Primate Conservation

Global evidence for the effects of interventions

Jessica Junker, Hjalmar S. Kühl, Lisa Orth, Rebecca K. Smith, Silviu O. Petrovan and William J. Sutherland

SYNOPSES OF CONSERVATION EVIDENCE SERIES

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Synopses of Conservation Evidence

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About this book

The purpose of Conservation Evidence synopses

Conservation Evidence synopses **do**	Conservation Evidence synopses **do not**
• Bring together scientific evidence captured by the Conservation Evidence project (over 5,300 studies so far) on the effects of interventions to conserve biodiversity	• Include evidence on the basic ecology of species or habitats, or threats to them
• List all realistic interventions for the species group or habitat in question, regardless of how much evidence for their effects is available	• Make any attempt to weight or prioritize interventions according to their importance or the size of their effects
• Describe each piece of evidence, including methods, as clearly as possible, allowing readers to assess the quality of evidence	• Weight or numerically evaluate the evidence according to its quality
• Work in partnership with conservation practitioners, policymakers and scientists to develop the list of interventions and ensure we have covered the most important literature	• Provide recommendations for conservation problems, but instead provide scientific information to help with decision-making

Who is this synopsis for?

If you are reading this, we hope you are someone who has to make decisions about how best to support or conserve biodiversity. You might be a land manager, a conservationist in the public or private sector, a farmer, a campaigner, an advisor or consultant, a policymaker, a researcher or someone taking action to protect your own local wildlife. Our synopses summarize scientific evidence relevant to your conservation objectives and the actions you could take to achieve them.

We do not aim to make your decisions for you, but to support your decision-making by telling you what evidence there is (or isn't) about the effects that your planned actions could have.

When decisions have to be made with particularly important consequences, we recommend carrying out a systematic review, as the latter is likely to be more comprehensive than the summary of evidence presented here. Guidance on how to carry out systematic reviews can be found from the Centre for Evidence-Based Conservation at the University of Bangor (www.cebc.bangor.ac.uk).

The Conservation Evidence project

The Conservation Evidence project has three parts:

1) An online, **open access journal** *Conservation Evidence* that publishes new pieces of research on the effects of conservation management interventions. All our papers are written by, or in conjunction with, those who carried out the conservation work and include some monitoring of its effects.

2) An ever-expanding **database of summaries** of previously published scientific papers, reports, reviews or systematic reviews that document the effects of interventions.

3) Synopses of the evidence captured in parts one and two on particular species groups or habitats. Synopses bring together the evidence for each possible intervention. They are freely available online and available to purchase in printed book form.

4) ***What Works in Conservation*** is an assessment of the effectiveness of interventions by expert panels, based on the collated evidence for each intervention for each species group or habitat covered by our synopses.

These resources currently comprise over 5,000 pieces of evidence, all available in a searchable database on the website www.conservationevidence.com.

Alongside this project, the Centre for Evidence-Based Conservation (www.cebc.bangor.ac.uk) and the Collaboration for Environmental Evidence (www.environmentalevidence.org) carry out and compile systematic reviews of evidence on the effectiveness of particular conservation interventions. These systematic reviews are included in the Conservation Evidence database.

In the context of this synopsis, the 'primate' taxon includes all non-human primates. Primates are referred to separately from humans throughout the text.

Of the 162 primate conservation interventions identified in this synopsis, none were the subject of a specific systematic review. The following interventions we feel would benefit significantly from systematic reviews:

- Conduct regular anti-poaching patrols
- Regularly de-activate/remove ground snares
- Implement local no-hunting community policies/traditional hunting ban
- Provide food to workers/locals to reduce hunting
- Use selective logging instead of clear-cutting

In light of the increase in mining activities, we stress the need for conducting more studies that investigate the effect of interventions that aim at mitigating the impact of energy production and mining on primates and their habitat, including:

- Minimizing ground vibrations caused by open cast mining activities
- Establishing no-mining zones in/near watersheds so as to preserve water equilibrium
- Using 'set-asides' for wildlife (primate) protection within mining areas

We did not find any studies on these interventions. Likewise, we found no studies providing evidence for the effects of 'Providing sustainable alternative livelihoods' and 'Employing hunters in the conservation sector to reduce their impact'.

In addition, only 14 studies investigated the effect of interventions to promote education and awareness-raising and only four studies collected evidence on interventions that provided monetary or non-monetary benefits to local communities for sustainably managing their forest and its wildlife communities. This paucity of data and the lack of evidence for their effectiveness are unfortunate given the enormous amounts of conservation spending invested into these interventions.

Scope of the Primate Conservation synopsis

This synopsis covers published evidence for the effects of conservation interventions for native wild primates until the end of 2014 (except the PLOS series, which we searched until the end of 2016). In addition, we included studies that:

- translocated primates to increase the viability of populations or communities of native wild primates (e.g. (re)introductions into the wild, captive breeding and subsequent release of individuals into the wild, captive breeding to increase the gene pool),
- translocated problem animals, even though the focus may have been on individuals rather than communities or populations,
- carried out interventions that indirectly aimed at maintaining/increasing primate community/population size (e.g. improving local livelihoods, education, raising awareness),
- carried out interventions that reduced persecution/human contact with species (to stabilize community/population size) (e.g. no-feeding-policies, installing primate-proof garbage bins), and
- carried out a method of birth control if it was aimed at the long-term conservation of the species and was not invasive like sterilization

We explicitly excluded studies that:

- were carried out to support individuals only, unless these have been carried out to maintain/increase wild native primate communities/populations,
- reported on husbandry of pet, sanctuary or zoo primates, unless these interventions are directly relevant to the conservation of native wild populations,
- intentionally aimed at harming individuals or reducing community/population size (e.g. setting snares around agricultural areas, culling & problem animal control, sterilization),
- aimed at conserving species other than primates, but have an effect on primate species,
- did not present quantitative results (however, we included studies that provided qualitative results, if they clearly stated e.g. that there was a population change)
- evaluated very indirect conservation interventions (e.g. relating to economic factors such as improving livelihoods) that did not directly aim at conserving primates, and

- reviewed the literature but did not introduce any new studies, and
- simulated the effect of interventions without actually doing them

Evidence from all around the world is included. Any apparent bias towards evidence from some regions reflects the current biases in published research papers available to Conservation Evidence.

