-0.013	0.712	7	14	0.729
雌性最大生育年龄= 35	6.29	0.000	0.338	24	24	0.775
雄性最大生育年龄= 30	6.29	-0.006	0.472	16	21	0.754
雄性最大生育年龄= 40	6.29	-0.005	0.464	17	21	0.767
繁殖率31% (繁殖周期=3年)	6.29	-0.026	0.984	0	1	0.682
一夫一妻	6.29	-0.023	0.916	2	7	0.758
雌幼猿死亡率低	6.29	-0.001	0.358	24	24	0.778
雄性幼猿死亡率低	6.29	-0.004	0.454	18	22	0.771
雌幼猿死亡率高	6.29	-0.008	0.520	13	18	0.750
雄性幼猿死亡率高	6.29	-0.005	0.468	17	21	0.767

年轻雌猿死亡率低	6.29	-0.003	0.392	20	22	0.773
年轻雄猿死亡率低	6.29	-0.005	0.470	17	22	0.764
年轻雌猿死亡率高	6.29	-0.006	0.482	16	20	0.759
年轻雄猿死亡率高	6.29	-0.005	0.476	16	20	0.766
成年雌猿死亡率低	6.29	0.002	0.312	29	25	0.795
成年雄猿死亡率低	6.29	-0.005	0.446	18	22	0.768
成年雌猿死亡率高	6.29	-0.011	0.638	9	15	0.737
成年雄猿死亡率高	6.29	-0.006	0.498	15	20	0.754
种群的人口特征 （无近亲繁殖）						
雌性首次生育年龄= 7	0	0.039	0.012	59	13	0.806
雌性首次生育年龄= 9	0	0.025	0.056	55	18	0.794
雄性首次生育年龄= 9	0	0.032	0.010	58	13	0.797
雄性首次生育年龄= 11	0	0.030	0.030	55	16	0.801
雌性最大生育年龄= 25	0	0.025	0.064	54	19	0.787
雌性最大生育年龄= 35	0	0.034	0.008	60	11	0.804
雄性最大生育年龄= 30	0	0.031	0.016	58	14	0.798
雄性最大生育年龄= 40	0	0.031	0.032	58	14	0.805
繁殖率31% (繁殖周期=3年)	0	0.004	0.262	34	27	0.745
一夫一妻	0	0.014	0.208	42	27	0.801
雌幼猿死亡率低	0	0.035	0.018	59	13	0.804
雄性幼猿死亡率低	0	0.031	0.026	58	14	0.802
雌幼猿死亡率高	0	0.027	0.034	56	17	0.795
雄性幼猿死亡率高	0	0.030	0.014	57	15	0.793
年轻雌猿死亡率低	0	0.033	0.010	58	12	0.801
年轻雄猿死亡率低	0	0.031	0.026	57	15	0.801
年轻雌猿死亡率高	0	0.030	0.030	57	15	0.799
年轻雄猿死亡率高	0	0.031	0.024	58	15	0.805
成年雌猿死亡率低	0	0.035	0.018	58	13	0.801
成年雄猿死亡率低	0	0.031	0.028	58	15	0.801
成年雌猿死亡率高	0	0.026	0.032	56	16	0.788
成年雄猿死亡率高	0	0.030	0.038	57	16	0.789

International Conservation Planning Workshop for the Hainan Gibbon

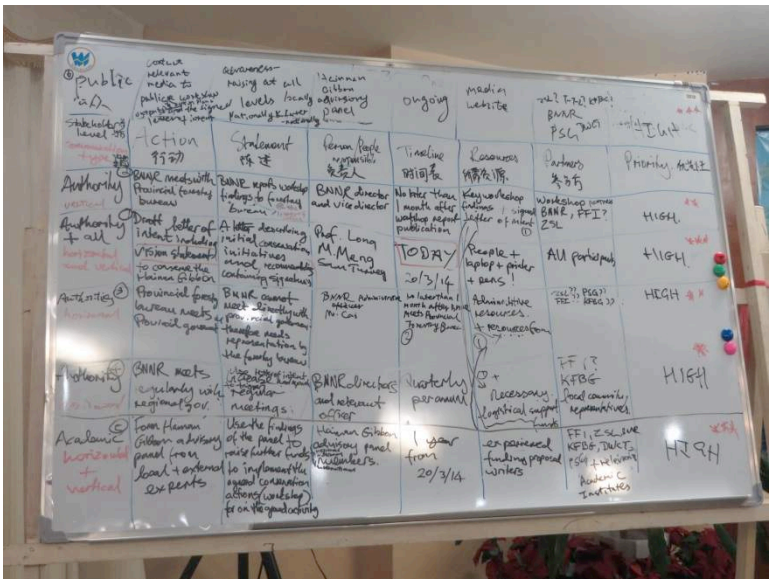
Bo'ao, Hainan, China
18 – 20 March 2014

Final Report

海南长臂猿保护博鳌国际论坛

中国海南省博鳌镇
2014年3月18至20日

总结报告



SECTION 9
Priority Action Steps

第九章　优先行动

Priority Action Steps

During plenary and working group discussions the workshop participants identified the following major concerns and challenges to Hainan gibbon viability and conservation:

- The current Hainan gibbon population is small and restricted geographically, characteristics that place it at risk of decline and even extinction.
- Formation of new breeding groups by dispersing subadults and expansion into new territories is not being observed as expected, the cause of which is uncertain.
- Natural and human-related factors may be decreasing habitat quality and connectivity within BNNR, effectively reducing and fragmenting available habitat to support gibbons.
- Conflicts of interest may exist between local communities and gibbon population needs, which may impact gibbon conservation and population expansion.
- Lack of effective communication among various stakeholders hinders effective management and conservation action for Hainan gibbons.

Through topic-focused working group discussions the participants identified 12 goals and recommended 44 specific actions to address these concerns, some of which overlapped between groups; these are summarised on the following page. Working groups rated each of their recommended actions in terms of Potential Benefit, Likelihood of Success, and Priority for Action. Table 4 lists 37 actions that were rated as HIGH or MODERATELY HIGH priority. All of these actions were considered to be of moderate to high benefit and also of moderate to high likelihood of being successful.

These actions vary in terms of urgency, timeline, resources needed, and partner collaborations (see working group reports for details). Figure 16 illustrates the urgencies and inter-relationships among the priority actions, and highlights those actions that should be pursued first.

Implementation of these actions will begin to address the concerns identified at the workshop, and will promote Hainan gibbon population expansion and viability in concert with increased stakeholder support as outlined in the vision statement for Hainan gibbons.

