An Interdisciplinary Examination and Assessment of Current Conservation Initiatives for Javan Gibbons (*Hylobates moloch*)

By

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Dedication

To my precious Luna, the best companion a girl could ever hope for, and my parents for without their love and support, this research endeavor would have never been possible.

ABSTRACT OF THE DISSERTATION

Protection of an Endangered species in its natural habitat should be at the forefront of conservation priorities, and necessary measures should be taken to ensure conservation programs use a holistic approach when developing initiatives aimed at conserving species in the wild. The research presented in this dissertation is comprised of four main components with the primary goal of contributing to Javan gibbon conservation initiatives: first, I conducted a literature review and used published data along with the computer simulation program, VORTEX, to create an updated Population Viability Analysis illustrating the long-term population viability of Javan gibbons with regards to current threats they face in the wild (habitat loss and the illegal pet trade); I investigated the illegal selling of gibbons through an extensive internet search on various social media platforms and compiled photographic evidence; through comparative analysis and published studies on gibbon reintroduction, as well as visits to both rescue centres in West Java, I provided an evaluation of the reintroduction program for Javan gibbons in West Java; and lastly, I utilised ethnographic methodology to explore local people's perceptions regarding conservation, wildlife, specifically, Javan gibbons. Results from the PVA model indicate if the natural habitat of Javan gibbons further declines and if individual Javan gibbons continue to be taken out of the wild for the illegal pet trade, it is very likely the species will become extinct within this century. Photographic evidence from my investigation into the illegal pet trade further substantiated this as Javan gibbons were one of the most traded gibbons on Instagram and Facebook, and all of the sellers were from Indonesia. Both the Javan Gibbon Centre and The Aspinall Foundation are seeing success with regards to the pairs and family groups of Javan gibbons that have been released in the western part of the island, with all of the reintroduced gibbons exhibiting appropriate social and ecological behaviour. At least three infants have been born in the wild since 2014. After conducting over 100 interviews with local people living on the border of Gunung Gede-

Pangrango National Park, West Java, results show the knowledge local people possess about conservation initiatives in the area, including the activities of Javan Gibbon Centre, was fairly limited. However, the majority of respondents from each of the five villages reported knowing that Javan gibbons are threatened with extinction and are a protected species by law (58% and 73% respectively) and 62% of local people knew it was illegal to keep a Javan gibbon for a pet. Adequate cooperation between researchers working with wild populations of Javan gibbons and reintroduction centres, would benefit to share knowledge so resources can be managed to achieve three conservation goals: (1) management and protection of wild populations and (2) rehabilitation, reintroduction, and management of the wild-born, captive-raised population, and, 3) focus more efforts on putting an end to the illegal pet trade. Ultimately, local people will have to be included in conservation initiatives if there is any hope of saving the Javan gibbon from extinction on the island of Java.

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amazed at how well-behaved she is. She is perfection and I am so thankful to have her by my side.

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ABBREVIATIONS

CALS: Cagar Alam Leuweung Sancang, West Java, Indonesia

CITES: Convention on International Trade of Endangered Species of Wild Fauna and Flora

DBH: Diameter at Breast Height

DPL: Daily Path Length

ESU: Evolutionary Significant Unit

GGPNP: Gunung Gede-Pangrango National Park, West Java, Indonesia

GHSNP: Gunung Halimun-Salak National Park, West Java, Indonesia

GRP: Gibbon Rehabilitation Project, Phuket, Thailand

JGC: Javan Gibbon Rescue and Rehabilitation Center (Javan Gibbon Center)

IUCN: International Union for the Conservation of Nature

KP: Kalaweit Gibbon Center, Central Kalimantan, Indonesia

M ASL: Metres Above Sea Level

NTFP: Non-Timber Forest Product

PHVA: Population Habitat Viability Analysis

PPKAB: Pusat Pendidikan Konservasi Alam Bodogol

PVA: Population Viability Analysis

TAF: The Aspinall Foundation (Javan Primates Conservation Project)

TRAFFIC: The wildlife trade monitoring network, a joint programme of WWF and IUCN

UKNP: Ujung Kulon National Park

* For this dissertation *primates* will refer to all nonhuman primates (prosimians, monkeys, and apes).

'The Indonesian gibbon legend states that the female great call is that of a mythical woman roaming the forest in search of her lost lover. She betrayed him and was killed so the mournful song you hear rising in the morning is her song of remorse.' (Raemaekers and Raemaekers, 1990)

Chapter One

Primate Conservation

Fig. 1.1. Photo of Iip and I promoting Javan gibbon conservation efforts at an International Gibbon Day event in Gunung Gede-Pangrango National Park, West Java, Indonesia.

Introduction

The majority of threatened species worldwide are endemic to the planet's most biologically rich and diverse ecosystems, areas known as 'biodiversity hotspots'. These

hotspots, most of which can be found in tropical forests, typically have high levels of endemic flora and fauna (Mittermeier et al., 2004; Pimm et al., 2014). There are currently 35 identified hotspots comprising 2.3% of the Earth's land surface, and hold the majority of all terrestrial vertebrates (42%) and around 50% of the planet's endemic plant species (Mittermeier et al., 2004; Malcom et al., 2006; Pimm et al., 2014; Moran and Kanemoto, 2017; Jaisankar et al., 2018). Threats to the hotspots and their endangered species are synonymous with threats to tropical ecosystems in general, including habitat loss and degradation of remaining habitat, hunting for bushmeat and the removal of species for the illegal wildlife trade, and medicinal use (Pimm et al., 2014; Estrada et al., 2017; 2018). The health and long-term sustainability of these valuable ecosystems are inextricably linked to the activities and welfare of human populations within developing nations, the majority of which are distributed throughout the tropics where the world's primates are also found (Malone, 2007; Jaisankar et al., 2018). Given the richness of biodiversity hotspot ecosystems, they are often areas which offer essential ecosystem services for humans and may account for up to 35% of the global ecosystem services (Mittermeier et al., 2001; 2004). Hotspots are home to approximately 2.08 billion people which adds significance to the ecosystem services that they provide. Furthermore, biodiversity hotspots can include a variety of human land-uses, rural and urban, as well as protected areas under a range of possible governance types, therefore, many social and/or cultural values are likely to be present in some parts (Mittermeier et al., 2004) and must be woven into all aspects of conservation initiatives.

The extinction of species is an integral part of the evolutionary process, yet the severity of the over exploitation of global forest resources, and thus the disappearance of species, by humans, demand the immediate attention of conservationists and scientists (Helmut et al., 2002; Brook et al., 2008; Estrada et al., 2018). The direct relationship between growing human populations and declining forested areas world over is undeniable. The repercussions of this wide spread forest loss range from the obvious to the less perceivable, and include increased

susceptibility to natural disasters such as fires and mudslides, negative impacts on water systems (Lukas, 2017), and a potential for social unrest related to the management and the availability, or lack thereof, of important natural resources (e.g., water for rice production or fuel resources for cooking) (Whitten et al., 1996; Malone, 2007). Given the extent and complexity of anthropogenic habitat alteration, the challenges and barriers for the implementation of conservation initiatives are significant (Malone, 2007; Bennet et al., 2017). Ultimately, the increasingly intense and widespread conservation challenges that we face today are not naturally occurring, but rather are human driven; therefore, only we have the power to restore balance to ecosystems and save the world's flora and fauna (Bennet et al., 2017; Estrada et al., 2017).

Almost half of the world's primates are threatened with extinction and are likely to disappear in our lifetime (Estrada et al., 2017). All of the great apes: gorillas, chimpanzees, orangutans, and bonobos are either Endangered or Critically Endangered (IUCN, 2018). In Asia, over 70% of primates are threatened with extinction, and at least two dozen taxa are classified as Critically Endangered (Brook et al., 2003; Sodhi et al., 2010; Estrada et al., 2017). Virtually all species of gibbons (sometimes referred to as the *small apes*) are threatened with extinction and one of the rarest subspecies, the Yunnan white-handed gibbon *(Hylobates lar yunnanensis*), may already be extinct (Grueter et al., 2009; IUCN, 2018) and two other species (*H. lar* and *Nomascus leucogenys*) have recently disappeared from China (Turvey et al., 2018). The Hainan gibbon (*N. hainus*) is currently the world's rarest ape, and potentially, may be the rarest mammal species with only an estimated 26 individuals remaining in the wild (Bryant et al., 2016; Turvey et al., 2018). There may have been as many as 2,000 Hainan gibbons in the 1950s, but the species suffered a severe decline in the late twentieth century due to habitat loss and hunting, and is now one of the most threatened species in the world (Bryant, 2014; Bryant et al., 2016).

In 2018 a new genus of gibbon, *Junzi imperialis,* was discovered in a tomb excavated in 2004 at Shenheyuan, Xi'an (formerly the ancient capital Chang'an). The ancient tomb is believed to be that of Lady Xia, grandmother of China's first emperor Qin Shihuang who reigned from 259–210 BCE (Turvey et al., 2018; Vogel, 2018). Gibbons were considered culturally important throughout Chinese history; their perceived 'noble' characteristics made them symbols of scholar-officials (*junzi*), and they became high-status pets from the Zhou Dynasty (1046–256 BCE) (Turvey et al., 2018). The discovery of *Junzi imperialis* in a tomb provides significant evidence of human exploitation (i.e., the gibbon was most likely kept as a personal pet). Furthermore, given the record of extensive deforestation near Chang'an during the late Imperial period and an analysis of the loss of mammals during the Chinese Holocene, the best supported theory of extinction of many mammal species during this time (including gibbons) demonstrates the losses may have been directly related to environmental pressures matched with known human population expansion (Turvey et al., 2018; Vogel, 2018). *J. imperialis* could *possibly* be the first example of a primate becoming extinct at the direct hands of humans (Turvey et al., 2018).

Threats to primates

The primary goal of conservation is to first determine and quantify the nature and magnitude of the threats species faces in their natural habitats (Wich and Marshall, 2016), and then establish necessary and appropriate measures to alleviate, and ultimately eradicate, those threats in the wild. The major threats all primate species face today are habitat loss, degradation, and fragmentation of suitable habitat, as well as hunting for both the illegal wildlife trade and bushmeat (Estrada et al., 2017). Other factors that may contribute to the demise of primate populations are infectious disease and climate change (Wich and Marshall, 2016; Estrada et al., 2017).

Habitat alteration

Habitat loss, degradation, and fragmentation pose a major threat to primates in all primate range countries. Habitat loss is considered the most severe as it significantly reduces the total amount of suitable habitat to a species, often resulting in the complete disappearance of all individuals in the area (Wich and Marshall, 2016). In some areas, human expansion into primate habitat causes conflict and pushes animals into less suitable areas. In addition, primate habitat is being cleared for commercial logging and agriculture leaving primates with little remaining suitable habitat. This is especially problematic in Southeast Asia where land is being logged or burned and cleared to make way for agricultural crops (e.g., palm oil plantations) (Estrada et al., 2017).

Hunting

Hunting occurs either to supply the illegal wildlife trade, for human consumption (e.g., bushmeat), traditional folk medicine (Alves et al., 2010), or at the interface between forests and agricultural land where people may target primates when they raid crops (Wich and Marshall, 2016). The bushmeat trade is a global threat as once remote populations of primates are now more accessible as their habitat shrinks and humans gain access to deeper forested areas via logging roads (Estrada et al., 2017). For many species, hunting is not sustainable and can lead to local extinction of populations (Wich and Marshall, 2016).

Although it is difficult to accurately quantify, it is estimated that up to hundreds of thousands of primates are captured and sold as exotic pets each year (Nijman et al., 2011). Unfortunately, many of these animals will die during the capture and transport process. Others are condemned to a life in captivity, often living in poor and inhumane conditions (Rosen and Smith, 2010). Infant primates are often the target of this industry and as a result, multiple adult animals are potentially killed during the capture. The illegal trade of wildlife is a multibillion-dollar

industry and is second only to the global black-market drug trade (Rosen and Smith, 2010; Estrada et al., 2017).

Approaches to conserving primates in the wild

A conservation action plan is a critical document describing the current status, threats, and intended methods for increasing rare and threatened species population sizes in the wild (Boersma et al., 2002; Carroll et al., 2014). The International Union for Conservation of Nature (IUCN) Species Survival Commission (SSC) Action Plan series assesses the conservation status of species and their habitats, and outlines conservation priorities that will hopefully ensure recovery of wild populations. The action plans are one of the world's most authoritative sources of species-related conservation information and are compiled by the SSC's Specialist Groups. The information is beneficial to natural resource managers, conservationists, and decision makers around the world (IUCN, 2018). Conservation action plans may serve as the foundation from which organisations develop a conservation initiative and may potentially make long-term conservation efforts more effective (Boersma et al., 2001; Clark et al., 2002; Carroll et al., 2014).

Important components of a cohesive conservation action plan include both adaptive management strategies and consideration for habitat conservation. When action plans are successful, they do not necessarily serve to definitively prevent extinction, but rather can restore species to a state of health so they are self-sustaining. There is evidence to suggest that the best recovery plans are adaptive and dynamic, and dependent on the social-cultural and environmental context (Boersma et al., 2001; Clark et al., 2002; Wilhere, 2002; Marshall et al., 2015). Adaptive management requires the system to be constantly monitored so that changes are identified; however, this is frequently not done, even for species that have already been red listed (Clark et al., 2002). The key elements of adaptive management should include an explicit

definition of management goals within a programme and the development of plausible alternative management strategies to achieve those goals. In addition, implementation of two or more strategies in a comparative experimental framework to help address potential failure and improve understanding of conservation measures, while addressing and evaluating the relative merits and limitations of alternate strategies, with the ultimate goal of ensuring successful conservation management long-term (Keith et al., 2011). In addition, the focal species must be monitored throughout the recovery period (and beyond) to ensure that the recovery plan is working as intended. The framework for this monitoring period should be planned before the start of the implementation, and the details included in the recovery plan must be plausible and should be obtainable (logistically and financially). Furthermore, information on how and when the data will be collected and reported should be supplied (Boersma et al., 2001; Keith et al., 2011).

An alternative method of conserving a species is to conserve the *habitat* the species lives in. In this process, there is no specific target species for conservation, but rather the habitat as a whole is protected and managed, often with a view to returning the habitat to a more natural state (Simberloff, 1998; Harding et al., 2001; Nel et al., 2015). In theory, this method of conservation can be beneficial because it allows for the entire ecosystem and the many species within to benefit from conservation, rather than just a single target species (Boersma et al., 2001; Harding et al., 2001). The IUCN suggests there is evidence that habitat-based approaches do not have enough focus on individual species to protect them sufficiently. Boersma et al., (2001) argues that habitat plans (multi-species) may be preferred and more effective than single-species plans because they must address a broad view of threats and be more integrative and robust.

Conservation programmes should include several diverse approaches when developing management schemes for recovering threatened species. Programmes should include

identifying threats species are facing in the wild, followed by evaluating the population and habitat viability of the species (Morris et al., 2002) and its geographical range, behavioural and ecological studies on the species, feasibility studies on whether reintroduction or translocation may be the most effective method for saving a species (Harrington et al., 2013; Moore et al., 2014), and finally, engaging with local communities and stakeholders to spread awareness about threatened species and habitat protection. These actions will hopefully work to ensure the programme will be fully supported (Marshall et al., 2015). Protection of threatened species' natural habitat should be at the forefront of conservation priorities, and necessary measures should be taken to ensure all different components acknowledge this within a conservation action plan.

Biodiversity conservation in Asia

A number of factors set Asian primates apart from the primate faunas found elsewhere in the world. Asian species play a significant role in not only tropical forest ecosystems but also in a variety of arid and temperate forests as well (Brandon-Jones et al., 2004; Estrada et al., 2017; McConkey, 2018). In contrast to the essentially continental distribution of African and Neotropical primates, Asian primates are found in significant numbers and species on both mainland and island areas, thus leading to high levels of endemism and sometimes low diversity (Cowlishaw and Dunbar, 2000; Brandon-Jones et al., 2004; Reed and Bidner, 2004). The major events in hominin evolution seem to have occurred in Africa, yet Asia is unique in that it has two ape families, *Hylobatidae* and *Pongidae* (Brandon-Jones et al., 2004; Reichard et al., 2016)). The history of Asian primates has been intertwined with that of human populations for millennia and there is no other region on the planet where commensalism between other primates and humans is so well established. This interconnectedness is in part a consequence of the toleration and respect (or at least avoidance) that has been afforded primates

and sometimes other animals by several of Asia's major religions (Brandon-Jones et al., 2004; Estrada et al., 2017).

Asian primates and the diverse habitats in which they are found face multiple threats creating myriad of complex conservation challenges. (Brandon-Jones et al., 2004; Estrada et al., 2017; 2018). Species in the region have suffered heavily through the years from trapping for export for research purposes (overall Asia was the major supplier of primates for biomedical research during the 20th century), instability and internal social conflict amongst people, and excessive destruction of natural resources (Asian forests are the major source of hardwoods used for plywood and veneers) (Brandon-Jones et al., 2004; de Almeida-Rocha, 2017). Conservation efforts are more challenging not only because of these factors, but also because of the high levels of human population pressure throughout Asia persisting for centuries (Estrada et al., 2017;2018). Due to the rapid expansion of the human population and highly developed technology and information seeping into rural areas, coupled with vast areas of forest being converted to agricultural land and development projects, local wisdom of rural people on primates (other wildlife as well) based on local ecological knowledge, beliefs and myths has begun to slowly fade (de Almeida-Rocha et al., 2017; Turvey et al., 2018; Permana et al., 2019).

Human population expansion and the associated exploitation of natural resources make it inevitable that a large part of the world's primate populations and their forest habitats will be lost (de Almeida-Rocha et al., 2017; Estrada et al., 2018; Permana et al., 2019). If there is any hope of preserving Earth's biodiversity, the current pattern of diversity must be established through proper surveying and monitoring, as well as continued behavioural and ecological observations of wildlife and habitats (Singh, 2002; Dobson, 2005). Moreover, conservation managers must engage with local communities, and incorporate education initiatives and revitalisation of local ecological knowledge into conservation action plans. Likewise, scientists

and managers in habitat countries should be provided with every opportunity to participate in conservation training programmes at home and abroad. There are a number of NGOs in Indonesia working in conservation and trying to integrate local communities into forest and wildlife management and educate them about conservation biodiversity (Permana et al., 2019), but with an ever-expanding human population and intense pressure on natural resources, conserving the environment often becomes second thought to families trying to survive for themselves (Boedhihartono, 2017). The conservation concern is trying to find the balance.

What about gibbons?

Gibbons, whose family name, Hylobatidae, is Greek for 'dweller in the trees', are the smallest of the apes and are distributed throughout tropical and subtropical forests of South, East, and Southeast Asia. Their range extends from northeastern India to southern China, Bangladesh, Myanmar, Vietnam, Lao PDR, Cambodia, the Malay Peninsula, Java, Borneo, Sumatra, and the Mentawai Islands (Cheyne, 2004; Malone, 2007). In terms of numbers of species and individuals, gibbons are the most successful and widely distributed of all the extant apes (Cheyne, 2004). Nonetheless, they are threatened throughout their range primarily due to loss of habitat and the illegal pet trade. All gibbon species are listed on Convention on International Trade of Endangered Species (CITES) Appendix 1 and hold various positions on the World Conservation Union (IUCN, 2013) Red List (Cheyne, 2004).

The Hylobatidae have been divided into four different genera based on their number of chromosomes, as well as morphological, vocal, and behavioural differences that exist throughout the family. The four genera are: *Hoolock*, *Hylobates*, *Nomascus,* and *Symphalangus* (Roos and Geissmann, 2001; Mootnick and Groves, 2005; Bartlett, 2007; Malone, 2007). There are currently 20 different species recognized in the Hylobatidae (Van Ngoc Thinh et al., 2010a; Van Ngoc Thinh et al., 2010b). Given this great diversity and presence in the natural world,

they still tend to exist in an in-between space in terms of social-cultural and evolutionary discussions. With regards to the biophysical margins gibbons occupy, they tend to be marginalised in both conservation circles and evolutionary debates when juxtaposed with the great apes (Malone et al., 2014), and receive less public attention from the press and the global conservation community, making them the 'true neglected apes' (Whittaker and Lappan, 2009; Malone et al., 2014; Fan and Bartlett, 2017). This marginalisation of gibbons in scientific circles lies in contrast to their centrality elsewhere, where they have held much more symbolic representations in some cultures, particularly in China. The dynastic art of Ancient and Imperial China reveals a deep symbolic and persistent association between humans and gibbons (Geissmann, 2008; Turvey et al., 2018). In Chinese culture, the gibbon occupies a special niche representing a powerful and mysterious connective force between humankind and nature (Geissmann, 2008; Turvey et al., 2018), with their fluid movements and intricate song bouts underpinning their revered status (Malone et al., 2014).

Gibbons, in general, are less conspicuous than other primates (e.g., macaques and orangutans) and they are not known to raid crops or venture out into human dominated landscapes (Permana et al., 2019), they live in smaller family groups, and tend to be relatively quiet when travelling through the forest canopy, with the exception of their loud and melodic morning calls (pers. obs.). Furthermore, there has been little documented literature on gibbons in Indonesian folklore (see Harrison, 1966; Reisland and Lambert, 2016; Permana et al., 2019) or tales of their relatedness to humans (unlike tales of monkeys and their relationship to the god Hanuman, see Riley, 2010), with many people knowing *of* gibbons, but very little *about* them in the wild (pers. obs.). It is necessary to increase knowledge and awareness for local people about gibbons and their unique place in not only our evolutionary history, but also the crucial role they play in maintaining tropical forest biodiversity (McConkey, 2018).

Organisation of the dissertation and significance of research

This research project is comprised of four main components each representing a specific aspect that will contribute to a more holistic conservation programme. The ultimate goal of the research presented in this dissertation is to provide an overview of the current conservation initiatives for Javan gibbons, in hope that the results will be useful for developing a more holistic conservation action plan to ensure their long-term survival in the wild.

This dissertation is based on the results of multiple research trips to West Java, Indonesia beginning in 2008. Whilst a long-term continued presence is perhaps preferable when conducting PhD fieldwork, given the nature of my project, the relatively short stints of research in West Java were sufficient in order to collect the data necessary for this research. Over the years I have forged successful working relationships with important research colleagues and collaborators in West Java, as well as accumulating a rich breadth of knowledge about the people and culture of Indonesia.

Research questions and aims

When conceptualising my PhD research, the goal was to create a project that would be a valuable conservation tool and guide, as well as providing new and significant research that would aid in ensuring successful conservation measures for Javan gibbons. Whilst Chapters 1 and 2 provide an introduction to primate conservation and background information on the island of Java and its primates, as well as research methods, Chapters 3-6 comprise the heart of the research. More specifically, ***Chapter 1*** provided a brief overview of primate conservation, including a discussion regarding the newly found extinct genus of gibbon (*Junzi imperialis*) which may be the first example of a primate going extinct at the direct hands of humans. I also discussed the threats primates are presently facing in the wild, highlighting different conservation strategies utilised in conservation action plans aimed at protecting

threatened species in the wild. ***Chapter 2*** introduces the reader to the island of Java and its primate inhabitants. More specifically, I provide an in-depth description of my focal species, the Javan gibbon (*Hylobates moloch*), as well as threats specific to their survival in the wild.

The first goal of my research, assessment, is presented in ***Chapter 3*** and involved evaluating the current state of a given population of Javan gibbons, predicting its future, and identifying any threats to its long-term persistence. I began by evaluating the most recent data available on wild Javan gibbons and the threats they are currently facing in the wild and how to determine what conservation measures could be enacted now to ensure their long-term survival. With assistance from four co-collaborators, I conducted an updated Population Viability Analysis to achieve this goal. PVA reports represent one of the most valuable approaches that has emerged from the field of conservation biology (McGowan et al., 2017). Although it is impossible to make precise predictions about the exact time to extinction for a species, a PVA has offered useful tools to estimate the relative risk of extinction, and to compare the efficacy of alternative management strategies specific to a species and its habitat. Considering we do not have any published data concerning the rates off hunting and deforestation on the island of Java, PVA is useful for estimating the risk of these threats in the future. Through PVA, I aimed to determine how valuable a population model may be in determining the future of Javan gibbons in the wild. More specifically: 1) how much impact will high rates of hunting have on wild populations of Javan gibbons; and 2) how much impact will different rates of deforestation have on wild populations of Javan gibbons. Ultimately, the results will hopefully help us determine the next best steps for the preservation of Javan gibbons in the wild. The results from the PVA for Javan gibbons have been published in *Folia Primatologica* with four co-authors (Smith et al., 2017).

Based on the findings of the PVA, one of the most significant threats to the long-term survival of Javan gibbons is the removal of viable individuals from the wild for sale in the

illegal wildlife trade (gibbons and siamangs are predominantly sold as *pets* so for the duration of the dissertation I will refer to it as the 'illegal pet trade'). In March of 2017, I was selected by Dr. Susan B. Cheyne with funding from the Arcus Foundation and the IUCN Primate Specialist Group – Section on Small Apes to conduct an investigative report on the prevalence of gibbons being sold online in habitat countries. I set out to explore how serious an issue the illegal selling of Endangered gibbons online is, and determine to what extent it is occurring on different social media platforms. More specifically, I wanted to uncover how prevalent the illegal trade is online and which species are at most risk, particularly focusing on Javan gibbons. Considering we do not yet know the impact the trade is having on wild populations of Javan gibbons, we first need to determine how significant the threat is online, and then we will be able to decide on a best course of action for putting an end to it. The research consisted of searching various social media platforms in gibbon range countries and collecting as much available information on illegal sellers and online markets. All results were compiled into an official report and make up the basis for ***Chapter 4*** of this dissertation. Though the research was not specific to Javan gibbons, but rather gibbons and siamangs in general, Javan gibbons were (and are presently) prevalent in the online illegal trade in Indonesia.

As a result of the illegal pet trade and loss and degradation of remaining habitat, a significantly high number of Javan gibbons have become displaced and have ended up in local rescue centres. There are two primary operating centres: The Javan Gibbon Rescue and Rehabilitation Centre (also referred to as JGC - the Javan Gibbon Centre) located in Gunung Gede-Pangrango National Park and the Aspinall Foundation Javan Primates Conservation Centre (referred to as TAF - this centre also rescues and releases Javan langurs). In the summer of 2008, I first visited JGC to begin my MA research and went back during the summers of 2009 & 2010 for further research. I focused my MA research on the examination of the behavioural preparedness of wild born, former pet Javan gibbons in order to determine their

suitability for potential release back into the wild. In October 2009, the first ever pair of Javan gibbons were returned to the wild in a small isolated patch of forest (Patiwel) near the border of Gunung Gede-Pangrango National Park. I was invited to participate in the official release and was able to conduct post-release behavioural observations on the pair (see Appendix 1.2 for a personal account of my experience). In ***Chapter 5***, I provide an examination and analysis of the rescue, rehabilitation, and reintroduction of gibbons, specifically Javan gibbons. In doing so, I review the literature on past and present reintroduction gibbon programmes and draw from my own personal experience participating in three different releases of Javan gibbons back into the wild. Given this experience, I set out to explore whether reintroducing Javan gibbons will be a successful conservation tool to ensure their long-term survival in the wild, and, more specifically, assess whether reintroduction efforts are currently aiding in the protection of wild populations and helping to spread awareness and education in local communities. To conclude, I review best practice guidelines for gibbon reintroduction, as well as provide recommendations for future reintroduction efforts.

Given my time and experience working in West Java over the years, as well as the knowledge I have gained from my academic endeavours, I have come to learn the value and significance of engaging local communities in conservation efforts and realised this has been mostly absent from Javan gibbon conservation initiatives. Conservation issues are essentially the result of human impact on the environment and humans can impact the environment in both negative and positive ways. Conservation means something different to each individual and it is important to attempt to understand what drives people to interact with the natural world in social and cultural ways; more specifically, how people perceive the natural world around them and further afield. It can be argued that conservation is about our well-being but ultimately, conservation is about compromise. It's about balancing the needs of human communities with those of other animals. In ***Chapter 6,*** I present my data from the short ethnographic study I

conducted in West Java, Indonesia. During the months of June through August 2016, I lived in the Sundanese village of Bodogol and carried out interviews with local people in five of the villages surrounding Gunung Gede-Pangrango National Park. By utilising methods in social anthropology and drawing from an ethnoprimatological perspective, I set out to 1) explore how knowledgeable local communities are with regards to local conservation initiatives and gain a better understanding of what they value most within their social and natural environment e.g., forest preservation or agricultural expansion; and 2) determine the extent of knowledge people have about wildlife, specifically pertaining to Javan gibbons. I was specifically interested in gaining a better understanding of how they *feel* about local conservation programmes, specifically efforts supported by JGC, determine the *value* people place on forest preservation, and determine the depth of their knowledge about Javan gibbons and the threats they face in the wild. Ultimately, I wanted to know whether local people who share the forest with Javan gibbons care if they survive in the wild.

Finally, I summarise each aspect of my research and how each individual project within the whole dissertation amounts to a larger contribution to conservation efforts for Javan gibbons. It is my hope this dissertation in its entirety will hopefully provide the foundation for, or at least contribute to, an updated and more holistic conservation action plan for Javan gibbons. In ***Chapter 7***, I discuss how the results of this research can hopefully contribute to an official conservation action plan and provide a detailed list of actions and goals based on the research presented in this dissertation. It is crucial for conservationists to address the interconnectedness of issues regarding conservation efforts for Javan gibbons (Fig. 1.2) if there is to be any hope of ensuring their long-term survival in the wild.

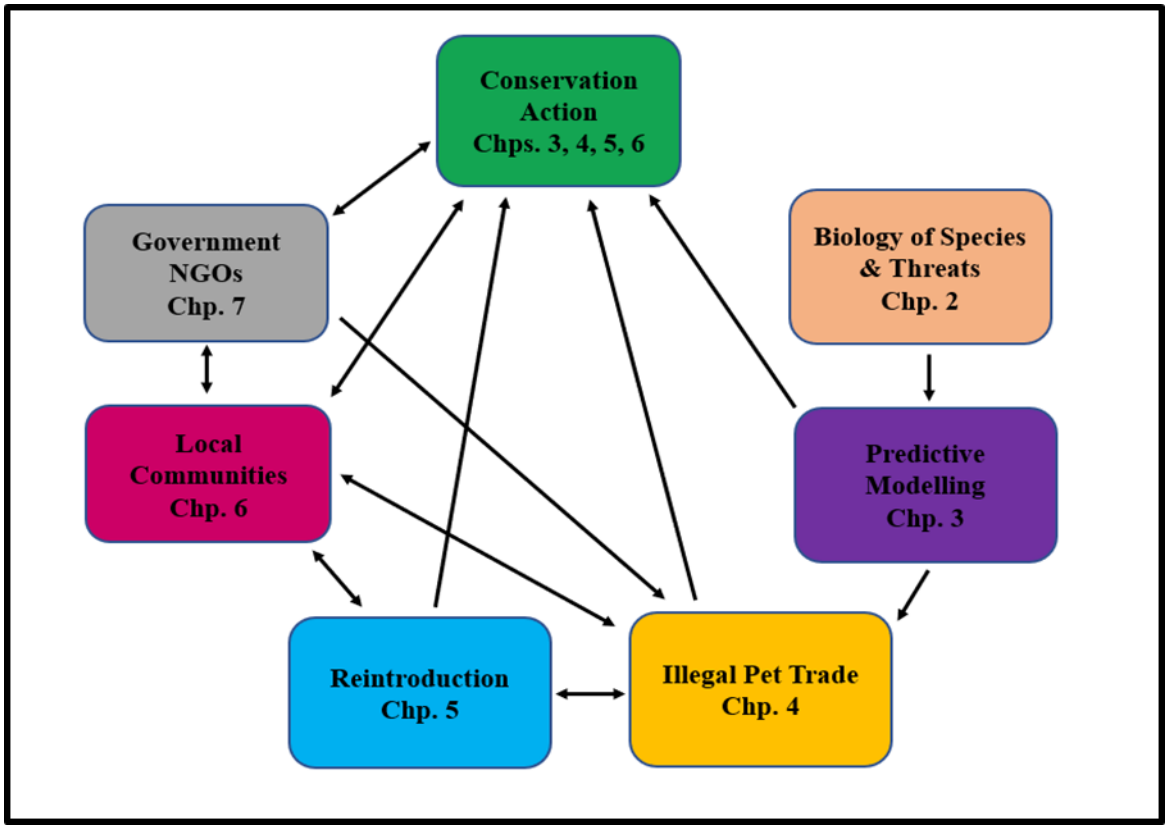

Fig. 1.2. Interconnectedness of Javan gibbon conservation.

Summary

The previous chapter provided the reader with an introduction to my dissertation topic and how I organised the dissertation based on the different components and methods of research. I discussed how chapters 3-6 each represent a specific aspect of Javan gibbon research and detailed the research questions and aims applicable to each component. I end the chapter by summarising how each chapter fits into the larger narrative, hopefully demonstrating the interconnectedness of conservation efforts for Javan gibbons.

Chapter 2 provides the reader with the necessary background information regarding the Island of Java, the extant primates, and more specifically my focal species, Javan gibbons. I address current conservation threats and actions specific to Javan gibbons whilst providing a direction of how my research fits into the larger picture and will hopefully contribute to a conservation action plan. I conclude the chapter by describing my general methods for acquiring and analysing the necessary data for each aspect of my overall project, emphasising

the need to utilise different research approaches to address the different facets of the project in its entirety.

Chapter Two

Background and Methods

Fig. 2.1. Photo of the forest in Gunung Gede-Pangrango National Park from the Javan Gibbon Rescue and Rehabilitation Centre. Photo by JH Smith.

Introduction

This dissertation was conceptualised and carried out in both West Java, Indonesia and in the United Kingdom requiring a high level of self-directed work and collaboration with both national and international colleagues. From approximately September 2014 – June 2018, I participated in research activities that directly and indirectly facilitated the completion of this dissertation (Table 2.1). To address the particular aspects of my research, I utilised several different approaches with regards to methods, analysis, and writing styles; each chapter (3-6) represents a project in itself. In this chapter, I will introduce the reader to the island of Java

where the research is focused, as well as my focal species, the Javan gibbon, and the threats they face in the wild. In conclusion, I will discuss the data acquisition and analysis specific to each chapter and with respect to each aspect of the research project.

Table 2.1. Timeline of research and conservation activities in Indonesia from 2008-2018.

Field trips to Indonesia	Year /Duration	Objective
West Java & Sulawesi	2008 /2 months	My first visit to the Javan Gibbon Rescue and Rehabilitation Center (JGC) in Gunung Gede-Pangrango National Park to introduce myself and discuss my future MA research. I also assisted my MA advisor with her research on Tonkean macaques in Lore Lindu National Park, Sulawesi.
West Java	2009 /5 months	Carried out pre- and post-release behavioural observations on wild- born, former-pet Javan gibbons for my MA research, as well as participating in the first ever release of a pair of Javan gibbons back into the wild.
West Java & Sulawesi	2010 / 2 months	Conducted follow-up research on the pair of gibbons released in 2009 at Patiwel Forest. I also assisted my MA advisor with her research on Moor Macaques in Bantimurung-Bulusaraung National Park in Sulawesi, and attended the Association of Tropical Biology conference in Bali to meet fellow gibbon researchers and conservationists.
West Java & East Kalimantan	2012 / 2 months	Visited the Javan Primates Conservation Project (TAF) to work as a volunteer caregiver and visit local schools to spread conservation awareness. I also visited JGC to collect follow-up research and observe wild Javan gibbons in Gunung Gede-Pangrango National Park.
West Java	2015 / 2 months	Visited JGC to begin PhD research (visiting local villages to determine which would be included in the interviews); participated in conservation outreach activities including serving as an ambassador for Javan gibbons at the first International Gibbon Day event in Bandung; and assisted with the release of a family of Javan gibbons. I also visited TAF to work as a volunteer caregiver, talk to local school children about primate conservation, and participated in the release of a pair of Javan gibbons in Mt. Tilu Nature Reserve.
West Java	2016 /2 months	Spent two months living in Bodogol village to conduct semi-structured interviews for PhD research in four villages bordering Gunung Gede-Pangrango National Park.

Background

Indonesia

Indonesia is home to approximately 267 million people and more than 300 ethnolinguistic groups (Hidayati et al., 2015). Distinct regional languages and local dialects are ubiquitous, while the Indonesian language, or Bahasa Indonesia, is nationally promoted and used for formal purposes throughout the country (Cohn and Rayindranath, 2014). The population is predominantly Muslim (approximately 90%) making Indonesia the most populous Islamic nation in the world (Whitten et al., 1996). Indonesia is comprised of rich social, cultural, spiritual, and economic practices all woven together with a vast amount of religious diversity at the heart of the nation (Whitten et al., 1996; Baidhawy, 2007).

Indonesia belongs to the Sundaland Biodiversity hotspot (Mittermeier et al., 2005; Supriatna et al., 2010). It is rich in endemic species and has the third largest forested area in the world. Unfortunately, Indonesia is also experiencing one of the highest rates of deforestation in the world and its ecosystems are constantly under threat from human activities (Mittermeier et al., 2005; Siscawati, 2010; Margono et al., 2014). The deforestation rate in Indonesia is almost three times higher than the average rate of tropical deforestation in the world and there is only about 37 percent (Estrada et al., 2017; 2018) of the original primary forest remaining out of the total forest area that existed in 1966. Prior to 1966, Indonesia had not yet suffered from structural adjustment programmes, debts, and aggressive private capital flows (Siscawati, 2010; 2012). These contributed to policies including inequitable land tenure and incentives that lead to deforestation and forest degradation. The accompanying social, economic, cultural and spiritual exploitation caused the suffering of more than 40 million indigenous people and many local communities in Indonesia (Siscawati, 2010; 2012).

Island of Java

Java is one of the most densely populated areas in the world with over 140 million inhabitants with an average human density approaching 1,000 people/km^2 (Whitten et al., 1996; USAID, 2004; Nijman, 2006; Supriatna, 2006; Supriatna et al., 2010; Biro Pusat Statistik, 2018). The island is home to the nation's capital city of Jakarta which is the political and economic center of Indonesia. Over 60% of Indonesia's 267 million inhabitants live on this 126,566 km2 island. The extent of past and present economic development on the island is correlated with a dramatic decline in environmental quality (Whitten et al., 1996; Malone, 2007). Population pressure and the exploitation and degradation of natural resources will continue to impact the remaining forests, as well as the health and quality of coastal areas, inland river systems, and arable land (Malone, 2007; Siscawati, 2012; Lukas, 2017).

Java has had a long history of cultivation and deforestation that began in 1,000 AD. It is now largely deforested and the majority of the forest fragments cover parts of the many volcanoes on the island. The remaining land of Java is a mosaic of cities, villages, and rice fields (Nijman, 2006). The Dutch arrived on Java in 1830 and began heavily exploiting the natural resources of the island. The Dutch colonial government initiated a state forestry system and required farmers to grow export crops on communal grounds, which was often the forest (Peluso, 1993; Whitten et al., 1996; Nijman, 2004). By the end of the 19th century the natural forest was severely fragmented, especially in western and central Java. Presently, the major cause of loss to remaining forest is due to illegal small-scale logging (i.e., tree cutting for subsistence plots, firewood, forest fires, and charcoal production), much of what goes unpunished by law and is often times harder to monitor, as opposed to the industrial scale logging of the past (Smiet, 1992; Supriatna, 2006; Supriatna et al., 2010; Estrada et al., 2017). It is estimated that Java has lost over 90% of its original forest, with as little as 19 percent of

hill forest (500-1000 m asl), and approximately two percent of the lower montane forest (<500 m asl) still present (Nijman, 2004).

The Indonesian government owns most of Java's forests and manages them through the State Forestry Corporation (Peluso, 1993; Whitten et al., 1996; Kheng et al., 2017). Teak wood is still exported by Java but is regulated by the government which sets rules about the size and number of trees to be exported (Bailey and Harjanto, 2005). Environmental groups have applauded the management of teak plantations, largely due to the improvement of well managed rotation of the crops and the government's attempt to implement a social forestry programme. The social forestry programme was created with the goal of including local people in forest resource management but has not been entirely successful (Hidayat, 2008; Siscawati, 2012). In general, local people are only given a limited amount of control and only if they participate in the system working as forest laborers (Peluso, 1993, Hidayat, 2008). In 2001, legislation for regional autonomy went into effect and forest management was given over to local governments, except for in conservation areas (Resosudarmo, 2004; Supriatna et al., 2010;). Local governments tend to focus on short-term economic gains such as logging, instead of long-term sustainable management of natural resources (Supriatna, 2006; Malone, 2007; Supriatna et al., 2010). The decentralization of the government has both positive and negative implications for conservation and the livelihood of the local people. The positive outcome is the increased ability for NGOs to lobby for local regulations that recognize the indigenous rights to natural resources and promote sustainable forest use. On the negative side, local districts can now issue a larger number of permits for local companies that may potentially exploit the forests (Supriatna, 2006; Supriatna et al., 2010). The local people, including the decision makers, are not provided with adequate information regarding the importance of conservation and the long-term benefits they can derive from the forests (i.e., watershed protection) (Supriatna, 2006). Moreover, the concept of forest management developed by the

Department of Forestry itself does not ensure conservation. The logging companies never comply with their own policies in consistently implementing forest management concepts (Hidayat, 2008). Concessionaires breach the limits of logging areas and illegal logging of small diameter trees is permitted. In addition, they do not replant trees and they forge timber transport documents, as well as log on upland areas. Therefore, the management concept of Indonesian forests has not been entirely successful and the forests continue to slowly disappear (Hidayat, 2008).

It is imperative to raise awareness for the local people in regards to the benefits they will appreciate from sustainably utilising forest resources (Boedhihartono, 2017). The rich forests of Gunung Gede- Pangrango, Gunung Halimun-Salak are primary water catchment areas for over 20 million people in the surrounding area, including the capital city of Jakarta (Fig. 2.2). It is crucial to protect these forests in order to ensure a long-time water supply for the people (Supriatna et al., 2010).

Fig. 2.2. The capital city Jakarta: the centre of economics, culture and politics in Indonesia. Photo credit: (https://www.todayonline.com/world/jakarta).

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Fig. 2.3. Photo of Java, Indonesia. Java may be one of the most densely populated islands in the world, yet there are still many areas of great beauty. Photo credit: (http://www.citiestips.com/view/-140592).