Husbandry vs conservation of species

This synopsis does not include evidence from the substantial literature on husbandry of pet or zoo primates. However, where these interventions are relevant to the conservation of native wild species, they are included (e.g. 'Captively breed and re-introduce primates into the wild'). For scientific evidence on interventions to manage captive primates, please refer to the 'Management of Captive Animals' synopsis available at http://conservationevidence.com/synopsis/index."

How we decided which conservation interventions to include

A list of interventions was developed and agreed in partnership with an advisory board made up of international conservationists and academics with expertise in primate conservation. We have tried to include all actions that have been carried out or advised to support populations or communities of wild primates.

The list of interventions was organized into categories based on the International Union for the Conservation of Nature (IUCN) classifications of direct threats and conservation actions.

How we reviewed the literature

In addition to evidence already captured by the Conservation Evidence project (from 30 general conservation/ecology journals plus 146 other more specialist journals), we have searched the following sources for evidence relating to primates:

- Twenty one specialist primate journals and newsletters, from their first publication to the end of 2014 (*African Primates, American Journal of Primatology, Asian Primates Journal, Contributions to Primatology, Ecological and Environmental Anthropology, Evolutionary Anthropology, Folia Primatologica, Gibbon and Siamang, Gibbon Journal, Gorilla Journal, International Journal of Primatology, Jurnal Primatologi Indonesia, Lemur News, Monkey Matters, Neotropical Primates, Primate Conservation, Primate Eye, Primate Report, Primate Research (Reichorui-Kenkyu), Primates, Vietnamese Journal of Primatology).*
- Sixteen general conservation journals over the same time period (*Conservation Evidence, Endangered Species Research, International Journal of Biological Sciences, Journal of Wildlife Rehabilitation, Madagascar Conservation and Development, Madagascar Fauna Group Newsletter, PLOS ONE, PLOS Pathogens, PLOS Biology, Open Biology, PLOS Neglected Tropical Diseases, PLOS Genetics, PLOS Computational Biology, PLOS Medicine, ZooKeys, F1000Research*).

- All journals in the PLOS-series were searched with electronic literature searches until (and including) the year 2016, by using the following search string: (((title:primate) OR title:monkey) OR title:ape) OR title:gorilla) OR title:chimpanzee) OR title:bonobo) OR title:orangutan) OR title:orang-utan) OR title:gibbon) OR title:tarsier) OR title:lemur) OR title:sifaka) OR title:saki) OR title:loris) OR title:baboon) OR title:drill) OR title:mandrill) OR title:capuchin) OR title:potto) OR title:mangabey) OR title:"aye aye") OR title:muriqui) OR title:macaque) OR title:tamarin) OR title:colobus) OR title:howler) OR title:angwantibo) OR title:indri) OR title:vakari) OR title:titi) OR title:marmoset) OR title:vervet) OR title:guereza) OR title:galago) OR title:surili) OR title:langur) OR title:siamang) OR title:allenopithecus) OR title:allocebus) OR title:alouatta) OR title:aotus) OR title:arctocebus) OR title:ateles) OR title:avahi) OR title:brachyteles) OR title:cacajao) OR title:callicebus) OR title:callimico) OR title:callithrix) OR title:cebus) OR title:cercocebus) OR title:cercopithecus) OR title:cheirogaleus) OR title:chiropotes) OR title:chlorocebus) OR title:daubentonia) OR title:erythrocebus) OR title:eulemur) OR title:euticus) OR title:hapalemur) OR title:hoolock) OR title:hylobates) OR title:lagothrix) OR title:leontopithecus) OR title:lepilemur) OR title:lophocebus) OR title:macaca) OR title:mandrillus) OR title:microcebus) OR title:miopithecus) OR title:mirza) OR title:nasalis) OR title:nomascus) OR title:nycticebus) OR title:oreonax) OR title:otolemur) OR title:pan) OR title:papio) OR title:perodicticus) OR title:phaner) OR title:piliocolobus) OR title:pithecia) OR title:pongo) OR title:presbytis) OR title:procolobus) OR title:prolemur) OR title:propithecus) OR title:pygathrix) OR title:rhinopithecus) OR title:saguinus) OR title:saimiri) OR title:semnopithecus) OR title:simias) OR title:symphalangus) OR title:tarsius) OR title:theropithecus) OR title:trachypithecus) OR title:varecia)

Evidence published in languages other than English were not included.

The criteria for inclusion of studies in the Conservation Evidence database are as follows:

- There must have been an intervention carried out that conservationists would do.
- The effects of the intervention must have been monitored quantitatively.

These criteria exclude studies examining the effects of specific interventions without actually doing them. For example, predictive modelling studies and studies looking at species distributions in areas with long-standing management histories (correlative studies) were excluded. Such studies can suggest that an intervention could be effective, but do not provide direct evidence of a causal relationship between the intervention and the observed biodiversity pattern.

The literature search yielded a total of 221 relevant studies, of which 80 were allocated to interventions they tested quantitatively. Additional studies published before 2015 were added if recommended by the advisory board or identified within the literature during the summarizing process.

How the evidence is summarized

Conservation interventions are grouped primarily according to the relevant direct threats, as defined in the IUCN Unified Classification of Direct Threats (http://www.iucnredlist.org/technical-documents/classification-schemes/threats-classification-scheme). In most cases, it is clear which main threat a particular intervention is meant to alleviate or counteract.