Summary of priority actions for Hainan gibbon conservation identified by working groups:

ACTIONS 1.1 – 1.10

ACTION 1.1: Improve monitoring of individuals in all social groups
ACTION 1.2: Tracking of subadult individuals
ACTION 1.3: Develop an individual identification guide/report
ACTION 1.4: Possible habituation of Group C to enhance future monitoring of dispersing individuals
ACTION 1.5: Increase the frequency and area surveyed by fixed-point counts
ACTION 1.6: Conduct playback experiments in unoccupied forest
ACTION 1.7: Employ new acoustic technologies to support monitoring efforts
ACTION 1.8: Increase survey effort on the ground at BNNR
ACTION 1.9: Conduct community surveys within and outside BNNR to investigate reports of possible recent gibbon sightings
ACTION 1.10: Survey forest areas within and outside BNNR for other gibbon populations or individuals

ACTIONS 2.1 – 2.4

ACTION 2.1: Increase habitat availability for new groups by investigating and removing local human disturbance
ACTION 2.2: Attract or encourage gibbons into new forest by provisioning
ACTION 2.3: Translocate solitary individuals to form a new social group
ACTION 2.4: Translocate individuals from an existing social group to a new forest patch

ACTIONS 3.1 – 3.2

ACTION 3.1: Increase monitoring, including health status and mortality in social groups and lone gibbons
ACTION 3.2: Assess and write an EMP, and establish an approval mechanism

ACTIONS 4.1 – 4.3

ACTION 4.1: Establish fine-scale forest plots within current gibbon habitat to assess plant species composition and phenology
ACTION 4.2: Evaluate distribution and connectivity of suitable gibbon habitat across BNNR using satellite imagery and ground-truthing
ACTION 4.3: Create new high-resolution maps of habitat quality and connectivity across BNNR

ACTIONS 5.1 – 5.5

ACTION 5.1: Evaluate connectivity of habitat at BNNR in terms of the necessity and feasibility of artificially connecting gaps in the landscape
ACTION 5.2: Trial canopy bridges to reconnect existing small-scale gaps in canopy
ACTION 5.3: Monitor use of canopy bridges by gibbons
ACTION 5.4: Conduct habitat restoration and forest corridor establishment
ACTION 5.5: Fade out pine resin production in/near gibbon habitat

ACTION 6

ACTION 6.1: Enhance patrolling and monitoring capacity at BNNR

ACTION 7

ACTION 7.1: Investigate potential impacts of human and environmental disturbance

ACTIONS 8.1 – 8.6

ACTION 8.1: Improve education
ACTION 8.2: Develop agroforestry
ACTION 8.3: Provide vocational training and technical support
ACTION 8.4: Develop agroforestry sales strategies and marketing channels
ACTION 8.5: Investigate potential for developing cultural tourism
ACTION 8.6: Establish communication channels between local communities, authorities and reserve management

ACTIONS 9.1 – 9.5

ACTION 9.1: Draft and sign Letter of Intent for Hainan gibbon conservation
ACTION 9.2: BNNRMO reports workshop findings and presents Letter of Intent to HFB
ACTION 9.3: Conduct meeting between HFB and Provincial Government
ACTION 9.4: Conduct regular meetings between BNNRMO and County Governments
ACTION 9.5: Draft and ratify an up-to-date formal Species Action Plan

ACTIONS 10.1 – 10.2

ACTION 10.1: Form Hainan Gibbon Advisory Panel consisting of national and international experts
ACTION 10.2: Provide training to officials and monitoring team

ACTIONS 11.1 – 11.4

ACTION 11.1: Analyse socio-economic needs, benefits and issues of local communities
ACTION 11.2: Develop sustainable alternative livelihoods for local communities
ACTION 11.3: Improve co-management between authorities and local communities
ACTION 11.4: Conduct communication, education and public awareness-raising in local communities

ACTION 12

ACTION 12.1: Publicise Letter of Intent, workshop output, and species action plan

Table 4. Recommended actions which were considered of High or Moderately High Priority by the working groups (*for clarity, some actions developed by the Habitat Availability and Connectivity Subgroup are listed under the Habitat Constraints Working Group).

Population Status Constraints Working Group		**Potential benefit**	**Likelihood of success**	**Priority for action**
PROBLEM: There is a lack of understanding of survivorship of dispersing individuals and lack of suitable quality habitat for new group formation. Dispersing individuals are apparently not finding mates and thus not forming new groups.				
GOALS: Improve understanding of the fate of dispersing individuals. Strengthen capacity to detect gibbons, to enable improved monitoring of the known gibbon population at BNNR, and potential detection of other surviving gibbon populations or lone individuals within and outside BNNR.				
Priority actions	Improve monitoring of individuals in all social groups.	HIGH	HIGH	HIGH
	Tracking of subadult individuals (of entire population).	HIGH	Moderate	HIGH
	Develop an individual identification guide/report.	HIGH	Moderate	HIGH
	Possible habituation of Group C to enhance future monitoring of dispersing individuals.	HIGH	HIGH	HIGH
	Increase the frequency and area surveyed by fixed-point counts.	HIGH	HIGH	HIGH
	Conduct playback experiments in unoccupied forest.	HIGH	HIGH	HIGH
	Employ new acoustic technologies to support monitoring efforts.	HIGH	HIGH	HIGH
	Increase survey effort on the ground at BNNR.	Moderate	HIGH	HIGH
	Conduct community surveys within and outside BNNR to investigate reports of possible recent gibbon sightings.	HIGH	HIGH	HIGH
	Survey forests within and outside BNNR for other gibbon populations or individuals.	HIGH	HIGH	HIGH
GOAL: Facilitate new group formation.				
Priority actions	Increase habitat availability for new groups by investigating and removing local human disturbance.	HIGH	HIGH	HIGH
PROBLEM: There is no Emergency Management Plan (EMP) in place that would deal with a rapid decline in the gibbon population due to an unpredictable event.				
GOAL: Increase monitoring efforts to allow confirmation of when the "catastrophe decline threshold" has been reached, triggering implementation of the EMP.				
Priority actions	Increase monitoring, including health status and mortality in social groups and lone gibbons.	HIGH	HIGH	HIGH
	Assess and write an EMP, and establish an approval mechanism.	HIGH	HIGH	HIGH

Habitat Constraints Working Group *		**Potential benefit**	**Likelihood of success**	**Priority for action**
PROBLEM: Hainan gibbon habitat constraints within BNNR include natural and anthropogenic factors that reduce the connectivity and quality of suitable forest. These factors not only limit the spatial distribution of Hainan gibbons, but also increase the risk of food shortage.				
GOAL: Evaluate the extent, quality and connectivity of suitable gibbon habitat in the BNNR landscape.				
Priority actions	Establish fine-scale forest plots within current gibbon habitat to assess plant species composition and phenology.	Moderate	HIGH	Moderately HIGH
	Evaluate the distribution and connectivity of suitable gibbon habitat across BNNR using satellite imagery and ground-truthing.	Moderate	HIGH	HIGH
	Create new high-resolution maps of habitat quality and connectivity across BNNR.	HIGH	HIGH	Moderately HIGH
GOAL: Enhance the connectivity of the habitat immediately surrounding the existing gibbon population. Connect fragmented habitat, increase their size, and improve the quality of habitat.				
Priority actions	Evaluate connectivity of habitat at BNNR in terms of the necessity and feasibility of artificially connecting gaps in the landscape.	HIGH	HIGH	HIGH
	Trial canopy bridges to reconnect existing small-scale gaps in canopy.	Moderate	Moderate	HIGH
	Monitor use of canopy bridges by gibbons.	HIGH	Moderate	HIGH
	Conduct habitat restoration and forest corridor establishment.	HIGH	HIGH	HIGH
	Fade out pine resin production in/near gibbon habitat.	HIGH	Moderate	HIGH
GOAL: Strengthen BNNRMO's capacity to protect habitats.				
GOAL: Improve understanding of human and environmental distubance.				