The extant primates of Java

Java is home to an array of unique flora and fauna (Fig. 2.3). There is a total of five primate species found on the island, two of which are classified as Endangered: the Javan gibbon (*H. moloch*) and the grizzled leaf monkey (*Presbytis comata*); the Javan langur (*Trachypithecus auratus*) and the long-tailed macaque (*Macaca fascicularis*) are both classified as Vulnerable; and the Javan slow loris (*Nycticebus javanicus*) is Critically Endangered (IUCN, 2018). The faunal assemblage on the island of Java used to be much more varied and diverse, and included several other species of primates such as orangutans (*Pongo pygmaeus*), siamangs (*Symphalangus syndactylus* – previously *H. syndactylus*), and another species of gibbon (*H. leuciseus*) now known as the *Javan gibbon*, as well as pig-tailed macaques (*Macaca nemestrina*) (Whitten et al., 1996; Storm and de Vos, 2006; Supriatna et

al., 2010). Fossil evidence indicates the eastern part of the island was more of a tropical rainforest environment which allowed orangutans and gibbons to flourish. Orangutans and siamangs vanished from the island of Java and now only survive on the islands of Borneo and Sumatra. The disappearance of these two ape species could have been due to the change in climate to a more arid and drier environment or the result of overexploitation by early humans on the island (Whitten et al., 1996; Storm et al., 2005; Storm and de Vos, 2006). Given that gibbons, siamangs, and orangutans are currently hunted for their meat on both the islands of Borneo and Sumatra, it is very likely that early humans were hunting these species on Java in the late Pleistocene as well (Corlett, 2007).

At present, primates on the island of Java are typically found in wet forest areas (including riparian, swamp, and primary montane forest) on the western side of Java; however, all but the Javan gibbon will inhabit drier forest areas, secondary forests, and can also be found in human altered forest areas near plantation blocks farther into the eastern part of the island (Whitten et al., 1996; Nijman, 2001; Malone, 2007). Marked climate and habitat type distinctions can be made on both west-east and north-south gradients, with a general pattern of the wettest vegetation types found in the west and central part of Java. Lowland rainforest remains in isolated fragments along the south coast, while 'islands' of rainforest can be found on the south and south eastern facing slopes of the higher volcanic rises located throughout the seasonally dry east (Whitten et al., 1996; Nijman, 2001).

Fortunately, the hunting of primates on Java for human consumption is less widespread than in other areas of Indonesia due to the related dietary restrictions of Islam, though in some areas, primates are killed to protect against crop raiding behaviour (particularly long-tailed macaques) or for traditional medicine (Javan slow loris) (Malone, 2007; Nekaris et al., 2008; 2010; Estrada et al., 2017). The capture of primates (as well as several other species of wildlife) for the illegal pet trade, however, is widespread throughout Indonesia, and the island of Java

plays a key role in this regional trade as both the demand center and the distribution link via the island's many animal markets (Malone et al., 2004; Nijman, 2004; Supriatna et al., 2006). As result, the illegal acts of selling endangered wildlife and felling of timber continues in spite of legislative controls and the protective status of species and is undoubtedly linked to the worsening deforestation rates and disappearance of endangered species across Indonesia, including the island of Java (Malone, 2007).

Focal species: the Javan gibbon

The Javan gibbon (Fig. 2.4) is currently listed as Endangered on the IUCN Red List of Threatened Species (IUCN, 2018) based on the 2001 criteria C2a(i), which refers to a 'population estimated to number less than 2,500 mature individuals and a continuing decline, observed, projected, or inferred, in numbers of mature individuals and no subpopulation estimated to contain more than 250 mature individuals.' Currently, it is *estimated* that less than 4,500 Javan gibbons remain in the fragmented forests of Java (Nijman, 2006; Supriatna et al., 2010). The Javan gibbon was among the first species to become protected by Indonesian law in 1925, and is listed in Appendix I of CITES, which prohibits all international trade of the species, its parts, and derivatives (Geissman and Nijman, 2006; Nijman, 2006). The Javan gibbon is found only in forest remnants of western and central Java in the remaining lowland and lower montane forest (Andayani et al., 2001; Supriatna et al., 2010). It is estimated that the Javan gibbon has lost up to 96 percent of its original habitat and should receive the highest priority of protection for Asian primates (Supriatna, 2006; Malone, 2007).

There have only been a handful of major studies done on Javan gibbons from researchers outside of Indonesia. Several Indonesian scientists study the species in-situ, but often the results typically are not published in international journals. In 1978, M. Kappeler (1984) conducted a two-month population survey in forest areas of West and Central Java and

concluded an estimated population between 2,400 and 7,900 Javan gibbons on the island, with the largest populations in Ujung Kulon and Gunung Halimun National Parks (Asquith, 2001; Nijman, 2004). Asquith et al. (1995) re-surveyed most of the forest patches where Kappeler (1984) reported having observed Javan gibbons, and, again on the basis of geographic area inhabited and density at different altitudinal zones, estimated the total population to be approximately 2,700 individuals. In 1994, Supriatna et al. (1995) convened a Population Habitat and Viability Analysis (PHVA) workshop compiling demographic information on the species. In 1998, D. Rinaldi studied the food preferences and habitat use of Javan gibbons in Ujung Kulon National Park (Rinaldi, 1999; Nijman, 2004) and he studied the distribution, population dynamics, and behaviour in Gunung Halimun National Park (Rinaldi, 2003). Between 1994 and 2001 V. Nijman conducted a series of surveys in West and Central Java, including Dieng Mountains, and collaborated with T. Geissmann on recordings of vocalisations. These were later analysed in a series of papers by Geissmann and colleagues (Geissman et al., 2005). N. Malone studied Javan gibbons in Cagar Alam Leuweung Sancang (CALS) focusing on behaviour and ecology, and he continues to research the interface of Javan gibbons and people in West Java (Malone, 2007). M. Reisland (2013) investigated the shared space between humans and Javan gibbons in CALS. Located within the forest reserve is a sacred waterfall and pilgrimage site for local people (Reisland and Lambert, 2016). In 2011, Kim et al. studied the diet and ranging behaviour of Javan gibbons in Halimun-Salak National Park. Between 2009 and 2010, A. Setiawan and colleagues conducted population surveys on Dieng Mountains and Mount Slamet, Central Java, Indonesia (Setiwan et al., 2012). There are many opportunities for further research regarding Javan gibbon population dynamics and behavioural patterns across the western and central parts of the island.

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Fig. 2.4. Focal species: Javan gibbon. Photo of Nancy (female) from JGC now living in the wild with her mate, Moli. Photo by Anton Ario/CI Indonesia.

Javan gibbons tend to exhibit a socially monogamous mating pattern (i.e., the adults may not be sexually exclusive) (Marshall, 2009). They generally live in small, familial social units consisting of an adult pair and their dependent offspring, typically averaging three to five individuals (Fuentes, 2000; Bartlett, 2007). The onset of sexual maturity for females is on

average eight and half years, and around age ten for males. The age at first birth for females usually occurs around age nine or ten (Brockelman et al., 1998). Interbirth interval falls between two to three years (Hodgkiss et al., 2009). Adult gibbons were traditionally believed to force their same-sexed offspring out of the family group upon sexual maturity via aggressive behavior (Chivers, 1974; Fuentes, 2000). However, the dynamics of dispersal (e.g., the age and sex) by young adult gibbons has been shown to vary and they may disperse as near as the neighboring group, leading to potentially a certain degree of relatedness amongst neighboring family groups (Brockelman et al., 1998; Fuentes, 1999; 2000). Furthermore, there is evidence that young adult gibbons may be tolerated within their groups for at least two years (possibly more) past sexual maturity and they may benefit the group by aiding in territorial defense (Brockelman et al., 1998). There is also increasing evidence of behavioural flexibility and higher levels of affiliative interactions between neighboring groups across the *Hylobatidae,* including Javan gibbons, and intergroup encounters are not always agonistic (see Bartlett, 2007; Malone, 2007). Bartlett (2001) suggests that intergroup encounters between adult gibbons provide an opportunity for the young adult gibbons to meet and identify potential mates and therefore, facilitating dispersal from their natal group. Data collected from field studies has shown that there is a significant rate of movement by individual gibbons across groups and home ranges, suggesting a larger, more fluid, social network among groups of gibbons (Malone, 2007). Though gibbons generally do spend the majority of their time living in a two-adult unit, there have been observations of gibbons living solitary, in greater-than-two-adult groups, and movement between those groups (Palombit, 1994; Fuentes, 2000). In addition, gibbons are known to engage in extra-pair copulations with individuals from adjacent territories (Reichard, 1995). Malone (2007) observed at least one group of wild Javan gibbons living in a multi-male/uni-female group in CALS in West Java.

Javan gibbons are one of only two gibbon species not known to produce duet songs (Kloss's gibbon (*H. klossii*) being the other). Instead, most of the singing is produced by females and mated females appear to be the vocal 'representative' of the family (Geissmann, 2002). Male Javan gibbons will sometimes produce their own specific vocalizations, or contribute to the female's great call, especially during territorial disputes (Geissmann et al., 2005; pers. obs.). Although gibbons are considered to be territorial, they do not necessarily defend their entire home range. Both male and female Javan gibbons will attempt to defend their territories by engaging in vocal and/or physical displays and chasing intruders out. Each family group typically occupies a home range of approximately 15- 37 hectares (Nijman, 2004; 2006; Supriatna, 2006; Malone, 2007; Kim et al., 2010). The home range of Javan gibbons may vary depending on resource abundance, habitat disturbance, and altitude. Furthermore, these factors also influence the daily path length (dpl) exhibited by Javan gibbons, which ranges from 835 – 1,400 meters/day (Kappeler, 1984; Malone, 2007, Kim et al., 2010). Javan gibbons are exclusively arboreal and prefer the upper canopy of lowland (≤ 500 m asl) to lower montane tropical forest (1,000 – 1, 500 m asl) (Malone, 2007; Kim et al., 2010). Lowland forests tend to exhibit higher plant diversity and fruit availability, as well as a higher density of large trees having a diameter at breast height (dbh) of greater than or equal to ten centimeters (Kim et al., 2010). The majority of Javan gibbons in the wild inhabit hill (500-1,000 m asl) and lower montane forest (Kim et al., 2010).

Gibbons are the most suspensory of all the primates and utilise brachiation as their main form of locomotion. They will also traverse through the canopy by climbing, leaping, and running or walking bipedally along the branches. Brachiation is a unique form of movement in which the gibbon uses its pectoral limbs to support the full weight of its body in suspension beneath a superstratem, as it moves utilizing a hand over hand locomotion along a branch. They have precise adaptations for maximizing the forward momentum gained from the pendular

motion of the body during brachiation (Fleagle, 1974; Cheyne, 2004). The gibbons' thumb is greatly reduced to hook onto branches during brachiation, rather than grasping, allowing them to move at a greater pace through the canopy. In addition, they have a well-developed scapular spine, long forearms relative to their body size, and they also raise and lower their legs in order to maximize momentum while brachiating (Fleagle, 1974). In order for gibbons to efficiently travel through the forest they require primary, continuous canopy forest with dense foliage and horizontal growth (Asquith, 1995; Bartlett, 2007). Only captive-raised gibbons tend to travel on the ground (at times) (Cheyne, 2004; pers. obs.). Gibbons and siamangs are considered the only true brachiators of all the primates, moving through the canopy at speeds as high as 40 kilometers per hour, leaping as far as 15 meters, and traveling as far as 6 meters with each swing (Fleagle 1988). They are incredibly agile and exceptional acrobats when traversing through the forest (pers. obs.).

Javan gibbons are predominantly frugivorous, but will also consume insects, flowers, and leaves (Groves, 1984; Leighton, 1987; Bartlett, 2007; Dillis et al., 2015). They require a wide variety of tree species that will fruit at different times of the year to support their dietary needs. Gibbons in general are one of the most important frugivores in Southeast Asian forests, typically dispersing over 81 percent of the species they consume (McConkey, 2000; Bartlett, 2007; Dillis et al., 2015). They tend to disperse few seeds under parent trees with more than 90 percent distributed over 100 meters away (McConkey, 2000). McConkey (2000) also reported that gibbons actually improve the chance of germination of some of the species in their diet; many fig seeds will not germinate without prior passage through the gut. It is very unlikely that Javan gibbons will inhabit secondary forest or cross open sections of forest, thus they will contribute very little to forest regeneration in secondary forests by seed dispersal. Secondary forests have gaps in the canopy and the growth is sparse, thus restricting the gibbon's ability to efficiently move around. There is also less of a variety of fruiting trees in new growth forest

(McConkey, 2000) which potentially cannot support the dietary needs of the Javan gibbon. Therefore, the role of Javan gibbons, and primates in general, in maintaining forest biodiversity is an area of increasing interest and has significant implications for conservation programmes, including reintroduction efforts and increasing the amount of protected areas in primary forest (Chapman, 1995; Bartlett, 2007). Educating local communities about the importance of primates in maintaining forest biodiversity via seed dispersal (Dillis et al., 2015), may aid in gathering more support for reintroduction programmes and habitat protection.

In comparison to other small bodied primates, Javan gibbons have very few natural predators (i.e., leopards, birds of prey, pythons) and a relatively low predation rate, with the exception of humans (Kappeler, 1981). As a result, they are able to avoid predation mostly by remaining in the upper levels of the forest canopy. Javan gibbons are rarely found less than ten metres above the ground. Leopards and pythons are most often found in the lower levels of the forest canopy (Kappeler, 1981). Most species of gibbons, particularly Javan gibbons with their silvery gray fur, are well camouflaged within the canopy. They are naturally vigilant creatures, exceptionally so during feeding and grooming where they will actively scan the area in an attempt to avoid possible predators (Kappeler, 1981; pers. obs.). After gibbons engage in singing or other noisy behaviour, they tend to quietly move on to a new area of the forest in an attempt to avoid being discovered by potential predators (Kappeler, 1981; pers. obs.).

Threats to the survival of Javan gibbons

Loss of habitat/habitat fragmentation

The Javan gibbon prefers relatively undisturbed lowland and lower montane rainforest, ideally below 1,600 meters. Due to human encroachment, gibbons are being pushed up into higher elevations where the habitat is less suitable for them (Nijman, 2004). However, there are groups in CALS that inhabit edge and disturbed forest fragments (Malone, 2007). The

behavioural and ecological flexibility demonstrated by some Javan gibbons, may pave the way for future studies with regards to their response to anthropogenic disturbance.

Javan gibbons, like all gibbons, tend to prefer full, closed canopy within mature forest for sleeping, eating, and singing. Female gibbons prefer taller trees that extend beyond the canopy for performing their 'great calls' and accompanying displays (Whitten, 1982). Gibbons can be sensitive to disturbance and will often alter their behavior in response to frequent logging, collection of forest resources, human encroachment, or hunting (Nijman, 2006). This behaviour can potentially be manifested in several ways, including an increase in vigilant behaviour resulting in avoidance, retreat or hiding behaviours, the gibbons may move lower in the canopy, and ultimately, suppress their vocalisations (Bleisch and Chen, 1991; Nijman, 2006; Malone, 2007). Gibbons produce loud vocalisations in order to defend their territory, attract mates, and potentially reinforce the pair bond. Although Javan gibbons are not known to duet, males will occasionally contribute to the females' great call or during territorial disputes (pers. obvs.) and this could be considered a form of pair bond reinforcement. In addition, calling frequency in gibbons is dependent on, amongst others, the density of gibbons (Chivers, 1974; Nijman, 2004). If wild gibbons are suppressing their vocalisations or engaging in other types of cryptic behaviour due to anthropogenic disturbance, it may prove difficult for researchers to obtain an accurate count of gibbons in the wild, which can influence conservation strategies aimed at protecting them.

In 2008, the IUCN downlisted the Javan gibbon from Critically Endangered to Endangered. This recommendation came from more intensive surveys that were conducted in the western *and* central part of the island that indicated a larger population in the wild than was previously believed (Nijman, 2004). The underestimation of Javan gibbons in the wild seemingly was the result of methodological differences in population estimation (i.e., actual numbers of gibbons observed in a few areas vs. extrapolation from density estimation at

varying geographic and altitudinal zones) (Nijman, 2004; Malone, 2007). Based on a review of the literature, there have been a variety of methods used to determine the actual number of Javan gibbons left in the wild, all yielding different estimates. Methods range from rapid presence-absence surveys, range mapping, fixed line transects to fixed-point counts (Nijman, 2004) and population estimates have ranged from as few as 400 individuals (Supriatna et al., 1994) to as many as 7,900 individuals remaining in the central and western parts of Java (Kappeler, 1981). Wild Javan gibbons prefer to avoid humans when they encounter them in the forest. This could potentially make it more difficult for researchers to actually detect them in the wild and may lead to inaccurate counts of individuals (Nijman, 2004). Most primates in the wild are elusive, however, Javan gibbons live in smaller groups and therefore, tend to be more difficult to detect in the wild. If the number of Javan gibbons is estimated too low in the wild, this could potentially lead to focusing conservation efforts more on saving the ex-situ population (i.e., the captive population), as opposed to providing more protection in their natural habitats (in-situ) (Nijman, 2004). One way to potentially reinforce wild populations of Javan gibbons would be establishing a captive breeding population /metapopulation that could then be used to supplement the population of Javan gibbons in the wild.

Illegal pet trade

It is possible that the equivalent of an entire population of Javan gibbons (approximately 300 individuals) is held illegally in captivity in Indonesia (Nijman, 2006; Supriatna, 2006). The north coast of the island of Java is a major route for the trafficking of Indonesian primates, possibly including the Javan gibbon (Malone et al., 2004; Supriatna, 2006). The majority of Javan gibbons held in captivity in Indonesia are derived from the wild, as opposed to captive breeding programmes, including the individuals who are in zoos and wildlife rescue centers (Nijman, 2006). When infant gibbons are removed from the wild, it is usually after their mother

(and perhaps other family members) have been shot and killed. This has potentially detrimental effects on the wild Javan gibbon population because aside from the young gibbons being removed, viable female gibbons are also being removed from the total population (Malone, 2007; Cheyne, 2009). If the infant does survive the pet trade and become a household pet, it will most likely never have the opportunity to reproduce and contribute to any population of wild Javan gibbons.

One of the major challenges in the enforcement of illegal wildlife trade regulations is the willingness of the authorities to become engaged in and carry through the required judicial procedures (Supriatna et al., 2010; Freund et al., 2017). As a result, current offenders of wildlife laws are rarely prosecuted (Supriatna, 2006; Freund et al., 2017; Nijman, 2017). The current system in Indonesia allows for individuals to donate their pet gibbons to zoos, wildlife rescue centers, and rehabilitation programs when they realise they can no longer manage the gibbon as a pet. As a result, it becomes easier for private owners to dispose of their adult gibbon and potentially obtain a younger individual from the wild, perpetuating the illegal pet trade system (Supriatna, 2006). Malone (2007) provides an excerpt from a report discussing a potential link between the Ministry of Forestry and the illegal trade of wildlife, including Javan gibbons:

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> Contesting the official lament about the plundering of Indonesia's natural wealth is Iwan Setiawan, staff member of the Indonesian Environment Information Center (PILI). In September, he led a team to research the trafficking in endangered species in the Pramuka and Barito pet markets. He said he found some protected animals on sale and evidence of transactions, and reported his findings to the ministries of Forestry and Environment, the Nature Conservation Body and the police. The result? Nothing, said Iwan, which has led him to conclude that there is a nexus between the smugglers of endangered species and the authorities. It is a view that is repeated by the Gibbon Foundation, a conservation group based in Jakarta. A member of the group's office explained that the foundation had at one time entered into a cooperation agreement with the Forestry Ministry to map wild-animal populations using satellite imagery. The aim was to identify the remaining concentrations of wild species. 'But this invaluable information was leaked out,' said the staffer, 'then we found traces of professional hunters in the regions and the animals had gone.' (Yamin, 2003 as reported in Malone, 2007).

The illegal pet trade is unfortunately a valuable mode of profit for individuals in Indonesia. Internal exploitation and corruption are undoubtedly contributing to deforestation rates in the country, as well as the disappearance of wildlife, and is the result of a system that perceives natural resources as a means of revenue that can be exploited for political and social gain (Malone, 2007; Rosen and Smith, 2010). The ownership of an endangered primate is sometimes portrayed as a symbol of status and economic success. It is reported that many government officials, army officers, and entertainers own pet primates, especially orangutans (Malone et al., 2004; see Chapter 4). This practice unfortunately encourages other people to purchase primates and enhances the symbolic or social status of owning an endangered species. As a consequence, the reported public display of primate pets by the wealthy and influential serves as a demonstration of political power, and ultimately, the selective enforcement of Indonesian law and is a blatant disregard for national and international regulations (Malone et al., 2004). This information exemplifies the challenges that conservationists face when developing conservation programs that seek to preserve the remaining forests and wildlife of Indonesia. Furthermore, regarding the primary issues of habitat loss and the illegal trade in

gibbons, local people will have to be involved in the long-term effective management of forest resources and they must demonstrate the will to report and prosecute individuals who are involved in the illegal pet trade (Malone, 2007; Rosen and Smith, 2010).

Small population processes

Due to the fragmentation of Java's forests, the majority of suitable habitat remaining on the island for Javan gibbons is isolated patches of forest, some areas being too small to hold a large population (>100 individuals) (Nijman, 2004). The fragmented nature of this remaining habitat makes the species potentially vulnerable to extinction via small population processes, including environmental stochasticity, demographic stochasticity, and loss of genetic diversity (Cowlishaw and Dunbar, 2000; Benson et al., 2016). In general, extinction risk is a function of population size. If populations are large, the risk of extinction is relatively low, but if species exist in smaller populations, the risk of extinction becomes much greater (Cowlishaw and Dunbar, 2000; Pimm et al., 2014). If Javan gibbons are unable to disperse into new territory and acquire new mates, the isolated populations could potentially be at great risk for extinction through loss of genetic variability. A reduction in genetic diversity of a population (i.e., decreased heterozygosity, increased homozygosity) is considered undesirable for two reasons: first, the loss of heterozygosity means populations have less genetic flexibility allowing them to respond to changes in the environment. Secondly, there is a potential increase in the likelihood of inbreeding depression (i.e., the phenotypic expression of deleterious recessive genes). As population size decreases, the effect of such an impact becomes disproportionately severe (Cowlishaw and Dunbar, 2000; Benson et al., 2016).

In order to increase genetic diversity in small populations of Javan gibbons, it could prove beneficial for conservation efforts to translocate gibbons between forest patches and establish a metapopulation between wild and captive individuals. Researchers have suggested

the need of establishing a metapopulation management programme through some form of genetic supplementation (e.g., Andayani et al., 2001). This would include capturing young individuals who are preparing to leave their natal groups and transferring them to other areas (translocation) (Nijman, 2004; 2006). This conservation strategy was utilised in an effort to save the golden lion tamarin (*Leontopithecus rosalia*) from going extinct in the Atlantic coastal forest of Brazil. Similar to Javan gibbons, golden lion tamarins are found only in isolated forest patches and are vulnerable to extinction via small population processes. The golden lion tamarin wild population was estimated at only 100-200 individuals in the 1970s. A metapopulation was established and the first captive-bred tamarins were released in the mid-1980s, and by 1994 the wild population had grown to approximately 450 individuals with an additional 550 in captivity (Kleiman et al., 1986; Ballou et al., 2002; Britt et al., 2003; Kierulff et al., 2012; see Chapter. 5). For Javan gibbons, another conservation strategy that may prove successful in supplementing the wild populations and is almost 10 years in progress, is the rehabilitation and reintroduction (conservation translocation) of individuals from rescue centers into isolated forest areas without resident gibbons (Nijman, 2006; Supriatna, 2006). In a molecular genetics study, Andayani et al. (2001), found that two lineages of Javan gibbons *may* exist: a western lineage (*H. moloch moloch*) that is represented by a large population in Gunung Halimun and a central lineage (*H. moloch pongoalsoni*) consisting of isolated populations around the Gunung Masigit/Simpang/Tilu complex, Gunung Gede-Pangrango, and Gunung Slamet in central Java (Andayani et al., 2001; Asquith, 2001; Supriatna, 2006). Based on the findings, the morphological differences between the two populations are quite subtle, so additional research on the phylogenetic analyses of mtDNA and vocalisations may shed further light on the finding (Mootnick, 2006; Supriatna et al., 2010). Dallmann and Geissman (2009) found variation in the songs (i.e., female great-calls) between the Javan gibbons in the western and central populations; however, their findings did not align with the genetic boundary

suggested by Andayani et al. (2001). According to the study conducted by Andayani et al. (2001), the discovery of the two possible lineages has potential implications for conservation policy and reintroduction programmes and they make the following recommendations: 1) the western population should be managed as a separate and distinct population unit and should not be used to reinforce the central population; 2) the gibbons from the Gunung Masigit/Simpang/Tilu complex, Gunung Gede-Pangrango, and Gunung Slamet represent a second distinct unit and can be translocated if need be between the surrounding areas; and 3) the gibbons from Gunung Slamet (and Dieng Mountains) are not evolutionarily distinct from the gibbons directly to the west. Fifteen years later, and partially based on the same samples as used by Andayani et al. (2001), Kheng et al. (2017) examined the phylogeography and population structure of Javan gibbons. They found evidence for two Evolutionary Significant Units (ESU) for Javan gibbons: a western ESU, extending from Ujung Kulon NP to Gunung Gede-Pangrango NP, and a central ESU, from Gunung Masigit–Simpang–Tilu to Gunung Slamet. Their conclusions are provisional owing to the small sample size (47 gibbons) and they encourage a more comprehensive genetic study of Javan gibbons, with a more in-depth analysis across all occupied forest patches where the species occurs in order to fully support the existence of the two ESUs and the population structure in each of them.

With regards to the two ESUs identified by Kheng et al. (2017) and the possible need for conservation management at the ESU level, and Andayani et al. (2001) suggesting the two lineages identified in their study be managed separately, it should be acknowledged that this is *not* currently a part of Javan gibbon conservation management. Javan gibbons are actively moved from one population to the next as there are at least three areas (Takokak, Mt. Tilu, Mt. Malabar) where Javan gibbons have been released in recent years. The released gibbons comprise a mixture of wild-caught individuals (confiscated pets, rehabilitated individuals), captive-born individuals out of wild-born parents and captive-bred individuals from captive-

born parents; mostly are from Java but recently the first Javan gibbon from a UK zoo (Port Lympne) was released into the forests on Java. Release sites are project-specific (e.g., JGC releases gibbons on Mt. Malabar and one pair was first released near Gunung Gede-Pangrango NP (see Chapter 5), and TAF releases them on Mt. Tilu) and to the best of my knowledge, no genetic tests have been conducted to assess the geographic origin, or the putative ESU, of these released individuals or their parents and/or lineage (Nijman et al., 2018: in press).

Stanford (2001) argues that splitting primate taxa into subspecies should be done cautiously and conservatively, because it will heavily influence conservation initiatives. There should be a consensus of biogeographic, genetic, morphological, behavioural, and ecological factors that are used to distinguish the subspecies from one another, all of which are limited (if not absent) for Javan gibbons. Considering Andayani et al. (2001) and Kheng et al. (2017) represent the only molecular studies conducted on Javan gibbons to date, and each study came up with different conclusions, it would seem necessary to conduct more in-depth behavioural and ecological studies on determining the level of distinction between the two potential subspecies, prior to developing conservation policies aimed at protecting them in the wild. Groves (2001), Mootnick (2006), and Geissmann et al. (2002) do not acknowledge the subspecies level of classification for the Javan gibbon. Also, the 2006 Asian Primate Red List workshop assessed the conservation status of all species of gibbons and the Javan gibbon was listed as *H. moloch* (and still is on the IUCN Red List), with no regards to the two lineages (IUCN, 2018). This assessment would seem to suggest that conservation initiatives aimed at preserving them in the wild consider the Javan gibbon to be a monotypic species.

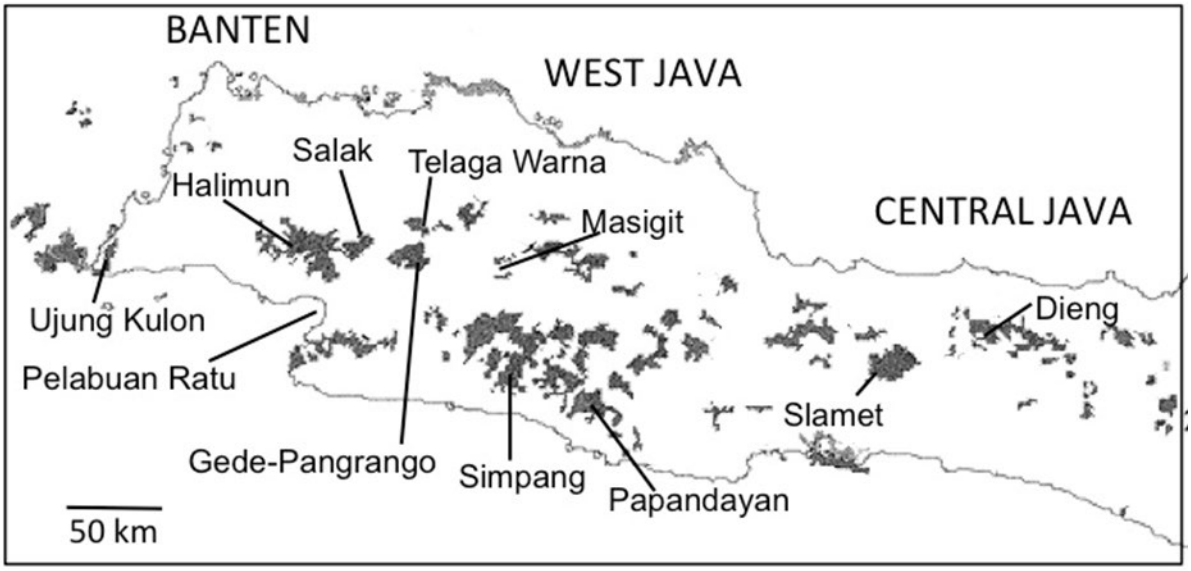

Fig. 2.5. Map illustrating the distribution of primary forest patches in western and central Java inhabited by Javan gibbons. Isolated populations may exist in smaller patches of forest.

General methods

Data acquisition and analysis (chapters 3-6)

Given the nature of the research, each chapter represents a project in itself and is predominantly comprised of qualitative data; therefore, each chapter required a different approach to how I collected and analysed the data, and thus presented it in writing. The specific methods for each aspect of research are detailed in the respective chapter. With regards to how I conceptualised this project in its entirety, I first began by reviewing all relevant literature on Javan gibbons and conservation efforts aimed at protecting them in the wild. I have spent a considerable amount of time at both the Javan Gibbon Rescue and Rehabilitation Center (JGC) and the Aspinall Foundation Javan Primates Conservation Project (TAF) in West Java. I have assisted with caregiving duties for captive gibbons, participated in education outreach activities in local villages, and have observed how each centre carries out rescue and rehabilitation measures, and ultimately, the process involved with reintroducing Javan gibbons back to the wild. Over the course of my programme, I have met with both government officials and

conservationists in West Java and here in the United Kingdom to discuss Javan gibbon conservation. In addition, since 2009, I have participated in three different releases of Javan gibbons back into the wild.

Chapters 3-6 comprise the heart of the research with each chapter highlighting a different aspect of Javan gibbon conservation. ***Chapter 3***, *Modelling population viability of three independent populations of Javan gibbons*, is the result of a collaborative project involving myself and four co-authors. I was primarily responsible for reviewing the literature and determining the parameters used in the VORTEX analysis. This entire process required that I read all relevant literature pertaining not only to Javan gibbons, but current literature on all gibbons in general, as well as other species of long-lived mammals for which PVAs have been used in conservation management and projecting risk of extinction. The outcome of this research resulted in a publication in the journal, *Folia Primatologica* in early 2018 (see Appendix 1.4). The version in this dissertation includes an additional scenario and analysis indicating the likelihood of extinction after reintroduction.

Chapter 4, *Investigating the extent and prevalence of gibbons traded illegally on social media***,** is comprised of data from the research I conducted for the Arcus Foundation investigating the prevalence of gibbons being sold illegally online on different social media platforms. The data collection consisted of an exploration strategy in which I investigated different social media platforms and gathered as much photographic evidence as possible of gibbons being either sold online or portrayed as pets. I also recorded names and accounts of individual sellers, and the group names of online 'markets.' Considering there is no systematic way to search out sellers and buyers on social media, I essentially utilised a method of snowball sampling in which I would find one 'seller' (either randomly or word of mouth via colleagues and/or rescue centres) and then search posts based on that one advertisement, leading to a number of other interested parties or accounts selling threatened wildlife. In addition, there is

no way of specifically quantifying the extent of which gibbons are being sold online other than tallying up the number of posts found on the different platforms and estimating how many gibbons this may represent in total. Therefore, I compiled lists of all known buyers/sellers and online markets into tables, and present the number of gibbons being sold or portrayed as pets in two different tables.

In ***Chapter 5***, *Rehabilitation and reintroduction: a new hope,* I discuss the role of reintroduction in gibbon conservation, and include insights from my personal experience taking part in the first release of a pair of Javan gibbons back into the wild, as well as two other releases (2013 & 2016). I detail my experience (see Appendix 1.2) rather than presenting actual quantitative data because at the time we (myself and fellow observers from JGC) were unable to collect daily behavioural data due to the aggressive and territorial behaviour exhibited by the gibbons. In order to provide a well-rounded examination of the role reintroduction may play in Javan gibbon conservation, I review the literature on other primate reintroduction projects and how reintroduction may benefit (or hinder**)** conservation for Endangered species, as well as drawing from my own personal experiences working at both Javan gibbon rescue centres in West Java. In summary, I include an assessment of the current programmes with an outline of best-practice objectives and where future research should focus efforts in order to ensure successful rehabilitation and reintroduction practices.

Finally, in ***Chapter 6***, *The people's voice: it's what matters,* I present qualitative data from the semi-structured interviews I conducted in five local villages bordering Gunung Gede-Pangrango National Park in West Java. I interpret and discuss my findings with support from literature to assess the social-cultural environment regarding conservation and knowledge of wildlife, specifically pertaining to Javan gibbons. Qualitative data were analysed using data driven coding, or open coding. In data driven coding, the researcher observes the collected data to identify ideas/concepts based on the responses' internal relevance (Bernard and Ryan, 1998;

Gibbs, 2007). I describe more specifically the themes and relationships between the various responses from the people and their significance to my research goals and questions. The identification of these broad themes through which all answers are represented after data collection rather than before is what constitutes 'open coding' (Gibbs, 2007). This style emphasises using the emic perspective when organising data into meaningful components for analysis and interpretation (Gibbs, 2007).

To conclude in ***Chapter** 7*, I provide a summary of the research findings in each chapter and discuss how each aspect of research contributes to the bigger picture for Javan gibbon conservation. The questions I set out to explore within this research project aim to identify key conservation issues that currently exist for Javan gibbons in Indonesia. Each research component and the respective questions address different threats they are facing in the wild and what measures are currently being taken to hopefully mitigate some of those pressures, as well as what actions can be enacted now to help ensure Javan gibbons do not go extinct in the future. It is my hope the actions and goals elucidated from this research will help to inform a new and unique conservation efforts aimed at protecting Javan gibbons in the wild. Consequently, I have included a list of actions and goals I believe will significantly benefit a more holistic conservation action plan.

Summary

The previous chapter provides necessary background information by introducing the reader to the island of Java, the extant primates, and more specifically, Javan gibbons. In addition, I briefly described the ecological and anthropogenic context of the research setting in Indonesia. In doing so, I provide a general insight into the potential challenges of engaging in primate research and conservation activities, given the scale and history of habitat alteration by humans on the island of Java. It is crucial to understand the social-cultural context of Java and

incorporate aspects of its complexities into the methodologies and interpretations of the research programme. This will hopefully ensure a more efficacious approach to conducting future conservation research in Indonesia. To conclude, I discuss my methods for data acquisition and analysis, yet state more specific methods are detailed in each chapter (where relevant).

The next chapter discusses the results from the PVA model with an interpretation of the results based on the analysis and a comparison of previous studies and literature. Most importantly, the chapter documents the estimated projection of the long-term survivability of three of the largest populations of Javan gibbons and includes recommendations for future conservation initiatives.

Chapter Three

Modelling Population Viability of Three Independent Javan Gibbon Populations

Fig. 3.1. Photo of a wild Javan gibbon in Gunung Gede-Pangrango National Park. Photo by Igud Supian.

Introduction

Gibbons living in the wild are subject to a complex combination of both extrinsic and intrinsic factors that can influence the demographic growth rate of the population. Understanding how these factors interact with one another is essential in order to successfully manage a population of threatened species (Soulé, 1985; Bryant, 2014). External drivers that can potentially cause a population to decline include habitat destruction (due to either loss from

forest fire or land clearing for plantations), poaching for the illegal wildlife trade, and for some species of gibbons, poaching for traditional medicine. These threats are largely deterministic in nature and generally have a consistent and predictable effect upon population growth rates (i.e., they directly increase mortality or decrease fecundity), potentially causing the population's growth rate to decline (Marshall et al., 2009; Bryant, 2014).

As a population declines, it can suffer additional deterministic effects (e.g., loss of genetic diversity) and ultimately, may be subject to further stochastic factors that can vary greatly in terms of the magnitude and outcome of their impact. These factors may have a minimal effect on larger populations, as their large size allows for more flexibility in such fluctuations. However, the same stochastic processes may have a much more significant impact on smaller, isolated populations (Bryant, 2014; Pimm et al., 2014). If populations are generally large, the risk of the population decreasing to extinction is relatively low, but small, isolated populations are potentially at greater risk of decline due to stochastic processes, and therefore may be more susceptible to local extinctions (Caughley, 1994; Cowlishaw and Dunbar, 2000; Pimm et al., 2014). Caughley (1994) posits that the dynamics of a large population are determined by the law of averages, while those of a small population are determined by the specific fortunes of its few individuals (Bryant, 2014). Within a small population, instability is exacerbated by the influence of four forms of stochasticity: demographic, environmental, and genetic stochasticity, and catastrophes (Shaffer, 1981; Bryant, 2014). These stochastic effects can interact with and add to deterministic effects and lead to a further reduction in population size, which may increase the instability of the population. This increased instability can result in yet further decline in population size, driving populations inevitably downward in a cycle to extinction, known as the 'extinction vortex' (Gilpin and Soulé, 1986; Bryant, 2014).

Population Viability Analysis (hereafter PVA) is a predictive measure that incorporates the combined effects of species-specific deterministic and stochastic factors to determine the

likelihood of a species' risk of extinction over a pre-defined period of time. The model uses mathematical simulations to estimate extinction probabilities of populations when subject to different deterministic forces and stochastic events (Soulé, 1985; Marshall et al., 2009; Stark et al., 2012). When paired with empirical data from the field, PVA models can identify several factors that make a species more susceptible to extinction processes, and can help to better guide conservation management and funding (Marshall et al., 2009; Sodhi et al., 2010).

PVAs have been a widespread tool in species conservation for the past 30 years, helping to provide assessments of species population trajectories and viability (Coulson et al., 2001; Reed et al., 2002); projections of the impacts of potential changes to habitat or direct threats to populations (Coulson et al., 2001; Nilsson, 2003); assessments of the relative efficacy of proposed management actions (Nilsson, 2003); and predictions for population growth under management practices or habitat limitations (Boyce, 1992; Reed et al., 2002; Stark et al., 2012; McGowan et al., 2017). PVA models are not intended to determine an absolute risk of extinction, rather they are best used to help identify aspects of the system for which more data are needed, help direct funding to priority populations where it can be used efficiently and appropriately (e.g., policy decisions, habitat management, and conservation planning), and overall, to offer insight into which current and potential management /mitigation strategies are likely to have the greatest positive effect on species' long-term survival (Shaffer et al., 2002; Drechsler and Burgman, 2004; Stark et al., 2012).

PVAs have been utilised in conservation management for several primates (muriquis: Strier, 1993; orangutans: Singleton et al., 2004; proboscis monkeys: Stark et al., 2012; gorillas: King et al., 2014), including for different species of gibbons (Tunhikorn et al., 1994; Walker and Molur, 2005; Fan et al., 2013; Bryant, 2014). In 1994, a PVA (which was a component of the PHVA workshop) (http://www.cbsg.org/pva-process) for Javan gibbons was conducted (Supriatna et al., 1994), and it was concluded there were 386 Javan gibbons left in the wild,

surviving only in small, isolated populations, and were at serious risk of going extinct. This conclusion of an extremely small population of Javan gibbons remaining in the wild, led to their Critically Endangered status designated by the IUCN (Andayani et al., 2001; Nijman, 2004). The workshop participants concluded that the fundamental threat to the survival of Javan gibbons was low genetic diversity, and with such a small population remaining in the wild, an action plan was set forth to begin immediate active genetic and demographic management. For the small, isolated populations, 'rapid habitat expansion, genetic supplementation, translocation, and captive propagation' was to be carried out (Supriatna et al., 1994; Asquith, 2001). In contrast, field studies had demonstrated there were potentially large populations of Javan gibbons still living in large tracts of unprotected forests, as well as potentially large, viable populations within the protected area network (Nijman and van Balen, 1998; Asquith, 2001) not only in western Java, but also in central Java.

Through PVA, I aimed to determine the viability of three independent Javan gibbon populations under assumed (current) conditions on the island of Java, and identify key intrinsic factors that have the greatest influence on the population growth rates and viability, and explore the impact of key extrinsic threats upon viability to identify the drivers of Javan gibbon extinction risk. More specifically: 1) how much of an impact will high rates of hunting have on wild populations of Javan gibbons; and 2) how much of an impact will different rates of deforestation have on wild populations of Javan gibbons. In addition, I aimed to determine the relative viability of the population under different conservation management scenarios. For my analysis, I used the most recent survey data from the three largest known populations of Javan gibbons to explore the viability of these populations under a certain set of environmental pressures and threats. I selected three areas: one that has potential for population increase; one that comprises potentially fragmented populations; and one unprotected forest area that could be subject to substantial levels of poaching (i.e., hunting for the illegal pet trade). This analysis

was intended to provide insight into the likely outcomes of possible conservation actions, and thus the relative ability to improve the species' chances of long-term survival in the wild.