All IUCN threat types are included, as all of them may threaten primates, and for all of which realistic conservation interventions have been suggested.

Some important interventions can be used in response to many different threats, and it would not make sense to split studies up depending on the specific threat they were studying. We have therefore separated out these interventions, following the IUCN's Classification of Conservation Actions (http://www.iucnredlist.org/technical-documents/classification-schemes/conservation-actions-classification-scheme-ver2). The actions we have separated out are: ['Education and awareness', 'Habitat protection', 'Habitat & natural process restoration', 'Long-term presence of research-/tourism project', 'Species management', and 'Livelihood; economic & other incentives']. These respectively match the following IUCN categories: ['Education and awareness', 'Land/water protection – Site/area protection, 'Land/water management - Habitat & natural process restoration', 'Other', 'Species management', and 'Livelihood; economic & other incentives'].

Normally, no intervention or piece of evidence is listed in more than one place, and when there is ambiguity about where a particular intervention should fall there is clear cross-referencing. Some studies describe the effects of multiple interventions. Where a study has not separated out the effects of different interventions, the study is included in the section on each intervention, but the fact that several interventions were used is made clear.

In the text of each section, studies are presented in chronological order, so the most recent evidence is presented at the end. The summary text at the start of each section groups studies according to their findings.

At the start of each chapter, a series of **key messages** provides a rapid overview of the evidence. These messages are condensed from the summary text for each intervention.

Background information is provided where we feel recent knowledge is required to interpret the evidence. This is presented separately and relevant references included in the reference list at the end of each background section.

The information in this synopsis is available in two ways:

- As a pdf to download from www.conservationevidence.com
- As text for individual interventions on the searchable database at www.conservationevidence.com.

Terminology used to describe evidence

Unlike systematic reviews of particular conservation questions, we do not quantitatively assess the evidence or weight it according to quality within synopses. However, to allow you to interpret evidence, we make the size and design of each trial we report clear. The table below defines the terms that we have used to do this.

The strongest evidence comes from randomized, replicated, controlled trials with paired-sites and before and after monitoring.

Term	Meaning
Site comparison	A study that considers the effects of interventions by comparing sites that have historically had different interventions or levels of intervention.
Replicated	The intervention was repeated on more than one individual or site. In conservation and ecology, the number of replicates is much smaller than it would be for medical trials (when thousands of individuals are often tested). If the replicates are sites, pragmatism dictates that between five and ten replicates is a reasonable amount of replication, although more would be preferable. We provide the number of replicates wherever possible, and describe a replicated trial as 'small' if the number of replicates is small relative to similar studies of its kind. In the case of translocations or release of animals, replicates should be sites, not individuals.
Controlled	Individuals or sites treated with the intervention are compared with control individuals or sites not treated with the intervention.
Paired sites	Sites are considered in pairs, when one was treated with the intervention and the other was not. Pairs of sites are selected with similar environmental conditions, such as soil type or surrounding landscape. This approach aims to reduce environmental variation and make it easier to detect a true effect of the intervention.
Randomized	The intervention was allocated randomly to individuals or sites. This means that the initial condition of those given the intervention is less likely to bias the outcome.
Before-and-after trial	Monitoring of effects was carried out before and after the intervention was imposed.
Review	A conventional review of literature. Generally, these have not used an agreed search protocol or quantitative assessments of the evidence.

Systematic review	A systematic review follows an agreed set of methods for identifying studies and carrying out a formal 'meta-analysis'. It will weight or evaluate studies according to the strength of evidence they offer, based on the size of each study and the rigour of its design. All environmental systematic reviews are available at: www.environmentalevidence.org/index.htm
Study	If none of the above apply, for example a study looking at the number of people that were engaged in an awareness raising project.

Taxonomy

Taxonomy has not been updated or standardized. Where possible, common names and Latin names are both given the first time each species is mentioned within each synopsis.

Significant results

Throughout the synopsis we have quoted results from papers. Unless specifically stated, these results reflect statistical tests performed on the results.

Multiple interventions

Some studies investigated several interventions at once. When the effects of different interventions are separated, then the results are discussed separately in the relevant sections. However, often the effects of multiple interventions cannot be separated. When this is the case, the study is included in the section on each intervention, but the fact that several interventions were used is made clear.

How you can help to change conservation practice.

If you know of evidence relating to primate conservation that is not included in this synopsis, we invite you to contact us, via our website www.conservationevidence.com. You can submit a published study by clicking 'Submit additional evidence' on the right hand side of an intervention page. If you have new, unpublished evidence, you can submit a paper to the *Conservation Evidence* journal. We particularly welcome papers submitted by conservation practitioners.

1. Threat: Residential and commercial development

Background

Residential and commercial development threatens primate populations through habitat loss and fragmentation and the killing of primates perceived as 'problem' animals. Further interventions related to human development in the form of settlements or other non-agricultural land uses are described in the chapters 'Threat: Energy production & mining', 'Threat: Transportation & service corridors', 'Threat: Pollution', 'Habitat protection' and 'Habitat creation or restoration'.

Key messages

Remove and relocate 'problem' animals

Three studies, including one replicated, before-and-after trial, in India, Kenya, the Republic of Congo and Gabon found that primates survived the translocation. One study found that all translocated rhesus monkeys remained at the release site for at least four years. Another study showed that after 16 years, 66% of olive baboons survived and survival rate was similar to wild study groups. The third study showed that 84% of gorillas released in the Republic of Congo and Gabon survived for at least four years.

Relocate primates to non-residential areas

We captured no evidence for the effects of relocating primates to non-residential areas on primate populations.