Impacts of Human Activities Working Group		**Potential benefit**	**Likelihood of success**	**Priority for action**
PROBLEM: Gibbons occur in a fragmented forest mosaic landscape at BNNR that is also utilised by local villagers, mostly Li and Miao ethnic minorities, who have lived in close association with the region's forests for generations. Gibbons and humans are likely to come into close contact as a result of this shared habitat use, and the current range of the newly formed Group C is very close to settlements in Qingsong Township. The livelihoods of local communities around BNNR have been substantially affected by the establishment of the reserve, leading to local tensions and reduced economic opportunities, and many villagers continue to use the forests for a range of activities.				
GOAL: Use local knowledge and resources to increase local income.				
Priority actions	Improve education.	HIGH	HIGH	HIGH
	Develop agroforestry.	HIGH	Moderate	HIGH
	Provide vocational training and technical support.	HIGH	Moderate	HIGH
	Develop agroforestry sales strategies and marketing channels.	HIGH	Moderate	HIGH
	Establish communication channels between local communities, authorities and BNNRMO.	HIGH	Moderate	HIGH
Policy and Communication Working Group		**Potential benefit**	**Likelihood of success**	**Priority for action**
PROBLEM: The key problem that hinders effective management, action and policy-making for Hainan gibbon conservation is the general lack of effective communication among stakeholders.				
GOAL: Enhance horizontal and vertical communication among authorities.				
Priority actions	Draft and sign Letter of Intention for Hainan gibbon conservation.	HIGH	HIGH	HIGH
	BNNRMO reports workshop findings and presents the Letter of Intention to the Provincial Forestry Bureau.	HIGH	HIGH	HIGH
	Conduct a meeting between the Provincial Forestry Bureau and Provincial Government.	HIGH	HIGH	HIGH
	Draft and ratify an up-to-date formal Species Action Plan.	HIGH	HIGH	HIGH
GOAL: Enhance understanding, communication and collaboration between authorities and academics.				
Priority	Form a Hainan Gibbon Advisory Panel consisting of national and international experts.	HIGH	Moderate	HIGH
GOAL: Enhance communication and collaboration between authorities and communities.				
GOAL: Enhance public awareness for Hainan gibbon conservation.				
Priority	Publicise Letter of Intention, workshop output, and Species Action Plan.	HIGH	Moderate	HIGH

Figure 16. Inter-relationships and approximate time sequence for different Hainan gibbon conservation actions recommended by working groups. Level of resources required, order of priority, and working group proposer also indicated for each action (see key).

优先行动

总体来说，参会人员认同海南长臂猿及其保护正面临的威胁如下：

- 海南长臂猿种群小，地理分布受到严重限制，因此，种群衰落与灭绝的风险较高。
- 年轻个体组成新家庭群并建立新家域的情况未如理想，原因暂不能确定。
- 长臂猿栖息地的质量与连通性可能受多种自然和人为因素的影响，导致退化与破碎化。
- 社区与保护区管理部门之间的冲突可能影响长臂猿的有效保护与恢复。
- 利益相关者之间缺乏有效沟通妨碍保护区的有效管理与长臂猿的有效保护。

通过工作小组的热烈讨论，最后共产生13个保护目标与44个建议行动（工作小组之间存在重叠）。概括如下，工作小组根据每项保护行动的潜在得益和成功率，把其优先性进行了粗略的评估。表4列出共37个“高”和“中高”优先等级的建议保护行动，这些建议估计能达到中至高等得益以及中至高等成功率。

各建议行动有不同的迫切性、资源需求、负责和合作单位（详情见工作小组报告）。图16总结了建议行动的迫切性以及彼此的关系，并突出了应该尽快开展的建议行动。

各利益相关者的持续支持，这些保护行动能帮助消除海南长臂猿所面对的种群威胁，促进种群繁衍和生存，是实现所有利益相关者共同愿景的途径。

工作小组提出的所有优先建议行动摘要：

行动1.1 – 1.10

行动1.1：加强对所有家庭群每个个体的常规性监测力度
行动1.2：跟踪调查所有年轻个体
行动1.3：编写海南长臂猿个体辨认指南或报告
行动1.4：使C群习惯人类近距离调查，以更有效进行监测
行动1.5：增加长臂猿定点调查的频率和面积
行动1.6：在已知家庭群活动区以外进行叫声回放实验
行动1.7：以新的声学技术来增加监测力度
行动1.8：加强在霸王岭的长臂猿监测
行动1.9：通过社区问卷收集与分析长臂猿的目击事件
行动1.10：在霸王岭以内及以外林地侦查未知长臂猿

行动2.1 – 2.4

行动2.1：调查并消除栖息地的人为干扰以增加栖息地的可用性

行动2.2：以食物投放吸引长臂猿探索新栖息地
行动2.3：移迁独猿以促进新家庭群的组成

行动2.4：移迁现有家庭群到新的栖息地

行动3.1 – 3.2

行动3.1：加强对家庭群和独猿的跟踪监测与健康分析
行动3.2：编制海南长臂猿紧急应变计划，并确立启动机制

行动4.1 – 4.3

行动4.1：在长臂猿的主要分布区对植被组成和物候进行详细的样方调查
行动4.2：利用卫星图像与地面调查评估保护区内长臂猿适宜生境的分布和连通性
行动4.3：为保护区制作高精度栖息地质量与连通性分布图

行动5.1 – 5.5

行动5.1：评估人工连通栖息地的必要性和可行性
行动5.2：测试以树冠桥梁连通林窗的可行性
行动5.3：对树冠桥梁进行监测
行动5.4：栖息地恢复与廊道建设
行动5.5：在长臂猿栖息地逐步取缔采松脂

行动6

行动6.1：巡护与监测队的能力建设

行动7

行动7.1：评估人为和自然干扰对长臂猿及其栖息地的影响

行动8.1 – 8.6

行动8.1：提高教育水平
行动8.2：发展混农林业
行动8.3：提供林业相关的技能培训
行动8.4：为混农林业设计营销策略和开发销售渠道
行动8.5：研究发展文化特色旅游的可行性
行动8.6：建立林业部门、管理单位与社区之间的沟通渠道

行动9.1 – 9.5

行动9.1：草拟与签署海南长臂猿保护联名倡议书
行动9.2：保护区管理局向省林业厅汇报论坛情况和产出
行动9.3：省林业厅向省政府办公室汇报论坛情况和产出

行动9.4：保护区管理局定期与县政府进行沟通
行动9.5：草拟并认可最新的海南长臂猿保护行动计划

行动10.1 – 10.2

行动10.1：组建海南长臂猿专家顾问团
行动10.2：主管部门员工与监测队员的能力培训

行动11.1 – 11.4

行动11.1：开展社区经济发展专项调查了解社区需要
行动11.2：发展社区可持续替代生计
行动11.3：加强社区公管
行动11.4：开展社区交流、教育、公众意识提升活动