Methods

Study areas

I used three sites in my modelling: Ujung Kulon National Park, Halimun-Salak National Park, and Dieng Mountains (Fig.3.2; Table 3.1). I chose these sites for the viability analysis as they represent the three largest known populations of Javan gibbons remaining on the island of Java, including the western and easternmost ones of the species, and each area faces a range of different challenges and opportunities for Javan gibbon conservation.

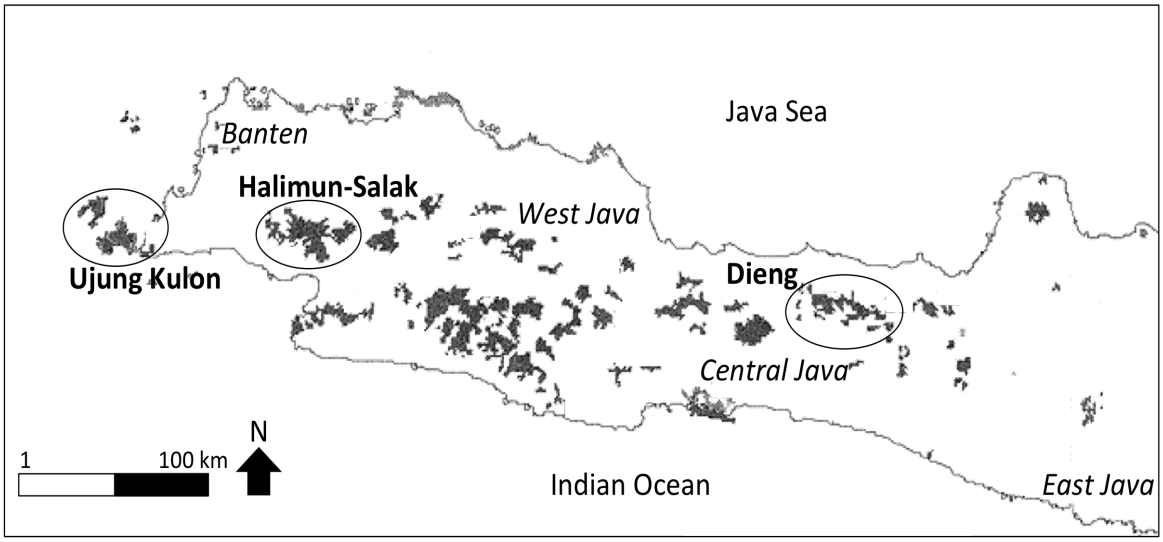

Fig. 3.2. The island of Java, Indonesia, showing the remaining forest cover including the three study areas: Ujung Kulon National Park, Halimun-Salak National Park, and Dieng Mountains. Province names are indicated in Italics.

Ujung Kulon National Park

Ujung Kulon (S 6°45', E 105°20') is a UNESCO World Heritage site, located on the southwestern tip of Java, best known for supporting the last remaining population of Javan rhinos (*Rhinoceros sondaicus*). The park comprises a mainland section (Mt. Honje), a

peninsula and several islands, mostly covered in lowland forest; Javan gibbons are mostly present in the mainland section with a smaller population on the easternmost part of the peninsula (Tanjung Ranjang). Asquith et al. (1995) (see also: Kappeler, 1984; Rinaldi, 1999; Djanubudiman et al., 2004) present data indicating there are approximately 300 to 560 Javan gibbons living in the park, and it is estimated that only 30-85 km^2 of the park remains as suitable habitat for them (Nijman, 2004).

Halimun-Salak National Park

Halimun-Salak (S 6°72', E 106°46') has some of the largest remaining contiguous lowland forest on Java; however, small-scale and plantation agriculture, infrastructure development, gold mining, and unsustainable fuel wood and non-timber forest product harvesting threaten the integrity of the area (Nijman, 2015). Javan gibbons are present throughout the Halimun area, on Mt. Salak, and in the corridor linking the two (Nijman, 2015), but the loss of lowland forest and the presence of enclaves may have led to the population becoming fragmented and thus isolated from one another. Estimates of the number of Javan gibbons in Halimun-Salak vary, but range between 900 and 1,220 individuals (Kool, 1992; Asquith et al., 1995; Sugarjito and Sinaga, 1999; Nijman, 2015), and it is estimated that 330-400 km^2 of suitable habitat remains for the gibbons (Rinaldi, 2003; Djanubudiman et al., 2004; Nijman, 2004).

Dieng Mountains

In contrast to Ujung Kulon and Halimun-Salak, the forests of Dieng Mountains (S 7°12', E 109°54'). are entirely unprotected and receive little attention from the conservation community (Nijman and van Balen, 1998; Setiawan et al., 2012). The area comprises a mixture of secondary forest and forest plantation dissected by a relatively large number of secondary roads. Javan gibbons are found throughout Dieng Mountains; Setiawan et al. (2012) identified four to five subpopulations with an unknown degree of connectivity between them. It is

estimated there are approximately 850 gibbons (Setiawan et al., 2012) living in the Dieng Mountains, and 90-167 km^2 of forest remains as suitable habitat for them (Nijman, 2004; Setiawan et al., 2012).

Definitions and modelling

I used the software VORTEX V.10 for all analyses (Lacy and Pollak, 2014; http://vortex10.org/Vortex10.aspx) to explore the viability of three independent Javan gibbon populations on the island of Java. VORTEX is a Monte Carlo simulation program that models the combined effects of deterministic forces and stochastic events (demographic, environmental, genetic and catastrophes) on small populations by simulating population dynamics as discrete sequential events that occur according to defined probabilities (Lacy, 2000; Miller and Lacy, 2005; Marshall et al., 2009; Bryant, 2014). Each individual is tracked as the simulation steps through life cycle events (e.g., births, deaths, catastrophic events) with growth checked by truncation to the specified carrying capacity (Marshall et al., 2009; Bryant, 2014). VORTEX is appropriate for modelling populations of Javan gibbons as it is designed specifically for mammalian and avian populations with low fecundity and long-life spans (Bryant, 2014; King et al., 2014; Lacy and Pollak, 2014). Given there are limits to the complexity with which VORTEX can represent a particular scenario, a certain amount of simplification with regards to the demographic variables was required when developing simulation models (Bryant, 2014).

Many PVAs developed for conservation management report the probability of extinction predicted under a given set of area or species-specific scenarios, and there are several quantitative measures which can be used to evaluate population viability within different environmental contexts (Bryant, 2014). There is no consensus on which viability measure is the most suitable, and different measures reveal different aspects of the population's (projected)

behaviour and thus can answer different questions. Furthermore, given the inherent limitations of PVA, which like all population modelling will only be as accurate as the input data, it is advisable to assess multiple measures of viability under each scenario and compare these measures across scenarios, rather than assuming the model offers exact probabilities of reaching extinction (Reed et al., 2002; Bryant, 2014).

For the analysis, I set the simulations to run 500 times over a 100-year period. After each simulation, results recorded were: the probability of extinction (**PE**) of the population; mean time to extinction (**TE)** which indicates the simulated population(s) that became extinct; mean stochastic growth rate (**stoc-r**) observed growth rate taking into account stochastic processes (whereas deterministic- *r* which does not), prior to any truncation in population size exceeding *K* (as this more accurately represents the growth potential of the population), with standard deviation across iterations (**SD**. If stochastic-r is similar in value to deterministic-r, then the population is considered stable, and if stoc-r is less than det-r, the population is considered unstable. When the standard deviation of N is half or more than N, the population is considered to be unstable and thus more susceptible to fluctuation (Stark et al., 2012); mean number of individuals for surviving populations **(N-extant**) the population size in final year of simulation from those populations that did not go extinct; and gene diversity (**GD**) which is the mean expected heterozygosity remaining in extant populations in final year of simulation, expressed as a percentage of initial population's gene diversity.

I define a population as the combination of all subpopulations at a particular site (i.e., each site is considered an independent population), and a population was considered extinct when only one sex remained. The baseline model was designed to represent each Javan gibbon population under the conditions for which we understand them to presently exist based on the most current and available data (i.e., minimal threatening processes, beyond the demographic and stochastic effects of each population were incorporated into this model) (Bryant, 2014).

Therefore, the model provides insight into the probable population trajectory and viability of the species under the optimistic assumptions that the species is not significantly vulnerable to threats such as high levels of hunting and habitat loss, and hopefully fortunate enough as to avoid catastrophic events. Ultimately, the model provides us insight into the probable outcome of the species' survivability in the absence of significant threats or if we fail to implement any conservation management actions (even in the absence of threats) (Bryant, 2014).

The life history data on Javan gibbons in the wild is limited, therefore, I selected input values for the demographic variables within the baseline model using available information from the literature on closely related gibbon species (Brockelman et al., 1998; Hodgkiss et al., 2009) and that used in the 1994 PHVA report (Supriatna et al., 1994). In addition, there is not any available data with regards to how many Javan gibbons are removed from the wild annually for the illegal pet trade, therefore best estimates were used for the rates of hunting in the analysis (Ujung Kulon National Park: 2 adult females, 2 juveniles; and for both Halimun-Salak National Park and Dieng Mountains: 4 adult females, 4 juveniles). Given the protected status of both Ujung Kulon and Halimun-Salak, I estimated a lower number of gibbons being removed from the wild. Dieng Mountains are unprotected, I assume more gibbons would be removed from the wild, thus estimated a higher rate of hunting for the area. Consequently, these numbers are estimates as we do not currently have data on how many Javan gibbons are actually removed from the wild each year, and therefore, we must consider the ramifications for either under or over-estimating the rates of hunting and factor this into management plans.

The island of Java has had a long history of deforestation. By the end of the 19th century the natural forest was severely degraded, and at the beginning of the last century the remaining forest on the western and central part of the island showed a similar pattern of fragmentation similar to what is seen today (Nijman, 2004). It is estimated that over 90% of the original forest remains, including 54% of the montane forest (>1000 m asl), 19% hill forest (500-1000 m asl),

and only 2% of the lowland forest (<500 m asl). Over the last few decades, the rate of deforestation has slowed and is estimated to occur at potentially about 1% per year (though most likely varies by area), however, given there is insufficient data to support this, and each region of Java is subject to different rates of deforestation, I estimated the rate of deforestation based on the area (i.e., protected vs. unprotected) (Nijman, 2004). The forests of Dieng Mountains in central Java are unprotected, so we can assume the habitat is at greater risk of destruction. Both Ujung Kulon and Halimun-Salak NP are protected, therefore, we assume the rate of deforestation is less in these forested areas. It must be acknowledged this has potential consequences in that the actual threat may be under (or over) estimated.

Given the relative uncertainty of how many gibbons are left on the island of Java, for the modelling I assume the populations are at or close to carrying capacity; however, I tested the baseline scenario with two different carrying capacities for each site, one low and one high. For the *low value*, I set the carrying capacity equal to the initial population size, and for the *high value*, I divided the total estimated habitat (high end of the range) available for Javan gibbons in each area (Ujung Kulon: 85 km^2; Halimun-Salak: 400 km^2; Dieng Mountains: 167 km^2) by the average exclusive territory range of one group (26 ha = .26 km^2), and then multiplied that by the average group size (2.5 groups km^2) (Fan et al., 2013).

Catastrophes are remarkable events outside the realm of normal environmental variation, such as natural disasters (e.g., on the island of Java this could potentially be volcanic eruptions, tsunamis, or forest fires) and/or disease. Such events can impact the survival and/or reproduction of wildlife populations (Bryant, 2014). Given there is not any available information on the probable impact of disease on wild populations of Javan gibbons, nor of the possible effect of small-scale forest fires on the island, and the chance of a volcanic eruption is unlikely, I chose not to model catastrophes in my analysis. In absence of this data, any decrease

of habitat, whether caused by agricultural expansion or small-scale fire, is accounted for in an annual decrease in carrying capacity

Table 3.2. Species-specific parameters: Input values and rationale for values used in the baseline scenario(s) EV: environmental variance; SD: standard deviation; PVA: population viability analysis.

Species-specific parameters	Input Value	Rationale
Inbreeding depression	0.0	Inbreeding is unlikely to have a significant effect on populations of modelled sizes (all three populations > 100) (Robert Lacy, in litt; Supriatna et al., 1994).
EV correlation between reproduction and survival	1	Good survival years tend to be good years for reproduction.
EV correlation among populations	0	Populations are considered to be independent of one another.
Dispersal age range for females and males/survival rate at dispersal	5-8; 50%	Gibbons tend to disperse at the sub-adult age or upon sexual maturity (Supriatna et al., 1994; Brockelman and Reichard, 1998).
Breeding system	Long-term monogamy	Gibbons tend to exhibit long-term pair bond associations (Supriatna et al., 1994; Brockelman and Reichard, 1998).
Age of first reproduction (yr.) for: females/males	8 female: 10 male	Age of first reproduction tends to be between 8 and 10 for both males and females in wild populations of gibbons (Brockelman and Reichard, 1998; Supriatna et al., 1994; Tunhikorn et al., 1994).
Percent adult females breeding	33 ± 17	The proportion of females breeding each year determines the interbirth interval. This interval is reported to be three years in the wild meaning 67% of adult females on average do not produce offspring (Brockelman and Reichard, 1998; Supriatna et al., 1994).
Maximum number of broods per year	1	Female gibbons typically give birth to only one baby per year (Husbandry Manual for Javan Gibbons, 2008).
Maximum number of progeny per brood	1	Female gibbons typically give birth to only one baby as twins are rare (Husbandry Manual for Javan Gibbons, 2008).
Max age of reproduction (yr) also equals maximum lifespan	25	Gibbons are assumed to be able to reproduce their entire adult life. The estimated maximum age of 25 is based on several studies done on captive gibbons (Supriatna et al., 1994; Hodgkiss et al., 2009).
Sex ratio at birth (% males)	50	There is not any data on sex ratio for wild gibbons (Supriatna et al., 1994).
Mortality rates for all ages, female and males	10 ± 3 for age 0-1/7-8; 5 ± 1 for every other age class	Mortality rates are equivalent to those used in the 1994 PVA (Supriatna et al., 1994) for both females and males for all scenarios.

Area-specific scenarios

In the model, I assume all three populations to be independent of one another and subject to similar environmental factors, albeit at potentially different rates of intensity as indicated in the scenarios. I included rates of deforestation and hunting (i.e., removal of gibbons for the illegal pet trade) as those parameters that can be influenced by management practices or a change in human behaviour, and specific to each area. Without definitive data indicating how many Javan gibbons are removed from the forest annually for the illegal pet trade, all estimates of hunting (modelled as *Harvest* in Vortex) are *estimated***.** I modelled habitat loss (modelled as *Deforestation* in Vortex) as an annual percentage decrease in carrying capacity (=K*(proportion of previous year's forest cover remaining ^ year)), and the percentage is based on estimated rates of annual forest loss (1% annually) in each area (Nijman, 2004). Importantly, the different scenarios modelled provide insight to the probable outcome of failing to implement any conservation management actions in each of the designated areas in the immediate future.

Demographic sensitivity testing

To investigate uncertainty surrounding the baseline input values, I carried out demographic sensitivity testing on select variables. Sensitivity testing involves modelling a range of values for a given input parameter to determine the impact of imprecision in that variable on the model projections (Bryant, 2014). More importantly, it reveals the sensitivity of the model to the different model parameters, indicating which factors are key in determining Javan gibbon population dynamics, and thus which demographic variables have the greatest impact on the long-term viability of the population (Bryant, 2014).

It is rare for a population of endangered species to experience only one threatening process; typically, it is a complex combination of threats that causes the eventual decline for many

threatened species (Bryant, 2014). Therefore, to test sensitivity of select demographic variables that may cause a decline in Javan gibbon populations, I tested higher rates of mortality (which could arise from disease or less food availability), and each population was subjected to increased rates for both infant and dispersing gibbons (age groups 0-1 and 7-8 years; mortality rates 15 ± 4%/20 ± 5%), as it is assumed those are the two age ranges that would be the most sensitive to extreme environmental pressures and stochastic events.

Reduced genetic diversity can have direct implications for the long-term survival of a declining population, and if species are found only in small, isolated populations, loss of genetic variation can result in reduced ability to withstand sudden changes in the environment, compromised resistance to disease, and reduced survival and reproductive fitness of offspring ('inbreeding depression') (Soulé et al., 1986, Soulé, 1987; Bryant, 2014). Currently, there is no data on inbreeding depression on Javan gibbons in the wild; however, I tested the effect of inbreeding on the populations for sensitivity purposes (3.14; 50% due to lethal alleles) in both baseline scenarios. It has been suggested that with relatively large population sizes (>100), as was modelled in this PVA, inbreeding depression will most likely have very little effect on the final outcome of the model (Nilsson, 2003; R. Lacy in litt., 2016). Kheng et al. (2017) analysed data on the phylogeography and population genetic structure of Javan gibbons from three different studies (see Andayani et al., 2001) and found that there was no clear relationship between genetic diversity and estimated gibbon population size or remaining forest area. With respect to the conservation and management of Javan gibbons, the most encouraging aspect of Kheng et al. (2017) study was the finding of sufficient levels of genetic variation both in mtDNA and nDNA, comparable to other gibbons, and no indications of a substantial loss of nDNA variation in the species as a whole (Nijman et al., 2019).

Reintroduction is the primary conservation effort for Javan gibbons in the western part of the island; therefore, in an attempt to test the potential impact releasing individuals into the

wild will have on the long-term survivability of populations, I simulated a reintroduction scenario for each of the populations. VORTEX assumes that the individuals that are being added to the recipient population are unrelated to both each other and to any other individual in the recipient population. Consequently, supplementation (i.e., reintroduction) is a means of increasing genetic diversity as well as total number of individuals within the population (Bach et al., 2010). At present, gibbons have not yet been released into any of the populations included in this analysis, but could prove to be suitable release sites in the future. For the analysis, I modelled one pair (1 adult female; 1 adult male) reintroduced into each population each year over the next 10 years.

Results

Baseline scenarios

The baseline model predicted a declining population trend for each population of Javan gibbons (Fig 3.3; Table 3.3). The modelling, which incorporated minimal levels of annual hunting (4 individuals: 2 adult females/2 juveniles from Ujung Kulon; and 8 individuals: 4 adult females/4 juveniles from Halimun-Salak and Dieng Mountains) and habitat loss (1% annual deforestation) indicated moderately high to low levels of extinction within 100 years in Ujung Kulon (18 and 68.8 % probability for the high and low carrying capacity scenarios respectively), Halimun-Salak (5.8 and 26.2 %), and Dieng Mountains (18.6 and 66.0 %). The model resulted in a positive deterministic growth rate of 0.011, indicating an annual growth rate of around 1.1% per year. This is the average growth that could be expected with minimal impact from stochastic processes and extrinsic threats, based upon the specified rates of fecundity and mortality within the model, and therefore indicates the growth potential of the population under (assumed) present conditions on Java. This deterministic annual growth rate

is roughly in line with that observed for other species of *Hylobates* (range 1.2 - 1.5%; Supriatna et al., 1994; Tunhikorn et al., 1994), and only slightly less than *Hoolock* and *Nomascus* (3.7%; 2.6% respectively) (Molur et al., 2005; Traeholt et al., 2005; Bryant, 2014).

Table 3.3. Results from the baseline scenarios (500 iterations over 100 years) for three independent Javan gibbon populations on Java. Initial N: initial population size (for Ujung Kulon and Halimun-Salak the average between the low and high population estimate was used for analysis); Carrying Capacity (N=K) and increased carrying capacity; PE: probability of extinction; TE: mean number of years to extinction; Stoc-r: mean growth rate (mean stochastic population growth/decline rate); N-extant: mean number of individuals not extinct after 100 yr.; GD: genetic diversity or the mean 'expected heterozygosity' remaining in the extant populations; SD: standard deviation; Det-r for all three populations: 0.011.

Site & Scenario	***PE (%)***	***TE (Yrs)***	***Stoc-r ± SD***	***N-extant ± SD***	***GD ± SD (%)***
Ujung Kulon (Initial N = **430**)					
Low K (=430)	68.8	83.1	-0.028 ± 0.068	65 ± 40	96.3 ± 1.2
High K (=817)	18.0	84.2	-0.011 ± 0.060	199 ± 84	98.0 ± 1.0
No hunting or deforestation (low K)	0	0	0.009 ± 0.054	388 ± 47	98.5 ± 0.2
No hunting or deforestation (high K)	0	0	0.008 ± 0.054	427 ± 51	98.6 ± 0.2
Deforestation only (low K)	0	0	0.008 ± 0.055	149 ± 12	97.5 ± 0.3
Hunting only (low K)	34.6	82.7	-0.016 ± 0.063	204 ± 123	97.7 ± 1.0
Halimun-Salak (Initial N = **1060**)					
Low K (=1060)	26.2	90.7	-0.018 ± 0.061	190 ± 99	98.6 ± 0.5
High K (=3846)	5.8	88.6	-0.001 ± 0.060	992 ± 425	99.4 ± 0.3
No hunting or deforestation (low K)	0	0	0.009 ± 0.053	970 ± 109	99.4 ± 0.1
No hunting or deforestation (high K)	0	0	0.009 ± 0.053	2738 ± 868	99.6 ± 0.1
Deforestation only (low K)	0	0	0.009 ± 0.053	373 ± 22	99.0 ± 0.1
Hunting only (low K)	7.4	87.7	-0.007 ± 0.057	590 ± 298	99.1 ± 0.4
Fragmented population	22.6	92.3	-0.024 ± 0.052	105 ± 55	97.4 ± 1.0
Fragmented population, no hunting or deforestation	0	0	0.008 ± 0.032	909 ± 74	99.4 ± 0.1
Dieng Mountains (Initial N = **850**)					
Low K (=850)	66.0	83.6	-0.030 ± 0.070	110 ± 64	98.0 ± 0.7
High K (=1298)	18.4	83.1	-0.013 ± 0.060	296 ± 126	98.9 ± 0.4
No hunting or deforestation (low K)	0	0	0.009 ± 0.053	775 ± 85	99.3 ± 0.1
No hunting or deforestation (high K)	0	0	0.010 ± 0.053	1184 ± 135	99.5 ± 0.1
Deforestation only (low K)	0	0	0.009 ± 0.053	295 ± 20	98.7 ± 0.1
Hunting only (low K)	32.0	82.5	-0.016 ± 0.061	395 ± 230	98.9 ± 0.4

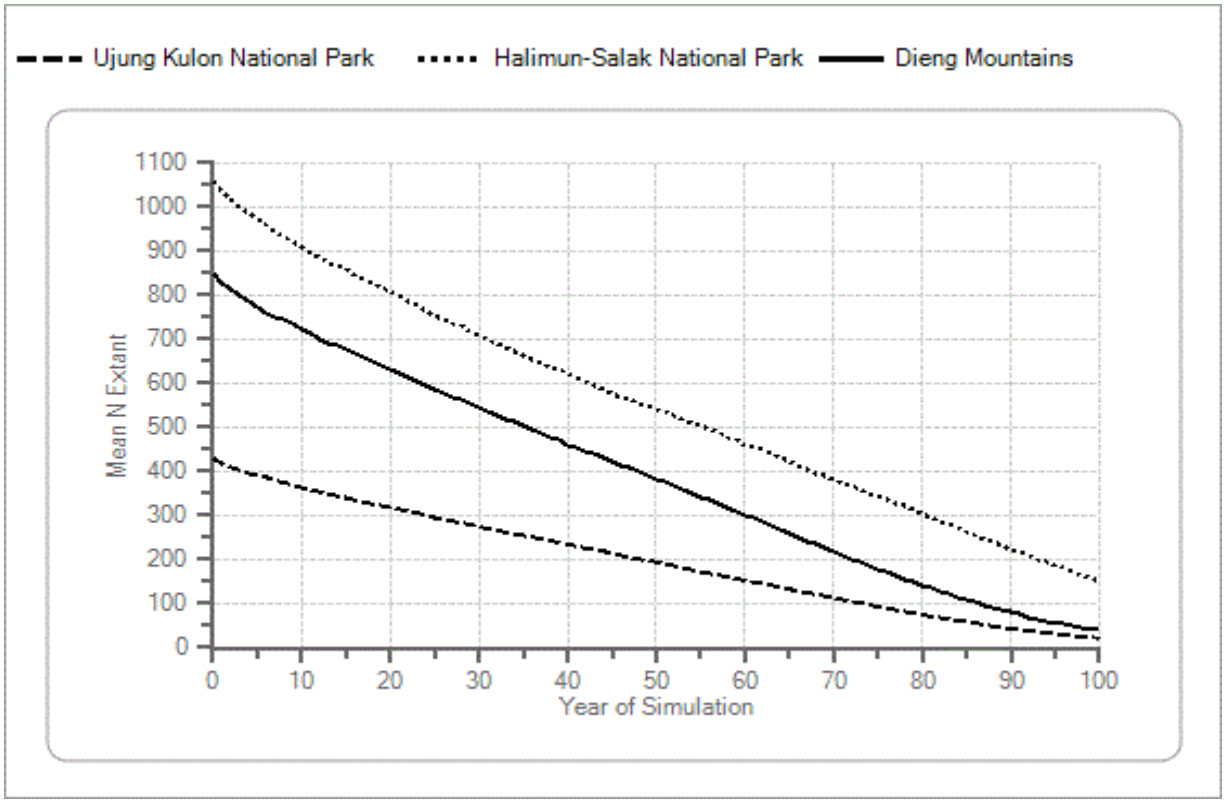

Fig. 3.3. Baseline scenario run for 500 iterations representing 100 years showing the mean number of extant individuals for the three independent populations. *Deforestation*: -1.0% annually; *Hunting*: Ujung Kulon: 2 infants/2 adult females; Halimun-Salak: 4 infants/4 adult females; Dieng Mts.: 4 infants/4 adult females. **Low K** (carrying capacity is equal to initial population size N=K).

Increasing the carrying capacity in each population within the baseline scenario reduces the probability of extinction over the next 100 years; however, there still remains almost a 20% chance of extinction in both Ujung Kulon and Dieng Mountains (Figure 3.4). The population in Halimun-Salak remains relatively more stable with only a 5.8 % chance of becoming extinct in the next 100 years (Table 3.3).

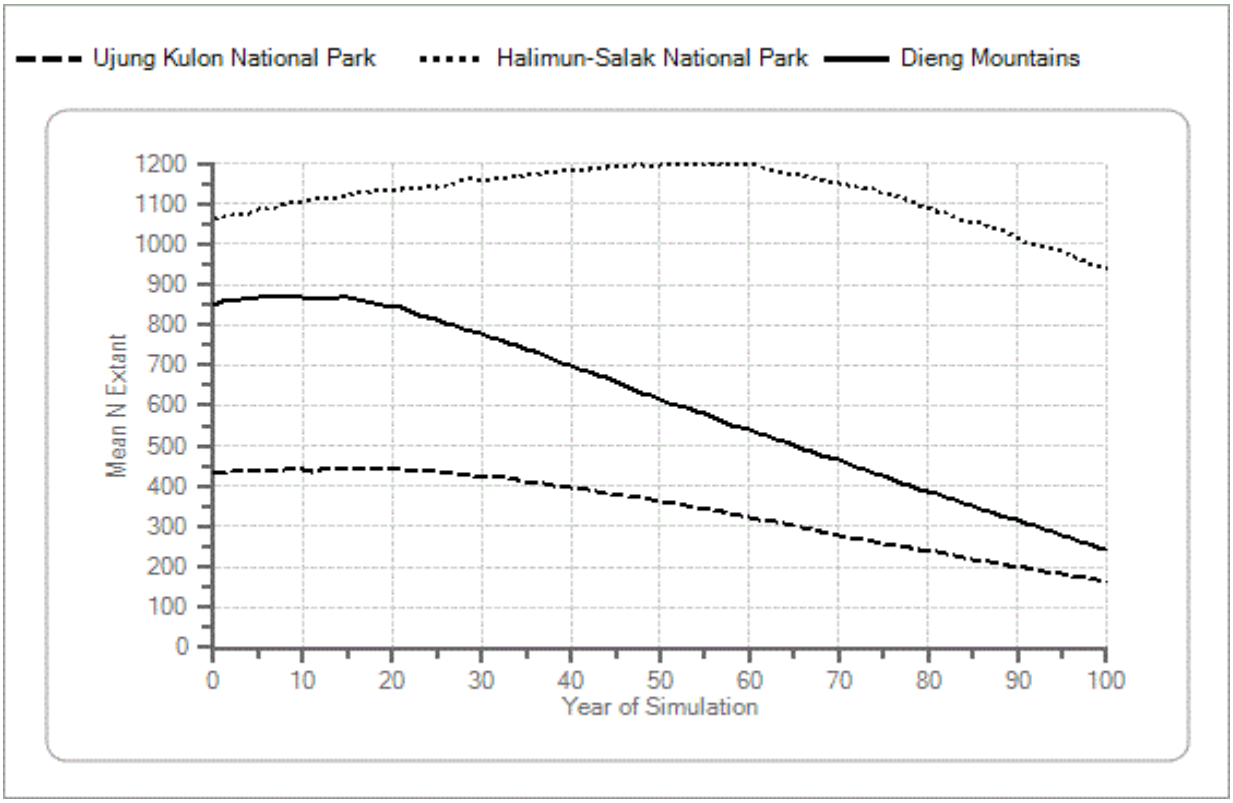

Fig. 3.4. Baseline scenario run for 500 iterations representing 100 years showing the mean number of extant individuals for the three independent populations. *Deforestation*: -1.0% annually; *Hunting*: Ujung Kulon: 2 infants/2 adult females; Halimun-Salak: 4 infants/4 adult females; Dieng Mts.: 4 infants/4 adult females. **High K** (total estimated habitat available for Javan gibbons in each area divided by the average exclusive territory range of one group, then multiplied that by the average group size (Fan et al., 2013).

When the three modelled populations of Javan gibbons are considered together (i.e., the metapopulation; could be useful for conservation management decisions) and they exist at carrying capacity, there is a 11% chance of extinction during the next 100 years (Figure 3.5). However, if there are more Javan gibbons in the western and central part of the island than presumed, or if more are reintroduced from rescue centres, the likelihood of extinction may potentially decrease.

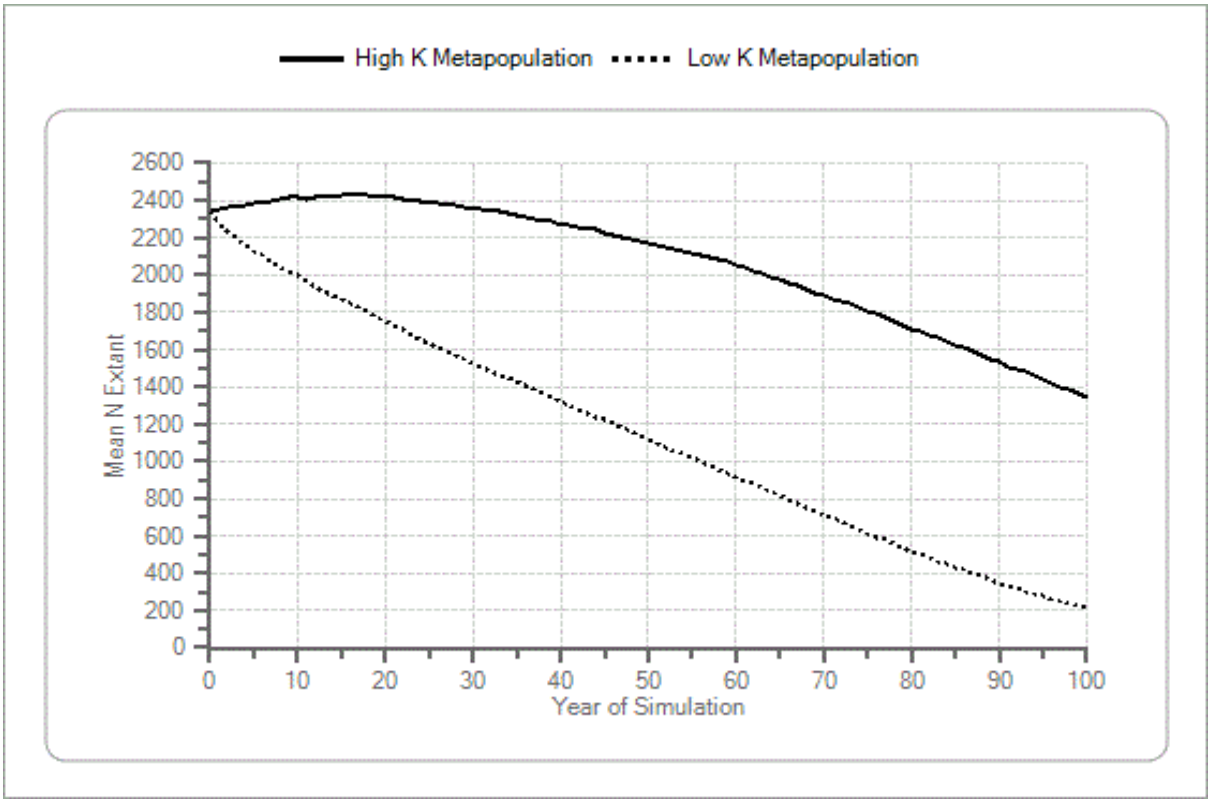

Fig. 3.5. Results from the baseline scenarios (Low and High K) representing all three populations modelled as one Metapopulation (N=2,340).

Demographic sensitivity testing

The baseline model showed uncertainty in projections, particularly when rates of mortality at the 0-1 (infant) and 7-8 (dispersal) age groups were increased, and just slight variation if the populations were subjected to an inbreeding depression (3.14: 50% lethal alleles). Higher rates of mortality led to increased risk of extinction and a significantly reduced deterministic growth rate (det-r), at both the low and high carrying capacities. If the mortality rate for infant and dispersing gibbons was set to 15%, the growth rate dropped from 1.1% to 0.36%; at 20% the growth rate drastically drops to -0.44%. Therefore, all three Javan gibbon populations, whether they occur at either the low or high carrying capacity, have a high chance of going extinct within the next 100 years (Table 3.4; Figure 3.6). The gibbons of Halimun-Salak have the best chance of persisting as the rate of extinction is just over 50%. Projections indicated that if dispersal mortality does not reach 20%, then the viability of the population

would remain stable and probability of extinction would decrease significantly in each population.

Table 3.4. Results from baseline scenarios (Low and High K) testing the effect of high mortality rates (age groups 0-1 and 7-8 years: 15 ± 4% and 20 ± 5%) on each individual population.

	PE (%)			Stoc-r (SD)		
	Baseline 10%	**High Mortality 15% (det-r 0.36)**	**High Mortality 20% (det-r -0.44)**	**Baseline 10%**	**High Mortality 15%**	**High Mortality 20%**
Ujung Kulon						
Low K	68.8	97.6	99.6	-0.028 ± 0.068	-0.044 ± 0.075	-0.050 ± 0.075
High K	18.0	85.2	99.4	-0.011 ± 0.060	-0.040 ± 0.072	-0.050 ± 0.074
Halimun-Salak						
Low K	26.2	80.0	96.2	-0.018 ± 0.061	-0.038 ± 0.070	-0.045 ± 0.070
High K	5.8	55.6	83.2	-0.003 ± 0.055	-0.030 ± 0.067	-0.041 ± 0.070
Dieng Mountains						
Low K	66.0	99.2	99.8	-0.028 ± 0.066	-0.045 ± 0.072	-0.050 ± 0.072
High K	18.4	81.6	96.0	-0.013 ± 0.060	-0.039 ± 0.070	-0.047 ± 0.072

As predicted with larger populations, the effect of an inbreeding depression did not have a significant impact on the population viability of any of the three Javan gibbon populations. The risk of extinction was just slightly greater when the populations were at a lower carrying capacity; however, the likelihood of extinction within 100 years is still low (Table 3.5; Fig. 3.6).

Table 3.5. Results from the baseline scenarios (Low and High K) testing the effect of inbreeding depression 3.14: 50% lethal equivalents) on each individual population.

	PE (%)		Stoc-r (SD)	
	Baseline 0.0	**Inbreeding 3.14**	**Baseline 0.0**	**Inbreeding 3.14**
Ujung Kulon				
Low K	68.8	73.6	-0.028 ± 0.068	-0.029 ± 0.69
High K	18.0	24.2	-0.011 ± 0.060	-0.013 ± 0.061
Halimun-Salak				
Low K	26.2	27.0	-0.018 ± 0.061	-0.018 ± 0.060
High K	5.8	5.9	-0.003 ± 0.055	-0.002 ± 0.055
Dieng Mountains				
Low K	66.0	68.0	-0.028 ± 0.066	-0.028 ± 0.066
High K	18.4	21.6	-0.013 ± 0.060	-0.014 ± 0.060

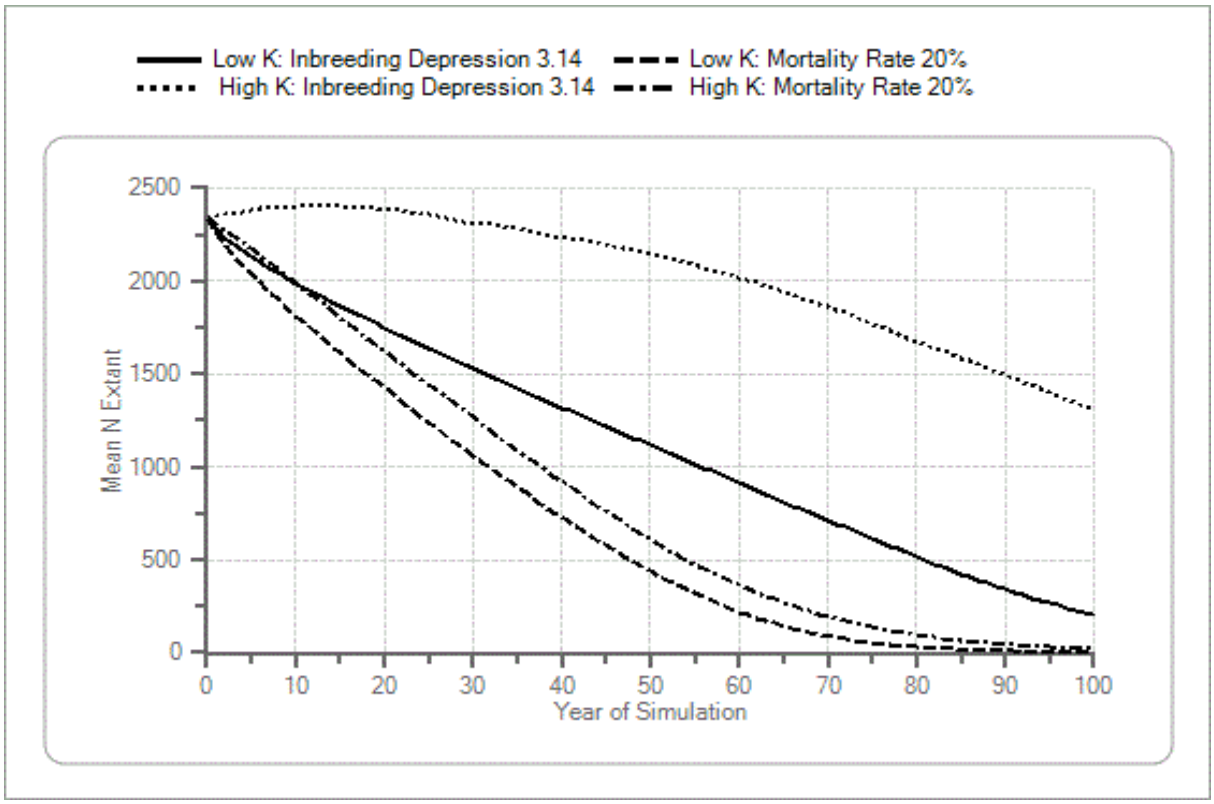

Fig. 3.6. Results from the baseline scenarios (Metapopulation: Low and High K) showing the effect of inbreeding depression (3.14; 50% lethal alleles) and high mortality rates (20 ± 5% for the age groups 0 -1 and 7-8 years).

If one pair (1 adult female: 1 adult male) are introduced into each population every year over the next 10 years, the risk of extinction for Ujung Kulon and Halimun-Salak only very slightly decreases (~ < 2.5%; Table 3.6; Fig. 3.7). The risk of extinction of wild Javan gibbons in Dieng Mountains actually increases by 2% if the population is at carrying capacity (Low K), and decreases at a higher carrying capacity (High K). In addition, the genetic diversity remains high in each population for each scenario (Low K and High K) at an average of 99%.

Table 3.6. Results from the baseline scenarios (Low K and High K) simulating the supplementation of individuals (via reintroduction) into each population (two pairs of adult gibbons each year for 10 years).