Discourage the planting of fruit trees and vegetable gardens on the urban edge

We captured no evidence for the effects of discouraging the planting of fruit trees and vegetable gardens on the urban edge on primate populations.

1.1. Remove and relocate 'problem' animals

- One replicated, before-and-after study in India[1] found that 'problem' rhesus monkeys that were translocated, alongside other interventions, survived and remained at the release sites for at least four years.
- One controlled, before-and-after study in Kenya[2] found that after 16 years, most crop-raiding olive baboons that were translocated from farmland, alongside other interventions, had survived and had similar survival rates compared to non-translocated populations.
- One before-and-after, site comparison study in the Republic of Congo and Gaboon[3] found that 84% of the 'problem' western lowland gorillas that were relocated, alongside other interventions, survived for at least four years.

Background

So-called 'problem' animals are animals that cause damage to humans or their property. Problem causing animals can be captured alive in the area of conflict, and transported and released in another suitable area. Animals are either returned to their normal home range, in the hope that the negative experience will prevent them from returning to the area of conflict, or are transported further, to an area with reduced conflict potential, where it is hoped that they will stay (Linnell *et al.* 1997).

Linnell J.D.C., Aanes, R., Swenson, J.E., Odden, J. & Smith M.E. (1997) Translocation of carnivores as a method for managing problem animals: a review. *Biodiversity and Conserrvation*, 6, 1245–1257.

A replicated, before-and-after trial in 1995-2001 in temple orchards in urban Vrindaban, India (1) found that rhesus monkeys *Macaca mulatta* that were perceived as 'problem' animals by local residents and translocated along with other interventions, remained at their release sites for at least four years. The 600 monkeys that were translocated to eight different forest patches established resident populations, appeared healthy and showed no signs of stress. Also the time individuals from one of the translocated groups (150 individuals) spent engaged in different activities during the first three months after release was similar to activity budgets of wild groups in northern India. Authors reported that after the translocation, the residents of Vrindaban generally expressed their relief at the lessening of the 'monkey problem'. No quantitative results were provided in this study. Twelve groups (of 24–115 individuals) totalling 600 monkeys (45% of total population) were translocated to eight natural forest patches without resident monkeys in January 1997. Monkeys were monitored for a total of 300 hours by one person during the first four months and again for five days, four years after their release. The study does not distinguish between the effects of the different interventions mentioned above.

A controlled, before-and-after trial in 1973-2001 in savannah at the Laikipia Plateau, Kenya (2) found that crop-raiding olive baboons *Papio anubis*, regarded as 'problem' animals and translocated from farmland to natural habitat along with other interventions, survived the translocation, with most individuals surviving over 16 years. The survival rate of two translocated troops (total of 94 baboons) did not change significantly 16 years after the release (1984: 94 animals; 2001: 62 animals). Also, there was no difference in survival rate compared to a wild troop at the capture site and another resident troop at the release site (data reported as statistical model results). Both troops were released into habitat with resident baboons and predators. Prior to translocation, individuals underwent veterinary screens and some sick baboons were treated. A long-term research study was launched to study these animals. After release, baboons were temporarily provided with food during periods of drought in the first two years post-translocation but no other interventions took place after 1986. The study does not distinguish between the effects of the different interventions mentioned above.

A before-and-after, site comparison study in 1996-2006 in tropical forests of Lesio-Louna Wildlife Reserve, the Republic of Congo and Batéké Plateau National Park, Gabon (3) found that the majority of reintroduced western lowland gorillas *Gorilla gorilla gorilla* that became 'problem' animals and were therefore recaptured and relocated along with 14 other interventions, survived for at least four years and some reproduced. Twenty-one of 25 gorillas (84%) released in the Congo and 22 of 26 gorillas (85%) released in Gabon survived for at least four years. Nine females gave birth to 11 infants, of which nine survived. In the Congo, five reintroduced 'problem gorillas' (solitary males) were recaptured after they moved outside of their home range to a more densely human populated area and were relocated back to avoid potential human-gorilla conflicts. Prior to release, gorillas underwent disease screening during quarantine and received preventative vaccinations. Gorillas were released in groups and prior to release were allowed to adapt to local environment and supplemented with food. Gorillas were released into habitat with no resident gorillas to re-establish populations and were treated for parasites and when sick. Dead gorillas were examined to determine their cause of death and to avoid disease transmission. Forty-three individuals were rehabilitated wild-born orphaned gorillas and eight gorillas were ex-situ captive-born animals. Both release sites were proclaimed protected areas before reintroduction. The study does not distinguish between the effects of the different interventions mentioned above.

(1) Imam E., Yahya H.S.A. & Malik I. (2002) A successful mass translocation of commensal rhesus monkeys *Macaca mulatta* in Vrindaban, India. *Oryx*, 36, 87–93.

(2) Strum S.C. (2005) Measuring success in primate translocation: a baboon case study. *American Journal of Primatology*, 65, 117–140.

(3) King T., Chamberlan C. & Courage A. (2012) Assessing initial reintroduction success in long-lived primates by quantifying survival, reproduction, and dispersal parameters: western lowland gorillas (*Gorilla gorilla gorilla*) in Congo and Gabon. *International Journal of Primatology*, 33, 134–149.

1.2. Relocate primates to non-residential areas

- We found no evidence for the effects of relocating primates to non-residential areas on primate populations.

Background

Primates may cause hazards to humans and their property in residential areas. For example, they may enter private homes, steal food, and cause damage to properties. Primates that live in/near residential areas may also injure people and represent a health hazard, as they can transmit various diseases to humans and vice versa. In an effort to protect both primates and humans, primates may be relocated to areas that are less densely populated by humans, or natural areas. This intervention may be implemented before the building of the residential area or at a later stage in response to primates invading an existing residential area.

1.3. Discourage the planting of fruit trees and vegetable gardens on the urban edge

- We found no evidence for the effects of discouraging the planting of fruit trees and vegetable gardens on the urban edge on primate populations.