行动12

行动12.1：接洽相关媒体，发布论坛产出、倡议书和保护行动计划

表4 “高”和“中高”优先等级的建议保护行动（*为了更好表达保护行动的逻辑关系，一些由栖息地可利用性和连通性亚组建议的行动被置于栖息地的限制工作小组之下）。

种群现状工作小组		潜在得益	成功率	优先性
问题：对扩散的年轻个体生存情况缺乏了解，缺乏建立新家庭群的适宜栖息地。扩散的年轻个体未能找到合适的伴侣，导致无法组成新家庭群。				
目标:对扩散个体进行跟踪调查，加强对霸王岭以内及以外独猿的侦查力度和已知家庭群的监测力度。				
优先行动	加强对所有家庭群每个个体的常规性监测力度	高	高	高
	跟踪调查所有年轻个体	高	中	高
	编写海南长臂猿个体辨认指南或报告	高	中	高
	使C群习惯人类近距离调查，以更有效进行监测	高	高	高
	增加长臂猿定点调查的频率和面积	高	高	高
	在已知家庭群活动区以外进行叫声回放实验	高	高	高
	以新的声学技术来增加监测力度	高	高	高
	加强在霸王岭的长臂猿监测	中	高	高
	通过社区问卷收集与分析长臂猿的目击事件	高	高	高
	在霸王岭以内及以外林地侦查未知长臂猿	高	高	高
目标:促进新家庭群的组成				
优先行动	调查并消除栖息地的人为干扰以增加栖息地的可用性	高	高	高
问题:缺乏能应对突发性灾难造成的种群衰退的紧急应变计划。				
目标：增强监测力度，以确保种群达到“灾难性种群衰退临界点”时能及时启动紧急应变措施。				
优先行动	加强对家庭群和独猿的跟踪监测与健康分析	高	高	高
	编制海南长臂猿紧急应变计划，并确立启动机制	高	高	高

*栖息地的制约工作小组 **		潜在得益	成功率	优先性
问题：海南长臂猿在霸王岭所受的栖息地制约来自于多种自然与人为因素，导致森林连通性与质量的下降。这些问题不但影响长臂猿的分布，还会增加食物短缺的风险。				
目标:对霸王岭保护区内长臂猿适宜栖息地的面积、质量与连通性进行详细的评估				
优先行动	在长臂猿的主要分布区对植被组成和物候进行详细的样方调查	中	高	中高
	利用卫星图像与地面调查评估保护区内长臂猿适宜生境的分布和连通性	中	高	高
	为保护区制作高精度栖息地质量与连通性分布图	高	高	中高
目标:增加栖息地连通性、面积与质量。				
优先行动	评估人工连通栖息地的必要性和可行性	高	高	高
	测试以树冠桥梁连通林窗的可行性	中	中	高
	对树冠桥梁进行监测	高	中	高
	栖息地恢复与廊道建设	高	高	高
	在长臂猿栖息地逐步取缔采松脂	高	中	高
目标：提高保护区管理局保护栖息地的能力				
目标：增加对人为与自然干扰的理解				

人类活动的影响工作小组		潜在得益	成功率	优先性
问题：海南长臂猿栖息于霸王岭保护区内，破碎的生境是当地黎族与苗族居民世世代代赖以生存的自然资源，因此，海南长臂猿容易与人类产生近距离的接触，比如，新组成的C群就在青松乡的村子附近活动。霸王岭保护区周边的社区生计受保护区影响严重，造成社区与管理部门之间发生矛盾与冲突，经济收入减少，部分村民依然利用保护区内的森林资源。				
目标:以传统知识和当地资源增加社区经济收入				
优先行动	提高教育水平	高	高	高
	发展混农林业	高	中	高
	提供林业相关的技能培训	高	中	高
	为混农林业设计营销策略和开发销售渠道	高	中	高
	建立林业部门、管理单位与社区之间的沟通渠道	高	中	高
政策与管理工作小组				
问题:由于利益相关者之间缺乏有效沟通，阻碍海南长臂猿的有效管理、保护行动的实施与保护政策的制定。				
目标:加强政府部门之间的纵向与横向沟通				
优先行动	草拟与签署海南长臂猿保护联名倡议书	高	高	高
	保护区管理局向省林业厅汇报论坛情况和产出	高	高	高
	省林业厅向省政府办公室汇报论坛情况和产出	高	高	高
	草拟并认可最新的海南长臂猿保护行动计划	高	高	高
目标:加强主管单位和学术界之间的沟通与合作				
优先行动	组建海南长臂猿专家顾问团	高	中	高
目标:加强管理部门和社区之间的沟通与合作				
目标:提高公众的海南长臂猿保护意识				
优先行动	接洽相关媒体，发布论坛产出、倡议书和保护行动计划	高	中	高

图16 建议保护行动之间的关系和建议实行时间，以及每项行动的所需资源、建议工作组与优先性。

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总结报告

SECTION 10
Literature Cited

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2014年3月18至20日

总结报告

APPENDIX I

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International Conservation Planning Workshop for the Hainan Gibbon

Bo'ao, Hainan, China
18 – 20 March 2014

Final Report

海南长臂猿保护博鳌国际论坛

中国海南省博鳌镇
2014年3月18至20日

总结报告

APPENDIX II

Workshop Activities

附件 II　　会议活动简介

Workshop Aims

1. Review past conservation efforts for Hainan gibbon conservation
2. Discuss and identify priority actions for Hainan gibbon conservation through PHVA
3. Promote awareness of Hainan gibbon conservation across Hainan

Workshop Outputs

1. Workshop report with priority actions for Hainan gibbon conservation
2. Appointment of Hainan gibbon conservation ambassadors
3. Open letter signed by participants to call for public and government attention on Hainan gibbon conservation
4. Media coverage about the workshop and the importance of Hainan gibbon conservation

Summary of Activities

2014/3/13	Talks by Long Yongcheng and Katherine Feng on Hainan gibbon conservation at Hainan University; more than 100 students attended.
2014/3/14	Talks by Long Yongcheng and Katherine Feng on Hainan gibbon conservation at Hainan University; more than 100 students attended.
2014/3/17	Field visit for international attendees to BNNR.
2014/3/18	Opening ceremony of workshop; scientific presentations on Chinese gibbons, conservation of Hainan gibbon, and conservation lessons from threatened gibbon species across Asia. At the workshop, Chengmei Charity Foundation announced its intention to establish a Hainan gibbon conservation fund. CBSG's introduction to the PHVA process; participants identified all potential threats and issues that the Hainan gibbon might be facing.
2014/3/19	Second and third PHVA sessions, where participants formed working groups to discuss specific conservation issues.
2014/3/20	Fourth and fifth PHVA sessions, where participants discussed the potential risks, benefits, resources required, timelines, responsible parties, and priority of all recommended actions raised by their group. At the closing ceremony, an Open Letter was signed by participants to call for attention on Hainan gibbon conservation, which was immediately reported and broadcasted by the media. Participants agreed that a Hainan Gibbon Conservation Advisory Panel should be formed, and that a government-endorsed action plan should be prepared as soon as possible based on the recommended actions from the workshop.