	PE (%)		**Stoc-r (SD)**	
	Baseline	**Reintroduction**	**Baseline**	**Reintroduction**
Ujung Kulon				
Low K	68.8	66.6	-0.028 ± 0.068	-0.026 ± 0.069
High K	18.0	17.2	-0.011 ± 0.060	-0.010 ± 0.060
Halimun-Salak				
Low K	26.2	24.2	-0.018 ± 0.061	-0.018 ± 0.061
High K	5.8	4.6	-0.003 ± 0.055	-0.001 ± 0.055
Dieng Mountains				
Low K	66.0	68.2	-0.028 ± 0.066	-0.029 ± 0.067
High K	18.4	16.6	-0.013 ± 0.060	-0.012 ± 0.059

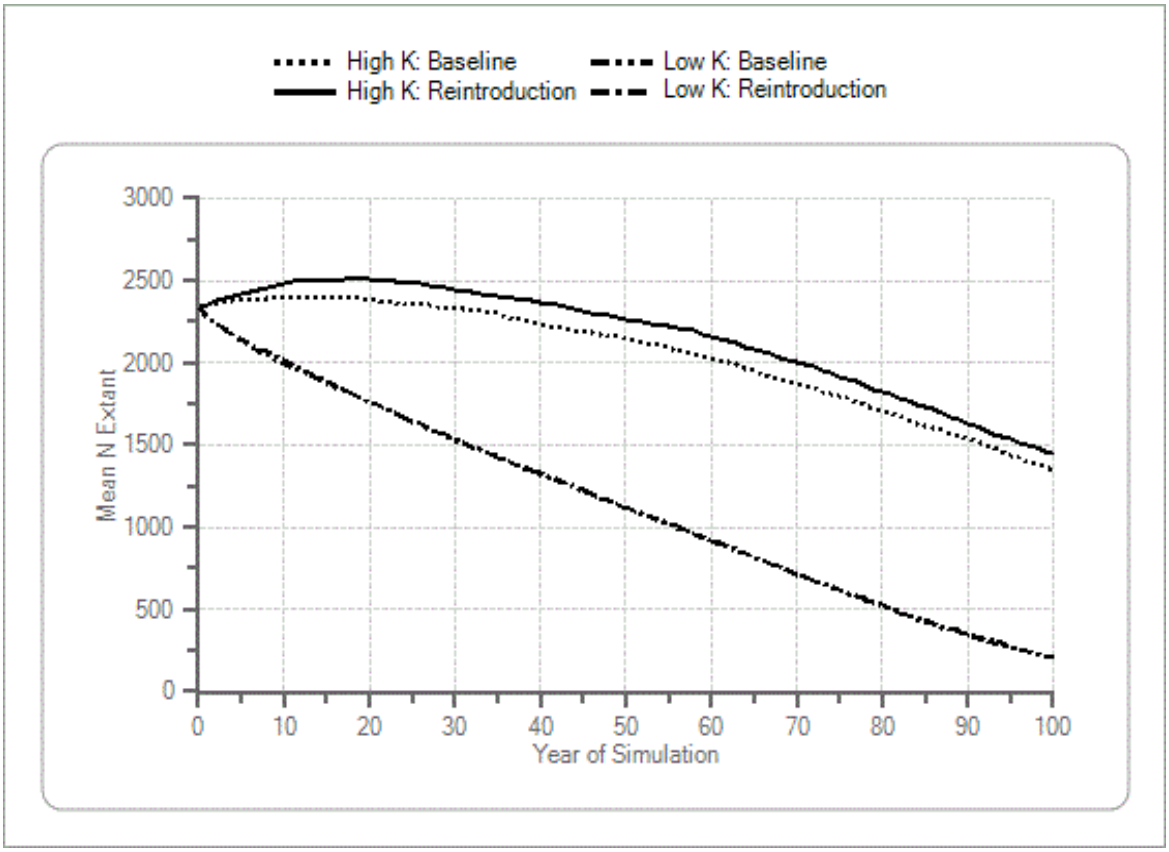

Fig. 3.7. Results from the baseline scenarios (Metapopulation: Low and High K) showing the impact reintroduction of one pair (1 adult female: 1 adult male) will have on each population over the next 10 years.

Area-specific scenarios

The results from the PVA model show that if any of the populations of Javan gibbons living in Ujung Kulon, Halimun-Salak, and Dieng Mountains are *not* subjected to high rates of hunting or deforestation, they will remain stable and are likely to persist for the next 100 years (refer to Table 3.3). The modelling demonstrates the importance of initiating site-specific conservation programmes, as each population is sensitive to varying levels of threats (i.e., rates of hunting and/or deforestation) and may respond differently to different conservation strategies.

Given the lack of data regarding the level of annual removal of gibbons for the illegal pet trade occurring in each of the areas, I used relatively low levels of hunting in the modelling. If hunting is occurring at the simulated rate as modelled in the baseline scenario, the population

of Javan gibbons living in Ujung Kulon will be safe from extinction for the next the next 80 years (refer to Table 3.3). However, if the rates of hunting are actually much higher than we know and up to 12 Javan gibbons (6 adults and 6 juveniles) are removed from the wild, the population will inevitably become extinct within 47 years (Table 3.7). Modest rates of deforestation, in the order of 1.2% annually over the 100-year period, leads to a decline in the population with only 135 individuals surviving. Therefore, if higher rates of hunting are occurring and more Javan gibbons are being removed from the wild each year, the rate of extinction will be exacerbated and inevitable if there is also a persistent rate of deforestation, with the population of Javan gibbons living in Ujung Kulon going extinct within the next 45 years.

If the population of Javan gibbons in Halimun-Salak is fragmented, and consists of smaller subpopulations such as modelled, and the rates of hunting and deforestation are persistent for the next 100 years, each subpopulation will suffer a drastic decline, with the three smallest subpopulations going extinct within the next 100 years (refer to Table 3.7). One of the subpopulations (N = 25) will become extinct within just 10 years, and is significantly unstable with a stoc-r value of -0.157. The population as a whole (N = 1,060) suffers a gradual decline decreasing to a final population of just 114 individuals in 100 years. However, if deforestation and hunting are eliminated, the population of Javan gibbons has a high probability of surviving through the next 100 years, even if the population exists in fragmented, smaller populations.

Given Dieng Mountains is largely unprotected and currently there is not any available data with regards to the levels of hunting occurring in the area, I modelled two different scenarios with varying levels of hunting and deforestation. In the scenarios where a fairly high level of hunting is modelled (12 individuals removed annually) the population suffers a steady decline and becomes extinct within 83 years (PE = 43%), and when even more individuals are removed from the population annually, the populations will become extinct within 45 years

(Table 3.7). When hunting is coupled with a moderate, but constant rate of deforestation (1.2% per year), the population will inevitably become extinct within 45 years (83 years if only 12 individuals are removed), if rates of hunting remain high (24 individuals removed annually).

Table 3.7. Results from area-specific scenarios for Ujung Kulon, Halimun-Salak, and Dieng Mountains. PE: probability of extinction; TE: mean number of years to extinction; Stoc-r: mean growth rate (mean stochastic population growth/decline rate); N-extant: mean number of individuals which are not extinct after 100 yr.; GD: genetic diversity or the mean 'expected heterozygosity' remaining in the extant populations; SD: standard deviation. Det-r for all three populations: 0.011.

Site & Scenario	PE (%)	TE (yrs)	Stoc-r ± SD	N-extant ± SD	GD ± SD (%)
Ujung Kulon: Higher carrying capacity (K=473)					
No hunting or deforestation	0	0	0.008 ± 0.053	424 ± 55	98.6 ± 0.2
Deforestation (1.2%)	0	0	0.007 ± 0.056	135 ± 10	97.4 ± 0.3
Hunting (6 adults (4F 2M/6 infants)	100	46.7	-0.070 ± 0.095	0 ± 0	0 ± 0
Deforestation and hunting	100	44.7	-0.073 ± 0.098	0 ± 0	0 ± 0
Halimun-Salak: Fragmented populations (-2 AF, -2 Juv; 1% Deforestation)					
Subpopulation 1 (N=25)	100	7.5	-0.157 ± 0.087	0 ± 0	0 ± 0
Subpopulation 2 (N=500)	27.6	91.6	-0.020 ± 0.064	111 ± 44	97.0 ± 1.0
Subpopulation 3 (N=145)	100	33.7	-0.067 ± 0.080	0 ± 0	0 ± 0
Subpopulation 4 (N=315)	94.4	73.3	-0.040 ± 0.073	43 ± 27	94.9 ± 1.6
Subpopulation 5 (N=75)	100	17.7	-0.092 ± 0.076	0 ± 0	0 ± 0
Metapopulation (N=1,060)	26.0	93.7	-0.024 ± 0.052	114 ± 54	97.4 ± 1.0
No hunting or deforestation					
Subpopulation 1 (N=25)	43.0	72.8	-0.012 ± 0.109	12 ± 7	64.9 ± 17.8
Subpopulation 2 (N=500)	0	0	0.009 ± 0.054	449 ± 55	98.7 ± 0.1
Subpopulation 3 (N=145)	0	0	0.006 ± 0.058	119 ± 24	95.3 ± 1.0
Subpopulation 4 (N=315)	0	0	0.008 ± 0.055	282 ± 36	98.0 ± 0.3
Subpopulation 5 (N=75)	0	0	0.002 ± 0.067	53 ± 17	90.1 ± 4.0
Metapopulation (N=1,060)	0	0	0.008 ± 0.032	909 ± 74	99.4 ± 0.1
Dieng Mountains: High levels of hunting (N=850; K=935)					
Hunting (6 adults/6 infants = 12)	43.4	82.4	-0.024 ± 0.071	390 ± 263	98.8 ± 0.7
Hunting (12 adults/12 infants = 24)	100	45.2	-0.070 ± 0.092	0 ± 0	0 ± 0
Deforestation (1.2%), no hunting	0	0	0.009 ± 0.053	269 ± 15	98.7 ± 0.1
Deforestation and hunting (1.2% and 12 ind.)	83.2	82.9	-0.040 ± 0.082	72 ± 55	97.2 ± 1.5
Deforestation and hunting (1.2% and 24 ind.)	100	45	-0.073 ± 0.094	0 ± 0	0 ± 0

*Carrying capacity (K) for Ujung Kulon, Halimun-Salak, and Dieng Mountains 10% increase in N.

Discussion

The results of the PVA model developed in this study will hopefully provide insight for future conservation planning to preserve populations of Javan gibbons in the wild. I selected three of the largest known populations of gibbons to include in the PVA model; however, there still remains several smaller, more isolated populations on the island that need to be considered for conservation management. If the populations of Javan gibbons living in Ujung Kulon, Halimun-Salak, and Dieng Mountains are left as they are, with no active conservation management, each population is potentially at risk of becoming extinct within the next 100 years. The probable time to extinction and the likelihood of extinction are dependent upon the complexity and level of threats we consider each of the populations to be subject to, and the metapopulation (in the wild) must also be taken into consideration when determining the fate of the species.

If the current situation on Java remains unchanged (i.e., rates of deforestation and hunting remain relatively low and do not increase in the future), and if the current population estimates for the modelled populations are indeed accurate (or as close to approximation), there is time to enact serious conservation management schemes to ensure extinction does not occur within the next century. Each population of Javan gibbons is subject to different conservation issues and pressures, and may respond differently to various management scenarios; therefore, it is crucial to develop conservation strategies that are based on the characteristics and trends of individual populations and their habitat. Furthermore, in the future, creating PVA models for individual forest reserves, national parks, or even the metapopulation, could provide more useful and directed results than an island-wide model, and may assist the authorities in the direction needed to improve species and site management, and guide conservation funding.

Reintroduction of Javan gibbons is currently the primary effort utilised in conservation efforts on Java, and currently only in the western part of the island. Approximately 30 Javan

gibbons have been released into select forest areas in West Java (see Chapter 5) since 2009 between the two rescue centres (JGC and TAF), and more gibbons are currently undergoing rehabilitation for future release. To date (and to the best of my knowledge), there have not been any Javan gibbons released into the three forest sites modelled in this PVA; however, as the overall programme develops and more gibbons are ready for reintroduction, the centres may need to find additional sites to release gibbons (currently each centre focuses roughly on one area each in Bandung: JGC - Mt. Puntang/Malabar Mountain and TAF - Mt. Tilu Nature Reserve), and the forests of Ujung Kulon, Halimun-Salak, and potentially Dieng Mountains (if protection of Javan gibbons could be strictly enforced), could prove to be suitable areas for future release efforts. It should be acknowledged, according to the PVA results, the addition of just one pair of adult gibbons every year for 10 years did not significantly reduce the likelihood of extinction for any of the three populations in Ujung Kulon, Halimun-Salak, and Dieng (High K). Interestingly, when the population in Dieng is at carrying capacity (Low K) the likelihood of extinction actually increases by 2%. It is difficult to say why exactly this is, but with such a minimal amount, this outcome does not likely impact the risk of extinction over the next 100 years. Furthermore, with such a small decrease in extinction risk, should conservation efforts be redirected elsewhere (i.e., increased protection of remaining habitat, stricter law enforcement and regulation, and elimination of the illegal pet trade) rather than focusing on reintroduction entirely? It is difficult to determine the impact reintroduction of former-pet gibbons will have on the wild population in the long-term.

Area specific scenarios

Ujung Kulon National Park

Due to the presence of Javan rhinos on the peninsula, it is assumed active protection of the national park is above average when compared to other protected areas on the island of

Java. Considering the higher level of protection in the park, and its remote location far removed from any urban centres, the hunting of Javan gibbons is assumed to be low; however, there is not any available data to substantiate this. While forest loss on the peninsula is negligible, the lower parts of Mt. Honje are subject to small-scale logging (Whitten et al., 1996; V. Nijman, pers. comm.). Primary forest remains on Mt. Payung in the west of the park, and currently there are no Javan gibbons living there, thus potentially making it an ideal area for future population increase (either through natural dispersal or reintroduction) (Kappeler, 1984). Therefore, if the high level of protection and relative inaccessibility is maintained in Ujung Kulon, and if Javan gibbons manage to disperse to Mt. Payung or if this area is used as a future reintroduction site thereby increasing the habitat, then the population of Javan gibbons in Ujung Kulon will have a high probability of surviving without human intervention.

Halimun-Salak National Park

Halimun-Salak is relatively well-managed, however, the park remains under pressure from human encroachment and low levels of deforestation (Nijman, 2015). Indigenous Kasepuhan people live on the southern and northern borders of the park and depend on its natural resources (Whitten et al., 1996). In addition, the park (along with the better-known neighbour, Gunung Gede-Pangrango National Park) is an important watershed for western Java, including the major urban conglomerates such as Jakarta, Bogor, Tangerang, and Bekasi. Within the park there are several large enclaves including plantations, villages, and the Nirmala tea plantation which spans approximately 10 km^2 (1,000 ha) (Kim et el., 2010; Nijman, 2015). High mountains and plantations throughout the park may potentially result in a higher degree of fragmentation with varying levels of connectivity between forest patches; therefore, Javan gibbons living in the park may reside in isolated populations and each population may need to be managed differently, or at least conservation management should include creating forest corridors where possible to allow Javan gibbons to disperse efficiently between forest patches.

Dieng Mountains

Numerous communities of people live inside and adjacent to the forests, all relying to some degree on it for their livelihood, thus inevitably placing continuous pressure on natural resources in the area. In addition, Dieng Mountains are situated near, and are well-connected to, the large urban centres along Java's north coast. The forests surrounding Dieng Mountains are largely unprotected leaving the populations of Javan gibbons living in these areas potentially at greater risk of being hunted for the illegal pet trade. Therefore, levels of hunting are expected to be higher than in Ujung Kulon and Halimun-Salak National Parks. Furthermore, considering the area is unprotected, the forest is more at risk for fire due to small-scale clearing of land for agriculture. These threats need to be addressed and considered when devising an action plan for Javan gibbon conservation policies.

Demographic sensitivity

The higher level of mortality at dispersal is a key factor that can alter the viability of any population of Javan gibbons. This supports the concern about this being a critical life stage for young gibbons, and therefore a potential limiting factor constraining population growth (Bryant, 2014). When the mortality rate was set to 20%, the population growth rate became acutely negative, indicating that the population would almost certainly rapidly decline to extinction if mortality gets this high, even in the absence of other threats. With lower dispersal age mortality, closer to that reported for other gibbon populations (15%; Traeholt et al., 2005; Bryant, 2014), the risk of extinction was lower, however the growth rate dropped substantially lower (0.36 for 15%; -0.44 for 20%) than the baseline det-r of 1.1 %.

Conservation implications

Fortunately, rates of deforestation on the island of Java have slowed in recent years, though small-scale land clearing still poses a threat to both protected and unprotected areas where populations of Javan gibbons are still found (Nijman, 2004), and the expanding human population will continue to put pressure on the forests across the island, as communities adjacent to and within these areas are somewhat dependent on the forest for resources (i.e., food, fuel, medicinal plants) (Supriatna et al., 1994). Deforestation may have a significant impact on the population size, particularly if populations already exist at carrying capacity. Fan et al. (2013) found carrying capacity to be the limiting factor for the Cao-vit gibbon *(Nomascus nasutus*) in their PVA model, and concluded the current population would reach its limit within the next 40 years. According to this PVA model, the three Javan gibbon populations are at great risk of becoming extinct if hunting and deforestation rates continue at the modelled rate. However, all three populations are still large enough to persist and maintain high genetic diversity over the next 100 years if deforestation and hunting can be minimised. If it is possible to increase available habitat (i.e., create corridors connecting forest fragments), and prevent the further defragmentation of remaining forest, and finally, control the threat of hunting, as the best improvements to population viability occurred under situations in which these threats were controlled, specifically hunting.

If Javan gibbons exist in populations of fewer than ~100 individuals, such as those modelled in the fragmented population scenarios for Halimun-Salak (N = 25;75), they are more sensitive to increased levels of annual hunting and persistent rates of deforestation, as well as higher rates of mortality and loss of genetic diversity, and thus are at a great risk of extinction. Therefore, smaller populations would benefit from increased protection, as well as potential periodic genetic supplementation via translocation. The Hainan gibbon (*Nomascus hainanus*) is considered to be one of the rarest mammals living today, yet has persisted for over 30 years

at a relatively low population size consisting of approximately 26 individuals without human intervention (Bryant et al., 2016).

Subpopulations of up to at least 500 Javan gibbons residing in habitat capable of sustaining larger populations would benefit from increased protection, and could potentially expand in numbers by natural reproduction with potentially no need of supplementation from other sources (i.e., translocation) (Supriatna et al., 1994). By implementing various management strategies to decrease hunting and deforestation (such as more stringent forest patrol by rangers and an increase in local awareness regarding the protected status of Javan gibbons and the illegality of keeping gibbons as pets), the declining population trend could possibly be slowed, perhaps reversed, and the population could become more stable through the years. All populations of Javan gibbons would benefit from constant and persistent monitoring and increased habitat protection.

This PVA model illustrates how the removal of Javan gibbons from the wild for the illegal pet trade has a significant impact on the long-term survival of populations. Therefore, this threat should not be underestimated and should be regularly monitored, assessed, and controlled (see Chapter 4). The number of Javan gibbons openly offered for sale in the wildlife markets on Java has declined significantly over the last 25 years (Nijman et al., 2015), and while in the past Javan gibbons were ubiquitously present in the markets, currently they are very rarely seen (V. Nijman; pers. comm.). Whether or not this means the number of Javan gibbons extracted from the wild has declined at a similar rate is unknown, as we still see a relatively high number of individuals, particularly infants, coming into rescue centres (pers. obs; V. Nijman, pers. comm.); however, we have no evidence of where on the island people are actually poaching the gibbons from. There is evidence that gibbons are being traded online via different social media platforms, with traders openly selling infant Javan gibbons on social media (see Chapter 3; TRAFFIC, 2016), so it would seem the illegal trade network is shifting

from open markets to online forums. Unfortunately, this creates a more complex trade network that is much more difficult to monitor and enforce regulations. It was clear from the hunting threat model that removal of individuals from the population annually would greatly jeopardise the viability of the current population, both in isolation and when imposed in combination with other threats.

Javan gibbons rescued from the illegal pet trade have been thus far successfully reintroduced (though still be determined) into the wild (see Chapter 5) (pers. obs; Cheyne, 2009), and rigorous release criteria have been developed (Cheyne and Brulé, 2004) for the rehabilitation and release of *Hylobates* spp., including Javan gibbons (Cheyne, et al. 2012); however, if the forests of Java continue to disappear, there will be very little, if any, suitable habitat remaining to release Javan gibbons into. In addition, though there are isolated populations of Javan gibbons, translocation (i.e., specifically moving individuals between populations) has not yet been considered.

Chapter conclusion

In light of more recent survey data collected over the past two decades indicating that large, viable populations of Javan gibbons still persist on the island (Asquith, 2001), and with the PVA model in this study highlighting the fact that large populations (greater than 400) are viable and relatively safe from extinction over the next 100 years, these populations require protection from deforestation, fragmentation of remaining forest, and hunting to ensure their survival in the long-term. Despite the widespread belief that the island of Java is completely deforested, significant forest areas do still remain intact, and should receive higher protection, thus benefiting a diverse range of endemic flora and fauna (Nijman, 2004). Additionally, a large proportion of the Javan gibbon population has survived outside of the protected area

network in poorly protected forests in central Java; one of the greatest contributions to the survival of Javan gibbons, and should be a conservation priority, would be to increase the protection and preservation of the forests in central Java (as well as the western half). The model illustrates that hunting for the illegal pet trade has a significant impact on populations of Javan gibbons, and is a major threat to the viability and survival of even the largest populations on the island. Therefore, increased collaboration between social media networks, wildlife agencies/rescue centres, and law enforcement agencies should be a priority in order to improve detection of illegal trade on social media platforms, and to ensure that prolific dealers in the trade network are targeted in a coordinated and effective manner. The wide-scale monitoring of illegal activity on social media sites is relatively absent and remains a challenge for conservationists and law enforcement agencies.

Beyond the immediate insights that this PVA model has provided into the likelihood of Javan gibbon extinction and priorities for the species' conservation, this analysis is intended to be utilised as a platform for development of an expanded and updated PHVA. It is my hope the model constructed here will hopefully serve as a starting point for a new plan at a future PHVA workshop. Therefore, additional data to support or refine values used and assumptions made here would enhance future modelling. Future analysis should explore additional potential conservation actions, including more complex multi-faceted actions that implement multiple management strategies simultaneously, and where possible, consider more expensive and intrusive actions. Husbandry guidelines have been developed and are in place for the housing and captive breeding of Javan gibbons (Campbell, 2008), and the three rescue and rehabilitation centres on the island, are (hopefully) adhering to these guidelines to ensure the gibbons being reintroduced into their former habitat are well suited (behaviourally) for potential release into the wild.

Summary

The previous chapter discussed the outcome from the VORTEX analysis conducted by myself with the assistance of four co-authors. The results from the PVA model indicate that if any of the populations of Javan gibbons living in Ujung Kulon, Halimun-Salak, and Dieng Mountains are *not* subjected to high rates of hunting or deforestation, they will remain stable and are likely to persist for the next 100 years. However, high rates of hunting coupled with persistent rates of deforestation undoubtedly will cause populations of Javan gibbons to rapidly decline in the wild. In addition, the modelling demonstrates the importance of initiating site-specific conservation programmes, as each population is sensitive to varying levels of threats (i.e., rates of hunting and/or deforestation) and may respond differently to different conservation strategies. Increased protection of the remaining forest areas on Java, and developing and enforcing stricter regulations with regards to the illegal pet trade via social media platforms should be a conservation priority if Javan gibbons are to survive in the future.

Future conservation research should include quantifying rates of both hunting and deforestation through increased protection and surveying of forested areas in order to determine a more accurate assessment of survival for Javan gibbons. Researchers, conservationists, and rescue centre managers should increase collaboration efforts to determine the rate at which Javan gibbons are removed from the wild for the illegal pet trade. Though this is a major conservation challenge, determining best course of action into how to combat the illegal wildlife trade should be a priority for future research.

The next chapter demonstrates the serious threat the illegal pet trade is to the future viability of not only Javan gibbons, but several other species of Endangered gibbons. I discuss the various platforms being used to conduct illegal trade of gibbons and I provide photographic evidence of how prevalent the trade is online, as well as a list of online market accounts I discovered on both Facebook and Instagram. When infant gibbons are removed from the wild,

it is usually after their mother (and perhaps other family members) have been shot and killed. This potentially could have detrimental effects on the wild Javan gibbon population because aside from the young gibbons being removed, viable female gibbons are also being removed from the total population. Furthermore, if the infant does survive the pet trade and become a household pet, it will most likely never have the opportunity to reproduce and contribute to any population of wild Javan gibbons.

Chapter Four

Investigating the Extent and Prevalence of Gibbons Traded Illegally on Social Media

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Fig.4.1. Photo of a young Indonesian girl with a presumed pet Javan gibbon. Photo from Facebook.

Introduction

The online trade in wildlife is significant and is exacerbated by the Internet's ability to reach a wide audience in a short amount of time. Social media platforms are being used to conduct trade in wildlife, both legal and illegal. Although reports on the misuse of the Internet for the trade in illegal wildlife are available, research is just beginning to reveal how serious this issue is becoming, particularly on Facebook and Instagram (IFAW, 2014; Hinsley et al., 2016; TRAFFIC, 2016; Bergin et al., 2017; Siriwat and Nijman, 2018). Unfortunately, where

research does exist, results show it is rather difficult to quantify the precise scale of the Internet wildlife trade effectively and the impact it may be having on wild populations, as the multiple layers in which it operates are often untraceable (Hinsley et al., 2016).

As of 2017, there were over 2.50 billion social media users recorded worldwide on at least 23 major social networking sites (based on the number of active user accounts), the highest of which is Facebook with over two billion registered accounts (Statista, 2017). In the month of April 2017, Facebook was the first social network to surpass one billion registered accounts and currently has 2.23 billion monthly active users. According to Tech in Asia (2017), Asia is now Facebook's largest region with over 500 million daily active users, thus making the continent's user interface larger than anywhere else in the world. However, in 2016 the photo-sharing app Instagram gained significant momentum reaching over 700 million monthly active accounts, most of which are in Southeast Asia, making it one of the most popular social networks worldwide (Statista, 2017). Given its popularity and scope, it is not surprising Instagram is being used to conduct illicit trade in wildlife.

The illegal wildlife trade includes all exchanges of a wild animal and/or its parts and derivatives by people, and is currently at the very heart of biodiversity conservation and sustainable development (Broad et al., 2003; Sodhi et al., 2004; Nijman, 2010; Hinsley et al., 2016; Bergin et al., 2018). Expanding human populations, increasing buying power, and the demand for wildlife (both dead and alive) are all intrinsically linked to economic growth, whilst internal exploitation and corruption is undoubtedly contributing to deforestation rates across Southeast Asia, as well as the disappearance of wildlife, resulting in a system that perceives natural resources and wildlife as a means of revenue that can be exploited for political, economic, as well as social gain (Malone, 2007; Nijman, 2010). The wildlife trade provides a valuable income for some of the least economically affluent people while potentially generating considerable revenue nationally (Malone, 2007; Nijman, 2010; Hinsley et al., 2016).

The interconnectedness around the world has led to a rise in awareness and a desire for exotic wildlife as pets or for traditional medicine and is occurring in developed, emerging, and developing nations alike (Sodhi et al., 2004; Nijman, 2010). In the absence of strict regulatory mechanisms, and given large monetary gains the trade generates, these demands will be met, thus continuing to threaten and endanger wildlife populations the world over (Nijman, 2010; Rosen and Smith, 2010).

Southeast Asia, including China's international borders, has been identified as a 'wildlife trade hotspot' (i.e., a region where wildlife trade poses a disproportionately large threat) (TRAFFIC, 2008; Nijman, 2010; Sodhi et al., 2010). The primary motivating factor for wildlife traders tends to be economic and ranges from small-scale local income generation to major profit-oriented business (Izzo, 2010). Whilst most wildlife is traded locally, and the majority nationally (i.e., within the political borders of a country or state) there is a large volume of wildlife that is traded internationally (Blundell and Mascia, 2005; Shepherd and Nijman, 2007; Biggs et al., 2017). Any number of middlemen may be involved in the wildlife trade, including specialists involved in storage, handling, transport, manufacturing, industrial production, marketing, and the export and retail businesses, and these may operate both domestically and internationally (TRAFFIC, 2008; Nijman, 2010; R.A. Dongoran: pers. comm., 2017).

Over the past few years, much of the trade in wildlife, both legal and illegal, has increasingly been moving to online forums and away from more traditional open markets (IFAW, 2008; 2014). Given the accessibility of the internet around the world, changes and trends can occur very rapidly, thus providing a network that can adapt and facilitate these changes in a clandestine manner (TRAFFIC, 2016). In addition, the expansion of social media platforms has created greater access to goods and services whilst allowing for complete anonymity. The prevalence of wildlife trade occurring in 'closed' groups on social media and

password-protected online forums is on the rise and it is difficult to monitor these aspects of trade transactions (IFAW, 2014; TRAFFIC, 2016; Bergin et al., 2018). Previous research has largely focused on wildlife trade occurring on openly accessible platforms such as commercial trade portals and online auction sites (i.e., markets) (IFAW, 2014), which lend themselves to public monitoring. Stronger enforcement efforts and a greater awareness of the illegal wildlife trade has potentially contributed to some aspects of trade moving underground, due to the increased risk of detection in traditional open markets and retail outlets (TRAFFIC, 2016). As a result, the threats posed by 'closed' methods of trade are not yet fully understood, and the precise extent to which these methods are used remains largely unknown, as most of the transactions occur out of public view (see Yu and Jia, 2015; Hinsley et al., 2016; Bergin et al., 2018). The nature of the Internet trade may specifically affect wildlife in Asia, as it is a region abundantly rich in threatened and restricted-range species, and where over one billion internet users reside (Nekaris et al., 2013).

In 2014, the International Fund for Animal Welfare (IFAW) conducted a six-week study investigating the online wildlife trade and discovered 280 online markets in 16 different countries. Researchers found a total of 33,006 endangered animals and their parts and derivatives (54% were live animals), all from species listed on the Convention of International Trade in Endangered Species of Wild Fauna and Flora (CITES) Appendix I and II. Sales spanned 9,482 advertisements totalling over USD 10 million. The study also found that in China social media was the most commonly used method of contact between buyers and sellers, primarily via the networks 'QQ' or 'WeChat' (IFAW, 2014).

In March 2016, TRAFFIC published a report based on five months of monitoring 14 Facebook groups based in Malaysia, boasting over 68,000 active users. The researchers discovered more than 300 wild, live animals for sale as pets, ranging from sun bears, otters, binturong, owls, and gibbons. Most of the groups they monitored were 'closed' but TRAFFIC

had inside contacts that were able to gain more information with regards to the trade transactions. The study recorded approximately 80 different species for sale, with more than 60% being native to Malaysia. Almost half of them were totally protected from all aspects of hunting or trade. According to the report, Facebook responded positively when presented with the results, and a spokesperson was quoted saying the social networking site would work with TRAFFIC to help put an end to the illegal trade of wildlife in Malaysia through the site, and would remove all relevant content (i.e., groups, posts, accounts) as it violates their terms of use. However, given the presence of groups found in this research, it would seem this has not yet happened.

In June of 2017, the Jakarta Police arrested a 42-year-old man who was in possession of three endangered animals: a clouded leopard (*Neofelis nebulosi*), a sun bear (*Helarctos malayanus*), and an orangutan (*Pongo pygmaeus*). He claims to have purchased all three as infants through Instagram. The police have not yet identified the original sellers, and all three animals were handed over to the Natural Resource Conservation Agency. The suspect was charged under a 1990 law on the conservation of natural resources and the ecosystem, and faces up to five years in jail and a fine of Rp 100 million (USD7,500) (The Nation, 2017).

In February 2018, a group of animal traffickers were arrested in Indonesia for selling crocodiles, pythons and other protected species through Facebook and the messaging service WhatsApp. The seven suspects, who were arrested at separate locations in and around Jakarta, claimed to have bought the animals for just IDR 300,000 (USD21) each before re-selling them online for between two million and five million rupiah (USD138-345), authorities said. The rescued animals, including some rare species endemic to Indonesia, were most likely from Java and Sumatra and brought to Jakarta for export. During their raids, police said they confiscated two crocodiles, two reticulated pythons (*Python reticulatus*), six jungle cats, a pair of gibbons, two Javan langurs (*Trachypithecus auratus*), a Javan surili (*Presbytis comata*), two owls, a

brahminy kite (*Haliastur indus*), and a slow loris (*Nycticebus javanicus*) (some species' names were not listed). The animals were handed over to Jakarta's conservation agency, and the suspects were charged under Indonesia's environment law which carries a maximum penalty of five years in prison. Whether the suspects actually serve that time remains unknown. This is a prime example of how social media has become a crucial online market for animal traffickers, and is precisely why there needs to be more stringent regulations on social media (Anonymous, 2017).

As the Internet is gaining significant momentum in the global wildlife trade, perceptions of threatened species are changing as well (Nekaris et al., 2013). The ownership of an exotic (or Endangered) animal is sometimes portrayed as a symbol of status and economic success. It is reported that many government officials, army officers, and entertainers own pet primates, especially orangutans (Malone et al., 2004). This practice may encourage other people to purchase primates, and enhances the symbolic status of owning a rare or exotic species. As a consequence, the reported public display of primate pets by the wealthy and influential (or peer groups/celebrities on social media sites) serves as a demonstration of political power or social acceptance, and ultimately, the selective enforcement of law (Malone et al., 2004).

Another potential issue with regards to accurately monitoring and assessing the extent to which trade is occurring online, is sellers will use more than one account (or have more than one user name) to conduct their trade. I encountered several gibbons for sale online that appeared to be the same individual but were posted by users either on different groups' pages, or under a different user name. It has also been reported that potential sellers will often use a photograph from the Internet to advertise or generate an interest in an animal, then proceed with creating a trade transaction (V. Nijman: pers. comm., 2017). If it is the same photo or the same poster (e.g., same name, same IP address, or same phone number) then it may be possible to filter this out; otherwise it becomes rather difficult.

This research illuminates the devastating and serious issue of the illegal trade network; thousands of animals and/or their parts and products are available for sale over the Internet across the globe. The elusive nature of the illegal wildlife trade, and with no access to the item and sometimes very limited information about the animal/product, means that it can be difficult to determine the extent to which it is actually occurring, or track the exact trade route and exchange (Rosen and Smith, 2010). Therefore, utilising an exploratory approach, my goal was to discover how serious an issue the illegal trading of gibbons (*Hylobates spp*.) is online, and hopefully, gain some insight as to what extent it is occurring on different social media platforms. Considering we do not yet know the impact the illegal trade is having on wild populations of gibbons, specifically Javan gibbons, we need to determine how prevalent it is online before we are able to decide on a best course of action for putting an end to it.

Methods

From April 2017 to April 2018, the activity of individuals and/or groups on different social media platforms (predominantly Facebook and Instagram as my access to other platforms was severely limited or restricted), consisting of both *public* and *closed* groups (some closed groups still had visible photos and thus I was able to read through comments), were monitored in an attempt to determine the extent gibbons are being sold and traded online as part of the illegal wildlife trade network. These groups were selected as they were previously identified by myself, with assistance from colleagues in Asia and fellow members of the IUCN – Section on Small Apes, as listing posts where gibbons (along with other wildlife) were being offered for sale. In addition, once a photo was marked with a gibbon for sale, I utilised a form of snowball sampling and searched through the associated comments to find other posts of gibbons (or people expressing interest in buying a gibbon based on the

post), which then led to randomly (and anonymously) searching people's profiles. On both Facebook and Instagram, I would search any combination of 'gibbons for sale' 'pet Javan gibbon' 'exotic wildlife for sale' in order to seek out accounts and posts. Given I speak Bahasa Indonesia at a basic, conversation level, I was able to understand the comments included with the posts and photos. If I could not (e.g., often words in Bahasa Indonesia are shortened for communicating on social media), I would seek assistance from my colleagues in Indonesia. During the assessment period, all posts where gibbons were being offered for sale or portrayed as household pets were documented and compiled into an Excel database.

To avoid potentially double counting the number of individual gibbons observed for sale during the period reviewed, care was taken to determine that each gibbon was only counted once unless stated otherwise. Each offer of sale posted by an individual seller was reviewed and the number of gibbons were tallied based on the images provided and/or the text contained in the post. An attempt to verify individual gibbons was made where species were offered for sale more than once, and to reduce the risk of double counting gibbons offered for sale by the same seller (sellers will often use a different user name to post individual gibbons on different sites). Each species of gibbon found in trade was counted and an accumulative total of the estimated number of gibbons in different posts represented was also calculated. In some instances, it was difficult to discern which species of gibbon was portrayed in some of the photos, so my best guess was used and these photos are marked with an asterisk.

Countries investigated

Gibbons are the most diverse and widely distributed of the extant apes, and can be found throughout tropical and subtropical forests of South, East, and Southeast Asia. Their range extends from north-eastern India to southern China, Bangladesh, Myanmar, Vietnam, Lao PDR, Cambodia, the Malay Peninsula, and Indonesia (Cheyne, 2004; Malone, 2007). When

carrying out this research, I sought assistance from various contacts throughout gibbon range countries who had more inside access to information and sites locally, and I received feedback from several individuals working in various aspects of gibbon conservation throughout Asia.

Social media networks

Social media networks such as Facebook and Instagram are possibly more appealing to traders as opposed to more traditional commercial trade platforms or other forms of classified advertisements (and open markets), because trade can be conducted free of charge and with a very high degree of anonymity (TRAFFIC, 2016). Social media networks allow users to create special interest groups that provide a layer of control and accessibility that is governed by those managing the group. Often these groups require an invite to join thus making it difficult (or nearly impossible) for any non-member to acquire information about the group or view its contents (pers. exp). Therefore, social network sites and specialist forums help to perpetuate the wildlife trade, both through legal and illegal means, either directly by enabling trade exchanges or indirectly where discussions around the species in trade have been taking place (often sellers will instruct potential buyers to communicate via private or direct message either through the platform itself, Blackberry Messenger, or WhatsApp) (TRAFFIC, 2016). Most credible businesses and organisations now have Facebook pages that have grown to become the chosen platform for conducting various businesses, including trade (IAFW, 2014; TRAFFIC, 2016). Following is a list of the social media sites investigated for this aspect of research. All information pertaining to each social media platform was obtained from the 'About' section on the respective website.

1. **Facebook** is an American for-profit corporation and an online social media and networking service, which may be accessed by a large range of desktops, laptops, tablet computers, and smartphones over the Internet and mobile networks. Users can add other users as 'friends',

exchange messages, post status updates and digital photos, share digital videos and links. In July 2015, Facebook became the fastest company in the Standard & Poor's 500 Index to reach a market cap of US $250 billion. As of April 2017, Facebook was the most popular social networking site in the world, based on the number of active user accounts, and now has more than two billion monthly active users.

2. **Instagram** is a mobile, desktop, and internet-based photo-sharing application and service that allows users to share pictures and videos either publicly or privately. It was acquired by Facebook in April 2012. Users can add hashtags to their posts, linking the photos up to other content on Instagram featuring the same subject or overall topic. They can also connect their Instagram account to other social media profiles, enabling them to share photos to those profiles as well. After its launch in 2010, Instagram rapidly gained popularity, with one million registered users in two months, 10 million in one year, and ultimately 700 million as of April 2017. Its users have uploaded over 40 billion photos to the service as of October 2015. Instagram has been named 'one of the most influential social networks in the world'.

3.**Twitter** is an online news and social networking service where users post and interact with messages knows as 'tweets' that are restricted to 140 characters. Registered users can post tweets, but those who are unregistered can only read them. Users access Twitter through its website interface, SMS or a mobile device app. The service rapidly gained worldwide popularity, and as of 2016 had more than 319 million monthly active users.

4. **YouTube** is an American video-sharing website that allows users to upload, view, rate, share, add to favourites, report, comment on videos and subscribe to other users' pages. Available content includes: video clips, TV show clips, both short and documentary films, audio recordings, movie trailers, as well as other content such as video blogging, short original videos, and educational videos. YouTube is currently blocked in China, Iran, and North Korea.

5. **WeChat** is a Chinese social media network (instant messaging, commerce and payment services) application developed by Tencent. It was first released in 2011 and by 2017 it was one of the largest standalone messaging apps by monthly active users with over 938 million active users. WeChat has not been successful in penetrating international markets outside of China.

6. **Tencent QQ** (also known as QQ) is an instant messaging software service developed by the Chinese company Tencent Holdings Limited. QQ also offers services that provide online social games, music, shopping, microblogging, movies, group and voice chat. At the end of June 2016, there were 899 million active QQ accounts.

7. **TaoBao** (literally: 'searching for treasure network') is a Chinese online shopping website similar to eBay, Amazon, and Rakuten. Taobao Marketplace facilitates consumer-to-consumer retail by providing a platform for small businesses and individual entrepreneurs to open online stores that mainly cater to consumers in Chinese-speaking regions (mainland China, Hong Kong, Macau and Taiwan) and also abroad**.**

8. **Baidu.com** is a Chinese web services company headquartered at the Baidu Campus in Beijing's Haidian District. It is one of the largest Internet companies in the world. Baidu offers many services, including a Chinese search engine for websites, audio files and images. Baidu offers 57 search and community services including Baidu Baike (an online, collaboratively built encyclopaedia) and a searchable, keyword-based discussion forum.

Results

Of the known social media networks investigated (Table 4.1), I only found evidence of gibbons being sold (or portrayed as pets) on two sites: Facebook and Instagram. However, it should not be assumed the illegal buying and selling of gibbons (or any other wildlife) is not

occurring on other social media networks, rather efforts need to be strengthened in order to gain access to these sites so that we may uncover the trade network operating within. Both Blackberry Messenger and WhatsApp are used to further discuss the trade exchange, as sellers will provide their BBM pin or WhatsApp number (usually a personal phone number), which potential buyers can then contact sellers privately in a message format. As a result, it was (and is) often difficult, if not impossible, to determine where the gibbon winds up or who actually buys it, as the final exchange often takes place privately.

Most of the evidence that gibbons are being traded online comes from Indonesia, with 44 of the 51 individual sellers identified coming from the country; only five of the individuals were from Malaysia (it is not certain where two of the individuals with Instagram accounts are from, as it did not say on their profile) (Appendix 1.1). Correspondence from contacts in Cambodia, India, Myanmar, Thailand, and Vietnam indicate there is not yet any evidence of gibbons being traded online via social media in those countries. A contact in China confirmed she has not yet seen any evidence of online trading; however, it has been suggested that people in north Myanmar will sell gibbons (*Hoolock* spp.) to China at a price of around 10,000 khats (approximately USD10) per individual. Whether this exchange occurs on any social media network is presently unknown.

There were 19 Facebook groups or Instagram accounts with gibbons for sale, and again, mostly all originating in Indonesia (several more groups or accounts selling endangered animals were identified, but only those with gibbons for sale were included) (Table 4.2). Unfortunately, it was sometimes difficult to determine the extent of overlap between users on Facebook and Instagram if they do not use the same name for both social media sites, and users will often use more than one name or nicknames, and/or use different accounts to advertise the same gibbon.

Table 4.2. Special interest groups identified on social media sites during April 2017 – 2018

Social Platform	Country	Group Name	Status	Members/Followers
Facebook	Indonesia	Borneo Animal Buy & Sell	Closed	9,636
Facebook	Indonesia	Kings Exopets	Private	-
Facebook	Indonesia	Laman Jual Beli Haiwan Peliharaan	Closed	4,391
Facebook	Indonesia	Komunitas Pecinta Primata Indonesia	Closed [A]	1,172
Facebook	Indonesia	Terengganu Pet Lovers	Closed	3,973
Facebook	Indonesia	Buy and Sell Animal West Borneo	Closed	254
Facebook	Malaysia	Kedai Reptiel Planet Pets Studio Malaysia	Closed	857
Facebook	Malaysia	Exotic & Reptiles for Sale In Malaysia	Closed [A]	9,957
Instagram	Indonesia	Kingexopets	Private	3,021
Instagram	Indonesia	Vina Petshop	Open [A, B]	178
Instagram	Indonesia	Made Khania Jegeg Petshop	Open	97
Instagram	Indonesia	Vallen Exopets	Private	232
Instagram	Indonesia	Official.Galeria.Cleopatra	Open	426
Instagram	Indonesia	Dona_Petshop	Private	68
Instagram	Indonesia	Sandyanimalskeeper	Open	241
Instagram	Indonesia	Kenter Petshop	Open	438
Instagram	Indonesia	Vina Petshop Satwa	Open	9
Instagram	Malaysia	Kejora Pets	Private	15,800
Instagram	Malaysia	Exoticjazz_Petzone	Open	144

[A] Either myself or someone I know was permitted to join the group.
[B] Account changed its status to private 13 June 2017 and edited some of the photos.
1. All groups listed are those that either had a gibbon listed for sale, is affiliated with another group that posted a gibbon for sale, or had photos of someone portraying a gibbon as a pet
2. If a group on Facebook is closed, some pictures may still be visible to non-members.
3. Facebook and Instagram are the only two social media platforms in which I found evidence. of gibbons being sold online.
4. In total, over 50,000 members or followers between the two networks.