Background

In an effort to reduce crop raiding by primates, people may be discouraged to plant fruit trees and create vegetable gardens, particularly using plant species preferred by primates, on the edge of urban areas.

For interventions that aim to deter primates see ‘Use of natural thorny hedges’, ‘Use of buffer (unpalatable) crops’, ‘Change of crop (i.e. to a less primate-palatable crop)’ and ‘Plant primate-favoured crops away from primate areas’, ‘Destroy habitat inside buffer zones to make them unusable for primate species’, ‘Use nets to keep primates out of fruit trees’, ‘GPS and/or VHF devices on members of problem troop to provide farmers with early warning and researchers with raiding data’, ‘Chase primates using dogs’, ‘Train langurs to deter rhesus macaques’, ‘Use loud-speakers broadcasting sounds of potential threats (barking dogs, bird-fright explosions, gun-shots etc.)’, ‘Use loud-speakers broadcasting primate alarm play-back calls’, ‘Strategically lay out scent of primate predator (e.g. leopard, lion, etc.)’, ‘Humans chasing primates using noise (no specific sounds, but random noise)’, and ‘Humans chasing primates using bright light (Meerkat Optical Wildlife Rerouter)’.

2. Threat: Agriculture

Background

Agriculture (also described as farming) is the cultivation of animals, plants and other life forms for major agricultural products which can be broadly grouped into foods, fibres, fuels, and raw materials. Agriculture threatens primates directly through habitat loss, fragmentation and system modifications, such as frequent fire regimes. Indirect threats include an increased risk of disease transmission between primates, humans and their livestock, the killing of primates that raid crops, and increased hunting pressure as a result of an influx of people into primate habitat. Palm oil is one of the most important agricultural crops produced in monocultures on a large-scale and currently represents one of the greatest threats to primates in the tropics (Wich *et al*. 2014).

For 'Best Practice Guidelines for the Prevention and Mitigation of Conflict Between Humans and Great Apes' published by the IUCN/SSC Primate Specialist Group (PSG), please refer to Hockings & Humle (2009).

Hockings K. & Humle T. (2009) *Best Practice Guidelines for the Prevention and Mitigation of Conflict Between Humans and Great Apes.* IUCN/SSC Primate Specialist Group, Gland, Switzerland.

Wich S.A., Garcia-Ulloa J., Kühl H.S., Humle T., Lee J.S.H., & Pin Koh L. (2014) Will oil palm's homecoming spell doom for Africa's great apes? *Current Biology*, 24, 1659–1663.

Key messages

Create natural habitat islands within agricultural land

We captured no evidence for the effects of creating natural habitat islands within agricultural land on primate populations.

Use fences as biological corridors for primates

We captured no evidence for the effects of using fences as biological corridors on primate populations.

Provide sacrificial rows of crops on outer side of fields

We captured no evidence for the effects of providing sacrificial rows of crops on an outer side of fields on primate populations.

Compensate farmers for produce loss caused by primates

We captured no evidence for the effects of compensating farmers for produce loss caused by primates on primate populations.

Pay farmers to cover the costs of non-harmful strategies to deter primates

We captured no evidence for the effects of paying farmers to cover the costs of non-harmful strategies to deter primates on primate populations.

Retain nesting trees/shelter for primates within agricultural fields

We captured no evidence for the effects of retaining nesting trees/shelter for primates within agricultural fields on primate populations.

Plant nesting trees/shelter for primates within agricultural fields

We captured no evidence for the effects of planting nesting trees/shelter for primates within agricultural fields on primate populations.

Prohibit (livestock) farmers from entering protected areas

One before-and-after site comparison study in Rwanda found that numbers of young gorillas increased after removal of cattle from a protected area, alongside other interventions. One before-and-after study in three African countries found that gorilla numbers declined following the removal of livestock, alongside other interventions.

Regularly remove traps and snares around agricultural fields

We captured no evidence for regularly removing traps and snares around agricultural fields on primate populations.

Certify farms and market their products as 'primate friendly'

We captured no evidence for the effects of certifying farms and marketing their products as 'primate friendly' on primate populations.

Farm more intensively and effectively in selected areas and spare more natural land

We captured no evidence for the effects of farming more intensively and effectively in selected areas and sparing more natural land on primate populations.

Install mechanical barriers to deter primates (e.g. fences, ditches)

We captured no evidence for the effects of installing mechanical barriers to deter primates on primate populations.

Use of natural hedges to deter primates

We captured no evidence for the effects of using natural hedges to deter primates on primate populations.

Use of unpalatable buffer crops

We captured no evidence for the effects of using unpalatable buffer crops on primate populations.

Change of crop (i.e. to a crop less palatable to primates)

We captured no evidence for the effects of a change of crop on primate populations.

Plant crops favoured by primates away from primate areas

We captured no evidence for the effects of planting crops favoured by primates away from primate areas on primate populations.

Destroy habitat within buffer zones to make them unusable for primates

We captured no evidence for the effects of destroying habitat within buffer zones to make them unusable for primates on primate populations.

Use nets to keep primates out of fruit trees

One controlled, replicated, before-and-after study in Indonesia found that in areas where nets were used to protect crop trees, crop-raiding by orangutans was reduced.

Use GPS and/or VHF tracking devices on individuals of problem troops to provide farmers with early warning of crop raiding

We captured no evidence for the effects of using GPS and/or VHF tracking devices on individuals of problem troops to provide farmers with early warning of crop raiding on primate populations.

Chase primates using dogs

We captured no evidence for the effects of chasing primates using dogs on primate populations.

Train langur monkeys to deter rhesus macaques

We captured no evidence for the effects of training langur monkeys to deter rhesus macaques on primate populations.