会议目的

1. 回顾海南长臂猿的保护历程和成效
2. 为海南长臂猿的保护提出建议
3. 提高公众与政府部门对海南长臂猿的认识和保护意识

会议产出

1. 专家为海南长臂猿保护提出的建议
2. 委任海南长臂猿爱心大使
3. 拟定公开信以呼吁公众与政府部门关注海南长臂猿
4. 关于本次论坛和海南长臂猿保护的相关传媒报道

活动简介

2014/3/13	龙勇诚教授与冯文真博士到海南大学演讲，向逾百名学生宣传海南长臂猿保护的重要性。
2014/3/14	龙勇诚教授与冯文真博士到海南师范大学演讲，向逾百名学生宣传海南长臂猿保护的重要性。
2014/3/17	国外参会嘉宾到霸王岭国家级自然保护区进行考察。
2014/3/18	论坛开幕仪式，然后专家对中国长臂猿概况、海南长臂猿种群、管理状况、亚洲长臂猿保护历程等发表主题报告。 在开幕仪式上，海南成美慈善基金会发表其成立海南长臂猿专项基金的意向和构思。 CBSG介绍会议基本流程，参会人员提出可能影响海南长臂猿生存与恢复的所有威胁，为组建工作小组做好铺垫。
2014/3/19	专题讨论第二与第三节，工作小组对相关保护问题进行具体讨论，并在全体会议上分享。
2014/3/20	专题讨论第四与第五节，工作小组对保护行动的潜在风险、得益、所需资源、实施时间、负责部门，以及优先性等进行讨论，并在全体会议上分享。 在闭幕仪式上，参会专家签署联名公开信，呼吁公众与相关部门关注和支持海南长臂猿的保护行动。传媒为这次论坛和公开信内容作出即时报道。 参会人员提议相关专家组成海南长臂猿保护顾问团，并该根据本次论坛的产出尽快整理出一份政府认可的长臂猿保护行动计划。

International Conservation Planning Workshop for the Hainan Gibbon

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Final Report

海南长臂猿保护博鳌国际论坛

中国海南省博鳌镇

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总结报告

APPENDIX III

Open Letter to the Public

附件 III　　公开信

Let's Take Actions to Save the Hainan gibbon

——an Open Letter to the Public

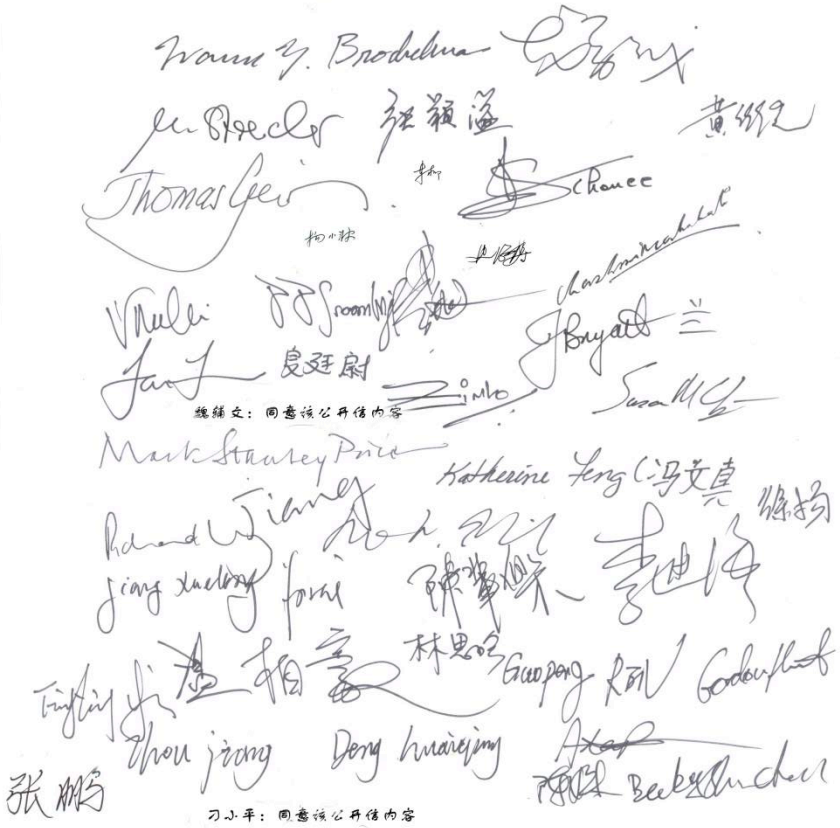
We came from ten countries and regions of the world, we all care about one animal species – the Hainan gibbon. This amazing creature brought us together to Bo'ao, and brought our hearts together for the survival of the remaining population of the species.

The Hainan gibbon is an endemic species of Hainan, which was once widespread on the island hundreds of years ago and was documented in a poem by a famous poet as well as other historical documents. The population dropped to 2000 by the 1950s, but their beautiful songs could still be heard and evidence of their existence could still be found from twelve counties of the province. Unfortunately, the species has now become the most endangered primate of the world, and faces the threat of imminent extinction.

The primary tropical rainforest, the habitat of the Hainan gibbon, is a result of evolution and adaptation on the island. It is also the most attractive landscape of Hainan as well as the most critical ecosystem of Hainan. Today, Hainan has become a world renowned tourist destination, therefore, eco-development should be the basis for future development.

Saving the Hainan gibbon is not only about preserving an endangered species, it is also an important component for planning eco-development. Conserving Hainan gibbons also preserves the primary rainforests; treasuring the Hainan gibbon encourages appropriate eco-development. As an international ecotourism destination, Hainan needs the continued presence of the Hainan gibbons, and we should do our best to prevent them from becoming extinct. Because we know we have a long and arduous road ahead of us demanding much time, finances and resources, we need the support from government, public and private sectors. With full support of all stakeholders and implementation of recommended actions, we envision a much larger, viable population of Hainan gibbons living in several large natural forest ecosystems on Hainan; enjoying the active support of local communities, general public, private sectors, and government and to be a focus of local and national pride. To accomplish this vision, we propose these initiatives:

1. Protection and effective management of the current population of Hainan gibbons.
2. Formation of a multi-disciplinary expert team to formulate the Hainan Gibbon Conservation Action Plan, and implementation as soon as possible.
3. Strengthening the effectiveness of rainforest protection over the entire Hainan island for the purpose of providing increased carrying capacity and dispersal of the gibbon.
4. Fostering and promoting the love for Hainan gibbons nationally and internationally, as has been done with the giant pandas.
5. Establishment of a specific fund for Hainan gibbon conservation that will support ongoing, long-term financial needs of the conservation measures.