Species identified

The most common species of gibbons for sale were Javan gibbons (*H. moloch*), siamangs (*S. syndactylus*), lar gibbons (*H. lar*), and possibly agile gibbons (*H. agilis*)* or Bornean agile gibbon (*H. albibarbis*)* or Müller's gibbon (*H. muelleri*)* (Figure 4.2), all of which are categorized as Endangered by the IUCN (IUCN, 2018). Prices ranged anywhere from USD1 (which could have been a misinterpretation as post said Rp 12, 345 which is ~USD1) to USD540, with Malaysia having the highest prices and Indonesia the lowest for gibbons.

1. **Agile gibbon** (*H. agilis*): Endangered; Indonesia, Malaysia, Thailand
2. **Bornean agile gibbon** (*H. albibarbis*): Endangered; Indonesia
3. **Javan gibbon** (*H. moloch*): Endangered; Indonesia
4. **Lar gibbon** (*H. lar*): Endangered; Indonesia, Malaysia, Myanmar, Thailand, possibly into southern China, and a small area of northwestern Lao PDR.
5. **Müller's gibbon** (*H. muelleri*): Endangered; Indonesia
6. **Siamang** (*S. syndactylus)*: Endangered; Indonesia, Malaysia, Thailand

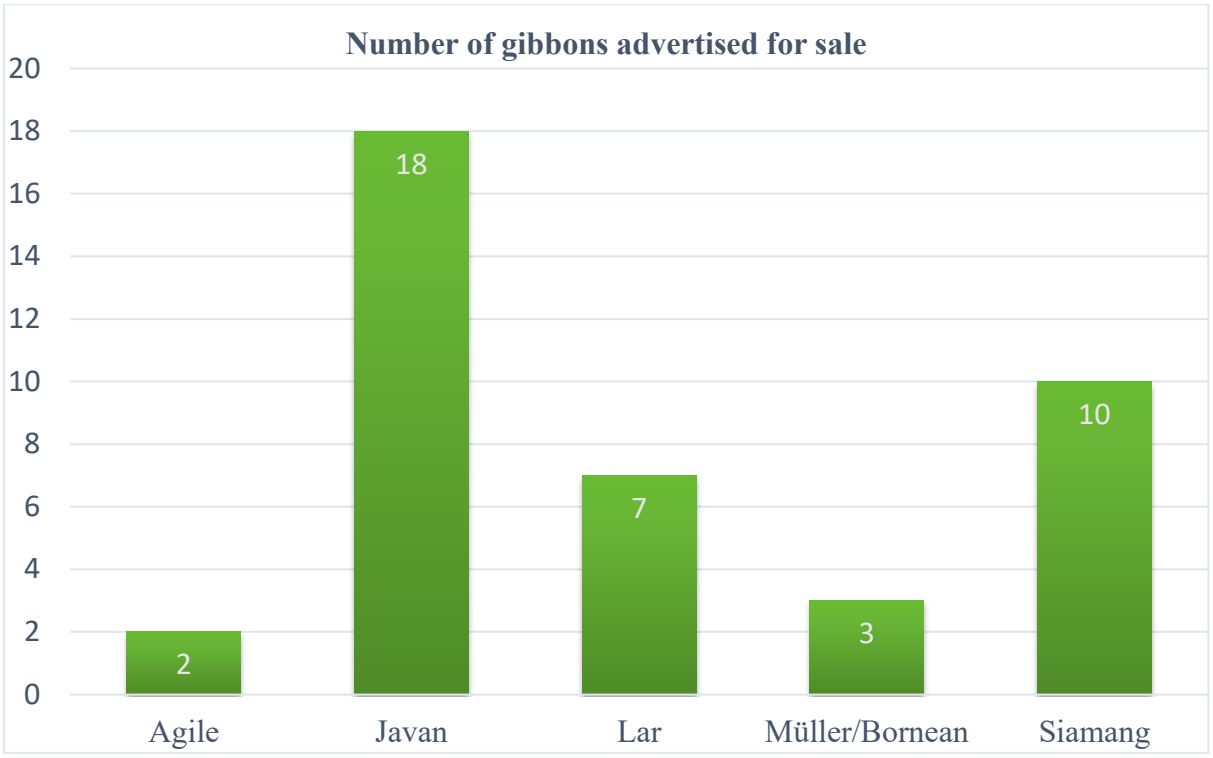

Fig. 4.2. Most common species of gibbons and siamangs for sale during research period: Javan gibbons, siamangs, lar gibbons, and possibly agile gibbons * or Bornean agile gibbon * or Müller's gibbon*. All are categorized as Endangered by the IUCN.

I chose to include photo evidence of gibbons portrayed as personal pets, as I felt this was important to document because when individuals show gibbons being kept as pets, this may generate future interest for other individuals to procure a gibbon of their own, thus perpetuating the cycle of online illegal trade. There are photos of individuals with their pet gibbons on display in public spaces (Figures 4.4 & 4.5), demonstrating a total disregard and violation of both national and international trade and endangered species laws (IUCN, 2018).

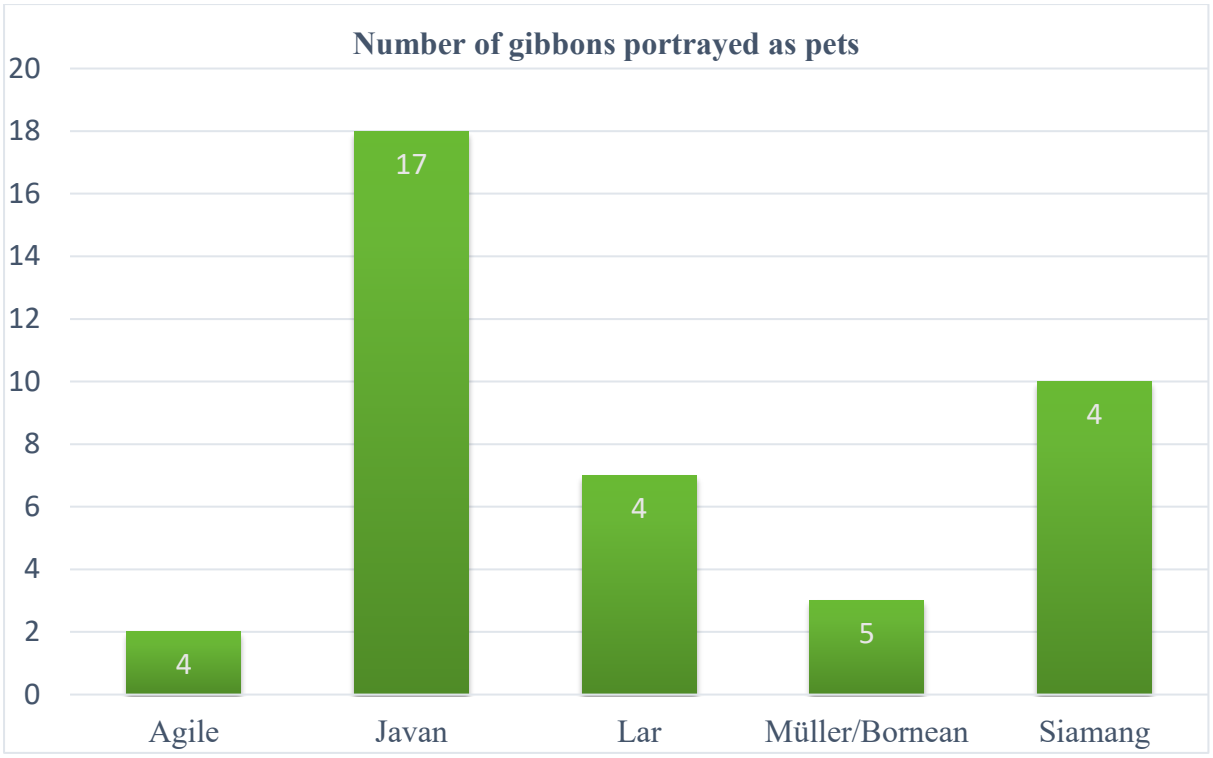

Fig. 4.3. Number of gibbons and siamangs portrayed as presumed pets during the research period. Javan gibbons, siamangs, lar gibbons, and possibly agile gibbons * or Bornean agile gibbon * or Müller's gibbon*. All are categorized as Endangered by the IUCN.

Fig. 4.4. Photos of gibbons advertised for sale or portrayed as pets. (a) Siamang for sale, Dec 2018. (b) Javan gibbon for sale, Nov 2017. (c) Lar gibbons for sale, Oct 2017. (d) Siamang(s) for sale, Oct 2017. (e) Javan gibbon for sale. (f) Lar gibbon for sale, Sept. 2016. (g) Bornean gibbon for sale. (h) Javan gibbon.

Fig. 4.5. Photos of gibbons advertised for sale or portrayed as pets. (a) Lar gibbon as pets, another pet gibbon in comments. (b) Siamang for 'adoption' located in Jakarta, but seller states can send to Java, Sumatra, Borneo, or Bali. (c) Javan gibbon for sale. (d) Javan gibbon for sale, April 2017. (e) Javan gibbon for sale, December 2017. (f) Javan gibbon for sale, May 2017. (g) Woman with lar gibbon in public. (h) Javan gibbon and siamang for sale.

Table 4.3. CITES International Trade Report for Javan gibbons between the years 2010-2018**.**

Year	App.	Taxon	Importer	Exporter	Origin	Importer reported quantity	Exporter reported quantity	Term	Unit	Purpose	Source
2010	I	*H. moloch*	GB	AU			1	live		B	C
2010	I	*H. moloch*	GB	AU		1		live		Z	C
2010	I	*H. moloch*	US	GB			1	live		Z	F
2010	I	*H. moloch*	US	IE	GB	1		live		Z	F
2011	I	*H. moloch*	ID	AU			1	live		B	C
2013	I	*H. moloch*	ID	GB			1	live		N	C
2015	I	*H. moloch*	GB	AU			2	live		Z	C
2016	I	*H. moloch*	IM	GB		2		live		Z	C
2017	I	*H. moloch*	ID	GB			6	live		N	C

1.GB-Great Britain; AU-Australia; ID-Indonesia; IE-Ireland; IM-Isle of Man; US-United States.
2.Purpose code: B- Breeding in captivity or artificial propagation; N- Reintroduction or introduction into the wild; Z- Zoo.
3.Source code: C- Animals bred in captivity in accordance with Resolution Conf. 10.16 (Rev.), as well as parts and derivatives thereof, exported under the provisions of Article VII, paragraph 5, of the Convention; F- Animals born in captivity (F1 or subsequent generations) that do not fulfil the definition of 'bred in captivity' in Resolution Conf. 10.16 (Rev.), as well as parts and derivatives thereof

For comparative purposes, I searched the CITES International Trade Database for *legal* trade in Javan gibbons for the past ten years. A comparative tabulation report is the most comprehensive type of output, since it allows reported exports or re-exports from one country to be compared with the imports reported by another. Comparative tabulations also show the reported sources (e.g., wild, captive-bred, artificially propagated, etc.) and purposes (e.g., commercial, scientific, personal, etc.) of the trade. This type of output is useful to examine the reported purpose and source of the specimens in trade (where this is available), especially with regard to trade in specimens of Appendix-I species and exports from non-range countries. It is also useful for assessing compliance with national and international trade controls, such as trade bans and quotas.

The data presented in a comparative tabulation are summed, rather than being provided on a shipment-by-shipment basis. This means that all quantities traded are added together for

all records where the following details are the same: taxon, term, importer, exporter, country of origin, purpose of transaction, source of specimen and the year in which the trade occurred. If all these details are reported identically by both the exporter and importer, the transactions will appear on the same line of the tabulation. However, if the details of a particular transaction reported by both the exporter and importer fail to show perfect correlation, and do not appear in the same line of the comparative tabulation, this is often for one or more of the following reasons: the source of the items and purpose of the transaction are often reported differently, if at all; terms and units may also be reported differently for the same items in trade; one of the trading partners may not have submitted a report for the year in question, or may not be a CITES Party; or specimens may be exported at the end of one year but not received by the importer until the following year. There are some discrepancies with regards to the number of Javan gibbons reported for either import or export, so it is assumed it is due to differences in recording. Ultimately, there is some international trade in live Javan gibbons, yet it is minimal; mainly from zoo to zoo and between zoos and rescue centres. The scale is significantly smaller than what is currently happening online with regards to the domestic trade in Javan gibbons.

Discussion

This research, as well as previous studies (e.g., Nekaris et al., 2013; IFAW, 2014; Yu and Jia, 2015; Hinsley et al., 2016; TRAFFIC, 2016; Siriwat and Nijman, 2018) demonstrates how social media has become a significant online market place for the selling of wildlife, including several species of Endangered gibbons. This could prove disastrous for conservation efforts in habitat countries if the trade is not halted in the near future. The public denouncement of the illegal wildlife trade on social media sites could serve to deter potential buyers and sellers (Waters and El-Harrad, 2013). Various options to report violations involving wildlife crime

exist, and can include either a direct report to law enforcement agencies at a national level, or a direct report to the social media site itself. For example, Facebook's Community Standards has a strong affirmation in its policy against any illegal activity, including wildlife crime, and provides a procedure for any direct reports to Facebook. Reports can involve posts, messages, groups and other elements that can be considered a violation of legislation.

Instagram's Community Standards under the 'follow the law' heading, only addresses the illegal posting or support and praise of terrorism, organised crime, hate groups, sexual services, buying or selling firearms or prescription drugs. It does not mention the illegal selling of wildlife, or any act of animal abuse for that matter, being prohibited in its guidelines. The guidelines do offer instructions as to how to report any post that is not following the Community Guidelines, and one can either report the account of the person or the post itself to Instagram directly. Given the rapid rise in popularity of Instagram, emphasis should be placed on holding the site more accountable for permitting the illegal trade of Endangered wildlife to occur so blatantly, and encouraging the site to create their own regulations, as well as enforce international trade regulations already established. In a positive step forward, in December 2017, Instagram initiated a pop-up message when one searches for specific hashtags involving *select* Endangered wildlife (e.g., #tigerselfie, #slowloris #monkey), but nothing pops up for any variation of the word 'gibbon' (also searched in Bahasa Indonesia and Malay). The message states*: Protect Wildlife on Instagram - Animal abuse and the sale of endangered animals or their parts is not allowed on Instagram. You are searching for a hashtag that may be associated with posts that encourage harmful behavior to animals or the environment.*

This statement is followed by a link that provides further information regarding the exploitation of wildlife, and a directory of conservation sites (e.g., TRAFFIC, World Wildlife Fund, and Worldwide Animal Protection). As positive as this step may be, people are still permitted to visit the accounts selling wildlife they may have been seeking, so it is not a *block*

in any way, but rather a hopeful deterrent. In spite of this, as this research shows, both Facebook and Instagram have not done enough to keep the trade from happening on the sites. I have made several attempts to contact both Instagram and Facebook with regards to the seriousness of the issue, inquire about how they monitor the illegal selling of wildlife on the site, and how they determine which species are 'flagged' on Instagram. I never received a response.

Javan gibbons: a case study

The majority of Javan gibbons held in captivity in Indonesia are directly derived from the wild, as opposed to captive breeding programmes, including the individuals in zoos and wildlife rescue centres (Nijman, 2006). It is estimated there may be hundreds of Javan gibbons currently held illegally in captivity in Indonesia (Nijman, 2006; Supriatna, 2006), and given the north coast of the island of Java is a major route for the trafficking of Indonesian primates, (Malone et al., 2004; Supriatna, 2006), it is possible the number of Javan gibbons leaving Indonesia illegally is relatively high as well.

In November 2015, a Kuwaiti woman was intercepted by authorities at Jakarta's Soekarno-Hatta International Airport and arrested for attempting to smuggle two infant Javan gibbons out of the country and back to Kuwait. The woman had diapers on the young gibbons for what would have been a 12-14hr flight, and taped the infants to the backs of her thighs, where they were hidden by her long dress. This incident highlights Indonesia's growing intolerance for crimes like this, as the woman was charged with smuggling and endangerment of a protected species. Unfortunately, though, it is unknown if she was actually found guilty (if she was, she would face up to five years in jail, and a fine of more than USD7,000) (Anonymous, 2015). Sadly, as a result of this incident, one of the gibbons died in transit to the Javan Gibbon Centre (JGC), from possible dehydration and trauma. The other, an infant female, is thriving and still living at JGC undergoing rehabilitation. Now named Irma, and over

2 years old, she will eventually be paired with a suitable male Javan gibbon, and if all goes according to plan, they will be released back into the wild together.

One of the major challenges in the enforcement of illegal wildlife trade regulations is the willingness of the authorities to become engaged in and carry through the required judicial procedures (Supriatna et al., 2010), consequently, offenders of wildlife laws are rarely prosecuted (Freund et al., 2017; Nijman, 2017). In addition, the current system in Indonesia allows for individuals to donate their pet gibbons to zoos, wildlife rescue centres, and rehabilitation programmes when they realise they can no longer manage the gibbon as a pet. As a result, it becomes easier for private owners to dispose of their adult gibbon and potentially obtain a younger individual from the wild, perpetuating the illegal pet trade network (Supriatna, 2006).

How do we reconcile with individuals who believe they are helping to conserve Javan gibbons by keeping them as pets, and believe if the forest is disappearing, is it not better to give gibbons a safe place to live within their own home? How do we as conservationists tell these people what they believe is wrong? Following are quotes taken from a male individual discovered on Facebook who posts pictures of himself with his two (presumed) pet Javan gibbons. These quotes are the captions on three of his photos (English translation of Bahasa Indonesia is in bold):

Owa jawa itu peliharaan yg sangat setia'

'Java gibbon is a very loyal pet'

'Jangan kembalikan kami ke habitat kami yang kini terancam oleh serakahnya pembangunan, biarkan kami hidup dengan manusia yang baik sampai akhir hayat'

'Do not return us to our habitat which is now threatened by greedy development, let us live with a good human until the end of life'

'Owa jawa itu jenis owa paling langka di dunia dan keberadaannya cuma ada di indonesia, utk itu kita sbagai masyarakat yg perduli wajib dan bertanggung jwb menjaga hewan ini dari kepunahannya dgn cara apapun, inget dgn cara apapun, baik in-situ maupun ex-situ'

'Java gibbon is the most rare type of gibbon in the world and its existence is only in Indonesia, for that we are as a society that cares compulsory and responsible keep this animal from extinction in any way, remember in any way, either in-there and ex-there'

JGC has engaged with this particular individual on several occasions (via Facebook messenger), yet he is evasive and will not respond to their enquiries. He has several photos on his Facebook page displaying his two Javan gibbons in public and open spaces (i.e., school ground, shop front). He believes what he is doing is *morally right* for Javan gibbons: taking them out of the forest, keeping them in his home, and protecting them from harm. This kind of behaviour may encourage other individuals to want a pet gibbon of their own. There are several comments of support and agreement with his words, and if enough of his Facebook followers ascribe to his way of thinking, this could in turn have a drastically negative impact on the campaign to end the illegal trading of Javan gibbons.

This kind of belief illustrates the need to actively engage with local communities to educate them about the Endangered status of Javan gibbons and the crucial role they play in maintaining a healthy and diverse forest. Some people may not realise the process involved when infant gibbons are snatched from the wild, as other family members are often killed in the process. Perhaps if they did know, they may feel differently about wanting a gibbon for a pet and instead redirect their focus to protecting the last remaining forests on Java. Ultimately, a more integrated and tactical approach must be taken if we are to put an end to the illegal wildlife trade, especially online, and understanding the social and cultural drivers of the trade needs to be at the forefront of the movement (Nekaris et al., 2010; Verissimo et al., 2013). We need to understand individuals' desire to seek out an exotic or rare animal to either buy or sell.

Only then can we begin to target consumers and hopefully encourage them to change their beliefs and adopt more conservation-oriented attitudes and behaviours.

Chapter conclusion

Increased collaboration between social media networks, wildlife rescue centres, and law enforcement agencies should be priority in order to improve detection on social media platforms, and ensure that prolific dealers in the trade network are targeted in a coordinated and effective manner (Bergin et al., 2017). In addition, members of the public accessing these sites are encouraged to report illegal activity to the authorities, or other platforms available for such purposes (TRAFFIC, 2016; Bergin et al., 2017). The wide-scale monitoring of illegal activity on social media sites is relatively unmonitored and remains a challenge for conservationists and law enforcement agencies. Given the current environment, we need careful and consistent monitoring and engagement with potential sellers (perhaps even buyers) by individuals who may obtain access to 'closed' or 'private' groups and accounts.

Furthermore, viable options for self-policing by social media networks and its users combined with mechanisms for reporting illegal trade to enhance enforcement efforts should be established, including creating a system to prohibit or suspend social media accounts of repeat offenders (TRAFFIC, 2016). Sellers appear to be using one or more accounts under different names to conduct trade, so this needs to be monitored and infiltrated. Partnerships between governments, social media companies, international enforcement agencies, conservation groups and/or animal rescue groups (particularly those in gibbon range countries), and regulatory institutions such as CITES need to formulate new, realistic solutions to address this uniquely challenging and rapidly evolving method of illegal wildlife trafficking (TRAFFIC, 2016; Bergin et al., 2017).

The wildlife trade is complex and constantly evolving. It poses a major challenge to the conservation of biological diversity and sustainable development, either directly through over-exploitation of resources or indirectly through the negative impact of removing species from the wild (Verissimo et al., 2013; Challender et al., 2014). The illegal wildlife trade blatantly violates and undermines the rule of law, contributes to weak governance, hinders economic growth and development, and exacerbates poverty for those who are often amongst the poorest and most marginalised members of society (Verissimo et al., 2013; Challender et al., 2014; 2015). Some of the trade is legal, but a staggering amount of it is not. Both legal and illegal traders rapidly adapt to changing consumer and demand environments. They may target new species when others become depleted, shift to new markets, or in the case of illegal trade, develop new methods and routes to smuggle threatened species across borders (Challender et al., 2014; 2015; van Uhm, 2018).

The increasing globalisation of trade, creation of common markets and advances in technology all add further challenges to the already complex task of ensuring that trade is legal, maintained within sustainable levels, and does not negatively impact biodiversity conservation (Challender et al., 2014; 2015). Thus far more attention needs to be given to incorporating biodiversity conservation initiatives into broader livelihood policies and projects through collaborative engagement with local communities and supporting sustainable livelihoods (Challender et al., 2014; 2015; Ashuri et al., 2017).

We must better understand and manage the demand for illegal wildlife (Challender et al., 2014), and with regards to owning illegal wildlife as pets, we must understand the *desire* to do so. This has been recognised in a number of CITES trade resolutions (for example on bears, musk deer, and elephants), yet more emphasis tends to be in regulating the modes of trade, rather than determining what social and cultural forces are actually driving it (Nekaris et al., 2010). This largely has to do with limited and external (i.e., non-governmental

organisations) funding (Challender et al., 2014). More crucially, it is also hindered by a lack of in-depth knowledge and culturally sensitive understanding of both the demand for many species, and the most appropriate interventions with which to influence and thereby change the behaviour of illegal wildlife consumers (Challender et al., 2014; 2015). The situation becomes more complicated with those species that are kept as pets illegally, because this requires not only changing human behaviour, but essentially telling people what they can and cannot own. Reducing demand for animal parts or the desire to own an exotic pet is the most significant challenge. If we are to conserve such species as pangolins, tigers, primates, and elephants we desperately require an intensive research effort into consumer preferences, beliefs, social norms, and lifestyles to inform and develop the most appropriate social and cultural interventions (Verissimo et al., 2013; Challender et al., 2014). We need holistic and integrated approaches to address the illegal wildlife trade, specifically on social media platforms. By understanding human behaviour, we can begin to target consumers to change their preferences and purchasing behaviour (Nekaris et al., 2010; Challender et al., 2014).

While the functional use of wildlife was present in many ancient societies, as well as contemporary, the exclusivity and rarity of certain animals or products thereof may form the foundation of their value. In other words, the scarcer an animal, the greater its value (Courchamp et al., 2006; van Uhm, 2018). With regards to social media, the prevalence of 'exotic' pet ownership and viral videos of 'cute' animals engaging in anthropomorphic behaviours and lifestyles, may further encourage individuals to acquire one of these endangered animals for themselves (Nekaris et al., 2013). Thus, the social meaning and value of wildlife can be subject to change over time and space. At any point in time, one particular 'value' for wildlife can transform into new attributed social values, as we see different animals in trade becoming more or less popular on social media, depending on the attention or recognition they are assigned (Nekaris et al., 2013; Hill et al., 2017). Those attributed values reflect the dynamic

relationship between humans and animals in which the overexploitation of wildlife has become a *social problem* (van Uhm, 2018). When people ascribe a positive value to wildlife, they will likely be more motivated to support and/or engage in conservation efforts to protect them in the wild (e.g., from poaching and illegal trade). By the same logic, when people see no benefit around co-existing with wildlife, incentives for illegal use and trade are likely to exist (Hinsley et al., 2016). It would seem at present, human behaviour is the greatest threat to biodiversity conservation.

Summary

The previous chapter discussed the prevalence of the illegal pet trade on social media platforms, specifically Facebook and Instagram. I provided photographic evidence and an extensive list of individual sellers and accounts with Endangered gibbons for either sale or portrayed as pets, highlighting the severity of the issue. This research demonstrates how serious a threat the illegal pet trade is for gibbons in the wild, as I found evidence of five different species of gibbons being sold. Furthermore, results show that Javan gibbons are featured heavily in the online trade and are not only the species of gibbon most advertised for sale, but also the species most often portrayed as pets. The main conservation challenge is determining how many gibbons are being removed from the wild annually to fuel the illegal trade. Determining how to quantify this should be the focus of future research in Javan gibbon conservation. Perhaps more importantly, we must better understand and manage the demand for illegal wildlife and with regards to owning illegal wildlife as pets, we must understand the *desire* to do so. We need holistic and integrated approaches to address the illegal wildlife trade, specifically on social media platforms.

The next chapter serves as a review and examines the role of rehabilitation and reintroduction as a conservation tool for the preservation of wild populations of gibbons. I use

Javan gibbons as a case study, as reintroduction is the primary conservation initiative currently in place in West Java. More specifically, I discuss the role the Javan Gibbon Rescue and Rehabilitation Centre (JGC) plays in local conservation efforts drawing from my personal experience working and conducting research at the centre and taking part in the first ever release of wild-born, former pet Javan gibbons back into the wild. In conclusion, the chapter discusses best practice guidelines for gibbon rehabilitation and reintroduction with recommendations to hopefully ensure the long-term viability of reintroduction as a means to save Javan gibbons from going extinct in the wild.

Chapter Five

Rehabilitation and Reintroduction: A New Hope

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Fig. 5.1. Photo of Septa, male, one of the first Javan gibbons to be officially released back into the wild at Patiwel Forest in 2009. Photo by Duhe Anfield.

Introduction

Rehabilitation and reintroduction programmes have been widely used as a method of conservation for endangered species for some time (Kleiman, 1989; Ewen, 2012). The programmes may provide an opportunity for animals that have been taken from the wild and forced to live in captivity, to have another chance at living in the wild and ultimately, may be one way of reestablishing populations that have become locally extinct (Komdeur and Deerenberg, 1997; Ewen, 2012). Reintroduction efforts may address conservation on two

different levels: first, animals that are kept illegally as pets are rescued, rehabilitated, and then returned to the wild; and second, by reintroducing animals into areas where they are locally extinct, the wild populations are supplemented and potentially more forest can be protected (Kleiman, 1989; Cheyne, 2006; Ewen, 2012). It has been acknowledged that preservation of wild populations and their habitats is imperative for the conservation of many wild species, and rehabilitation and reintroduction may play a significant role in supporting the wild populations, as well as raising awareness of the plight of many threatened species, if the programmes adhere to established scientific principles and guidelines with regards to both pre- and post-release evaluation and monitoring (Seddon et al., 2007; Cheyne et al., 2008; Seddon, 2010).

There are a variety of terms used when discussing the movement of species between environments and a rather simple dichotomy exists for conservation-oriented translocation: there are those efforts that release species (e.g., plants or animals) into their known historic ranges and on the other hand, there are releases outside species' historic distributions (Seddon, 2010). Attempts to define or redefine established terms and the proliferation of new terms has the potential to confuse and hinder communication efforts; therefore, programmes should be specific with regards to their conservation aims when releasing species back into the wild (Seddon, 2010). The American National Wildlife Rehabilitation Association defines *rehabilitation* as 'the treatment and temporary care of injured, diseased and displaced indigenous wildlife, and the subsequent return of healthy viable animals to appropriate habitats in the wild' (Atkinson, 1994; Cheyne, 2004). According to the IUCN Guidelines for Reintroductions and Other Conservation Translocations (2013), *translocation* is the over-arching term referring to the 'human-mediated movement of living organisms from one area to another'. Translocations may be accidental (e.g., stowaways or release of exotic pets) or intentional. Intentional translocations may be utilised to address a variety of motivations such as controlling a population, welfare, political, commercial or recreational interests, or for

conservation efforts. *Conservation translocation* is the 'intentional movement and release of a living organism where the primary objective is a conservation benefit: this will usually comprise improving the conservation status of the focal species locally or globally, and/or restoring natural ecosystem functions or processes.' Conservation translocations can include releases of species either within or outside their indigenous range. *Reintroduction* is defined as the 'intentional movement and release of an organism inside its indigenous range from which it has disappeared' with the primary objective of a reintroduction project being to establish a viable, free-ranging population in the wild, of a species, which has become globally or locally extinct in the wild (Kleiman et al.,1994; Cheyne, 2004; IUCN, 2013). Cheyne (2006) posited a third definition: *population reintroduction*. This method refers to the use of wild-born, captive-raised animals to re-establish a population where it has become locally extinct. Population reintroduction can be a useful tool for gibbon conservation, but must only be conducted in areas that are adequately surveyed for suitability and protected.

Reintroducing threatened species to their original habitat is often a very attractive, expensive and highly involved measure for conservation, and sometimes is more used as a last resort for saving species that are almost extinct in the wild (Kleiman, 1979; Ballou et al., 2002). The operational costs of a reintroduction programme can be exceptionally high, and there are those who are critical of the efforts; therefore, it is necessary to first determine if rehabilitation and reintroduction programmes are an economically and morally viable solution to conserve endangered species (Cheyne, 2004; Moore et al., 2014). Furthermore, it is crucial the individuals that are to be released have either maintained, or developed, the appropriate behavioural repertoire necessary for survival in the wild and have gone through an extensive period of rehabilitation (Cheyne et al., 2008). Reintroduced individuals may be translocated from other wild populations or may come from captive breeding programmes (Sarrazin and Barbault, 1996; IUCN, 2010). In its recommendation section for reintroduction, the IUCN

(2013) states programmes should incorporate feasibility studies and habitat assessments, as well as intensive pre-and post-release monitoring periods. In order for a reintroduction programme to be successfully implemented, there must be adequate funding, local agreement amongst the government and communities, and the population viability of a species (i.e., demographic, genetic, behavioural, and ecological processes) within their natural environment must be thoroughly understood (Sarrazin and Barbault, 1996; Cheyne, 2006).

Several primate species are threatened with extinction and are the focus of extensive conservation efforts such as captive breeding programmes, habitat preservation, and rehabilitation and reintroduction programmes (Guy et al., 2014). As the species involved in rehabilitation are often endangered and tend to be those species most affected by the illegal wildlife trade and bushmeat (e.g., chimpanzees, orangutans, gibbons), rehabilitation of rescued primates may serve a dual purpose of both captive welfare and conservation (Guy et al., 2014). Reintroduction programmes involving primates have been in place since the early 1960s, with one of the most successful captive breeding/reintroduction programmes taking place in the 1970s with the golden lion tamarin (*Leontopithecus rosalia*) in Brazil's Atlantic coastal forest (Ballou et al., 2002; Britt et al., 2003; Kierulff et al., 2012). The golden lion tamarin became the first example of a 'flagship species' that served to ignite conservation efforts not only for the species itself, but also for the Atlantic coastal forest ecosystem as a whole. The golden lion tamarin wild population was estimated at only 100-200 individuals in the 1970s due to extensive habitat destruction and the illegal pet trade (Ballou et al., 2002). The first captive-bred tamarins were released in the mid-1980s, and by 1994 the wild population had grown to approximately 450 individuals with an additional 550 in captivity (Kleiman, 1989; Ballou et al., 2002; Britt et al., 2003; Kierulff et al., 2012*).* Both reintroduction and translocation have been successful as measured by survival and reproduction after release and both techniques have established growing populations of golden lion tamarins in the wild (Kierulff et al., 2012;

Estrada et al., 2017). After 21 years, the population formed by the reintroduced captive-born golden lion tamarins and their descendants was 589 in 87 groups. Although there continue to be threats (e.g., introduction of exotic primates) that continue to challenge efforts to preserve the golden lion tamarin in the wild, there is no doubt of the success of almost 30 years of the reintroduction programme (Kierulff et al., 2012).

A common challenge in rehabilitating primates is they have often had very little exposure to their native habitats before they were subjected to a life in captivity (usually via illegal pet trade), and therefore lack the appropriate knowledge and experience necessary for survival in the wild (Britt et al., 2003). In field studies, zoo observations, and laboratory experiments the great apes (as well as monkeys) have demonstrated a great capacity to learn in a complex and novel environment. The reintroduction programmes with the great apes, however, specifically orangutans, have been somewhat of a challenge because orangutans tend to imprint very heavily on their human caretakers. Considering they typically have extensive relationships with their mothers lasting seven to eight years in the wild, this is often difficult to negotiate when releasing orphaned orangutans, even after a period of rehabilitation, because they have been deprived of this vital relationship with their mothers and may seek this relationship with their human caregivers (Grundman, 2006; Palmer, 2018). Orphaned orangutans, and chimpanzees, will often return to the rescue centre in search of food, not show any fear of humans, and may not always engage in the appropriate social behaviour with conspecifics. Released orangutans have been observed remaining in small groups, approaching wild orangutans and entering their sleeping nests at night, and even attacking humans (Yeager, 1997; Grundman, 2006; Palmer, 2018). This is problematic for the reintroduction programme because these individuals are not adapting to a life free of human dependency and will most likely not contribute to the preservation of the wild population(s) of orangutans in anyway (i.e., not successfully reproduce in the wild or survive without human intervention).

In June 2009, the first ever group of rehabilitated bonobos (*Pan paniscus*) from Lola Ya Bonobo was released into a 20,000 hectares area of swampy forest in Equateur Province, Democratic Republic of Congo (Les Amis des Bonobos du Congo Newsletter, 2009). There were nine individuals released, including one pregnant female. Upon release the group remained cohesive and began to explore their new forest environment. The bonobos were continuously monitored by staff from the local community and minimally provisioned with food and water. The bonobos were observed making more sophisticated nests than they previously had in captivity, they were successful at locating and procuring food sources, and engaged in appropriate social behaviors with one another. However, some of the individuals, specifically one of the adult males, displayed aggressive behaviour (approaches, physical displays) directed at humans. After an intruding villager was bitten by one of the bonobos, the three individuals who were showing the most aggressive behaviour towards humans were transported back to Lola Ya Bonobo. The remaining individuals would frequent the release location for nesting and feeding, thus providing the researchers with an opportunity to directly observe the bonobos. The bonobos can easily be observed from the nearby river allowing the local villagers a chance to observe them from a closer distance. This has helped increase public awareness regarding conservation efforts for the bonobos and has had a very positive effect on the local communities. None of the villagers had actually ever seen a live bonobo before, and willingly admitted that if they had ever eaten bonobo meat before, they vowed never to do so again after realizing their close resemblance to humans (Lola Ya Bonobo, 2017).

The issues of successfully rehabilitating gibbons remain the same as for the great apes. Gibbons who have been kept as pets develop a very different behavioural repertoire than that of wild gibbons (Mootnick and Nadler, 1997). Different skills are needed for survival in the wild, and gibbons would normally acquire these valuable skills, such as how to locate and identify food, avoid predators, navigate in a complex environment, locate sleeping/singing

trees, and socialize with conspecifics from their parents (Cheyne, 2009). Wild gibbons may remain in their natal group for up to twelve years, sometimes longer, so when infants are removed from the wild, it can be extremely detrimental to their social and psychological wellbeing (Mootnick and Nadler, 1997). Former pet gibbons (i.e., human raised) have been deprived of this crucial learning period and must depend on humans to assist them in acquiring these skills (i.e., placing individuals into appropriate social environments, incorporating wild foods into the gibbons' diet, and providing an enclosure that will help facilitate proper forms of locomotion) (Grundman, 2006; Cheyne et al., 2008). Another potential issue with former pet gibbons is the prevalence of stereotypic or human-directed behaviours that arise from a life in captivity within an unnatural environment with human contact/interaction. These behaviours should be severely minimalized or eradicated before the gibbons are released into the wild. If rehabilitated gibbons solicit attention from humans, whether in an affiliative or an aggressive manner, it could potentially be harmful to them, or humans, and hinder their chance for survival in the wild. It is imperative that those responsible for rehabilitating and releasing gibbons (i.e., the reintroduction centres) have a better understanding of the their behaviour throughout the entire rehabilitation process, so they are better able to help facilitate the reintroduction phase of the project and ensure the gibbons are able to survive without human intervention once they are released into the wild (Cheyne, 2004; 2006).

Gibbon rehabilitation and reintroduction

Some of the early attempts to reintroduce gibbons were unsuccessful primarily due to poor planning and management practices (Table 5.1). For example, in Sarawak, Malaysia on the island of Borneo, the reintroduction effort of Mueller's gibbons (*H. muelleri*) suffered a 90 percent mortality rate in released individuals (Bennet, 1992). Several factors may have been

the cause of failure: hunting in the area, starvation, disease, and conspecific aggression (Cowlishaw and Dunbar, 2000). The release of lar gibbons (*H. lar*) as reported by Tingpalapong et al. (1981) saw far better rates of success. Thirty-one former laboratory gibbons were released into closed forest in Thailand. The released individuals consisted of 26 wild caught individuals and five offspring that were captive born. This reintroduction programme was more cautious in the pre-release planning by selecting forest that already had resident gibbons, although not many so there were vacant territories for the released gibbons, and the area was protected from hunting. Researchers monitored the gibbons post-release and provided the gibbons with food and shelter. The gibbons were released in family groups, pairs, or individuals. Unfortunately, two of the gibbons died at the release site, one was recaptured, 24 disappeared over time, and four of the gibbons joined wild groups. It is assumed that the most successful individuals were those in the first group to be released, because they were able to establish their own territories within the present population of gibbons (Bennet, 1992; Cowlishaw and Dunbar, 2000).

Table 5.1. Available data indicating estimated number of gibbons and siamangs rescued, rehabilitated, and reintroduced from centres in Asia.

Species	Location	Numbers released	Period	Comment on success
H. muelleri	Sarawak	87	1976-88 (1)	90% mortality
H. lar	Ko Klet Kaeo – Gulf of Thailand	21	1960s	4 pairs established territories and 4 young were born and reared successfully, but overall not a self-sustaining population
	Khao Phra Thaew Forest, Phuket, Thailand	30	2002-12	Sixteen (53%) of these 30 gibbons still survive in the forest, overall 83% survivability for all gibbons in the reintroduction programme
N. gabriellae	Cat Tien National Park, South Vietnam	8	2010-13	1 died, 2 were brought back to centre after falling ill
H. moloch	Mt. Malabar Protected Forest (JGC), Bandung, West Java	22	2009-present	Most individuals are still in family groups in the wild, one pair has died, one pair has gone missing
	Mt. Tilu Nature Reserve (TAF), Bandung, West Java	15	2011-present	Two missing, one potentially killed by leopard, all others remain in the wild. One male paired with a wild female and has successfully produced offspring
H. hoolock	Sonja Wildlife Rescue Center, Meghalaya, India	2 (one pair)	2009-present	Both gibbons are alive and well
H. albibarbis ***H. klossii*** ***S. symphalangus***	Kalaweit Gibbon Rehabilitation Project*, Central Kalimantan & East Sumatra, Indonesia	10+	1999-present	As of 2009, all individuals were alive and well, however, data is unavailable for how the released gibbons are at present

References: Kenyon et al., 2015; Osterberg et al., 2014; 2015; Roy et al., 2015; Gray et al., 2017; Ario, 2018; F. Magne pers. comm, 2018; 0axw : accessed Sept.1, 2018. * very limited information with regards to the number of gibbons and siamangs released from the project.

In general, conservation efforts for gibbons should focus on two issues: first, management and protection of wild populations and their habitat, and second, rehabilitation and management of the wild-born, captive-raised population. Due to the Endangered status of all gibbon species, several conservation projects have been established in Asia over the years,

all with the aim of rescuing and rehabilitating gibbons that have been rescued from the illegal pet trade (Cheyne, 2004). Gibbons are given to the centres when their owners realise they can no longer control the gibbon (i.e., the gibbon becomes too aggressive), or when the owners become aware of the disease risks, or ultimately, when the gibbon is confiscated by local police/forestry officials. These centres also provide a sanctuary for gibbons that may not be rehabilitated and released into the wild, but also can no longer be kept with humans (Cheyne, 2004). At present, there are a handful of rescue, rehabilitation, and reintroduction centres in Asia, devoted to gibbons (Table 5.2), with a few of the centres having measured success (the full potential is yet to be fully determined) in reintroducing gibbons back into the wild.