Use loud-speakers to broadcast sounds of potential threats (e.g. barking dogs, explosions, gunshots)

We captured no evidence for the effects of using loud-speakers to broadcast sounds of potential threats on primate populations.

Use loud-speakers to broadcast primate alarm calls

We captured no evidence for the effects of using loud-speakers to broadcast primate alarm calls on primate populations.

Strategically lay out the scent of a primate predator (e.g. leopard, lion)

We captured no evidence for the effects of strategically laying out the scent of a primate predator on primate populations.

Humans chase primates using noise (no specific sounds, but random noise)

One replicated, before-and-after study in Indonesia found that in areas where noise deterrents were used, alongside tree nets, crop raiding by orangutans was reduced. One study in the Democratic Republic of Congo found that chasing gorillas and using random noise resulted in the return of the gorillas to areas close to protected forest.

Humans chase primates using bright light

We captured no evidence for the effects of humans chasing primates using bright light on primate populations.

2.1. Create natural habitat islands within agricultural land

- We found no evidence for the effects of creating natural habitat islands within agricultural land on primate populations.

Background

Some primate species, such as the king colobus monkey *Colobus polykomos* in central Ghana can survive in relatively small forest fragments (Kankam & Sicotte 2012). It is therefore thought that creating or conserving islands covered by natural habitat within agricultural land could enhance the conservation of primate species living in such agroecosystems.

Kankam B.O. & Sicotte P. (2012) The effect of forest fragment characteristics on abundance of *Colobus vellerosus* in the forest-savanna transition zone of Ghana. *Folia Primatologica*, 24, 84, 74–86.

2.2. Use fences as biological corridors for primates

- We found no evidence for the effects of using fences as biological corridors on primate populations.

Background

Fences (also called 'fence rows') may be used by primates as travel pathways in agricultural-forest mosaics to move from one forest patch to the next. These may be 'living fences', which are wide fences that have natural vegetation (trees, bushes) growing around/between them, or they can be ordinary wire or wooden fences. A study found that red howler monkeys *Alouatta seniculus*, squirrel monkeys *Saimiri* spp., tufted capuchin monkeys *Sapajus apella* and dusky titis *Callicebus moloch* in gallery forest fragments in the Eastern Colombian Llanos used living fences and wire fences as corridors to travel between forest patches (Carretero Pinzón *et al*. 2008). However, this study reported on personal observations and did not evaluate this intervention using a robust study design and statistics and so has not been summarised as evidence below.

Carretero Pinzón X., Defler T. & Ruiz-Garcia M. (2008) Fence rows as biological corridors: An important tool for primate conservation in the Columbian Llanos. *Primate Eye*, 96, 25.

2.3. Provide sacrificial rows of crops on outer side of fields

- We found no evidence for the effects of providing sacrificial rows of crops on the outer side of fields on primate populations.

Background

Farmers may decide to sacrifice crop rows located on the outer side of fields to crop-raiding primates. This assumes that crop raiding individuals feed only at the periphery of the field.

2.4. Compensate farmers for produce loss caused by primates

- We found no evidence for the effects of compensating farmers for produce loss caused by primates on primate populations.

Background

Compensation schemes can be used to reduce the loss of income due to crop losses caused by primates. A study on wolves found that individual compensation appeared to have reduced the resentment of farmers to *Canis lupus* taking their livestock around Yellowstone National Park in the USA (Nyhus *et al*. 2003). The effectiveness of compensation schemes, however, is often undermined by difficulties in verifying claims by farmers (Mc Guinness & Taylor 2014).

Compensation schemes to cover the farmer's costs to deter primates are discussed under 'Pay farmers to cover the costs of strategies to deter primates that are not harmful to primates'.

Mc Guinness S. & Taylor D. (2014) Farmers' perceptions and actions to decrease crop raiding by forest-dwelling primates around a Rwandan forest fragment. *Human Dimensions of Wildlife*, 19, 179–190.

Nyhus P., Fischer H., Madden F. & Osofsky S. (2003) Taking the bite out of wildlife damage: the challenges of wildlife compensation schemes. *Conservation in Practice*. 4, 37–40.

2.5. Pay farmers to cover the costs of non-harmful strategies to deter primates

- We found no evidence for the effects of paying farmers to cover the costs of non-harmful strategies to deter primates on primate populations.

Background

By paying farmers to cover their costs for implementing strategies to deter primates from their crops, farmers may be more tolerant towards crop-raiding primates and less likely to kill them.

Schemes to compensate for the farmer's produce loss incurred by crop-raiding primates are discussed under 'Compensate farmers for produce loss caused by primates'.

2.6. Retain nesting trees/shelter for primates within agricultural fields

- We found no evidence for the effects of retaining nesting trees/shelter for primates within agricultural fields on primate populations.

Background

Many primate species display extraordinary behavioural flexibility, which allows them to adapt to rapidly changing environmental conditions and persist in moderately disturbed environments. For example, in Sierra Leone, small-scale subsistence farming allows areas of fallow land and secondary forest to remain where chimpanzees *Pan troglodytes verus* can find food and shelter (Brncic *et al.* 2010). Therefore, retaining sufficient amounts of nesting trees and/or shelter for primates within agricultural lands may promote primate conservation in these areas.

The planting of trees to provide nest sites and shelter for primates within agricultural fields is discussed under 'Plant nesting trees/shelter for primates within agricultural fields'. The creation/maintenance of natural habitat islands within agricultural land is discussed under 'Create natural habitat islands within agricultural land'.

Brncic T.M., Amarasekaran B. & McKenna A. (2010) *Sierra Leone national chimpanzee census, September 2010.* Tacugama Chimpanzee Sanctuary unpublished report.

2.7. Plant nesting trees/shelter for primates within agricultural fields

- We found no evidence for the effects of planting nesting trees/shelter for primates within agricultural fields on primate populations.