携手行动起来，拯救海南长臂猿

——致社会各界公开信

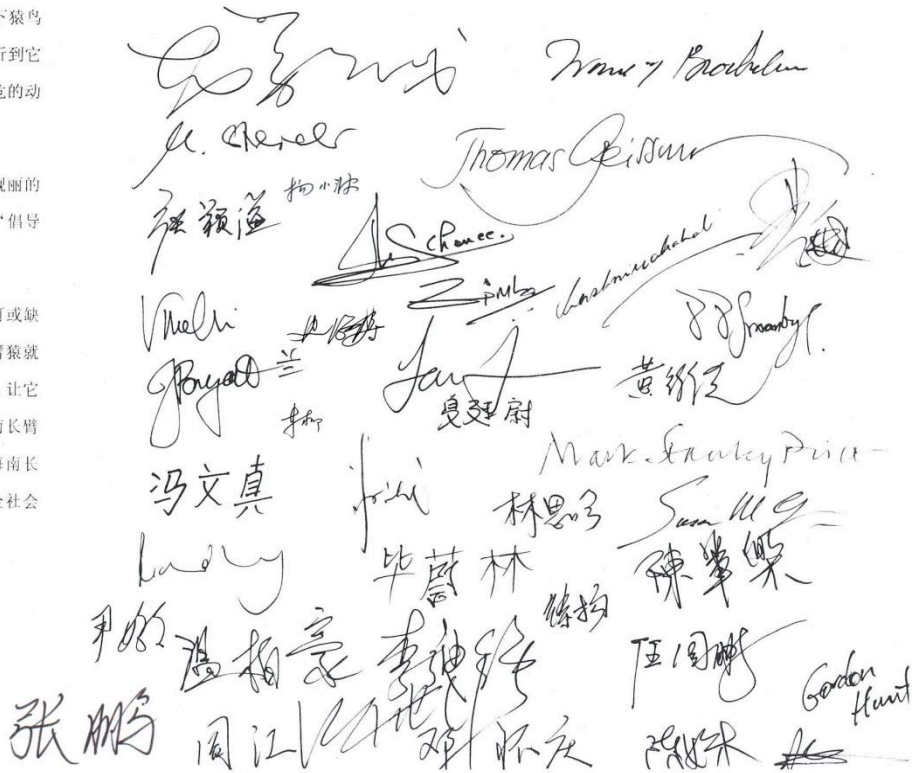
我们来自全球十个国家和地区，我们共同关注一种动物——海南长臂猿。正是这一世间最美动物把我们的心紧紧连在一起，我们相聚博鳌，乃是为海南长臂猿谋取那最后一线生机。

海南长臂猿是海南岛上的“原住居民”，早在数百万年前就已遍布全岛。苏东坡先生那流传近千年的名诗《七律·柏家渡》就曾生动地描述了这一场景：“柏家渡西日欲落，青山上下猿鸟乐。”直至20世纪50年代，海南长臂猿数量仍不下2,000只，全岛12个县市都还可以听到它们那悦耳嘹亮的歌声，见到它们那矫健敏捷的身影。然现在海南长臂猿已成为地球上最濒危的动物之一，是面临灭绝危险可能性最大的灵长类物种！

海南长臂猿赖以生存的原始热带雨林是海南岛上生命世界进化的结晶，是海南岛上最靓丽的一道风景线，也是海南岛生态系统的核心之一。今天的海南已是声名远播的国际旅游岛，“倡导生态文明，尊重大自然原创”已成为海南的生存和发展之本。

拯救海南长臂猿并非仅仅是对这一弱小灵长类动物的怜悯，乃是海南全岛生态建设不可或缺的重要组成部分；保护海南长臂猿就是保护海南最完整和最健康的热带雨林，珍视海南长臂猿就是倡导生态文明的具体体现。作为国际旅游岛的海南，需要雨林精灵永远与我们相伴同行，让它们的天籁之音永远在我们耳旁萦绕，灵长类物种灭绝之事决不应该发生在海南。但拯救海南长臂猿并非易事，而是一项巨大而复杂的自然保护系统工程，需要得到全社会的鼎力支持。为海南长臂猿的种群数量稳步增长，栖息地质量日益改善，政府职能部门、民营企业、当地社区和全社会更加主动参与海南长臂猿保护工作，关爱海南长臂猿蔚然成风。我们特提出如下倡议：

1. 保护和管理好全球最后的23只海南长臂猿，使之神圣不可侵犯。
2. 组织多学科专家团队，编制《海南长臂猿保护行动计划》，并使之尽快得以实施。
3. 立即加大对海南岛原始热带雨林的保护力度，使全岛所有热带雨林都得到有效保护，且为之提供自然扩展空间。
4. 营造关爱海南长臂猿的社会氛围，使海南长臂猿成为像大熊猫一样的全球关注焦点。
5. 建立专项基金，为海南长臂猿保护事业提供长效资金保障机制。



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APPENDIX IV

Media Articles

附件 IV　新闻发报

Hainan Television News (海南新闻联播) 2014-3-18 (2:18)

Summary: Reporting on the workshop, the population status of the Hainan gibbon and the urgency of conservation measures for the species, and urging attention and support from all stakeholders as well as the public.

Xinhua News (新华网) 2013-3-18

野生海南长臂猿仅剩23只 多国专家研讨种群恢复计划

2014年03月18日 19:34:11来源： 新华网
http://news.xinhuanet.com/tech/2014-03/18/c_119829852.htm
http://news.xinhuanet.com/tech/2014-03/18/c_119829852.htm

新华网海口3月18日电（记者姜恩宇）18日，来自中英德美等十个国家和世界自然保护联盟等国际组织的专家、代表聚首海南博鳌，研讨海南长臂猿保护恢复方案，并发表《拯救海南长臂猿霸王岭宣言》。

据了解，海南长臂猿仅存的一个种群分布于海南霸王岭国家级自然保护区的热带雨林中，目前共有3个“猿家庭”、23只。

为更好地对这一珍稀物种实施保护，与会专家围绕海南长臂猿生态与基因特征、小种群物种的保护问题和对策、保护工作中的困难和应对方法、海南长臂猿保护的战略目标、社区宣传在保护工作中的作用等问题展开发言和讨论，对不同的保护方法与手段进行可行性与有效性分析，提出保护建议和种群恢复计划，并在最大程度上推动长远保育计划的落实。

据悉，此次“海南长臂猿保护博鳌国际论坛”由英国伦敦动物学会、中国灵长类专家组和海南霸王岭国家级自然保护区共同主办。

Summary: At the workshop, experts from ten countries/regions gathered to present and discuss Hainan gibbon ecology and genetic characteristics, conservation issues and strategies for small populations, difficulties and strategies for gibbon conservation, and goals and past efforts in Hainan gibbon conservation. Feasibility and effectiveness of different conservation methods and approaches were discussed, and a list of actions has been recommended for a recovery plan that could facilitate the implementation of long-term conservation of the species.

Hainan Daily (海南日报) 2014-3-19


A04 深读

十年猿梦

·喜忧·


A05 海南新闻

全球专家齐聚博鳌，为防止海南长臂猿灭绝提出建议，并推动长远保育计划

让“青山上下猿鸟乐”再现

保护海南长臂猿呼唤更广泛的参与

拯救倡议从博鳌发出

Summary: Report of the workshop. The increase of Hainan gibbons from 13 individuals in two groups to 23 individuals in three groups in the past ten years gives hope to the conservationists for a brighter future for the species. It shows that the population may be viable and steadily increasing. But the experts are also worried that the habitat status could limit the capacity of the species to recover. It is therefore suggested that both forest restoration and the improvement of secondary forest should be implemented. Gibbons used to range at higher elevations to avoid human contact, but in recent years they have begun to range at lower elevations closer to local villages, reflecting that a lower level of human disturbance, community education and monitoring have been effective. Lack of scientific research, low survival rate, unsustainable economic development and human population growth may still pose a significant threat to the species. It is thus suggested that the National Forestry Bureau should take the lead to design and implement the Hainan Gibbon Conservation Action Plan as soon as possible.