The goal of this review chapter is to provide an examination and analysis of the rehabilitation and reintroduction of gibbons across Asia, specifically Javan gibbons. Given my experience conducting research and aiding in conservation efforts at both Javan gibbon rescue centres on West Java, I set out to examine whether current reintroduction efforts will be a successful conservation tool to ensure their long-term survival in the wild. In addition, I provide recommendations and guidelines for future efforts, as well as discuss whether reintroduction efforts are currently aiding in protection of wild populations and helping to spread awareness and education in local communities about the plight of Javan gibbons.

Table 5.2. Current rescue, rehabilitation, and reintroduction centres for gibbons in Asia

Centre	Location	Species
Huro Programme	Meghalaya, India (est. 2006)	Western Hoolock gibbon (*Hoolock hoolock)*
Gibbon Rehabilitation Project	Phuket, Thailand (est. 1992)	White-handed gibbon (*H. lar*)
Gibbon Protection Society	Muar, Johor, Malaysia (est. 2016)	White-handed gibbon (*H. lar*), Agile gibbon (*H. agilis*), and siamang (*S. syndactylus)*
Kalaweit Organisation	Central Kalimantan and Sumatra, Indonesia (est. 1999)	Bornean agile gibbon (*H. agilis albibarbis),* Sumatran agile gibbon (*H. agilis ungko*), Kloss's gibbon (*H. klossi*), siamang (*S. syndactylus*)
Javan Gibbon Rescue and Rehabilitation Centre	Bogor, West Java, Indonesia (est. 2003)	Javan gibbon (*H. moloch*)
Javan Primates Conservation Project – The Aspinall Foundation	Bandung, West Java, Indonesia (est. 2010)	Javan gibbon (*H. moloch*)

Rehabilitation process

The rehabilitation centres typically involve local people in all aspects of the reintroduction programme by only hiring people from the surrounding villages to work at the centres, but most do allow volunteers to participate in the daily activities (i.e., general husbandry duties, behavioural observations, and education outreach). In addition to the reintroduction programme, the centres also promote habitat protection and provide public education on local conservation initiatives through a variety of means (i.e., Kalaweit Centre manages a radio station that shares conservation messages every five hours and has established a local school that can accommodate up to 30 children). Based on my experience and knowledge gained from conducting research at the Javan Gibbon Rescue and Rehabilitation Centre (2008-2010), I documented the entire process from when a gibbon first arrives at the centre through to when the gibbon is paired with another individual. When a gibbon first arrives at the centre, they receive a full health evaluation and are tested for Hepatitis A, B, C, as well as Tuberculosis, and Herpes Simplex Virus 1 and spend one month in quarantine. This is done

in order to determine the gibbon's health status and ensure they can be properly treated if they do suffer from any disease. In addition, this process provides the keepers with an opportunity to gain a better understanding of the gibbon's temperament. Once the gibbon is removed from quarantine it is then moved into a socialisation enclosure, ideally next to another gibbon of the opposite sex. The socialisation enclosure consists of two sections that are connected by a small corridor. The keepers will then periodically open the corridor allowing the gibbons the opportunity to interact with one another if they choose. After a period of observation (one month minimum) the keepers will determine whether the gibbons will make a suitable pair based on the level of affiliative interaction between the two gibbons. If this step in the socialisation process is successful and the keepers determine the gibbons will make a good pair, they are then moved into larger, more naturalistic enclosures.

The naturalistic enclosures are built into the surrounding forest with trees being used as the primary supports (Figure 5.2). They range from six to eight meters high and vary in their overall shape and width depending on the natural landscape. Once the gibbons are moved into these enclosures, there is very minimal human/gibbon interaction, and since the enclosures are placed amongst the trees, the gibbons have a fairly limited view of neighboring enclosures. The gibbons are fed a diverse diet consisting of fruit and vegetables from the local market, as well as wild fruit and leaves collected from the forest in the park (Gunung Gede-Pangrango). In addition, they are also given a variety of greens, tofu, tempe, peanuts, and sweet potatoes. The keepers do not enter into the enclosures for any reason (unless in the case of an emergency or to repair any broken branches or supports).

Fig. 5.2. Naturalistic Enclosure at Javan Gibbon Rescue and Rehabilitation Center, Gunung Gede-Pangrango National Park, West Java, Indonesia. Photo by JH Smith.

The challenges associated with rehabilitating gibbons

There are a variety of problems facing gibbon rehabilitation efforts. Some of the gibbons will have spent their lives in tiny cages or chained to a tree, while others will have been relatively well treated and may experience difficulty adapting to life without their human family (Cheyne, 2004). Tame gibbons have been shown to form less stable pair bonds and exhibit unpredictable behaviour towards conspecifics (Cheyne, 2004; 2006), and they may not be able to adapt to a life in the wild free of human dependency (pers. obs). During the rehabilitation process, caregivers for rescued gibbons should differentiate between gibbons at the centre that are orphaned when young, and those that have been kept for a time as pets, as their rehabilitation and care needs will be very different. Primates in general have extensive parental care with long periods of infant and juvenile dependency (Cheyne, 2004; 2009). During this time young gibbons learn many valuable social, behavioural and sexual responses (e.g., the ability to correctly vocalise and communicate with others, how to manipulate and handle food, and how to avoid predators). Grouping juvenile gibbons is a useful method to encourage socialisation and to identify compatible individuals, but groups of juveniles should not be released into the wild (TAF has a socialisation enclosure for young gibbons and has been shown to encourage appropriate social behaviour: pers. obs.), and once they reach sexual maturity the gibbons should be paired with another suitable mate of the opposite sex. Another more ideal option is to pair a younger gibbon with an adult gibbon so the former may learn the necessary social and survival skills, rather than to have a human teach a gibbon those same skills (Cheyne, 2004). Though it cannot be assumed this would work for all gibbons, and there is the risk the adult and juvenile would not be compatible; thus, the juvenile could potentially develop a fear of conspecifics which may lead to problems in the development of an appropriate pair bond in the future (Cheyne, 2004). Another issue is that while a gibbon pair may have duetted (for those species that do engage in morning duets – Javan gibbons typically do not)

and copulated in captivity, this is not a conclusive indication that the association will continue once they are released into the wild. The pairs may split and reform with other individuals, one individual may disappear or one individual may fall ill or not adapt well and have to be brought back to the centre. Rescue centres must ensure gibbons that are to be released have satisfied all necessary behavioural criteria (Table 5.3) if they are to have the best chance of surviving in the wild.

The ultimate cause of failure in reintroduction programmes must be attributed to a lack of information about the species' behaviour & ecological requirements, the release area, and the individual's response to a novel environment. We can never truly know how each individual gibbon will respond to a life in the wild, therefore releasing an endangered animal is always a *conservation* risk. If the released gibbons do not live long enough to reproduce, then their conservation value is negligible (Cayford and Percival, 1992; Cheyne, 2004). Long-term monitoring and studying the gibbons' behavioural response(s) to their new environment, as well as accounting for any deaths/disappearances, is critical for the ongoing success of reintroduction efforts for gibbons, and conservation in general, as each species presents a unique challenge for a successful rehabilitation and reintroduction programme.

Table 5.3. Behavioural criteria necessary for rehabilitated gibbons

Behaviour of wild gibbons.	**Proposed criteria for assessing suitability of gibbons for release**	**Behavioural recommendations based on the results obtained from previous MA research and personal experience**
Gibbons spend 20–75% of travel time brachiating (Fleagle 1976).	The gibbon should be able to move around the enclosure well, and most of this movement should be by brachiation.	Gibbons should be able to effectively locomote and should utilise brachiation as their primary mode of travel around the enclosure.
Gibbons spend 50–65% of their time in the upper and emergent canopy (Gittins 1983) and have never been observed sleeping on the ground.	No more than 5% of time to be spent on the ground for any purpose. Gibbons should be at the top of the cage for at least 40% of the time and should not be sleeping on the ground at all.	Gibbons should be spending the majority of their time at the upper level of their enclosure, with no more than 5% of time spent on the ground.
The cohesion of the pair is important for territorial defense and successful raising of offspring (MacKinnon & MacKinnon 1984).	The pair should be spending at least 7% of total activity time in positive pair association. At least 3% of total activity time should be spent allogrooming.	The pair should be spending at least 15% of total observation records in positive association behaviour (i.e., groom, play, copulation, and within close proximity).
Proof that the gibbons are sexually mature and active (Chivers 1978).	They should be copulating successfully and each member of the pair should be able to initiate successful copulation with the other.	They should be copulating successfully and each member of the pair should be able to initiate successful copulation with the other.
To allow gibbons to survive once reintroduced their behavior should mimic that of wild gibbons (Cheyne 2004; Cheyne and Brulé 2004).	Activity budgets should approximate those of wild conspecifics in all major categories i.e., feeding, resting and travelling.	Gibbons should be fed a diet that includes wild fruits and foliage, and they must demonstrate a significant interest in these foods.
Stereotypic behaviors are a product of captivity (Cheyne 2007).	No more than 3% of total activity time engaged in a severe stereotypic behavior e.g., rocking or self-harm.	Gibbons should not exhibit any form of *severe* stereotypic behaviour and very infrequent occurrences of human-directed behaviour.

Adapted from Cheyne (2004) and author's personal research.

Discussion

Rehabilitation and reintroduction of globally threatened species has been heavily criticised because some argue there is little justification for the continuation of these projects because they are expensive, have limited success, and tend to focus too narrowly on one species (Kleiman, 1989; Ewen, 2012). Much of the failure of rehabilitation and reintroduction stems from the lack of knowledge about the specific requirements of the focal species in terms of

their social, behavioural, and nutritional needs (Cheyne et. al., 2008), which is precisely why having thorough knowledge of species' behaviour and ecology in the wild is crucial to the reintroduction process. The operational costs of a reintroduction programme can be exceptionally high; therefore, it is necessary to first determine if rehabilitation and reintroduction programmes are an economically and morally viable solution to conserve threatened species (Cheyne, 2004). It is crucial the individuals that are to be released have either maintained, or developed, the appropriate behavioural repertoire necessary for survival in the wild and have gone through an extensive period of rehabilitation (Cheyne et al., 2008; Cheyne, 2009).

The success of rehabilitation and reintroduction of gibbons is still yet to be fully realised as an effective conservation strategy, as there are few data published on the successful release of gibbons back into the wild (see Ario et al., 2018). All species of gibbons are currently listed as Endangered or Critically Endangered (Van Ngoc Thinh et al., 2010a; IUCN, 2018), therefore, the future of all gibbons is truly in peril (Cheyne et al., 2008). Many gibbons are kept illegally as pets and a large number of these end up in the various rescue and rehabilitation centres when the owners realise they can no longer control the gibbon. Therefore, the reintroduction of former pet gibbons may be one way to ensure the survival of many of these threatened species of gibbons in the wild (Cheyne et al., 2008).

A major challenge for the reintroduction programme is locating an appropriate release site for Javan gibbons on an island where lack of suitable habitat is one of the primary causes of their decline, and particularly where there are two operating rescue centres on the western side of Java both requiring release sites. Habitat where Javan gibbons have previously been known to exist, but that is currently not inhabited by other groups, would be the ideal location to release a pair of gibbons. However, caution must be taken to ensure that the reasons for the local declines in that area have been addressed (Armstrong and Seddon, 2008). Given hunting

for the illegal pet trade and deforestation are the primary threats to Javan gibbons in the wild, then evidence must be presented to show that these threats have been controlled or ideally, eliminated (Kleiman, 1989; Cheyne et al., 2010). Extensive habitat surveys should be conducted in order to determine if the release site will be able to sustain a pair of gibbons and any future offspring. Understanding the ability of a rehabilitation programme to successfully reintroduce gibbons will allow much needed scientific backing to a conservation strategy which may be crucial in stemming the illegal pet trade, preserving forest habitat, and increasing populations of gibbons in the wild (Cheyne, 2004).

Due to a relatively high number of Javan gibbons that are currently held illegally in Indonesia as pets, rehabilitation and reintroduction may be an invaluable conservation strategy for re-establishing populations of Javan gibbons in the wild. However, based on the aggressive response from previously released Javan gibbons, precaution is now taken for all future releases when monitoring reintroduced Javan gibbons. Observers keep their distance when observing the released gibbons. When I set out to observe the first pair of released Javan gibbons (see Appendix 1.2), I had expected to observe very little human-directed behaviour, either affiliative (i.e., soliciting grooming, petting) or aggressive behaviour, once they were released. This expectation was based on the fact that wild gibbons tend to shy away from humans and flee when they encounter them in the forest but will sometimes perform threat displays or alarm calls (Nijman, 2004; pers. obs.).

Captive gibbons, on the other hand, may have very little fear of humans. There has never been a published report of a wild gibbon physically attacking a human. Although the pair (Septa, male; Echi, female) was highly aggressive towards humans whilst in captivity, I did not expect the aggressive behaviour would persist once they were released. There is always a potential risk in releasing animals into the wild that have lived in captivity with humans for most of their life, because they will either have developed a psychological attachment or

resentment towards humans or will have no fear of them. There are reports of reintroduced orangutans, bonobos, and gibbons attacking humans (Yeager, 1997; Lola Ya Bonobo Newsletter, 2009; GRP, 2010). For example, one adolescent male orangutan attacked and bit humans over 25 times in a 15-month period in Tanjung Puting National Park in Indonesia (Yeager, 1997). In Phuket, Thailand at the Gibbon Rehabilitation Project (GRP), aggression directed at humans was displayed by two adult lar gibbons immediately after they were released from their enclosure. When the staff would attempt to observe the gibbons in the forest, the male would approach observers jumping from tree to tree at a low height in the canopy or running bipedally on the ground. Some of the observers, including both volunteers and staff, were actually scratched or bitten by the male gibbon and aggressive gibbons had to be recaptured and taken back to the facility (GRP, 2010; Svensson pers. comm.). The female (and the juvenile) would sometimes urinate or defecate on humans or their belongings. She also scratched some observers and seemed to specifically dislike female observers (GRP, 2010). At JGC, Echi showed a similar dislike for me while she was in captivity. Once she was released, she directed aggressive behaviour at all human observers (I was the only female observer). The staff of GRP would use sling shots to attempt to scare the gibbons and the gibbons eventually learned to back off when they became aware of the sling shots. We also used sling shots in an attempt to frighten Septa and Echi back up into the canopy (with careful consideration to not hit either of the gibbons), however, this method did not work for us. GRP reports that the aggressive behaviour of the adult male towards observers eventually decreased during the study period, while the adult female still exhibited aggressive behaviour to every new female observer. The gibbons at Kalaweit were released onto an island (Mintin) and most of the post-release monitoring was conducted from a boat off shore. However, observers would occasionally go onto the island and attempt to locate the gibbons, but there were never any aggressive encounters between the gibbons and human observers.

Gibbons that are were victims of the illegal pet trade and lived a life in captivity prior to being rescued are bound to have behavioural issues (e.g., either overly aggressive towards humans or too tame and seek affiliative attention). Considering Septa and Echi (the first pair released) spent the majority of their life in captivity with human interaction prior to being released, it was not altogether surprising they had maintained some degree of abnormal behaviour. However, even with the aggressive behaviour they displayed towards humans is not typical for wild gibbons, this did not mean they would not have been able to survive in the wild had they not met a tragic end. Their behaviour may have been wholly advantageous had they been able to move into the larger part of the park and establish a new territory near wild gibbons, thus assimilating themselves into the wild population. They demonstrated they were capable of effectively defending their territory, and therefore would have most likely been able to sustain themselves in the larger population of wild gibbons in Gunung Gede-Pangrango National Park as long as they did not encounter humans. Managers must consider how wise it is to release individuals that display aggressive behaviour as it may hinder the success of the project.

If released gibbons seek any type of behavioural interaction with humans post-release, their chance of surviving in the wild ultimately decreases. There is always the risk of injury to both humans and gibbons, risk of predation if the gibbons are spending too much time on the ground following observers (pers. obs.), as well as the risk of zoonotic disease transmission between gibbons and humans. Other projects (see Lola Ya Bonobo and GRP) tend to recapture individuals and return them to the rescue centre if they display overly aggressive behaviour directed at humans. With regards to the first pair of Javan gibbons released, both maintained normal species typical behaviour with one another and their bond remained intact, as has been the case with the other pairs released by JGC. In addition to engaging in normal social behaviour with one another, Septa and Echi made use of all substrates available to them in the

forest, despite never having any experience prior to being released that would have prepared them for the complexities of life in the forest. Ultimately, it was evident both Septa and Echi had developed appropriate survival skills and demonstrated that some gibbons are capable of some level of rehabilitation after having spent the majority of their life in captivity. JGC now has a new release site (Mount Malabar/Gunung Puntang) as it was critical to ensure the site has very little human activity in the area in order to minimise the encounter rate between gibbons and humans. When there is conflict between humans and wildlife, it is usually the wildlife that suffers the most (e.g., animals are either trapped, poisoned or shot) (Dickman and Hazzah, 2016; Nyhus, 2016). Wild gibbons tend not to interact with humans and are quite inconspicuous, so fortunately, as a species, they are not too involved with conflict. Released gibbons, however, are used to living in the presence of humans and this is where problems may arise. Sadly, as a result of overly-aggressive behaviour exhibited by the first pair of Javan gibbons released in 2009, they were eventually shot by local people, most likely due to their aggressive behaviour. Otherwise, only one pair released by JGC has gone missing since 2010 and there have been no reports of further conflict (to the best of my knowledge). Each gibbon has a different life history and the outcome of future release efforts will likely vary on a case by case basis.

Some form of population modelling should be incorporated into every reintroduction programme in order to explore the possible short-term consequences of management strategies, identify key vital rates of survival, provide information on uncertainty of population persistence, and assess longer-term viability of the population (Seddon et al., 2007). PVA is acknowledged, however, to be more than an attempt to model a probability of extinction because the need to synthesize information about a species entails close collaboration between managers and scientists to develop a long-term process of modelling and research to refine

models and explore management options. In this way PVA can be, as the above studies illustrate, a powerful example of adaptive management (Boyce, 1992; Seddon et al., 2007).

Chapter conclusion

Future considerations and recommendations

The measurement of success of a reintroduction programme is essential, not only to ensure that significant resources expended result in some positive conservation outcome, but also in terms of securing ongoing financial, government support, and the support of local communities for such programmes (Trayford and Farmer, 2013). Ultimately, the primary reason for reintroducing threatened or Endangered species should be for conservation benefits to accrue at the levels of population (IUCN, 2013) and, therefore, success should be measured against such criteria. How 'success' is defined in a reintroduction project has been debated, considering the long-term time scales required for positive conservation outcomes to be realised makes success difficult to quantify (Cheyne, 2009, King, et al., 2012; Trayford and Farmer, 2013). Determination of success must include the justification for undertaking the reintroduction programme in the first place. Explicit goals (species- and site-specific) should be identified early in the project planning process, with measurable targets identified (Campbell et al., 2015). The goals should include proposed numbers of gibbons to be released into the wild and the time scales for the reintroduction(s), as well as an expected survival rate and anticipated time frame before reproduction (PVA modelling may be useful here) (Cheyne, 2009; Campbell et al., 2015). Post-release monitoring is essential in tracking these indicators, so project goals must include appropriate protocols to ensure the data and all experience(s) can be collected and shared (Campbell et al., 2015). The following points indicate areas of

significant importance for reintroduction programmes, and must be woven into conservation management plans:

1) ***Habitat -*** It is essential to determine if sufficient resources are available to support translocated gibbons. Every effort must be made to find a release habitat that resembles the natural habitat as closely as possible. If a potential release site has an existing population, or one that has only recently become locally extinct, a comprehensive assessment is required to ensure that there have been no significant changes in habitat quality. Long-term habitat assessment, both before and after release, can help increase the probable success of a reintroduction programme (Cheyne, 2006; Campbell et al., 2015).
2) ***Threat(s)*** - In order for reintroduction efforts to be successful, it is critical the cause of the threats faced by these species and their habitats, currently and historically, are thoroughly understood (Nijman et al., 2009). The primary threats to the majority of gibbon populations are undoubtedly loss of habitat and hunting. As populations decline, the effects of threats from hunting, such as the illegal pet trade, and use of primates in traditional medicine, also become more important (Cowlishaw and Dunbar, 2000; Nijman et al., 2009). The illegal trade of gibbons can have a drastic effect on already small populations, and most often, reproductively viable adults are killed in the process of obtaining infants from the wild (Campbell et al., 2015).
3) ***Social -*** Local community acceptance and understanding are imperative to the success of reintroduction programmes. Local communities may play an important role in the project, potentially working at rescue centres engaged in protection and monitoring activities, connecting conservation and livelihoods. Knowledge of community attitudes and behaviours can assist in developing appropriate education and socialisation programmes, and ongoing environmental education activities can help build a sense of

partnership between gibbon reintroduction projects and local communities (Campbell et al., 2015).

4) ***Risk*** - Every reintroduction programme needs a detailed management plan in place. The probability of achieving desired results is favoured by early identification of the risk factors that might be encountered across all aspects of the reintroduction (IUCN, 2013), as each project may encounter unexpected outcomes. Risk is assessed as the likelihood of any risk factor occurring, combined with the severity of its impact and should be assessed at all stages. Managers must envision what may occur under various circumstances and consider all the likely permutations across the whole scope of reintroduction activities and develop counter-contingencies. Having the basic background, biological and ecological knowledge about the species is key to determining what is not known, and identifying areas where more management may be needed (Campbell et al., 2015).

A significant gap in gibbon reintroduction is the lack of an agreed monitoring and evaluation framework. This makes it more challenging to amass and compare data, identify trends amongst the different centres across Asia, test the assumptions embedded in the methods and, ultimately, to demonstrate welfare and conservation impacts on populations of wild gibbons (Campbell et al., 2015). It is imperative that gibbon rescue centres publish reports on the rehabilitation and reintroduction process, successes and failures. Documentation on gibbon reintroduction is currently very limited, with few published sources for developing projects to refer to. Thus, the results of reintroduction efforts should be published in scientific journals or made publicly available (e.g., rescue centre websites or annual reports), so that successes and failures can be shared in order to improve general practice and understanding of the science.

One of the most crucial components, I believe, for the future success of reintroduction efforts for Javan gibbons is for the rescue centres to engage more with local communities and involve

them in conservation efforts whenever possible. Surveys with local people should be conducted regularly in order to gain insight into how they feel about the programmes. Moreover, a general understanding of the socioeconomic status, human activities, cultural beliefs and overall security surrounding the release site, provides useful information for the planning of strategies to mitigate any potential conflict and/or threats (Campbell et al., 2015).

The purpose of any reintroduction programme should be thoughtfully weighed against the costs and benefits of alternative conservation strategies, including protection of the wild population. Rehabilitation and reintroduction of former pet gibbons can potentially serve to make a considerable contribution to the reestablishment of viable wild populations, as well as reduce significant welfare issues for gibbons already living in rescue centres (Cheyne et al., 2010). It has been suggested that conservation efforts should focus on preserving the remaining habitat and populations of wild primates and that the bulk of the available funding should be redirected to these causes (Sarrazin and Barbault, 1996). However, if rehabilitation and reintroduction programmes adhere to scientific principles and guidelines, coupled with careful planning and documentation of the pre- and post-release behaviour of the animals, the programmes can positively contribute to species' conservation and habitat protection (Cheyne, 2009). Ultimately, a reintroduction programme cannot succeed without the rescue centres interacting with the local and national governments, government and non-government professionals, and the local people in the communities. Education about the reintroduction programme is crucial to secure continuity and the long-term support, protection, and management (Kleiman, 1989) of the Javan gibbon and its habitat and ensure that this fascinating ape does not go extinct on the island of Java.

Summary

The previous chapter examined the role of rehabilitation and reintroduction as a conservation tool for the preservation of wild populations of gibbons, specifically referring to Javan gibbons, as it is currently the primary conservation strategy in West Java. I have direct experience participating in conservation activities for the species, specifically three different releases of Javan gibbons back to the wild. More specifically, I discuss the role the Javan Gibbon Rescue and Rehabilitation Center (JGC) plays in local conservation efforts and I provide insight from my personal research experience taking part in the first ever release of wild-born, former pet Javan gibbons back into the wild. At present, both rescue centres are seeing success with regards to the Javan gibbons they have released into the wild, either in pairs or family groups. With the exception of the first pair having met a tragic end in 2009 and another 3 individuals reported missing, all other Javan gibbons are adapting well to life in the wild and successfully reproducing. Since 2013, at least 3 Javan gibbons have been born in the wild. In conclusion, I provide future considerations and recommendations for gibbon reintroduction based on my literature review and research experience, and I discuss the long-term viability of reintroduction as a means to save Javan gibbons (and gibbons in general) from going extinct in the wild.

The next chapter, I present the research from my short ethnographic study in local villages bordering Gunung Gede-Pangrango National Park, West Java, Indonesia. During the summer months of 2016, I lived in the Sundanese village of Bodogol and carried out social anthropological research by conducting semi-structured interviews with local people. I was hoping to gain a better understanding of how they feel about local conservation programmes, specifically JGC, determine the value people place on forest preservation, and explore the depth of their knowledge about local wildlife, specifically Javan gibbons and the threats they face in the wild.

Chapter 6

The People's Voice: It's What Matters

Fig. 6.1. Photo of local Sundanese women who participated in interviews conducted in Ciwaluh, West Java, Indonesia. Photo of JH Smith and E Juanda by Budi Sarianto.

Introduction

The increasingly intense and widespread conservation challenges that we face today are not naturally occurring, but rather are anthropogenic in nature (Bennett et al., 2017); therefore, it must be acknowledged that conservation is as much about people as it is the environment and species we aim to preserve (Ellwanger et al., 2015). Conservation programmes should be developed and guided by the best available information, as well as adequate conceptual frameworks relevant to the area (i.e., research site, region, country) and the people who live

there (Sanderson et al., 2002; Ellwanger et al., 2015). It has become widely recognised that acknowledging and understanding local people's perceptions about the environment and conservation is imperative for developing successful and effective conservation programmes (Ellwanger et al., 2015; Bennett et al., 2017). The perceptions local people have about a particular conservation project within their immediate area can be fundamental to the project's success (Alexander, 2000; Vodouhê et al., 2010). The attitudes local people have towards the protection of primates may also vary greatly and is heavily influenced by their social-cultural beliefs and world views (Cowlishaw and Dunbar, 2000; Lee and Priston, 2005; Riley et al., 2010; Nekaris et al., 2013).

Conservation attitudes and knowledge may be influenced and guided by variables such as gender, education level, or overlapping ecological and geographical spaces (Ellwanger et al., 2015). Gender may play an important role in shaping determinants of pro-environmental behaviour and concern for the conservation of Endangered species (Vicente-Molina et al., 2018). Men and women may interact differently with the environment and it should not be assumed they share the same ecological knowledge base or hold the same values about the natural world (Zelezny et al., 2000; Ellwanger et al., 2015). In a literature review of studies examining gender and behaviour, Zelezny et al. (2000) found that women tend to express greater concern for the environment and similarly, McCright (2010) found that women tend to show greater concern about climate change than men (also see Czech et al., 2001). However, many approaches to conservation, including those that rely on local political and social institutions, can marginalise or sometimes exclude women's participation in conservation activities and exacerbate the already existing inequities within a society (Mukadasi and Nabalegwa, 2007; Bandiaky, 2008; Ellwanger et al., 2015). It has been shown that women's participation in conservation activities may positively influence the success of a conservation programme, as Agarwal (2009) demonstrated in India and Nepal. The study found that forest

management groups with a higher proportion of women involved in governance have significantly higher forest regeneration and canopy growth compared to other groups, particularly in the case of all female management groups. Ultimately, involving both women and men in conservation initiatives increases the number of community members who are aware of and committed to conservation issues, thus improving community knowledge of rules and activities (Ellwanger et al., 2015).

In terms of education, generally, respondents with higher levels of education tend to have more positive attitudes toward conservation (Infield, 1988; Badola et al., 2012) and more general knowledge about protected areas (Badola et al., 2012; Ellwanger et al., 2015). Infield (1988) found that respondents with less formal education were considerably more negative towards the concept of preserving wildlife than educated respondents in a local conservation area in Natal, South Africa. Those respondents with no formal education were consistently more negative towards conservation than respondents with some level of schooling, and among both males and females, higher education was associated with more knowledge and appreciation and a greater protectionist sentiment toward animals. Conversely, less emotional attachment for individual animals, and a limited concern for wildlife, were observed among both males and females of less education (Kellert and Berry, 1987; Czech et al., 2001). Education, thus, appears to exert substantial influence on male vs. female knowledge and attitudes toward wildlife and conservation initiatives (Kellert and Berry, 1987; Infield, 1988).

In areas where humans and primates share an ecological space or where they live commensally, some primates will have expanded their niche to overlap with the human domain, whereas advances in modern technology have allowed humans to penetrate deeper into the primate domain (Nekaris et al., 2013). With both humans and primates occupying shared ecological and geographical spaces, interspecies conflicts (e.g., crop raiding, hunting, shared resources) are somewhat inevitable. Reconciling these conflicts, as well as properly quantifying

their proximate and ultimate causes, has become an increasingly important part of conservation policies and practices (Bennet et al., 2017). In order to examine the ecological, geographical, and behavioural relationship between humans and primates, conservationists must engage with local communities to ascertain how to best develop culturally and ecologically appropriate conservation programmes. The field of ethnoprimatology (Sponsel, 1997; Riley, 2006; Fuentes, 2012) provides the foundation for such research. The subfield is comprised of elements of folk biology (i.e., the way people understand and categorise plants and animals) and ethnoecology (i.e., people's knowledge, beliefs, and values of their environment) and provides both a theoretical and methodical framework to address the ecological and cultural interconnections between humans and other primates, as well as the implications these interconnections may have for conservation (Riley, 2010; 2013). Examinations of cultural interconnections tend to focus on how humans and primates are linked via central elements of human culture, by illuminating how humans conceptualise and categorise features of their surrounding environment, such as forests and the wildlife they host and the social and mythological relationships between humans and other primates (e.g. Cormier, 2003; Riley, 2010; Fuentes, 2012).

Ethnoprimatology allows us to explore how these conceptualisations and relationships shape human behaviour towards primates and nature in general through an anthropological lense (Fuentes, 2010; 2012). Proponents reason that utilising an ethnoprimatological perspective (such as ethnography) allows conservation policy to be conceptualised within a local cultural context, in which traditions and religious parameters often exist for the preservation or to the detriment of wildlife (Wheatley, 1999; Kuriyan, 2002; Priston, 2005; Lee, 2010) and has now become an invaluable component in conservation policy development (Malone et al., 2014). When assessing the overall conservation efforts currently in place for Javan gibbons on the island of Java, one component was essentially missing: the people's

voices. Ethnographic methodology is one way to explore the worldviews of others in an effort to understand why activities such as forest clearing, encroachment, and the acquisition of pet primates occur (Malone et al., 2014), and can hopefully help conservationists move forward in achieving long-term goals to preserve threatened species such as the Javan gibbon.

Gibbons tend to exist in an in-between space in terms of social-cultural and evolutionary discussions. With regards to the biophysical margins gibbons occupy, they tend to be marginalised in both conservation circles and evolutionary debates when juxtaposed with the great apes (Malone et al., 2014), and receive less public attention from the press and the global conservation community, making them the 'true neglected apes' (Whittaker and Lappan, 2009; Malone et al., 2014; Fan and Bartlett, 2017). In addition, given the gibbons' longer period of divergence since sharing a common ancestor with humans and the emergence of molecular evidence (Chatterjee, 2006; 2009), coupled with the emphasis on our genetic relatedness to the great apes, has further placed gibbons on the verge of current discussions of human origins (Malone et al., 2014). When gibbons have featured prominently in evolutionary debates (Malone and Fuentes, 2009; Malone et al., 2014), the discussion focuses on their social and mating relationships, specifically their presumed monogamous mating pattern and formation of pair bonds (i.e., long-lasting, stable relationships between two unrelated adults) (Kleiman, 1977; Mitani, 1984; Fuentes, 1999; 2000; Malone et al., 2014). Despite research indicating gibbons may exhibit a more fluid and flexible social and mating pattern (Palombit, 1994; Reichard, 1995; Sommer and Reichard, 2000; Malone, 2007; Huang et al., 2013), they are still considered to be predominantly monogamous primates (Fuentes, 2000; Malone and Fuentes, 2009). Furthermore, from a more social-cultural perspective, Javan gibbons tend not to feature in the everyday lives of people on Java, placing them in somewhat of an in-between space both socially and culturally. Gibbons are not known to raid crops or venture out into human

dominated landscapes, so they are less conspicuous than other primates (e.g., macaques, orangutans on Borneo and Sumatra).

There has been little documented literature on gibbons in Indonesian folklore (Harrison, 1966; Reisland and Lambert, 2016; Permana et al., 2019) or tales of their relatedness to humans (unlike tales of monkeys and their relationship to the god Hanuman, see Riley, 2010), whereas in China gibbons held a much more revered and mythical place in the culture (Geissmann, 2008; Zhang, 2015). However, in a study by Permana et al. (2019), they revealed one tale about Javan gibbons in Sundanese lore. Owa, as they are locally called, were considered a 'good' animal (*bageur*) by rural people because they never did anything harmful to the people. The Sundanese people believe that owa are guarded by the ancestral spirits called *Mbah Layung* who lived in the Cigembong area, Bojongsalam Village, West Java. This story was revealed through a dream of one of the informal leaders in Bojongsalam village, in which he was visited by *Mbah Layung* who gave him a message to not disturb or hunt owa. The village leader swore an oath to the ancestral spirits and promised if he ever found owa hunters, he would arrest and prosecute them.

Javan gibbons are not typically hunted for their meat (or rather it has not yet been documented in West Java) yet they are still highly threatened because of (predominantly) human activities. However, in other areas of Asia (Myanmar, Laos, Vietnam) gibbons are hunted for their meat or traditional medicine (Johnson et al., 2005; Choudhury, 2006; Das et al., 2006; Geissmann et al., 2009) and in Thailand, gibbons are hunted for sale in the illegal pet trade being considered one of the 'favourite pets' in Thailand and are used as photo props for tourists (Geissmann, 1991; Eudey, 1994; Osterberg et al., 2015). Given Java is predominantly an Islamic island, there are taboos preventing the consumption of primates (Nyanganji et al., 2011), thus Javan gibbons are seemingly spared from this fate. Yet, this does not prevent people from hunting them for pets in the illegal wildlife trade.

Methods

The goal of this research was to explore how communities living on the border of Gunung Gede-Pangrango National Park in West Java perceive the natural environment and the wildlife with which they share the forest, specifically Javan gibbons. Utilising ethnographic field methods, I conducted qualitative interviews with local people (see Figure 6.1) to gain a better understanding of how they feel about local conservation programmes, determine the depth of their knowledge about Javan gibbons, and determine if they care if Javan gibbons survive in the wild. Ultimately, I wanted to uncover how we, as conservationists, may help local people come to care about an elusive and Endangered animal that may not hold any special significance in their social or cultural lives.

In the summer of 2016, from the months of June through August, I lived in the village of Bodogol (6°46'00.2"S 106°49'48.9"E) with four local people (two of which were my research assistants) and is where I conducted the majority of my interviews. I chose Bodogol village as my base since I have a fairly well-established presence there from visiting the Javan Gibbon Centre (JGC) over the past 10 years (2008-2018), as well as having engaged in social events with local people (such as the families of JGC employees) at different events (e.g., school activities and football games). This familiar association between myself and the local people allowed me to establish a friendly rapport within the village in a relatively short period of time. Bogor is the closest major city to the area and the nation's capital city, Jakarta, is approximately a two to three-hour drive northwest. Bodogol has a tropical climate with significant rainfall throughout the year (~ 4086mm annually), and the average temperature is around 25.2°C. Given the village is within close proximity to the forest, the air is significantly fresher and cooler. Bodogol is surrounded by cultivated lands which are farmed by the majority of the residents in the village, thus providing their primary form of income. There are roughly 800-900 people living in the village. It is approximately 1km from the forest of Gunung Gede-

Pangrango National Park and the closest entrance to the biological research station, Pusat Pendidikan Konservasi Alam Bodogol or simply PPKAB, which is situated approximately 1km from JGC inside the national park. Over the past 10 years the local people have seen an influx of visitors from Jakarta and tourists from other countries passing through the village on their way to visit the national park, and the staff of JGC regularly come through when delivering supplies to the centre.

The other four villages which I conducted interviews in were chosen based on their relatively close proximity to Bodogol, as well as to the national park and forest edge (Figure 6.2). Lengkong and Ciwaluh are the closest to the national park with Ciwaluh sitting a mere 200 metres from the forest edge (Lengkong is about 500-600m). The two villages are relatively small with an estimated 400-500 people living in Ciwaluh (Figure 6.3) and about 600 in Lengkong (Figure 6.4). Cibilik is approximately 1km from the park and has an estimated 1,000 people thus making it the largest of the five villages in the study. Ciletuh is the farthest away at 2km with around 700-800 people living there. All 101 respondents included in this study are of Sundanese origin (as most of the people in the region are) and spoke Bahasa Sundanese as their primary language.

Fig. 6.2. Map of villages included in the study. 1) Black dash line – Bodogol 2) Black solid arrow – Lengkong 3) Green solid arrow – Ciwaluh 4) Blue solid arrow – Cibilik 5) Orange solid arrow – Ciletuh. Map adapted from http://gedepangrango.org/download/petaAkses_TNGGP.jpg.

Fig. 6.3. Photo taken from the village of Ciwaluh showing the proximity to the forest edge. Photo by JH Smith.

Fig. 6.4. Photo looking down from the village of Bodogol to the village of Lengkong with Gunung Gede in the distance. Photo by JH Smith.

Interviews

Semi-structured interviews were conducted with a total of 101 people living in five villages bordering Gunung Gede-Pangrango National Park. Data collection was carried out by myself and my assistant, Elan Juanda, with adult (≥ 18 years) respondents being randomly chosen to minimise bias (Kapila and Lyon, 1994; Nekaris et al., 2013). All interviews for this sample were recorded and obtained through two general means: (1) non-probability sampling where my assistant and I went door to door looking for interviews and approached houses at random; or (2) convenience sampling where I interviewed individuals who were present at community events or public gathering places such as local shops or village offices. The format of each interview was determined beforehand and rehearsed with my research assistant to clarify exactly how each question should be asked. Having worked in West Java for over 10 years, I have discovered the best way to interact with local people is in a friendly and informal way. People tend to feel more comfortable opening up and sharing their stories and thoughts, if the environment is friendly in nature; therefore, establishing an affiliative rapport is crucial when conducting interviews in a local community (Kapila and Lyon, 1994; Wolff, 2004; O'Reilly, 2012). My assistant and I gave the participants the choice to have the interview in the national language, Bahasa Indonesia, or the local dialect of Bahasa Sundanese. If they were more comfortable speaking in Bahasa Sundanese, the interviews were conducted by my assistant to avoid confusion and the omission of vital information (over 90% of respondents chose to speak in Bahasa Sundanese). The interviews were open-ended but guided by a checklist of questions written by me in English and Bahasa Indonesia, and then translated to Bahasa Sundanese by my assistant at the time of interview. I thoroughly discussed the interview questions with my assistant and what I was hoping to achieve and discover by having conversations with local people. Given his advanced language capabilities in English, I was confident in his ability to translate the participants' responses from Bahasa Sundanese to

English. Family members, friends, and workers were permitted to remain present for the duration of the interview, but only answers given by the designated respondent were recorded. Interviews ranged anywhere from 20-45 minutes in duration and consisted of three sections: the structured interviews contained 26 questions which were broken down into three modular sections based on style of questioning and the topics being addressed (Bernard, 1994) (Table 6.1). Each module is organised to create a particular context in which the respondent answers questions regarding their perceptions of a particular subject. The first module consists of demographic questions to assess the respondent's age, gender, occupation, education level, and length of residency in the village. The second module contains questions relating to attitudes about forest preservation and livelihoods. My goal was to determine how people feel about preserving the forest/reforestation efforts and/or keeping the land free for agricultural expansion. This section also touches upon some of the basic beliefs people have about natural resources and attitudes about the national park. In the third module, I explored perception and knowledge about wildlife, specifically Javan gibbons and local conservation initiatives.

Through these exploratory questions, I hoped to uncover a general consensus of the feelings, attitudes, and beliefs local people have about the natural world around them. I worked together with my colleagues from the Javan Gibbon Centre (JGC) to determine the most insightful questions, whilst keeping the questions friendly and informal. Although guided, the nature of the interview permitted free speech and provided opportunities to follow new lines of questioning when novel perspectives were raised by the respondent (as a result, new questions were added half way through the study). All questions were worded clearly to elicit concise answers and devoid of jargon to avoid ambiguity (Kapila and Lyon, 1994; Nekaris et al., 2013). Though the majority of the questions were not of a sensitive nature, it was made clear the respondent did not have to answer any question if they did not wish to do so. At the end of each interview, the recording was stopped and my assistant and I would chat informally

with the respondent to demonstrate an interest beyond the project. At the conclusion of the interview, the respondent was thanked for their time spent answering questions and the interviewees departed. Respondents did not receive gifts or any monetary compensation for their participation. The interview protocol followed ethical guidelines and was approved by the Research Ethics Committee of Oxford Brookes University (Appendix 1.3).

Table 6.1. Interview Questions: English with Bahasa Indonesian translation.