Background

Many primate species display extraordinary behavioural flexibility, which allows them to adapt to rapidly changing environmental conditions and persist in moderately disturbed environments. For example, in Sierra Leone, small-scale subsistence farming allows areas of fallow land and secondary forest to remain where chimpanzees *Pan troglodytes verus* can find food and shelter (Brncic *et al*. 2010). Therefore, planting sufficient amounts of nesting trees and/or shelter for primates within agricultural lands may promote primate conservation in these areas.

The maintenance/protection of trees to provide nest sites and shelter for primates within agricultural fields is discussed under 'Retain nesting trees/shelter for primates within agricultural fields'. The creation/maintenance of natural habitat islands within agricultural land is discussed under 'Create natural habitat islands within agricultural land'.

Brncic T.M., Amarasekaran B. & McKenna A. (2010) *Sierra Leone national chimpanzee census, September 2010.* Tacugama Chimpanzee Sanctuary unpublished report.

2.8. Prohibit (livestock) farmers from entering protected areas

- One before-and-after, site comparison in Rwanda[1] found that the number of young gorillas increased after cattle were removed from a protected area, alongside other interventions.
- A before-and-after study in Rwanda, Uganda, and the Democratic Republic of Congo[2] found that a mountain gorilla population decreased over time following the removal of livestock from a number of protected areas, alongside other interventions.

Background

The aim of this intervention is to prevent farmers and/or livestock herders from entering protected areas, to reduce disease transmission and habitat degradation inside the protected area.

A before-and-after, site comparison study in 1976-1988 in tropical forest of the Volcanoes National Park, Rwanda (1) found that the number of immature mountain gorillas *Gorilla beringei beringei* on the Rwandan side of the park increased and snares decreased after the removal of cattle, along with other interventions. The number of immature individuals increased by 22% on the Rwandan side of the park, but had declined by 30% on the side of the park in the other two countries. However, no statistical tests were carried out to determine whether these differences were significant. Five years after cattle were removed, 30% of sampled quadrats on the Rwandan side of the park contained snares, compared to 70% of the sampled quadrats on the Ugandan and Congolese side. In 1976, all cattle were removed from the park in Rwanda. In 1979, a tourist project was initiated in the same site, which financed training, equipping and management of anti-poaching patrols. A conservation education programme was also implemented, but no further details of this programme were reported in the study. The study does not distinguish between the effects of the different interventions mentioned above.

A before-and-after trial in 1967-2008 in tropical forest in Volcanoes, Mgahinga and Virunga National Parks in Rwanda, Uganda, and the Democratic Republic of Congo, respectively (2) found that despite the removal of livestock from the park, along with other interventions, the mountain gorilla *Gorilla beringei beringei* population decreased over time. Annual population decline was 0.7%, resulting in an overall population decrease of 29% over 31 years. However, no statistical tests were carried out to determine whether this trend was significant or due to natural population fluctuations. Any cattle found by rangers were herded out of the park, confiscated, and their owners fined. Rangers also conducted regular anti-poaching patrols and regularly removed snares. Additional interventions included local conservation education and community development projects. The study does not distinguish between the effects of the different interventions mentioned above.

(1) Harcourt A.H. (2001) The benefits of mountain gorilla tourism. *Gorilla Journal*, 22, 36–37.
(2) Robbins M.M., Gray M., Fawcett K.A., Nutter F.B., Uwingeli P., Mburanumwe I., Kagoda E., Basabose A., Stoinski T.S., Cranfield M.R., Byamukama J., Spelman L.H. & Robbins A.M. (2011) Extreme conservation leads to recovery of the Virunga Mountain Gorillas. *PLoS ONE*, 6, e19788.

2.9. Regularly remove traps and snares around agricultural fields

- We found no evidence for the effects of regularly removing traps and snares around agricultural fields on primate populations.

Background

This intervention involves the regular removal of snares and traps frequently found around agricultural areas. For example, a nationwide chimpanzee *Pan troglodytes verus* survey in Liberia found that signs of hunting with snares were associated with non-forested agricultural land, whereas signs of hunting with guns overlapped substantially with unmodified, forested areas (Tweh *et al.* 2014).

The removal of traps and snares from areas other than agricultural lands is discussed under 'Regularly de-activate/remove ground snares'.

Tweh C., Lormie M., Kouakou C., Hillers A., Kuehl H. & Junker J. (2014) Conservation status of chimpanzees (*Pan troglodytes verus*) and other large mammals across Liberia: results from a nationwide survey. *Oryx*, 1–9.

2.10. Certify farms and market their products as 'primate friendly'

- We found no evidence for the effects of certifying farms and marketing their products as 'primate friendly' to sell at a premium on primate populations.

Background

This intervention aims to certify sustainably farmed products as 'primate friendly', and sell them at a premium. Several environmentally and/or socially responsible product certifications already exist, such as 'FAIRTRADE', Organic or 'Rainforest Alliance' certifications. A gorilla-specific certification, 'Gorilla Fund Cofee', was launched aiming to support Rwandan coffee farmers as they develop sustainable alternatives to logging and poaching, two of the largest threats facing mountain gorillas *Gorilla beringei beringei,* while also raising funds to support gorilla conservation programs in Rwanda (Ellison, 2004). Recently, another certification product, 'Grauer's Gorilla Fund Coffee', was launched using coffee from 3,600 co-operative Congolese farmers and aiming to support Grauer's gorilla *Gorilla beringei graueri* conservation in the Congo. Both products are also Fairtrade certified. If succesfull, such schemes could be used as models for other product certifications, such as 'lemur-friendly' vanilla production in Madagascar or San Martin titi monkey *Callicebus oenanthe* and cocoa production in Peru.