China Green Times (中国绿色时报) 2014-3-21

建立海南长臂猿保护专项基金

本报讯 记者韦荣华 通讯员蔡笃磊 许洋瑜报道 “世界超级模特”谢东娜在3月18日-20日举行的海南长臂猿保护博鳌国际论坛上接过海南霸王岭国家级自然保护区管理局局长曾新元颁发的“海南长臂猿保护爱心大使”聘书，并宣读《拯救海南长臂猿博鳌宣言》。《拯救海南长臂猿博鳌宣言》倡议：一是营造关爱海南长臂猿的社会氛围，使中国海南特有的“雨林精灵”充分感受到来自人类的珍爱。二是政府主管部门加大对霸王岭自然保护区野生动物的保护管理，增加人力和财力投入，让海南长臂猿最后3个家庭所有个体的生命安全有绝对保障，它们赖以生存的诺亚方舟永远不受任何侵扰。三是制订海南长臂猿保护战略行动计划，并及早实施。四是建立海南长臂猿保护专项基金，为拯救海南长臂猿行动提供长效资金保障。

海南长臂猿上升到23只
国内外专家呼吁：尽快修复栖息地，扩大种群数量

本报讯 记者韦荣华 通讯员蔡笃磊 许洋瑜报道 3月18日-20日，海南长臂猿保护博鳌国际论坛举办。海南省林业厅宣布：海南长臂猿已由2003年的2群13只发展到目前的3群23只。参加论坛的国内外专家呼吁，进一步加强保护，尤其是尽快修复已破坏的栖息地，力争更快地扩大海南长臂猿种群数量。

海南长臂猿是当今世界上最稀有的灵长类动物，也是最濒危的哺乳动物之一。过去，这一中国特有种广泛分布在海南岛的五指山、鹦哥岭、吊罗山、黎母山、东方和白沙等地，目前仅分布在面积29980公顷的霸王岭国家级自然保护区。2013年10月，霸王岭国家级自然保护区管理局启动海南长臂猿野外调查，本次论坛公布的种群数量是这次野外调查的结果。

海南长臂猿保护博鳌国际论坛由伦敦动物学会、中国灵长类专家组、海南霸王岭国家级自然保护区管理局共同举办，世界自然保护联盟保护繁育专家组、香港嘉道理农场暨植物园、野生动植物保护国际提供支持。

来自10多个国家和地区的专家一致认为，目前的海南长臂猿仍远远没有摆脱灭绝的危险。保护海南长臂猿，应借鉴其他长臂猿和极小种群的保护经验，分析不同的保护方法和手段，获得防止海南长臂猿灭绝的最可靠方案，并最大限度地推动落实长远保育计划。

Summary: At the workshop opening ceremony, supermodel Xie Dongna became the Ambassador for the Hainan Gibbon, and announced the Hainan Gibbon Conservation Initiative to promote government and public support. Experts urged for more intensive conservation and management, especially in habitat restoration, to enable population increase of the gibbons as quickly as possible.

Hainan Daily (海南日报) 2014-3-23

Summary: Report on the workshop and the Open Letter.

China Green Times (中国绿色时报) 2014-4-2

怎么来拯救你，最有可能灭绝的人类近亲？

习近平总书记考察海南时指出，青山绿水、碧海蓝天是海南省建设国际旅游岛的最大本钱。

就在海南的青山绿水、碧海蓝天之间，珍藏着一种全球绝无仅有的瑰宝：热带雨林的代表物种、当今世界上最稀有的类人猿——海南长臂猿。

3月18日-20日，来自英国、德国、瑞士、美国、澳大利亚、印度尼西亚、马来西亚、泰国、越南、印度和中国大陆、香港、台湾的数十位专家、学者齐聚海南，参加海南长臂猿保护博鳌国际论坛，就是为了探讨如何更好地保护这种除人以外最高等、最进化、智力最高的动物。

人类最濒危的近亲：3群23只

海南长臂猿，到底有多珍贵？

这是全球最接近人类的动物之一，比猴子更进化，有着跟人类高度相似的生理和智力，携带着人类进化的秘密。它是中国特有的世界级珍稀濒危物种，属国家一级重点保护动物。

它有多濒危？

这一物种全球只有一个种群，最新监测统计数量是：3群23只。它们分布在中国面积只有29980公顷的海南霸王岭国家级自然保护区内。这片最后的栖息地长期受到干扰破坏，已经不是它们最适宜的生境。种群数量极小、种群结构不合理、出生性比失调、雌性年龄偏大、适宜栖息地面积过小、栖息地质量较差、食物种类分布不均衡，这些“魔咒”罩在海南长臂猿的头上。世界自然保护联盟将海南长臂猿列为严重濒危物种，并宣布：“21世纪全球最有可能灭绝的灵长类动物就是海南长臂猿！”

历史上，海南长臂猿遍布海南岛。上世纪50年代，种群数量仍超过2000只，散在澄迈、屯昌一线以南的12个县（市）。70年代末，只在霸王岭林区有它的踪迹，种群数量仅为2群7只-9只。2003年霸王岭保护区调查发现，海南长臂猿有2群13只。

2014年3月18日，海南霸王岭国家级自然保护区管理局在海南长臂猿保护博鳌国际论坛上宣布：根据最新调查监测，目前海南长臂猿种群数量已增长到3群23只。从2群13只到3群23只，不仅数量增加，而且分出新群，这显然是一条重大喜讯。

中国科学院动物研究所副所长、世界自然保护联盟灵长类专家组成员魏辅文提示人们：“目前海南长臂猿依然是中国现存长臂猿中数量最少、分布面积最小、濒危程度最高的一种。”

林冠跳跃的精灵：热带雨林牵系着盛衰

海南长臂猿臂长腿短，不善于地面行走，但很长于爬树，喜欢在树上挂臂荡行。它们的家在海南岛热带雨林的高大树冠层中。树冠之间跳跃如飞，是它们美丽生命的淋漓展示。

长大后，海南长臂猿重7千克-10千克，长40厘米-50厘米。公猿两颊黑色，头顶有短直的冠状簇毛。母猿全身金黄，体背灰黄、棕黄或橙黄，头顶有菱形或多角形的黑色冠斑。海南长臂猿没有尾巴，这是它“最像人”的标志之一。

在霸王岭保护区，海南长臂猿的栖息地森林结构复杂。这里乔木高大，树种丰富，常见各种附生植物和蕨类植物。保护区内雅加大岭、黑岭、斧头岭一带的热带沟谷雨林、山地雨林和山地常绿林中，可见到它们的身影。在这里，它们主要吃多种热带野果，偶尔也吃点嫩叶、花苞、昆虫和鸟蛋。

海南长臂猿活动在海拔700米-1200米的区域，但它们最喜欢的还是海拔600米以下的低地热带雨林。不过，低地雨林早在20世纪就已被破坏殆尽，它们只能退到较高的海拔，成为分布海拔最高的一种长臂猿。