Respondent demographic information 1. Male/female- 2. Approximate/specific age- 3. How long lived in this village- 4. Occupation- 5. Education-
Questions regarding forest preservation 1. Do you think it is more important to expand agriculture or protect the forest on Java? (Apakah anda pikir itu lebih penting untuk memperluas pertanian atau melindungi hutan di Jawa?) 2. In your opinion, do you benefit from living close to the forest? (Menurut anda, apakah anda mendapatkan keuntungan dari tinggal di dekat hutan?) 3. How? (Bagaimana?) 4. Do you know the forest close to you is a national park? (Apakah anda tahu hutan di dekat anda adalah taman nasional?) 5. Do you visit the forest? Why? How often? (Anda mengunjungi hutan? Kenapa? Seberapa sering?) 6. Are there government restrictions here for land use and hunting activities in the forest? (Apakah di sini ada pembatasan dari pemerintah untuk penggunaan lahan dan kegiatan berburu di hutan di sini?) 7. Does the forest have an important role in your life and your family? (Apakah hutan memeliki peran penting dalam kehidupan anda dan keluarga?)
Questions regarding wildlife and Javan gibbons 1. Can you tell me about any interesting animals in the forest? (Bisakah anda ceritakan tentang setiap hewan yang menarik di hutan?) a) Can you tell me about the primates that live in the forest here? (Dapat anda ceritakan tentang primata yang hidup di hutan sini?) 2. Have you seen any gibbons in the forest? Or heard gibbons in the forest? (Apakah anda melihat ada owa di hutan? Atau mendengar owa di hutan?) 3. a) Where? b) When? c) How many? (Dimana? Kapan? Berapa banyak?) 4. Do you know gibbons are rare? (Apakah anda tahu owa langka?) /Are gibbons rare? (Apakah owa langka?) a) Did you know owa is endemic to Java? (Apakah anda tahu owa endemik/asli Java?) 5. Do (you know) gibbons need the forest to live? (Apakah (anda tahu) owa perlu hutan untuk hidup?)/ Are gibbons important for the forest? (help trees grow/seed dispersal) (Adalah owa penting untuk hutan - bagaimana?) 6. How would you feel if gibbons go extinct? (Bagaimana perasaan anda jika owa punah?) 7. Are gibbons protected by law? (Apakah owa dilindungi oleh hokum?) 8. Is it illegal to keep a Javan gibbon for a pet? (Apakah ilegal untuk menjaga owa untuk hewan peliharaan?) 9. Would you ever consider a Javan gibbon as a pet? (Apakah anda pernah mempertimbangkan owa sebagai hewan peliharaan?) 10. Do you know any person who has a Javan gibbon for a pet? (Apakah anda tahu setiap orang yang memiliki gibbon untuk hewan peliharaan?) 11. In your opinion, why does an animal become endangered? (Menurut anda, mengapa hewan menjadi langka?) 12. Can you tell me any stories about gibbons (or any of the other species of primates living in the forest – kukang, lutung, surili, macaque)? (Dapat anda ceritakan apa saja cerita tentang owa-owa di sini? Atau kukang lutung surili macaque). **a)** Or stories about the forest (stories, myths, folklore). (Dapat anda ceritakan setiap cerita atau mitos atau cerita rakyat tentang hutan di sini?) 13. Do you know about JGC (Javan Gibbon Rehabilitation and Rescue Centre)? (Anda tahu tentang JGC?) 14. Do you know the objective of JGC? (Anda tahu tujuan JGC?) **a)** What is your opinion about the conservation activities of JGC? (Apa pendapat anda tentang kegiatan konservasi JGC?)

Results

Demographic information

A total of 101 individuals (45 women; 56 men) were interviewed during the months of June through August 2016 (Table 6.2); however, not every individual answered each question during an interview (for various reasons), therefore, sample sizes differ for some of the questions. The mean age of the respondents was 37.1 years old (range: 18–80 years). The ethnic composition of the sample population was predominantly Sundanese. Overall, the education level in the community was relatively low. The highest percentage of the population had received some level of primary schooling, whereas individuals above a high school or university level accounted for less than 1% of the sample (50% of the respondents did not answer this question, as we did not ask until later in the study period) (Table 6.2). The majority of the women respondents classified themselves as housewives (56%) and of the men respondents, 20% were farmers (either of their own land or for a private company) and 32% worked in some form of physical labour. Over 50% of the respondents interviewed came from the village of Bodogol, as this is the village nearest to JGC and one of the lesser used entrances to the national park.

Table 6.2. Demographic information of respondents in data collection, West Java, Indonesia June 24, 2016–August 14, 2016 (N = 101).

Sex	No. of respondents	Age range	Education	Occupation	Village
Female	45	18-75	Elementary 17	Housewife 25	Bodogol 24
			Junior High 4	Farmer 5	Lengkong 6
			High School 1	Teacher 3	Cibilik 3
			University 1	Other 1	Ciwaluh 9
			No response 22	No response 9	Ciletuh 3
Male	56	18-80	Elementary 13	Labourer 18	Bodogol 33
			Junior High 8	Farmer 11	Lengkong 8
			High School 4	Student 2	Cibilik 11
			University 3	Other 10	Ciwaluh 2
			No response 28	No response 15	Ciletuh 2

Forest preservation

When we asked people, 'Do you think it is more important to expand agriculture or protect the forest on Java?', 45% of women under the age of 40 reported they valued forest preservation over agricultural expansion, compared to just 27% of men (Table 6.3). Both women and men over the age of 40 valued agricultural expansion over forest preservation (16%), yet 30% of all respondents believed that it is important to both protect the remaining forest (and would support a reforestation project), as well as having enough land to farm for their own personal livelihood.

Table 6.3. Responses regarding forest preservation and which was more important: agricultural expansion or protecting the forest, June 24, 2016–August 14, 2016 (N = 101).

	Expand agriculture	***Protect the forest***	***Both are important***	***Don't know***
Women				
18 – 40 yrs	2	20	8	1
Over 41 yrs	8	1	4	1
Men				
18 – 40 yrs	11	15	9	0
Over 41 yrs	8	4	9	0

When asked 'In your opinion, do you benefit from living close to the forest?', of the women 39 said 'yes' and 51 of the men said 'yes'. Significantly more men than women knew the forest near to them was a national park and visited the forest more regularly than women (Table 6.4). When we asked 'Does the forest play an important role in your life?', the responses were very similar between the women and men: 91% of women and 93% of men answered 'yes'.

Table 6.4. Responses regarding forest preservation, specifically pertaining to the benefits of living close to the forest, the status of the national park, June 24, 2016–August 14, 2016 (N = 100). Here the Chi - Square results show the expected vs. observed differences between men and women.

	Women (N= 44)	Men (N=56)	Chi – Square Value
Benefit from living close to forest	39	51	0.02, NS
Know the forest is a national park (GGPNP)	26	51	3.27, $p < 0.10$
Visit the forest	23	48	3.88, $p < 0.05$

Knowledge of Javan gibbons

The majority of respondents from each of the five villages reported knowing that Javan gibbons are threatened with extinction and are a protected species by law (58% and 73% respectively; Table 6.5); 62% of local people knew it was illegal to keep a Javan gibbon for a pet. When we asked respondents in the village of Bodogol, 'Do you know about JGC?' and 'Do you know about the objectives (activities) of JGC?' and compared this to the other four villages included in the study, significantly fewer people knew about JGC and the centre's objective than the other four villages combined ($\chi^2 = 8.32$, $p < .01$, $df = 1$).

More men (35%) than women (14%) reported having seen (or heard) Javan gibbons in the wild ($\chi^2 = 4.73$, $p < 0.05$, $df = 1$). A fair amount of people reporting having seen gibbons at JGC, but I did not include this as they are not wild gibbons. The centre is situated right on the boundary of the national park, therefore, people working on their farms nearby may catch a glimpse of gibbons in their enclosures amongst the trees. Most people have seen gibbons at the biological research station (PPKAB) situated about 2km within the national park where one habituated group (typically around five individuals) has its territory and can regularly be observed, always heard.

When we asked local people 'How would you feel if gibbons go extinct?', 90% of respondents had a positive response and said they would care if Javan gibbons could no longer be heard or seen in the forest. People reported feeling *sedih* (sad) or a sense of loss. Respondents often used the Sundanese word *tiiseun* or *lapur* which loosely translates to 'silence' and 'gone' respectively, and how the forest would be 'quiet' and 'empty' (*teu rame*) without the song of Javan gibbons. One woman from Lengkong sorrowfully said, 'the forest would be quiet without the gibbon'.

Table 6.5. Responses regarding general knowledge about Javan gibbons and their protected status, June 24, 2016–August 14, 2016 (N = 100). Here Chi-square was used to test the expected vs observed values for Bodogol vs. the other four villages combined.

	Bodogol (N=57)	***Lengkong (N=13)***	***Ciwaluh (N=11)***	***Ciletuh (N=4)***	***Cibilik (N=15)***	***Chi-Square Value***
Know Javan gibbons are threatened	37	7	3	2	9	1.09, NS
Know Javan gibbons are protected by Indonesian law	46	7	3	4	13	1.07, NS
Would feel sadness/or a loss if Javan gibbons were to become extinct	54	11	9	4	12	0.33, NS
Know it is illegal to keep a Javan gibbon for a pet	42	4	3	4	9	2.92, NS
Know about JGC and its objective	17	4	3	2	11	8.32, $p < 0.01$

In addition, and unfortunately half way through the study period, we asked local people (N = 50), 'Can you tell me about the types of primates that live in the forest here?' and discovered very few people could name all five species. We used the word 'types', rather than using the word 'species', because we were not certain the species concept would be relevant to local people. Only 2 out of 50 people were able to name all five species of primates that live in the national park. Most people (all but five) knew of the long-tailed macaque (*monyet*) (*Macaca fascicularis*) as they are quite conspicuous; they live in relatively large social groups and regularly can be seen near and in farms. Most respondents refer to them as 'naughty' or 'greedy' as they will sometimes raid farmers' crops. As one man from Ciwaluh stated, 'gibbons

are nice, not like macaques.' Interestingly, when we showed pictures of the different primates found in the national park and asked the respondents to identify them by name, some people were not able to identify the Javan gibbon even though they had reported 'knowing of them'. One man from Cibilik identified the Javan gibbon as a Javan surili (*Presbytis comata*) (commonly referred to as 'surili) and the surili as an orangutan.

Discussion

Forest preservation

Most respondents in this study described how beneficial it was to live close to the forest, with only a few people expressing complete indifference to their proximity to the national park. More men than women reported knowing the forest near to them was a national park and visited the forest more often. This would be expected given men tend to take on employment that requires visiting the forest (labourers, guides, ojeks) and it is often the men that venture into the forest to collect browse for their livestock. Collection of small forest resources e.g., browse and branches for cooking was one of the major reasons people went into the forest.

The majority of people living in the five villages included in the study work as farmers or labourers related to forest work (e.g., helping to maintain the water system, guides, ojeks etc.). People did express interest in forest preservation (or reforestation projects) and would prefer to see the forest remain intact and wildlife protected, as long as they had enough land to farm and could still maintain their livelihood. Restricted access to forest resources tends to be the most common complaint about protected areas (Harada, 2003; Ellwanger et al., 2015) and many researchers have found such results in their studies of attitudes toward conservation (Wang et al., 2006; Allendorf, 2007; Méndez-Contreras et al., 2008). However, respondents in this study do not rely heavily on forest resources for their livelihood, rather the resources they

may collect (e.g., browse for livestock, small branches for fires for cooking, and in the case of two women, plants for medicinal use) have minimal impact on the forest. As a result, it does not seem people living on the border of the forest harbour any negative feelings about it being a national park and having restricted use of its resources.

Moreover, the local people did not have any negative feelings about or associations with the forest and national park, rather they recognised a number of positive aspects of living close to the forest including both aesthetic and utilitarian benefits. This finding is similar to other studies of local people's attitudes toward conservation and protected areas/nature reserves where researchers found that respondents enjoyed aesthetic benefits like living near beautiful scenery and seeing wildlife (Allendorf, 2007; Ellwanger et al., 2015), as well as utilitarian benefits such as clean water, fresh air, and protection from floods and erosion (Sodhi et al., 2010). Respondents in this study discussed similar benefits such as a clean environment and beautiful views (there are several waterfalls within the park that people regularly visit). Each of the five villages included in this study get their water directly from the forest (as do the major cities in the region e.g., Jakarta and Bogor) and acknowledged they appreciate having clean and available water, as well as fresh and clean air to breath. People also commented on the joy of seeing wild animals or hearing the gibbons sing in the forest, and how important the forest was for its resources and for future generations. For example, one woman from Lengkong stated, 'if the animals disappear, no one will get to see them again. If the forest disappears, it will have a negative impact on the people of the village' and another man from Ciwaluh told us 'if there is no forest, it is dangerous for humans'.

Overall, there was general support for the protection of the forest in the national park. Reasons given were not only based on utilitarian motives but also with explicit reference to intrinsic values and future generations. Therefore, the use of non-utilitarian arguments may help to establish more local support for wildlife protection or ameliorate conflict should it arise

(Kuriyan, 2002; Ellwanger et al., 2015). The fact that farmers reported the greatest benefit of living close to the forest was for water conservation and browse for their livestock, may be attributed to specific resource requirements for livelihood activities (Alexander, 2000; Bauer, 2003; Harada, 2003; Ellwanger et al., 2015). Given that many of the respondents in this study have lived in one of the five villages their entire lives, I expected more positive feelings and attitudes toward wildlife, knowledge of the area, and a greater appreciation for the forest; rich tales of humans' connection to the forest and animals within. However, I discovered more of a moderate level of *indifference*, though not negative, among the majority of the respondents. Whitten et al. (1996) states that 'forests do not have a high cultural value on Java', which is congruent with my findings. People reported the forest was more beneficial for resources, but they did not think it was important for cultural reasons; no one shared any folktales about the forest. In addition, other researchers have found that respondents with higher levels of formal education have more positive attitudes toward forest conservation (Infield, 1988; Sodhi et al., 2010), and in this study, education level did not have a significant effect on attitudes about the forest.

Knowledge of Javan gibbons

The majority of respondents reported knowing that Javan gibbons are a protected species, but had various answers as to why they thought that or *why* Javan gibbons are threatened. When we asked if they knew what it meant for an animal to be classified as 'Endangered', respondents mostly answered because the animals are rare, they live in small groups, cannot be found, or people hunt them. All valid reasons as to why an animal is classified as Endangered, but what I was mostly interested in uncovering is, if local people place the same *value* on the concept of what an 'Endangered' species is as does the global conservation community (i.e., as defined by the IUCN); however, we found it difficult to articulate the

precise meaning of the concept. One woman from the village of Ciwaluh believed people outside of Indonesia care more about the animals living there than the people living in Indonesia and that if she had more money, she would do more to help protect wildlife.

When we asked local people how they would feel if Javan gibbons were to go extinct in the future, the majority (90%) of people gave positive responses and said they *would* care if Javan gibbons could no longer be heard or seen in the forest. People said they would feel *sedih* (sad) or a sense of loss, and often used the Sundanese words: *tiiseun* or *lapur* and *teu rame*, all of which represent feelings of silence and emptiness. Several people said they would feel great sadness if their grandchildren could never see or hear gibbons in the forest. Yet despite their knowledge of the Javan gibbon's protected status, very few people reported they are protected because they are rare or *langka*, and said they didn't really know.

More men did report having seen gibbons in the wild, but that was expected considering women tend not to go into the forest as often. Gillingham and Lee (1999) for example, discovered that women in Muslim societies were most likely to have slightly more negative attitudes to conservation because their marginalised position excluded them from public issues. Priston (2005) suggests that women are often less successful at deterring raiding species and as such, have direct experience of wildlife-related costs and therefore can often be less tolerant of wildlife. This was not the case in my study as Javan gibbons do not raid crops and are rarely seen, so people generally do not have any 'conflict' with them or harbour negative feelings about them as an animal (whereas they regularly stated how naughty and greedy macaques are). Though there was one woman from Cibilik, interestingly the farthest village from the forest edge, that said many people in the village were worried gibbons might come raid their crops if they are released from JGC (we assured her gibbons would not be released in the area and that gibbons tend not to raid crops). Men were more likely to have seen more animals in the forest, especially Javan gibbons, than women. This may be attributed to

the fact that most men worked in the field as farmers or agrarian labourers and as such, were more likely to have contact with primates than women, who typically worked at home as housewives (Gillingham and Lee, 1999; Ellwanger et al., 2015). This finding is similar to findings in studies on knowledge of wildlife in the United States, where men were significantly more knowledgeable about animals, particularly Endangered and rare species, than women (Czech et al., 2001). Ellwanger et al. (2015) found that knowledge about the Guizhou snub-nosed monkey was unevenly distributed among male and female respondents in Fanjingshan National Nature Reserve, China, and interestingly, women were more knowledgeable about why the snub-nosed monkey is protected. Also, women scored higher on humanistic and moral attitudes toward animals, showed stronger emotional attachments, and had a higher rate of anthropomorphic feelings toward animals. This was not apparent in my study as no one reported any overtly sentimental feelings about Javan gibbons nor did they report having any strong connection to them emotionally or culturally. This is in contrast to China were gibbons still feature prominently in folklore in regions of Hainan where they existed until very recently, yet elsewhere these animals are increasingly 'forgotten' in traditional tales (Turvey et al., 2018).

In general, respondents had limited knowledge about the population size and distribution of Javan gibbons, with very few people knowing they are endemic to the island of Java. I believe it would have been more fruitful to have used the photographs to test respondents' knowledge of primates earlier in the study, as it was interesting to observe people who reported knowing about gibbons and reported having heard them from afar, then incorrectly identify them in a line-up of the five primate species found on Java. Malone et al. (2014) found that people living around Cagar Alum Leuweung Sancang (CALS) possess a higher awareness of the rarity and intrinsic value of wildlife in the forest reserve, particularly Javan gibbons. Participants in the study said they feel 'comforted' by the call of gibbons, which

represents a lively and healthy forest, and they recall an earlier time when the spirits of the forest were both to be revered and feared. Respondents also reported that accounts of illegally captured gibbons were common, and most people were able to accurately distinguish gibbons from the other sympatric primates present at the site; whereas not one respondent in my study reported ever seeing a pet gibbon in any of the villages and not everyone successfully identified Javan gibbons out of photographs of the five primates on Java.

When we asked respondents in the village of Bodogol if they knew of JGC and its conservation activities and compared this to the other four villages included in the study, significantly fewer people knew about JGC and the centre's objective than the other four villages combined. One unexpected outcome from the interviews was the relatively low level of knowledge regarding Javan gibbons and JGC in the village of Bodogol. When we asked one woman from Bodogol if she knew the objective of JGC, she put her hands up, shrugged, and said 'No. You do your own business, I do mine.' Given the proximity of Bodogol to the national park and JGC (~2 km), also considering a few of the local guys who work for JGC and Conservation International-Lido actually live in the village, I would have expected people to be more knowledgeable about Javan gibbons in general, and more specifically, about the centre and its objective. This, however, turned out not to be the case. This would perhaps suggest JGC needs to ramp up its conservation presence and activities in the local villages surrounding the national park and further engage with local people. The people feel they are often not included enough in local conservation activities; therefore, may feel more indifferent to the goals of wildlife and forest conservation in general, and many people felt they had a right to be more included in local conservation initiatives.

Few respondents remarked that some animals, specifically wild boar (*Sus scrofa*) were destructive or harmful to people's livelihood in that they sometimes raided their farms (macaques were often mentioned). People always said Javan gibbons were beautiful and a

'good' animal, not 'greedy' or 'naughty' (*nakal)* like macaques. This finding is congruent with research on people's perceptions of 'good' and 'bad' animals in relation to their aesthetic qualities, dangerous or destructive behaviours, and utilitarian uses (Costa et al., 2013). The origination of 'good gibbons and evil macaques' in Chinese traditional culture dates back to 3,000 years and reflects a complex relationship between the perceptions people have about primates and nature in general (Zhang, 2015; Turvey et al., 2018). The Chinese believed gibbons were celestial beings with extended lives, and were depicted as 'beautiful, quiet, dolorous, and seclusive' creatures that lived deep in the mysterious forest. Following is an excerpt from Zhang's (2015) 'Good gibbons and evil macaques: a historical review on cognitive features of primates in Chinese traditional culture':

> 'Gibbons and macaques dwelled on different mountains; being of different nature, they could encounter with each other. The disposition of the gibbon was quiet and constant he tended to show benevolence, humility, filial piety and compassion. Gibbons lived in a group. They let others eat first, and drank one after the other. If one got separated from the group, he would wail in sorrow. They traveled in an order. When confronted with danger the gibbons placed young individuals in their midst (to better protect the young). They did not trample the crops in the field, and they would carefully check the fruits of the trees to ascertain whether they were ripe. They would call their group members to eat together with peace and enjoyment. They protected trees to grow, and walked carefully at around young plants and tree sprouts on their mountain. Therefore, those mountains where gibbons dwelled in used to be covered by dense forests." Macaques, on the contrary, are irascible and vociferous in nature. *Zeng-wang-sun-wen* (819 AD) noted: "they are always wrangling and shouting among each other and jabbering confusedly. Although they lived in groups, they were by no about in unruly groups. They had no fixed orders while drinking. They do not mind getting separated, and when confronted with danger they always put their young in front (so as to be able to escape by themselves). They love to raid crops. They gnaw at unripe fruit and throw it away after the first bite. They steal people's food and filled it in their cheek pouches. They trample down or uproot young plants and tree shoots in their habitat mountains. Therefore, the mountains where the macaques lived are always bare.'

I was hoping to uncover rich folktales such as the one above (not necessarily about 'naughty' macaques but about gibbons), yet I did not. Though people do have positive thoughts and feelings about gibbons, with one man from Ciwaluh saying 'gibbons are peaceful, they do

not bother anyone, and the forest would be quiet without their songs' and when we asked how people would feel if Javan gibbons went extinct, a man from Lengkong said, 'there would be nothing left to make happiness in the forest; their sound (rhythm) is beautiful'. Interestingly, given their long biogeographical history on the island, Javan gibbons have very little presence in local Sundanese culture or mythology (see Permana et al., 2019). There was one short tale told to me by at least two people about how gibbons *may* have received the name 'owa' which is the local word for gibbon in both Bahasa Indonesia and Sundanese and also, most likely, based on the sound of the Javan gibbon's morning call. The tale tells of a man who put his children in a [gazebo] in the field, he only fed them roasted corn so their little hands became burned and turned black (Javan gibbons have black skin on the palms of their hands and feet), they called out to their uncle who was called *Uwa* - 'Uwa Uwa Uwa' and thus, this could be the origin of the name 'owa'. One young man from Bodogol told the story as his mother told it to him with a slight variation in terms of the food that was given to the young boy and girl:

> 'There is orphan, brother and sister, who live with their uncle and aunt (*uwa* if you call your mom or dad/ big brother or big sister in Sundanese). Then day by day, their *uwa* treat the orphans very badly. And one day they put the orphans in the gazebo in the crop near the forest and only fed them roasted bananas. They don't want to take care the orphan anymore and since the orphans left by their uwa, they call their uwa every morning, uwa uwa uwa! They are waiting their uwa to respond but their uwa never come back to take them home. And then desperately, the orphans went to the forest near the gazebo and then they change to be a pair of gibbons.' – Igud, Bodogol.

Of the two respondents who told this story, neither could tell me the precise origin, or whether it was meant to be a story with a lesson, only that it was a Sundanese tale. How interesting if it was in some way a tale of one of the first Javan gibbons to be kept as a pet! Although positive views of gibbons dominated in traditional Chinese culture, negative images were also present in stories from the Tang dynasty (618 – 907AD), such as gibbons haunting houses, or a white gibbon kidnapping a human wife. These tales probably were associated with

a prevailing tradition of raising gibbons as pets (as presumed with the discovery of *Junzi imperialis*) during the period, as the stories often occurred in or around human settlements (Zhang, 2015). Sadly, I did not discover any rich tales of human / gibbon association on the island of Java, but hopefully with future exploration into the folk history of Indonesia, we may discover something remarkable yet.

Chapter conclusion

Many communities that live in close proximity with primates share unique biological, ecological, and cultural interconnections. In some of these cultures, there are rich mythologies detailing a shared origin between humans and primates (Shepherd, 2002; Cormier, 2003), yet this study revealed Sundanese people living in the vicinity of Gunung Gede-Pangrango National Park seemingly have no shared mythology or folklore about Javan gibbons (nor any of the primates on Java). Furthermore, not one respondent included in this study recounted any personal stories, positive or negative, about Javan gibbons. The absence of any shared stories about Javan gibbons might be a result of the low level of contact that people have with gibbons on a regular basis, as very few people have actually seen them in the forest. This low level of contact likely reflects the behaviour of Javan gibbons in the wild, in that they are rather elusive and tend to shy away from humans. They live in small, family groups (averaging 2-5 individuals) and are often rather quiet when foraging in the forest canopy. The exception being their loud, melodic morning call that carries through the mountains.

Despite the lack of shared mythology and folklore, respondents still expressed feelings of sadness or a sense of loss if Javan gibbons were to disappear from the forest. From an ecological perspective, people acknowledged that gibbons need the forest to survive, so if the forest were to disappear, so then would the gibbon. Local people in the area are not necessarily

dependent on the forest or its resources for their livelihoods, and there was not any acknowledgement of how their activities in the forest may affect Javan gibbons. For some residents in the villages, the presence of Javan gibbons signifies a forest imbued with life, health, and happiness. An elder from Bodogol said he would be disappointed if gibbons disappeared because the 'forest would be broken'. Malone et al. (2014) found that when people living near CALS learned Javan gibbons were endemic, endangered, and rare, they became proud. I did not receive this response in my study; however, a fairly common answer was how the forest would be *quiet* without gibbons and people would be *sad* to not have them in the forest because future generations would not be able to see or hear them.

There is an urgent need to understand indigenous folklore about threatened species, and how this body of knowledge can contribute both to the revitalisation of biocultural diversity and to species-specific conservation management initiatives (Gilchrist et al., 2005; Turvey et al., 2018). Given this research was only but a glimpse into how local people in West Java perceive the natural world, there is a significant opportunity to further explore local perceptions about the forest and wildlife within. We must listen to the people and ensure their thoughts and beliefs about the natural world are acknowledged and valued, and woven into conservation efforts. We must connect conservation goals with local cultural and worldviews, as it is necessary to develop a greater understanding about local knowledge of wildlife and the dynamics of why such knowledge is either not present in a culture or was lost over time (Turvey et al., 2018). Discovering how the retention or erosion of local ecological knowledge relates to the wider biocultural environment (Turvey et al., 2018), will provide more unique and new insights for informing conservation initiatives aimed at saving the last apes on Java and ensuring their songs are heard in the forest for years to come.

Summary

The previous chapter provided insight into the perceptions local people living on the border of Gunung Gede-Pangrango National Park, West Java have about the natural environment and conservation initiatives, specifically pertaining to Javan gibbons. In general, the older generation tended to value agricultural expansion over forest preservation with younger people placing a higher value and appreciation on the latter. Though all respondents stated they would support reforestation efforts as long as they still had enough land to farm for themselves. The majority of people believed living close to the forest was beneficial to their livelihoods and well-being, stating water as the most prized natural resource. I hoped to uncover rich tales about the forest and the wildlife living within, specifically Javan gibbons, but rather people tend to have more *neutral* feelings about wildlife and conservation in the area, if not *indifferent*. Most people appreciate and respect conservation efforts to protect the forest and wildlife, but also highly value their own livelihoods. The majority of local people in the five villages knew of Javan gibbons, their protected status, and would care if they could no longer see or hear gibbons in the forest. However, they were not as knowledgeable about the conservation efforts aimed at protecting Javan gibbons in the wild.

Overall, I provided a brief overview of the social-cultural context in the area, but indicate there is still much to explore as having more knowledge on local perceptions and ecological knowledge would greatly enhance the effectiveness of local conservation programmes and support. A socio-cultural analysis should be incorporated into future management plans.

The next and final chapter, I discuss the most pertinent points of each chapter and summarise the dissertation in its entirety whilst highlighting the main results and conservation implications of the research. I provide recommendations for future research with the hope of developing more holistic and inclusive conservation initiatives for Javan gibbons on the island

of Java. I conclude with offering detailed actions and goals to be incorporated into an updated conservation action plan for Javan gibbons.

Chapter 7

Conservation Implications and Significance of Research

Fig. 7.1. Serving as an ambassador for Javan gibbons at the first International Gibbon Day event at Mount Malabar, Bandung, West Java, Indonesia. Photo by Iip Latipah.

Introduction

In the opening chapter of the dissertation, I stated the relevance of this research to Javan gibbon conservation initiatives highlighting four crucial aspects that I believe should be

included in an updated conservation action plan: 1) an updated PVA report demonstrating the likelihood of extinction for Javan gibbons based on current (estimated) threats in the wild and what possible management scenarios could be developed to improve their chance of long-term survival; 2) addressing the illegal pet trade by thoroughly investigating, examining, and quantifying the impact this threat has on wild populations of gibbons. Crucially, more resources and efforts are needed to eliminate the illegal selling of gibbons on social media; 3) an examination and evaluation of the reintroduction programme for gibbons (in general) with specific guidelines to monitor the progress and success of the programmes; and finally, 4) the importance of utilising social anthropological methodology to engage with local communities to gain a better understanding of local people's attitudes, beliefs, and perceptions about conservation and wildlife, specifically Javan gibbons. In this final chapter, I will place the relevant results into these four categories and reflect on the contributions and limitations of the work. Finally, I will discuss recommendations for future conservation efforts and provide a detailed list of actions and goals to hopefully be incorporated into an updated conservation action plan for Javan gibbons.

Modelling population viability of three independent populations of Javan gibbons

PVA models cannot definitively demonstrate the exact probability or time to extinction of a population, but rather the models constitute an analytical approach that can be used to indicate the possible fate of a population from the parameter values modelled (Reed et al., 2002; Bryant, 2014). In general, the assumptions of PVA models are relatively simple and are based upon sound biological reasoning appropriate to long-lived mammals, thus the biases within the model (and the model predictions) are relatively simple and can potentially underestimate rather than overestimate extinction risk (Ellner and Fieberg, 2003; Slotta-Bachmayr et al., 2004; Traill et al., 2010; Bryant, 2014) and VORTEX model forecasts have

been demonstrated to perform with impressive accuracy given adequate data (Brook et al., 2000). The PVA results reported in this study are based upon the best available information for Javan gibbons, further informed by data from other gibbon species (and PVA reports), and sensitivity testing for the impact of parameter inaccuracies (see Supriatna et al., 1994; Tunhikorn et al., 1994; Bryant, 2014). Most variables did not substantially alter model predictions, but those that did (i.e., high levels of hunting and mortality rates) reveal important considerations for future conservation management (i.e., protecting the natural habitat of Javan gibbons). High rates of hunting coupled with persistent rates of deforestation undoubtedly will cause populations of Javan gibbons to rapidly decline in the wild. The modelling demonstrates the importance of initiating site-specific conservation programmes, as each population is sensitive to varying levels of threats and may respond differently to different conservation strategies. In addition, results from performing a reintroduction scenario demonstrated the addition (or reintroduction) of gibbons into populations may only have a minimal impact on the long-term survival of the species in the wild. Bach et al. (2010) found similar results when they used VORTEX to evaluate the Limpopo Valley Conservancy in South Africa as a potential reintroduction site for African wild dogs (*Lycaon pictus*). The simulations showed that the reintroduction of individuals had only a small effect on the overall population dynamics but when individuals were both supplemented and harvested (similar to Javan gibbons), the probability of persistence increased. Overall, they concluded the reintroduction programme may be successful if release areas are properly secured and the individuals to be released are suitable physically and behaviourally. Most importantly, it is essential to monitor the individuals followed by modelling efforts to re-evaluate the success of the reintroduction programme (Bach et al., 2010).

The modelling analysis will hopefully provide incentive to move forward in conservation efforts for Javan gibbons by highlighting the immediate threats (i.e., hunting for

the illegal wildlife trade), and developing management plans and strategies which seek to preserve wild populations and their habitats. In addition, it would prove beneficial to conduct PVAs more regularly in order to assess current population trends and ensure management strategies are implemented that remain relevant to specific populations and areas of western and central Java where Javan gibbons still remain. The two specific goals of future research should be to ramp up our efforts in monitoring the illegal wildlife trade in order to determine how many gibbons are being taken from the wild each year, and to increase protection in forested areas where gibbons currently live, as well as building forest corridors to connect fragments within larger forest networks.

Investigating the extent and prevalence of gibbons traded illegally on social media

It is apparent from the photographic evidence from social media sites that Javan gibbons are being hunted for the illegal pet trade, and they are most likely taken from within protected areas. As evidenced in this research, Javan gibbons were both the most traded species of gibbon, as well as the species of gibbon most often portrayed as personal pets on both Facebook and Instagram. Yet future investigation in the illegal wildlife trade on various social media platforms may reveal different results. While acknowledging the illegal trade in Javan gibbons is ongoing and may represent a significant proportion of the wild population, it is difficult to quantify the precise percent of loss the illegal trade is having on wild populations (Nijman, 2009; Rosen and Smith, 2010). Furthermore, Java's remaining forested areas remain under pressure from persistent encroachment, though it be relatively small-scale; this level of activity is often more difficult to detect and monitor (Estrada et al., 2017), as access to these forests (including within the protected area system) increases, so will encounter rates between humans and primates, and with it the potential for hunting to supply the demand in illegal trade (Malone, 2007; Nijman, 2009).

Law enforcement in Indonesia is generally lacking in both effort and efficiency, which makes it relatively easy for people to buy and sell threatened and rare species (online and in markets). Large sums of money can be made in the illegal wildlife trade, with gibbons fetching prices potentially up to one million rupiah (USD70). The chances of having protected animals confiscated, or of sellers and buyers facing legal charges, are extremely rare. Fines and jail terms handed out are comparatively lenient and even those that have violated the law rarely, if ever, receive the maximum penalty (Lin, 2005; Nijman, 2009; Freund et al., 2017). Furthermore, given the anonymity and exclusivity of trading and selling endangered gibbons on social media sites, individuals are even less at risk of being caught and prosecuted. Law-enforcement agencies need to persuade the necessary officials to convict traders and buyers, as well as owners, and more efforts need to be focused on devising incentives for law enforcers to carry out their duties with greater efficiency (Nijman, 2009; Rosen and Smith, 2010; Freund et al., 2017). In addition, the social media platforms and their moderators need to take greater responsibility to uphold international trade regulations and respond appropriately by reporting individuals who are involved in the illegal wildlife trade on their sites. The illegal trade in endangered wildlife is a threat to global biodiversity and it is devastating it is not considered a priority (Rosen and Smith, 2010), not even by the authorities that are responsible for upholding the laws to help protect wildlife. This can no longer be tolerated, and subsequent actions must be taken (Nijman, 2009).

One of the research projects I am involved in (as a result of my work investigating the illegal selling of gibbons online for the Arcus Foundation) is focusing on mitigating the trade of threatened and endangered wildlife (predominantly gibbons) on social media by testing a series of images and narratives (via storytelling) with the hope of gaining a better understanding of the social and cultural drivers of the illegal wildlife trade. Trade on social media is heavily image and narrative-based, and representations and information rapidly reach audiences far and

wide (Bering et al., 2018). The highly visual nature of posts on Instagram and Facebook presents a double-edged sword; in recent years, social media has become central to the efforts of conservation organizations' efforts to engage the international public and garner support for their work (Waters and El-Harrad, 2013). On the other hand, the inside groups with interests in trading Endangered species, portray images of gibbons (as well as several other endangered animals) in anthropomorphic (e.g., riding on the back of a moped, dressed in clothing, eating on the floor with children) environments, may also serve to encourage people who own, sell, or acquire wild and endangered animals as pets, that owning these animals facing habitat loss is their way of 'keeping them safe' (refer to quote on page 124).

We as concerned conservationists need to develop campaigns that engage with social media users to incite behavioural change, only then will people hopefully understand the impact they are having on individual animals, and ultimately, wild populations. The fact that such images and storylines of animals take on a conflicting social, moral and political significance in the digital sphere; plus, the lack of legal requirement and reluctance of social media platforms to intervene in any significant way to counter illegal trading, indicates that nuanced approaches informed by anthropology (as well as psychology and primatology) may be beneficially explored in this research (Blair et al., 2017). Ultimately, we need to change human behaviour, which is the greatest challenge of all.

Rehabilitation and reintroduction: a new hope

First and foremost, the protection of wild populations of gibbons should be the priority of conservationists, but proper care and management of gibbons in rescue and rehabilitation facilities is important as well (Cheyne, 2006; 2009). With regards to gibbon conservation, the potential for rehabilitation and reintroduction has yet to be realised, despite some encouraging success stories (e.g., Ario et al., 2018). Whether previous and ongoing rehabilitation efforts

have helped or hindered the plight of gibbons (and other Endangered species in general) is still an open and hotly debated topic (Cheyne, 2006, 2009; Harrington et al., 2013). Despite this uncertainty, the potential importance of rehabilitation and reintroduction programmes in terms of community and global education, increased awareness, and as a sanctuary for individual gibbons with nowhere else to go (Chivers 1991) cannot be overlooked. If the gibbons are not rescued and brought to rehabilitation centres, they face uncertain futures in unsuitable conditions (Cheyne, 2009). The conservation of all four genera of gibbons is becoming more urgent as suitable habitat continues to decline and gibbons become increasingly more threatened.

The most obvious criterion for determining the success of a reintroduction is a resulting self-sustaining population of animals (Griffith et al., 1989; Fischer and Lindenmayer, 2000). Another view suggests that if reintroduction results in a broader and more effective conservation of the habitat, then the programme is a success, even if all the reintroduced animals die soon after release (Kleiman 1989; Cheyne, 2009). Success should be measured independently for each species, whilst acknowledging that species' behaviour and life history. For gibbons, success should be measured by (1) survival post-release (i.e., finding suitable food), (2) maintenance of the pair-bond (i.e., duetting and copulating), and (3) reproduction and survival of the offspring (Cheyne, 2009; Ario et al., 2018). Another question to consider is how many deaths of released animals are acceptable in order to establish a sustainable population (Sanderson, 2006). Most importantly, any instances of death (or disappearances) need to be reported and included in the evaluation of the program so that future provisions can be made to hopefully (and if possible) eliminate the cause of death. Unfortunately, these incidents are not always reported (JH Smith; pers. obs.). Reintroduction programmes may be used for many Endangered and threatened species, but the ease with which an animal can be rehabilitated and prepared for release will ultimately depend on how much the animal is

required to learn in the rehabilitation centre (Fischer and Lindenmayr, 2000; Cheyne, 2009). For captive-raised monkeys and apes (who were not given the chance to learn life and social skills from their parents in the wild), the rehabilitation time, and hence the cost of the rehabilitation process, will be considerably higher than for other species that do not have such a long learning curve (Cheyne, 2009).

Ario et al. (2018) provides some of the first published research demonstrating the capability of reintroduced wild-born, former-pet Javan gibbons to adapt to a life in the wild. Anton and his team from JGC documented the behaviour of four groups; two pairs and two-family groups (one pair with two offspring; one pair with one infant) of gibbons that were released beginning in March 2014. The female in one of the family groups that was released with an infant, gave birth to her second offspring in 2017. All behavioural interactions were recorded, as well as fruit and foliage consumption, and locomotive patterns, and then compared to the activity budgets of wild Javan gibbons (e.g., Malone, 2007; Ario, 2011). The use of wild activity budgets may be useful in setting guidelines and illustrating the types of behaviour or level of expression that has been shaped through natural selection (Melfi and Feistner, 2002; Howell and Cheyne, 2018). On average, the reintroduced Javan gibbons showed approximately 58% similarity to wild Javan gibbons in terms of their behavioural and ecological response to life in the wild.

Rehabilitation and reintroduction projects must collaborate between several disciplines including nutritionists, physiologists, behavioural biologists, and veterinarians. Without the collation and distribution of information, valuable knowledge that may prove useful to the various disciplines remains inaccessible (Cheyne, 2009; Zamboni et al., 2017). Data on all aspects of the rehabilitation and reintroduction process should be recorded and shared among centres and made available to researchers to facilitate communication, prevent repetition of mistakes, and improve on successes (Cheyne, 2009). Centres should be collaborating and

working together, especially on the island of Java where there are two operating centres and suitable release sites are somewhat limited, and should make every effort to gather information from other rehabilitation projects in Asia; to do otherwise would be to ignore the data (both success and failures) already available and is irresponsible for conservation efforts. The primary goal for future consideration in rescue, rehabilitation, and reintroduction of gibbons is to fully document the entire process, from the time gibbons come into a rescue centre until they are released back into the wild, including post-release evaluation and monitoring. And most importantly, these data and results, as well as updates on the status of all released gibbons – successes and failures, should be made accessible and published in reports and scientific journals. This is crucial in order to ensure a more successful programme for gibbons across Asia, specifically Javan gibbons.

The people's voice: it's what matters

Local initiatives and support

Support from local governments and communities is crucial and one way to ensure successful conservation initiatives for Javan gibbons on Java. Based on a comprehensive review of previous research and an assessment of continued threats to the Javan gibbon and its habitat, Supriatna (2006) concluded that educational outreach, public support and participation, will be invaluable components in the elimination of existing pressures and the implementation of conservation initiatives (Malone, 2007). Conservation efforts should devote sufficient time and energy into the development of education programmes that will suit all audiences and focus on all aspects of conservation (Nijman, 2004). This must include speaking with local communities to learn more about their thoughts, attitudes, and beliefs regarding conservation and wildlife.

In order to increase community awareness and knowledge on biodiversity conservation in Gunung Gede-Pangrango National Park, Conservation International - Indonesia has enlisted the use of a mobile conservation education unit that travels to local communities teaching conservation education. The primary goal of the conservation education programme is to encourage local people to incorporate conservation concepts into their daily activities and provide them with more knowledge regarding the local flora and fauna. Embedded within the current conservation strategy for Javan gibbons, and in addition to the rescue and rehabilitation of former pet Javan gibbons, is an effort to elevate the gibbon to the status of a flagship species (Supriatna, 2006; Malone, 2007). A flagship species is well-known, easily identifiable (socially and culturally), and is generally associated with a particular region or hotspot (Bowen-Jones and Entwistle, 2002). Although there are no ecological criteria for choosing a flagship species, it is hoped that conservation of the target species will have protective benefits for other aspects of biodiversity conservation in its habitat (Bowen-Jones and Entwistle, 2002; Malone, 2007). The strategy hinges on the perceived value of a species to audiences at multiple overlapping scales from household level to international governing bodies or organizations and from cultural to economic value (Bowen-Jones and Entwistle, 2002). A growing recognition of the need to engage local communities in the need for the conservation of Javan gibbons makes them an increasingly important audience for information about such efforts. In such situations, an awareness of the local perception and value of Javan gibbons (and Endangered species in general) is central to choosing effective flagships (Bowen-Jones and Entwistle, 2002). The mobile conservation unit uses 'Moli' the Javan gibbon (named after the Latin *moloch*) and 'Telsi' the Javan hawk-eagle (named after the Latin *Nisaetus bartelsi*) as characters to deliver the program's conservation message. In addition, the mobile conservation unit has a small library that is accessible to the local communities.

Limitations

One disadvantage of conducting interviews in local communities is the likeliness of socially desirable answers. Indonesian people are generally very polite to their guests and as a result, can sometimes give answers that are also very polite. Consequently, in general, an interviewer runs the risk of being given answers that are adjusted to the topics (issues) that he or she might 'want to hear' according to the perception of the respondents and the people that are present during the interview. To reconcile this, I did not present myself as a 'PhD researcher who studies gibbons' but more of a general researcher wanting to learn more about how the people regard conservation activities and gain insight on their knowledge on wildlife, then focused in on gibbons. Given my assistant(s) were Sundanese (one of which was also born in the village of Bodogol) this may have given me a bit more credibility amongst respondents. In addition, of course, it would have been beneficial to talk with more local people to gain a greater sample size and thus a greater depth of knowledge; however, due to time constraints this was not feasible though remains an important (and crucial) area for future research.

Conclusion

Conservation efforts seek to preserve the diversity of the Primate Order and ensure the survival of representative populations of species in their natural habitats (Southwick and Blood, 1979; Estrada et al., 2017). In order for these efforts for primates to be successful, as well as for other wildlife, it is crucial that the cause of the threats faced by the different species in their habitats are thoroughly understood (Nijman, 2009). Based on a comprehensive review of previous research and an assessment of continued threats to the Javan gibbon and its habitat, Supriatna (2006) concluded that educational outreach and public support, as well as participation, will be invaluable components in the elimination of existing pressures and the

implementation of conservation initiatives (Malone, 2007). Conservation initiatives should devote sufficient time and energy into the development of education programmes that will suit all audiences and focus on all aspects of conservation (Nijman, 2004).

Regarding the primary issues of both habitat loss and the illegal trade in gibbons, local people will have to be involved in the long-term effective management of forest resources and they must demonstrate the will to reject, report, and prosecute individuals who are involved in the illegal pet trade (Malone, 2007). It is crucial for the Indonesian government, NGOs, scientists, and other concerned stakeholders to merge their efforts regarding the best conservation policies that will benefit the local people of Java and its wildlife (Orlove and Brush, 1996). Conservation is about changing the way in which people perceive the planet, including the wildlife with which they share it with. It is imperative to establish a well-rounded conservation education program that emphasises the value of all wildlife and its role in maintaining forest biodiversity.

Upon reflection, whilst each component of this research contributed novel data and knowledge to the overall conservation initiatives for Javan gibbons, I believe the greatest contribution to conservation for Javan gibbons would be to conduct a more in-depth and expansive ethnographic study on Java, in both the western and central part of the island. Whilst I believe my contribution of knowledge is valuable, it provides only but a glimpse of the attitudes, beliefs, and perceptions people have about the natural world and its wildlife, specifically Javan gibbons. If the Javan gibbon is to become a 'flagship species' we must first determine how much people care about this endangered ape and educate local people about its status in the wild. We must engage local communities, both rural and urban, to do more to ensure gibbons are kept in the wild where they belong and their forest habitat(s) remain intact.

Cheyne (2006) highlights issues relevant to gibbon conservation efforts: (1) a lack of effective communication about the plight of gibbons, both within range countries and

internationally; (2) a lack of wildlife law enforcement in range countries and lack of awareness of the laws already in place; and (3) failure to prioritise unprotected populations for surveys and protection. My research has shown all three to be applicable to Javan gibbon conservation. Even within local communities bordering Gunung Gede-Pangrango National Park, which holds a relatively large population of Javan gibbons, the knowledge local people possessed about conservation initiatives in the area, including the activities of JGC, and the plight of Javan gibbons in the wild was fairly limited. Evidence from my investigation into the illegal pet trade via social media platforms validated how significant a threat the trade is to wild populations, and even more worrisome, the true impact this will have on the long-term survival of gibbons in the wild is yet to be realised. Finally, of course, more thorough studies done on wild populations of Javan gibbons should be conducted so that we are able to better understand the species' population dynamics, as well as their behaviour and ecology. Actions to mitigate some of these hindrances should be incorporated into conservation strategies and include: identifying the fragments of forests containing gibbon populations must be appropriately surveyed and country-wide Population and Habitat Viability Analyses should be conducted to highlight the gaps in knowledge and pinpoint areas in need of protection and where to direct funds. Adequate cooperation between researchers working with wild populations and reintroduction centres, knowledge will be gained and resources can be managed to achieve three goals: (1) management and protection of wild populations and (2) rehabilitation, reintroduction, and management of the wild-born, captive-raised population, and ultimately, 3) focusing more efforts on putting an end to the illegal pet trade.

Recommendations and considerations for a Javan gibbon conservation action plan

The research presented in this dissertation comprised several approaches used to examine and assess the current conservation initiatives for Javan gibbons, with the goal of providing useful information for the development of an updated conservation action plan. A conservation action plan is a critical document describing the current status, threats, and intended methods for increasing rare and threatened species population sizes in the wild, as well as preserving natural habitats (Boersma et al., 2002; Carroll et al., 2014). The IUCN assesses the conservation status of species and their habitats, and outlines conservation priorities that will hopefully ensure recovery of wild populations. The plans are a collaborative effort from individuals across several disciplines with a range of knowledge, experience, and insight. It is my hope the results from this research will encourage new actions and goals to ensure the survival of Javan gibbons long into the future.

The following recommendations and considerations are based solely on this research and my own experience and knowledge gained from conducting conservation research on Javan gibbons on Java. I have summarised what I believe to be the most pressing goals based on each aspect of my research; however, it must be acknowledged these recommendations represent only but a fraction of the necessary actions and goals required for a fully developed conservation action plan for Javan gibbons.

1) Given the nature of their distribution, a landscape-based approach should be taken for the conservation of Javan gibbons that must include effective cooperation by rescue centres and conservationists not only in West Java, but also in the central part of the island.

2) There is a need to expand efforts to raise awareness among all aspects of human society about the value of conservation in general and about the uniqueness of the endemic Javan gibbon.
3) Community participation in conservation efforts is essential, and for this to occur there needs to be mutual understanding among both government and non-governmental organisations, researchers and conservation managers, and most importantly, local people.
4) Improvements are needed both in the existing legislation protecting Javan gibbons, and in how the laws are enforced, particularly with regards to the illegal pet trade, and specifically online. More resources should be allocated to the newly formed Javan Gibbon Taskforce.
5) Continued research is needed to better understand the population biology of the Javan gibbons, including surveys of lesser-known areas (especially within potential corridors connecting fragmented populations), the monitoring of known populations, and more intensive genetic sampling. Sites identified for specific actions are: Ujung Kulon National Park, Dieng Mountains, Halimun-Salak National Park, Gunung Gede-Pangrango National Park, as well as releases sites in Bandung (i.e., Mt. Tilu Nature Reserve and Mount Puntang)

Summary of goals and conservation actions

Goal 1: Enhance research and monitoring skills and reserve managment

Action 1.1 Investigate impacts of human activities such as small resource collection and illegal hunting of the Javan gibbon for the illegal pet trade.

(1) Clearer marking of core zone gibbon habitat, and establish an information system including boundary markers, conservation education signage, and warnings

against illegal behaviour, particularly in unprotected forests (e.g. Mts. Dieng and Slamet)

(2) Promote the importance of protecting gibbon habitat in communities around the reserve, through distribution of pamphlets and other printed material, and community engagement.

(3) Study on illegal hunting: Through interviews with hunters, research and analysis of wildlife seizure cases, characterise target species and determine the spatial and temporal patterns and magnitude of local hunting, the economic values of target species, the income contribution provided by hunting for the wildlife trade, and the general characteristics of hunters. Evaluate the impacts of hunting activities on Javan gibbon populations.

Action 1.2 Study gibbon biology, ecology, and habitat use.

(1) Identify areas outside known gibbon distribution with high potential of gibbon survival, and conduct new gibbon field surveys using acoustic monitoring and bioacoustic technologies. Useful for translocation and reintroduction sites.

(2) Research the vegetation, hydrology, climate, soil conditions, and other environmental parameters associated with current Hainan gibbon distribution, and analyse the impact of different ecological factors on gibbon habitat selection and behaviour, including moving, feeding and selection of sleeping sites. Using species distribution models, evaluate habitat suitability across national parks and forested areas where Javan gibbons are found. Identify the key factors that determine habitat suitability, analyse the ecological characteristics of optimal, suitable, and suboptimal areas of gibbon habitat, and use these results to produce a habitat distribution map to inform habitat restoration planning and reintroduction.

(3) Studies on reproductive behaviour and group social dynamics- Investigate courtship, pair formation, mating, male replacement and parenting behaviours of the Javan gibbon, as well as survival and development of young gibbons, and identify factors regulating and limiting population growth.

Action 1.3 Investigate impacts of human activities such as NTFP collection and

illegal hunting of Javan, and their impacts on wildlife.

Goal 2: Increase habitat coverage, quality and connectivity

Action 2.1 Enhance protection of core gibbon habitat: restore habitat and construct corridors

(1) Conduct new field research using vegetation plots within gibbon home ranges, and incorporating environmental variables such as landscape, vegetation type, vegetation characteristics, dominant species, and levels of human disturbance, to understand Javan gibbon habitat characteristics and requirements.

(2) Elevate status of unprotected forest areas that contain a significant number of Javan gibbons (e.g., Mts. Dieng and Slamet).

(3) Build corridors to connected fragmented forest patches.

Goal 3: Further develop the reintroduction programmes to include more behavioural research and sharing of data and progress

Action 3.1 Increased collaboration between rescue centres

(1) All data, well as updates on the status of released gibbons – successes and failures, should be made accessible and published in reports and scientific journals.

(2) Effective communication and cooperation between authorities and rescue centre managers is key to effective protection of the Javan gibbon

Action 3.2 Measuring and quantifying success

(1) For gibbons, success should be measured by (1) survival post-release (i.e., finding suitable food), (2) maintenance of the pair-bond (i.e., duetting and copulating), and (3) reproduction and survival of the offspring.

Action 3.3. Develop effective post-release monitoring programme

(1) Programme should be suitable for each release site and adhere to scientific guidelines

Goal 4: Improve regulations and infrastructure for Javan gibbons' protection

Action 4.1 Increase funding for daily reserve operations

(1) Include both protected and unprotected forest areas in Javan gibbon conservation planning at all government levels, so they are also included in all relevant development and implementation plans. Include nature reserve development in national economic and social development masterplans and annual plans.

Action 4.2 Improve infrastructure of National Parks.

Action 4.3 Build capacity for patrolling and law enforcement.

(1) Ensure fair wages and benefits of staff, and improve work safety by providing training in law enforcement. Encourage conservation stewardship.

Goal 5: Increase community co-management, development and environmental education

Action 5.1 Enhance public environmental and conservation awareness

(1) Community engagement in and increased awareness should be a conservation priority

(2) Promote conservation awareness and motivation for nature conservation in local communities, particularly those bordering Javan gibbon habitat.

(3) By promoting the Javan gibbon as a flagship species, conservation awareness of the species can be quickly improved. Raising public awareness is also a critical step to increase protection efforts from the Indonesian government. Activities such as gibbon adoption and name nomination can act as publicity and fundraising tools for both JGC and TAF.

(4) Conduct publicity campaigns for Javan gibbons in primary and secondary schools and universities in Indonesia, including activities such as exhibitions, talks, art contests and wildlife conservation volunteer activities. Invite experts to give talks about environmental and species protection and wildlife biodiversity in Indonesia.

Action 5.2 Ethnographic studies with communities bordering Javan gibbon habitat

(1) Further ethnographic research should be carried out in local communities bordering both national parks and unprotected forest areas. It is crucial the thoughts, attitudes, beliefs of local people are understood and acknowledged, and must be woven into all aspects of Javan gibbon conservation initiatives.

Final Thoughts

The goal of the research presented in this dissertation is to provide an overview of the current conservation initiatives for Javan gibbons, in hope that the results will be useful for developing a more holistic conservation action plan to ensure their long-term survival in the wild. The increasingly intense and widespread conservation challenges that we face today are not naturally occurring, but rather are anthropogenic in nature, therefore, understanding how people perceive and interact with the natural world is imperative for future conservation efforts and movements. Ultimately, conservation is about changing the way in which people perceive the planet, including the wildlife with which they share it with. Humans and wildlife have always shared a very close relationship with the environment in which they live. Unfortunately for endangered species today, their fate rests in the hands of humans. Throughout the World, primates are facing an impending extinction crisis, where approximately 60% of the 504 primate species are threatened with extinction and approximately 75% have declining populations (Estrada et al., 2017). If we can prevent the rich forests from disappearing on Java, and put an end to the illegal pet trade, there may still be hope for the survival of the island's only ape.

Despite the ever-growing pressures on Javan gibbons and their habitat, the outlook for these apes is far from hopeless, but a concerted and sustained effort will be required if their long-term survival is to be assured. Most importantly, if the people of Java do not share an interest in preserving natural resources and wildlife on the island, it is highly possible the last

ape on Java may not survive into the future. We as conservationists must work to encourage and inspire more conservation-oriented attitudes and beliefs, through not only our research but in all aspects of our engagement with local communities. Successful efforts to secure the future of the Javan gibbon and its natural habitat would provide a wide range of important conservation benefits for both the wildlife and humans sharing the natural resources of Java. It is my hope these recommendations will assist in guiding the actions needed to improve the conservation prospects for this highly Endangered and enchanting ape.

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Ushko, the first Javan gibbon to win my heart. Photo credit: Alan Mootnick, Gibbon Conservation Center, Santa Clarita, California

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Photo credit (page 19): Gibbons in Chinese Folklore: Gibbons are a common motif in classical Chinese artworks such as this 15th century painting. Freer Gallery of Art and Arthur M. Sackler Gallery, Smithsonian Institution, Washington, D.C.: Gift of Charles Lang Freer, F1911.272.

Appendices

1.1. Number of sellers and/or buyers identified on social media sites (individual names were not listed in order to maintain anonymity; however, I have record of all names for my personal database).

SELLERS (ID NUMBER)	SOCIAL MEDIA PLATFORM	FRIENDS (FB)	FOLLOWERS (INSTAGRAM)	COUNTRY
001	Facebook	2, 414	-	Indonesia
002	Facebook	Private	-	Indonesia
003	Facebook	Private	3,215	Indonesia
004	Facebook	1,177	-	Indonesia
005	Facebook	Private	-	Indonesia
006	Facebook	1,516	-	Indonesia
007	Facebook	1,370	59	Indonesia
008	Facebook	2,097	-	Indonesia
009[A]	Facebook	713	-	Indonesia
010	Facebook	3,058	-	Indonesia
011	Facebook	4,078	-	Indonesia
012	Facebook	Private	-	Indonesia
013	Facebook	Private	-	Indonesia
014	Facebook	Private	-	Indonesia
015	Facebook	Private	-	Indonesia
016	Facebook	555	-	Indonesia
017	Facebook	2,724	-	Indonesia
018	Facebook	2,589	-	Indonesia
019	Facebook	414	-	Indonesia
020	Facebook	635	-	Indonesia
021	Facebook	Private	-	Indonesia
022[B]	Facebook	(481)	-	Indonesia
023	Facebook	4,997	-	Indonesia
024	Facebook	448	-	Indonesia
025 [B]	Facebook	2,665	-	Indonesia

026	Facebook	4,927	-	Indonesia
027[B]	Facebook	1,589	-	Indonesia
028	Facebook	34	-	Indonesia
029	Facebook	Private	-	Indonesia
030 [B]	Facebook	2,925	-	Indonesia
031	Facebook	4,964	-	Indonesia
032 [B]	Facebook	1,079	-	Indonesia
033[B]	Facebook	(1,444)	-	Indonesia
034[C]	Facebook	656	-	Indonesia
035 [B]	Facebook	1, 169	-	Indonesia
036 [B]	Facebook	3,711	-	Indonesia
037 [B]	Facebook	3,585	-	Indonesia
038	Facebook	9	-	Indonesia
039 [B]	Facebook	Private	-	Indonesia
040 [B]	Facebook	482	-	Indonesia
041	Facebook	312	-	Indonesia
042 [B]	Facebook	Private	-	Indonesia
044	Facebook	632	-	Malaysia
045	Facebook	4,708	-	Malaysia
046	Facebook	1	-	Malaysia
047	Facebook	1,759	-	Malaysia
048	Facebook	473	-	Malaysia
049	Instagram	-	880	-
050	Instagram	-	1,449	-
051	Facebook	4,991	1.167	Indonesia

[A] I found evidence of online trade in gibbons.
[B] I had limited or full access in viewing profiles and/or groups.
[C] Required an invite by member of group.
[D] I had no access to group or its contents.

1.2. Release of first wild born former pet Javan gibbon pair – a personal account

On Friday, October 16th, 2009, the staff of JGC, Conservation International- Indonesia, Gunung Gede - Pangrango National Park, and members of the Indonesian Department of Forestry, released Septa and Echi back into the wild (Figures A.3 and A.5). They were officially the first (known) pair of wild-born, former pet Javan gibbons to be reintroduced into the wild (it is possible other individual gibbons may have been released from other more general wildlife rescue centres, or by individuals releasing their unwanted pet gibbon into the forest). The pair was released into a small, isolated patch of forest, Patiwel, located within the Gunung Gede-Pangrango National Park boundaries.

I was provided with the unique opportunity to conduct post-release behavioural observations on the pair, and my intended method for data collection was to consist of full day focal follows utilising time-interval sampling (Altmann, 1974). Unfortunately, due to the unexpected aggression the gibbons exhibited towards human observers, I was unable to systematically collect data and fully carry out the research. The gibbons made it very difficult to follow them and prevented us from monitoring them at a close distance. Therefore, I utilised *ad-libitum* (Altmann, 1974) and opportunistically recorded any behavioural data I was able to collect, whenever I could observe the gibbons from a safe distance.

Septa and Echi (Figure A.3.) demonstrated a high level of territoriality directed both at us and the monkeys (long-tail macaques, Javan langurs, and grizzled leaf monkeys) who also inhabit (or travel through) the small forest of Patiwel. There were approximately seven Javan langurs observed living in the small forest, and groups of long-tailed macaques frequently came into Patiwel from the larger area of the park to forage and feed. When the gibbons encountered either one of the groups of monkeys, they would engage in territorial behaviour that is typical of wild Javan gibbons. In the wild, both male and female gibbons will actively defend their territory by approaching the intruder (usually the male initiates the approach), performing visual displays (branch shaking, brachiating), and males may produce solo calls while the female sings and displays (pers. obvs). Territorial disputes rarely involve physical aggression in the wild. Wild gibbons regularly tolerate food competitors, such as macaques and other primates (MacKinnon, 1977b), but unlike captive gibbons, wild gibbons have been exposed to the various other species in the forest from a very young age and know which species are potentially threatening and which are not (Cheyne, 2004). There were only two observed interactions between the gibbons and the monkeys and consisted of the gibbons displaying,

chasing the monkeys away, and vocalising. On one occasion the gibbons were displaced by the long-tailed macaques and moved further back into the forest, and the other encounter resulted in the long-tailed macaques being displaced and moving to the west side of Patiwel.

Both Septa and Echi exhibited a very high level of aggression towards myself and observers from JGC as we attempted to monitor them. Echi also exhibited a relatively high level of aggression towards me while I was conducting pre-release behavioural observations whilst she was still at the rescue centre. For example, she would often direct open-mouth threats at me (both male and female gibbons have long canines they display in a yawn like gesture meant as a threat), and she would regularly present her backside to me and shake the wire of the enclosure, also a sign of agitation. Once in the forest, the pair directed their territorial/aggressive behaviour towards us (the observation team typically consisted of Pak Komar – an elder from the local village who graciously took to overseeing the small forested areas, myself, and one or two other guys from JGC), similarly to how they responded to the monkeys in Patiwel. A typical observational occurrence consisted of us attempting to locate the gibbons in the forest and once they became aware of us, they would approach us, coming very low (< 5 m) in the canopy to threaten us. One incident resulted in one of the observers being physically attacked and bitten by both of the gibbons. On our first day of observations when we located the gibbons in Patiwel, they were feeding on the fruit of a fallen tree just off the trail. After approximately two hours into our observation period, Septa moved into a tree that branched out above the trail about 25 meters up from where myself and the other observer (Igud) were standing. After a few minutes, Septa dropped down onto the trail and began to approach us, walking bipedally down the trail. Igud and I quickly retreated out of the forest and returned to our post located just outside of Patiwel (Conservation International built a small bamboo hut on the edge of the forest we used as our research post). We decided to continue our observations of the pair and returned to the forest in the later part of the afternoon. When we located the gibbons, we found them in the same general area as earlier that morning. Once again, Septa dropped down onto the forest trail and began to approach me (I was standing directly on the trail and Igud was standing to the far right of the trail amongst the trees). This time I moved toward Septa in an attempt to frighten him away and he turned and went the other direction, again walking bipedally up the forest trail. I was not aware of Echi's location at the time. After a few minutes, Igud and I continued up the forest trail. When we reached the top of the trail where the gibbons' old acclimation enclosure was located, we found both Septa and Echi foraging around the vicinity. Once they became aware of us, Septa moved down onto the

ground at the top of the trail coming towards us, and Echi began moving at us, brachiating through the trees. Igud and I were approximately 25-30 meters down the forest trail from the enclosure. Echi then began brachiating faster and moving lower down in the canopy, while Septa began to run bipedally down the forest trail, and they proceeded to chase us. Unfortunately, both Igud and I tripped and fell down the trail. Igud fell first and then I, so at that moment both of the gibbons came upon Igud first and physically attacked and bit him. We were able to get up and continue running out of the forest; however, Septa and Echi followed us all of the way out and moved into the upper level of the canopy. Once we made it out of the forest, Echi then began to vocalise and display at the forest edge. Fortunately, there were no other incidents resulting in aggressive physical contact, but Septa and Echi continued to chase us out of the forest each and every time we attempted to observe them. They displayed similar behaviour to the first incident. Once they became aware of us, they approached us coming very low into the canopy, sometimes within five meters of the ground, and threatened us. We would use small (~ 3 meters) bamboo sticks to bang against the trees in an attempt to frighten the gibbons back up into the canopy of the forest. This was always unsuccessful. Our guide, Pak Komar, would also use a sling-shot to fire small pieces of fruit in the gibbons' direction (never actually hitting Septa or Echi), also attempting to frighten them away from us. This was also unsuccessful. Septa and Echi were completely fearless of human observers. Fortunately, we were able to observe the pair from the outer edge of the forest, the surrounding fields, and the research station located just outside of the forests' edge, as we realised we would not be able to follow them through the forest for research.

Aside from their aggressive behaviour towards humans, they responded well to their new forest environment from an ecological perspective. In addition to jointly defending their territory, Septa and Echi often maintained a close proximity (typically within 5 meters) to one another while foraging and feeding and were observed grooming each other as well as copulating (by staff of JGC). We did not provide food supplementation for the gibbons. Only on one occasion did we observe Septa and Echi foraging around their old enclosure (the day of the attack) and not once did they seek us out for food or appear to be waiting around their enclosure for food. While in captivity both gibbons showed a preference for wild fruit/foliage that the keepers incorporated into their diet. From the first day they were released, Septa and Echi were successful at locating the appropriate food sources (fruit, leaves, flowers, and insects) in Patiwel and were observed drinking water from a hollow in a tree.

Unfortunately, we were never able to locate them in the later part of the afternoon when they would normally move into their sleeping tree, thus it is uncertain if they were sleeping in the same tree. However, when we were able to locate them during Echi's morning call, both gibbons would be in the same tree, typically a Rasamala tree (*Altingia excelsa*). Rasamala trees typically reach heights of 40-60 meters and with their crown extending above the canopy, this provided Echi with the ideal setting for producing her morning call. Both Septa and Echi utilized brachiation as their primary mode of locomotion in Patiwel, in addition to leaping through the canopy. I would regularly observe them leaping distances of greater than ten meters, which was spectacular. They would also climb up vines or the bough of a tree to gain access to fruit patches within a tree and were also observed foraging and feeding on smaller branches.

During the month of June 2010, I returned to Patiwel to assess the behaviour of Septa and Echi eight months post-release. Due to time constraints, I was only able to visit the release site for one afternoon. Considering my experience with Septa and Echi while attempting to conduct behavioural observations on them in the past, I did not enter the forest. Instead, I walked around the edge of Patiwel until I could locate and see the gibbons from the surrounding cropland. They were observed foraging and feeding in the trees at the edge of the forest, and I was able to observe the pair grooming one another. Interestingly, but not surprising, once they became aware of my presence, they exhibited the same aggressive behaviour as before. Both gibbons came to the edge of the forest and Echi began to vocalise and display in the upper canopy. The staff of JGC continued to monitor Septa and Echi at Patiwel from a safe distance, and the pair were still engaging in the same territorial and aggressive towards them. Unfortunately, it was reported in the summer of 2011 that Septa and Echi had both been shot by an unknown individual from one of the local villages. Local people would regularly travel through Patiwel and collect resources from the small patch of forest. It is assumed Septa and Echi were shot after acting aggressively towards local people. There was an invaluable lesson learned from the first release of Javan gibbons in 2009, mainly it changed how I conducted research and how subsequent pairs of gibbons that have been released are now monitored. My (along with JGC) hope was to collect a substantial number of hours of behavioural data on the gibbons, especially considering the behavioural ecological data on Javan gibbons in general is lacking. However, given the gibbons responded very aggressively towards us, we had made the decision to only observe them from afar – either from the research house located just outside of the small forest patch, or from the periphery of the forest (i.e., walking along the forest edge) for all future

monitoring. As a result, JGC has now created a patrol group who checks on the gibbons each day noting general behaviour and well-being but does not follow them consistently (this is also how gibbons are monitored at the other rescue centres). One of the primary goals of rehabilitating gibbons is to give them the opportunity to live as wild gibbons again, without the need of human intervention or assistance. This requires very little human presence in their daily lives so that they may resort back to a more natural fear or apprehension of humans. It is absolutely critical that a released gibbon does not depend on humans or approach them for any reason once they are reintroduced into the wild.

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Fig. A.1. Septa and Echi being released from their enclosure at Patiwel Forest. Photo by Duhe Anfield.

Fig. A.2. Release site, Patiwel Forest, West Java, Indonesia. Photo by JH Smith.

Fig. A.3. Septa and Echi post-release in Patiwel Forest, West Java, Indonesia. Photo by Anton Ario/CI-Indonesia.

1.3. Ethical Approval

Dr Sarah Quinton

Chair of the University Research Ethics Committee

Oxford Brookes University

Headington Campus

24 May 2016

Dear Dr. Sarah Quinton,

UREC Registration No: 161006

An examination and assessment of current conservation practices for Javan gibbons (*Hylobates moloch*) in West Java, Indonesia

We have discussed and addressed each of the following conditions in support of Jaima Smith's UREC form.

1.**Please clarify the relationship between Anton Ario and the research project.**

Anton Ario is my Indonesian counterpart (it is necessary for foreign researchers wishing to conduct research in Indonesia to obtain a sponsor) and the Director of the Javan Gibbon Rescue and Rehabilitation Centre. He will not be assisting me in any aspect of the interview process (I probably did not need to list him on the ethics application.).

2. **Please explain how the translator will be recruited, trained and monitored. If a third party is used they will need to complete and sign a data confidentiality agreement for which there is a template should it be required.**

The individual I have in mind is a long-time friend and a volunteer at PPKAB (Pusat Pendidikan Konservasi Alam Bodogol - an educational outreach centre in Gunung Gede-Pangrango National Park). However, this is not yet confirmed. I will not be able to officially hire someone as my assistant until I arrive in West Java.

I will be conducting the interviews in Bahasa Indonesia, my assistant will be there for support and to clarify answers should I not understand entirely, or if the respondent is more comfortable replying in Bahasa Sundanese, of which I am not able to speak, my assistant will be able to translate their responses. Before I begin the research, I will thoroughly discuss the interview

questions with my assistant, and what I am hoping to achieve through these conversations with local people. He will accompany me at all times on each interview, but he will not be responsible for any interviews.

3. **A description of the type of local events at which recruitment will take place and how people will be approached should be forwarded to the committee.**

If I were to talk to local people at an event, it would purely be opportunistic (i.e., soccer game, holiday celebration), so I am not able to describe specifically what kind of event it would be as I do not have anything planned.

I am not depending on this for my primary form of recruitment, so I will omit this from my research protocol.

4.**Whilst a formal participant information sheet is not appropriate, a script of what will be said to the participants should be forwarded to the committee and this should include that interviews will be recorded.**

In my experience working in West Java for several years, I have discovered the best way to interact with local people is in a friendly and informal way, hence the reason why I believe it is best to have interviews that are semi-structured (guided by questions that facilitate conversation) and in the least intimidating format as possible. People will feel more comfortable opening up, sharing their stories and thoughts if the environment is friendly in nature. So, while I am aiming to create this friendly environment, I of course will introduce myself, my assistant, and the goal of my research. An example follows:

Begin: Hello, my name is Jaima Smith and this is [assistant's name]. I am a PhD researcher from Oxford Brookes University in Oxford England, and this is [assistant's name] is from PPKAB. I would like to ask you questions regarding conservation efforts for endangered wildlife here on Java, would that be ok? In addition to taking notes, I will also be recording our conversation, is that ok? I will keep all of your answers and information confidential. Do I have your permission to proceed with the interview?

End: Thank you so much for taking the time to talk with me today; I really appreciate it. If you have any questions or concerns, you can reach me through the Conservation International – Lido office (where my Indonesian counter-part, Anton Ario, works) *

*This would be the best option for any respondent to contact me should they need to. Considering most people in the local villages do not have access to internet, nor do they drive, they would need to make the trip into Lido where the office is to contact me. Given the nature of my questions (not sensitive subject matter), I do not believe respondents will contact me post-interview/conversation.

5. **Clarification of how the interviews will be recorded is needed, a notebook is mentioned (5.2) but also audio recording (1.4,2.3).**

I will use a Sony ICDPX333.CE7 4GB PX Series MP3 Digital Voice IC Recorder to record the interviews.

6. **As the research is being conducted overseas, please ensure the standard risk assessment is carried out prior to travel. In addition, consideration is needed for lone researcher safety; please outline what practical measures will be taken when in the villages**.

I have been going to Indonesia for various research activities over the past eight years, so I am very knowledgeable and experienced in my travels through West Java and know what considerations and precautions need to be taken. I was in Indonesia during the Autumn and so have completed a risk assessment, but will update it before I travel next month. As for travel through the villages, I will always have a travel companion (i.e. my assistant) at all times.

7. **Please outline what feedback, in the form of a summary, and how this will be communicated, to the communities. It is university practice to provide feedback to all participants and stakeholders wherever possible**.

Given it is my goal to conduct over 100 interviews, at random, in local villages where most people do not have access to internet (except perhaps younger family members via mobile phones), I do not imagine it would be feasible to revisit every home and provide feedback to the participants for the following reasons: 1) for the same reason participant information sheets would not appropriate, I also would not be able to write up a form of feedback to distribute to the participants given the various languages spoken in the villages. I also have to consider that some of the older individuals may not be able to read; 2) given the number homes I plan to visit, I do not see the feasibility of finding each home again, and making contact again with the specific respondent; and 3) given the potential lack of internet accessibility in the villages, I do not think even if I offer to give my email for questions or feedback, I do not believe they would follow through or have the means to do so.

8. **Confirmation is required that the research will not recruit anyone working at either of the conservation centres to avoid dependent relationship issues**.

I will not be recruiting any individual working at either of the conservation centres because that would be a conflict of interest.

9. **At present the 'interview questions' resemble a set of questionnaire questions, please clarify whether interviews or questionnaires will be implemented and if interview, an outline of the opening and closing of the interview.**

I intend to use open-ended questions and less structured procedures for the qualitative component of my research (semi-structured interview). Therefore, the questions I have come up with are meant to be an "interview guide" and will be used by me to facilitate the flow of a verbal conversation. The sequence of the questions can be changed; some questions can be omitted or new questions can be added during the process of the interview. My main aim is to better understand local peoples' perceptions of endangered species and their thoughts about conservation efforts in West Java. In addition, the nature in which I intend the interviews (conversations) to be conducted in, will make it possible for the discussion to reveal new information about my predefined topic of research.

Below is an example of how I could begin and close the discussion:

Begin: Hello, my name is Jaima Smith and this is [assistant's name]. I am a PhD researcher from Oxford Brookes University in Oxford England, and this is [assistant's name] is from PPKAB. I would like to ask you questions regarding conservation efforts for endangered wildlife here on Java, would that be ok? In addition to taking notes, I will also be recording our conversation, is that ok? I will keep all of your answers and information confidential. Do I have your permission to proceed with the interview?

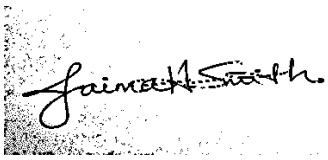
End: Thank you so much for taking the time to talk with me today; I really appreciate it. If you have any questions or concerns, you can reach me through the Conservation International – Lido office (where my Indonesian counter-part, Anton Ario, works). *

*please see note above regarding contacting post-interview conversation.

We hope our revisions are to your satisfaction and Jaima Smith's UREC form is granted full approval.

Thank you.

Jaima Smith, Research Student



Cc Maja Cederberg, Research Ethics Officer

Jill Organ, Research Degrees Team

Louise Wood, UREC Administrator

Yours sincerely

Dr Sarah Quinton

1.4. Curriculum Vitae

Jaima Hillary Smith

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RESEARCH INTERESTS Conservation, Ethnoprimatology, Human-animal relationships, Folklore, Human ecology – perceptions of nature, Illegal wildlife trade, Environmental anthropology, Rewilding, Wolf conservation

APPOINTMENT

Present (July) Education Officer, Royal Zoological Society Scotland, Edinburgh, United Kingdom

EDUCATION

PhD Anthropology, Oxford Brookes University
Supervisors: Professor Vincent Nijman and Professor Anna Nekaris
Dissertation: An interdisciplinary examination and assessment of conservation initiatives for Javan gibbons (*Hylobates moloch*)

MA Anthropology, San Diego State University
Supervisor: Dr. Erin P. Riley
Thesis: Reintroducing Javan gibbons (*Hylobates moloch*): An assessment of behavioral preparedness

BA Biological Anthropology, John Muir College: University of California, San Diego

TEACHING EXPERIENCE

Formal-
Oxford Brookes University:
Graduate Assistant
Population Genetics and Management

San Diego State University:
Lecturer
Principles of Biological Anthropology
Principles of Biological Anthropology - Lab

Teaching Associate
Human Biocultural Origins

Graduate Teaching Assistant
Observing Primate Behavior
The Supernatural in Cross-Cultural Perspective
Introduction to Socio-Cultural Anthropology
Principles of Biological Anthropology

Informal-
Oregon Zoo:
Conservation Education

PUBLICATIONS

1. Nijman V, Morcatty T, **Smith J**, Atoussi S, Shepherd C, Siriwat P, Nekaris KAI & Bergin D (2019). Illegal wildlife trade – surveying open animal markets and online platforms to understand the poaching of wild cats. Biodiversity, DOI: 10.1080/14888386.2019.1568915.

2. Nijman V, **Smith J**, Kanda RK (2019). Phylogeography, Population Genetics, and Conservation of Javan Gibbons (*Hylobates moloch*). In: The International Journal of Primatology, DOI: 10.1007/s10764-019-00080-3.

3. **Smith J**, King T, Campbell C, Cheyne S, Nijman V (2018). Modelling population viability of three independent Javan gibbon (*Hylobates moloch*) populations on Java, Indonesia. Folia Primatologica, 88:507–522.

4. **Smith J** (2017). Investigating the extent and prevalence of gibbons being traded online in habitat countries: A preliminary report, Arcus Foundation.

5. **Smith J** & Nijman V (2016). Buffer cropping. In: The International Encyclopedia of Primatology, Vol.1. Editor: Fuentes A. Wiley Blackwell. Hoboken: New Jersey.

6. **Smith J** (2010). Reintroducing Javan gibbons (*Hylobates moloch*): An assessment of behavioral preparedness. The Gibbon's Voice, 12: 2-7.

Reviewer
Peer-reviewed journals
Folia Primatologica
Primate Conservation

PROFESSIONAL CONFERENCE PRESENTATIONS

1. Cheyne SM, **Smith J**, Ramli M. Gibbon, Gibbon Gone: The impact of social media and photo group trade on the small apes. Poster presented at the 2018 Wildlife Trade Symposium, Oxford, United Kingdom.

2. **Smith, J**. The people's voice: It's what matters. Poster presented at the 2017 Student Conference on Conservation Science, New York, New York.

3. **Smith J** & Cheyne SM. Trading online: Sales of small apes on social media. Poster presented at the 2017 Wildlife Trade Symposium, Oxford, United Kingdom.

4. **Smith J**. Javan gibbon conservation: An overview. Presentation at the 2016 Research Student Symposium, Oxford Brookes University, Oxford, United Kingdom.

5. **Smith J**. Modelling population viability of local Javan gibbon (*Hylobates moloch*) populations. Poster presented at the 2015 European Federation for Primatology conference, Rome, Italy.

6. **Smith J**. Reintroducing Javan gibbons (*Hylobates moloch*): An assessment of behavioral preparedness, Javan Gibbon Rescue & Rehabilitation Center, West Java, Indonesia. Presentation at the 2012 1st International Gibbon Husbandry Conference, Greensboro, North Carolina.

7. **Smith J.** Behavioral ecology of reintroduced Javan gibbons (*Hylobates moloch*), Javan Gibbon Rescue & Rehabilitation Center, West Java, Indonesia. Poster presented at the 2011 American Society of Primatologists, 34th Annual Meeting, Austin, Texas.

8. **Smith J**. The effects of behavioral enrichment on captive Allen's swamp monkeys (*Allenopithecus nigroviridis*) and Schmidt's spot-nosed guenons (*Cercopithecus ascanius schmidti*). Poster presented at the 2002 Southern California Primate Research Forum, California State University, Fullerton, California.

INVITED TALKS AND GUEST LECTURES

2017 'The illegal wildlife trade on social media' - lecture presented during the International Legislation, Humans and Wildlife module for MSc in International Conservation students, Oxford, United Kingdom

2017 'Population viability modelling in conservation' - lecture presented during the Population Genetics and Management module for MSc in Primate Conservation students, Oxford, United Kingdom

2016 'An examination and assessment of current conservation practices for Javan gibbons (*Hylobates moloch*) in West Java, Indonesia'- lecture presented during the Primate Conservation and Diversity module for MSc in Primate Conservation students, Oxford, United Kingdom

2016 'From the US to the UK: The path to PhD'- presentation for new MSc in Primate Conservation students, Oxford, United Kingdom

2015 'Gibbon rescue, rehabilitation, and reintroduction'- lecture presented during the Captive Management and Rehabilitation module for MSc in Primate Conservation students, Oxford, United Kingdom

2015 'Let them be wild'- oral presentation at Gunung Puntang Puncak Mega International Gibbon Day consortium, Bandung, West Java, Indonesia

2015 'Rescue, rehabilitation, and reintroduction of Javan gibbons in West Java'- invited talk at SMK Al- Wafa, Ciwidey, West Java, Indonesia

RESEARCH EXPERIENCE AND FIELDWORK

Arcus Foundation/ IUCN SSC Primate Specialist Group - Section on Small Apes, Independent Consultant, Oxford, United Kingdom: I investigated the illegal selling of Endangered species (*Hylobates spp*.) on various social media platforms and compiled the data for an official report; I created (and continue to manage) a Facebook page highlighting conservation success stories from gibbon rescue centres throughout Asia.

PDX Wildlife, Staff Scientist, Portland, Oregon: I helped develop innovative research to conserve species and their habitats in the wild and created educational outreach activities and programmes to encourage people to conserve the natural environment.

The Aspinall Foundation: Javan Primate Conservation Centre, Visiting Researcher, West Java, Indonesia: I prepared and distributed food to captive Javan gibbons and Javan langurs, constructed and provided environmental enrichment, collected natural fruit and foliage to be used for enrichment and dietary supplementation, maintained and cleaned enclosures, and conducted behavioural observations on Javan gibbons.

Javan Gibbon Rescue and Rehabilitation Centre, Visiting Researcher, West Java, Indonesia: I promoted conservation awareness for school children in local communities, assisted with reforestation projects, prepared and distributed food to captive Javan gibbons, assisted with rescue procedures, provided care for infant Javan gibbons, maintained facility grounds, conducted behavioural observations on gibbons, and monitored wild Javan gibbons.

Bantimurung Bulusaraung National Park, Research Assistant, South Sulawesi, Indonesia: I assisted with behavioural observations on wild moor macaques to evaluate social relationships within the group, collected phenological data in order to evaluate the quality of habitat, helped to collate behavioural data, and mentored a new graduate student. Supervised by Dr. Erin P. Riley.

Lore Lindu National Park, Research Assistant, Central Sulawesi, Indonesia: I collected dietary information on wild tonkean macaques in order to evaluate nutritional quality of food sources and overlapping resource use between the macaques and local people, and assisted with interviews with local people to determine perspectives on conservation. Supervised by Dr. Erin P. Riley.

Gibbon Conservation Center, Volunteer Keeper, Santa Clarita, California: I prepared and distributed food to captive gibbons, assisted with quarantine and medicating procedures, maintained enclosures and facility grounds, conducted behavioural observations on gibbons, and assisted the director with guided tours and fundraising events.

San Diego Institute for Conservation Research, Volunteer Research Assistant, San Diego Zoo, San Diego California: I observed female black bears to examine mother/cub interactions during hibernation (via video analysis), collected cub vocalisation samples, and decoded and entered data into an excel database. Supervisor: Dr. Megan Owen.

University of California, San Diego & San Diego Zoological Society, Internship, San Diego, California: I conducted behavioural observations on captive bonobos to examine group social dynamics, maintained communication log for zoo keepers regarding the bonobos' behaviour and activity patterns. Supervisor: Dr. Christine Johnson.

PROFESSIONAL MEMBERSHIPS

European Association of Social Anthropologists
Society for Conservation Biology - Social Science Working Group
IUCN SSC Primate Specialist Group - Section on Small Apes
International Society of Primatologists
John Muir Trust
Scottish Wildlife Trust

SKILLS AND QUALIFICATIONS

Software:	*Field Equipment:*	*Languages:*
VORTEX	GPS	English
Microsoft Office	Camera Trap	Bahasa Indonesia
SPSS	Digital Voice Recorder	American Sign Language
WordPress		

External Training:
First Steps into Learning and Teaching in Higher Education, Oxford Brookes University, Oxford, UK
Forest School Training: Level 1, Bonaly Outdoor Centre, Edinburgh, UK
United for Wildlife: Introducing Conservation and Insights (online course)