专家研究发现，海南长臂猿分布点和种群数量锐减的过程，与海南原始热带雨林减少和退化的过程相重合。高强度的木材采伐面前，一片片珍贵的热带雨林消失了，当地的人们种上了橡胶树。这样，一些地方的橡胶林取代了原生态的热带雨林，余下的热带雨林大多破碎成斑块。有专家指出，严格来说，目前霸王岭的森林已经不是热带雨林，而演替成了热带季雨林。

伴随着大树倒下的巨响，人们不难倾听到海南长臂猿逃散时的凄厉哀鸣。那些热带雨林，一直牵系着海南长臂猿的兴盛与衰微。

霸王岭的努力：力争留住美丽的物种

许多国内外专家、学者的研究指出：海南长臂猿受到的最大威胁是栖息地破坏、当地人们的偷猎行为和近亲繁殖可能导致的毁灭。

为了留住这一人类近亲，各方作出了种种努力。

1962年，国务院和林业部分别行文，严禁猎捕长臂猿。1980年，广东省政府批准建立霸王岭长臂猿省级自然保护区，1988年晋升为国家级自然保护区。2003年，国务院批准霸王岭保护区面积由原来的6626公顷增加到29980公顷。海南长臂猿栖息的森林得到更大范围的保护。

霸王岭保护区加强了有关工作。2005年以来，保护区管理局与香港嘉道理农场暨植物园、野生动植物保护国际等合作保护海南长臂猿，开展野外监测、栖息地恢复和野外巡护。近10年来，保护区全力阻止栖息地破坏和偷猎行为，栽植海南长臂猿食源树种，恢复已退化的栖息地植被，并实施社区共管，提高当地人们的保护意识。目前，

保护区内斧头岭山腹已建立南叉河监测站、老点监测点、葵叶岗监测点和十字岗监测点，14名专职的监测队员日常观察监测长臂猿。

海南长臂猿是典型的极小种群，近亲繁殖严重。中国科学院动物研究所研究员、博士生导师、中国濒危物种科学委员会(CITES公约中国科学机构)常务副主任蒋志刚对记者说："海南长臂猿的近亲系数很高，有的是父亲和女儿交配，有的是母亲和儿子交配，这有可能会引起这个唯一的种群走向崩溃。"

伦敦动物学会动物研究所的杰西卡·布兰特研究发现，种群数量稀少和近亲繁殖，已导致海南长臂猿出现近亲衰退迹象。

针对海南长臂猿近亲繁殖这一严峻局面，保护区管理局和国内外专家、学者都在加强研究，积极探索试验，确保永远留住这一美丽的物种。

博鳌国际论坛的声音：像关爱大熊猫一样关爱海南长臂猿

海南长臂猿保护博鳌国际论坛的最主要目的，是通过交流、探讨、分析全球各种保护方法和手段，结合霸王岭海南长臂猿实际情况酝酿形成最有效的保护方案——《海南长臂猿保护行动计划》。

《计划》编制和定稿仍需数月时间。一些中外专家、学者接受《中国绿色时报》记者独家采访，谈了个人对海南长臂猿保护的建议。

中国灵长类专家组组长、大自然保护协会中国部首席科学家龙勇诚多年来呼吁加强保护海南长臂猿，是这次论坛的主持人。他说，中央财政和海南省财政应加大投入，全程跟踪保护管理霸王岭现存的3个猿群，全面保护海南长臂猿赖以生存的热带雨林，划定原生性热带雨林生态保护红线。

魏辅文建议，近期以就地保护为主，中期尝试迁地保护，远期可重点考虑栖息地廊道建设，连接海南中部山区各个保护区，扩大栖息地。

香港嘉道理农场暨植物园中国保育部主管、海南鹦哥岭自然保护区管理局副局长陈辈乐深度参与海南长臂猿保护，霸王岭保护区的海南长臂猿保育工作就是他设计实施的。他对记者说，应增加人手监测海南长臂猿，加强低海拔热带雨林保护管理，在关键地区开展森林恢复。

伦敦动物学会海南长臂猿保护项目协调员黄衡芝希望有更多的公众关注这一物种，投入到保护行动中。牛津大学灵长类生物学与保护专业资深专家苏珊·切恩博士说，海南长臂猿的困境是吸引全球关注的全球性问题。拯救海南长臂猿需要所有层面的不同组织和政府之间的合作。借鉴其他长臂猿保护的做法，让海南人在走向未来时总是心系海南长臂猿——这些都是至关重要的。

论坛闭幕之际，各国专家、学者发表一封致公众公开信，提到要有效保护管理海南长臂猿的现有种群；加强保护整个海南岛的热带雨林，为长臂猿种群扩散增加承载能

力；在中国和国际上像关爱大熊猫一样关爱海南长臂猿；建立海南长臂猿保护专项基金，满足当前和长期保护工作的资金需要。

海南长臂猿，南海之滨跳跃在绿水青山之间的人类近亲——全球的许多人都在关注着你们，为你们的种群繁衍殚心竭力。人类祈祷你们在地球上绵延永续。

Summary: Report on the workshop, Hainan gibbon population status, ecology and biological characteristics, and official regulations and establishment of Bawangling Nature Reserve to protect the Hainan gibbon. The head of the China Primate Specialist Group, Long Yongcheng, suggested more government input to gibbon monitoring and protection of primary rainforest. Wei Fuwen suggested *in situ* conservation in the short-term, *ex situ* conservation in the medium-term, and connecting habitat between nature reserves in central Hainan in the long-term. Bosco Chan suggested strengthening species monitoring, rainforest management and forest rehabilitation in critical areas. Michelle Wong suggested more public attention and support for the species. Susan Cheyne suggested enhancing collaboration between authorities and organisations at all levels, and making the Hainan gibbon an important factor in future development on Hainan.

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"***Time running out for rarest primate:*** *Rescue bid launched to save Hainan gibbon from becoming first ape driven to extinction by humans*"

Includes the following quotes from workshop participants:

"With the right conservation management, it is still possible to conserve and recover the Hainan gibbon population. But given the current highly perilous state of the species, we cannot afford to wait any longer before initiating a more proactive and coordinated recovery programme."

Samuel Turvey

"It's one of the smallest populations I've ever worked with. That number – in one place – is extremely scary."

Kathy Traylor-Holzer

"The government is paying more attention; the general public is paying more attention … I'm quite positive. When I first started back in 2003, there were only 13 individuals we could confirm. Last year, we recorded 23."

Bosco Chan

标题: 最珍稀猿类保护告急～拯救行动防止海南长臂猿成为人类造成灭绝的首种猿类

International Conservation Planning Workshop for the Hainan Gibbon

Bo'ao, Hainan, China

18 – 20 March 2014

Final Report

海南长臂猿保护博鳌国际论坛

中国海南省博鳌镇

2014年3月18至20日

总结报告

APPENDIX V

Workshop Photos

附件 V　照片展示

Group photo
大会合影

Opening ceremony
开幕仪式

Scientific reports
科学报告

Contributing and organising ideas
汇集观点

Plenary session facilitated by Kathy Traylor-Holzer, CBSG
凯西特•雷勒霍尔萨主持全体会议

Plenary session
全体会议

Signing the Open Letter
签署联名信

Organisers
主办单位合影