Ellison, K. (2004) Gorillas in the coffee shop *Frontiers in Ecology and the Environment* 2.6: 336-336.

2.11. Farm more intensively and effectively in selected areas and spare more natural land

- We found no evidence for the effects of farming more intensively and effectively in selected areas to spare more natural land on primate populations.

Background

There are a variety of practices and improvements relating to nutrient and water use, disease and pest control, soil fertility, and livestock production that could each contribute to increased agricultural efficiency. Improving yield levels in already cultivated areas could help to reduce current rates of agricultural land-conversion and facilitate the protection of remaining natural habitats.

2.12. Install mechanical barriers to deter primates (e.g. fences, ditches)

- We found no evidence for the effects of installing mechanical barriers to prevent primates from entering agricultural areas and raiding crops on primate populations.

Background

Fencing is the most often used mechanical barrier to keep animals out of agricultural lands. However, fence design and materials can be very expensive and must constantly be maintained. In addition, primates quickly learn how to by-pass electric fences. Furthermore, the area on either side of the fence has to be kept clear of tall vegetation to prevent the animals using overhanging branches to move across the fence. This suggests that such fencing might be more effective for restraining larger, less agile animals such as great apes, than for baboons *Papio* spp. and guenons *Cercopithecus* spp. that are able to jump considerable distances. Walls and ditches, on the other hand are considered largely ineffective because of most primate species' agility and climbing skills (Strum 1994). Canals could be useful barriers, but they have to be deep and wide enough to deter primates from crossing. However, deep, wide canals can create a drowning risk for primates and for humans, as well as pose disease risks if water becomes stagnant, and could become ineffective if problems develop with maintaining water levels. Canals and their banks must be kept devoid of items that primates might use as tools to get across (Hockings & Humle 2009).

Hockings K. & Humle T. (2009) *Best Practice Guidelines for the Prevention and Mitigation of Conflict Between Humans and Great Apes.* Report by the IUCN/SSC Primate Specialist Group (PSG).

Strum S.C. (1994) Prospects for management of primate pests. *Revue d'Ecologie (Terre et Vie)*, 49, 295–306.

2.13. Use of natural hedges to deter primates

- We found no evidence for the effects of using natural hedges to prevent primates from entering agricultural areas and raiding crops on primate populations.

Background

Certain plants can make effective mechanical barriers due to their thorns, spines, or teeth-like leaf edges, as well as because of their bulk and density. Therefore, natural hedges can be used to keep primates out of farmland areas.

2.14. Use of unpalatable buffer crops

- We found no evidence for the effects of using unpalatable buffer crops to prevent primates from entering agricultural areas on primate populations.

Background

Crops that are unpalatable to primates can be planted as buffer crops to prevent crop raiding incidents in adjacent areas with more palatable crops. Buffer crops usually constitute plants that are high in fibre and secondary compounds such as tea, timber, or sisal (Chiyo *et al*. 2005, Hockings & Humle 2009), or chilli. However, if not managed well, the buffer crop may attract primates. The use of buffer zones in which habitat was destroyed to make them unusable for primate species and therefore deter primates from these areas is discussed under

'Destroy habitat inside buffer zones to make them unusable for primate species'.

Chiyo P.I., Cochrane E.P., Naughton L. & Basuta G.I. (2005) Temporal patterns of crop raiding by elephants: a response to changes in forage quality or crop availability? *African Journal of Ecology*, 43, 48–55.

Hockings K.J. & Humle T. (2009) *Best practice guidelines for the prevention and mitigation of conflict between humans and great apes.* Report by the IUCN/SSC Primate Specialist Group (PSG).

2.15. Change of crop (i.e. to a crop less palatable to primates)

- We found no evidence for the effects of changing the crop to a less palatable crop on primate populations.

Background

This intervention entails changing crops favoured by crop-raiding primates to those less palatable or accessible to raiders. However, switching to less susceptible subsistence crops may lead to reduced dietary diversity and food insecurity possibly affecting human communities living in/near the primate habitat (e.g. Akankwasah 2008). Additionally, changes in the range and type of food crops may reduce fertility if crops are not rotated (Mc Guinness & Taylor 2014).

Akankwasah B. (2008). *The Effect of Crop Raiding on Household Food Security in the Albertine Rift: A Case Study of Queen Elizabeth National Park, Western Uganda.* Kampala, Uganda: Ministry of Tourism, Trade and Industry.

Mc Guinness S. & Taylor D. (2014) Farmers' perceptions and actions to decrease crop raiding by forest-dwelling primates around a Rwandan forest fragment. *Human Dimensions of Wildlife*, 19, 179–190.

2.16. Plant crops favoured by primates away from primate areas

- We found no evidence for the effects of planting crops favoured by primates away from primate areas on populations.

Background

The idea behind this intervention is that crop damage by primates may be prevented if crops that are favoured by particular species are planted out of its reach, i.e. outside of its home range.

2.17. Destroy habitat within buffer zones to make them unusable for primates

- We found no evidence for the effects of destroying habitat within buffer zones to make them unusable for primate on primate populations.

Background

This intervention involves the clearing/destruction of the natural vegetation within buffer zones to render the habitat unusable to primates, thereby buffering adjacent areas of palatable crops against crop-raiding primates.

The use of unpalatable buffer crops to deter primates is discussed under 'Use of unpalatable buffer crops'.

2.18. Use nets to keep primates out of fruit trees

- A controlled, replicated, before-and-after study in Indonesia[1] found that areas where nets were used to protect crop trees, crop-raiding by orangutans was reduced.

Background

Tree nets can be used to close off tree canopy travel pathways of primates in order to protect the fruit from being eaten by the primates. Netting is cheap to install but can be labour intensive for subsistence farmers.

A controlled, replicated, before-and-after trial in 2007-2009 in an agro-forest system in Batang Serangan region, north Sumatra, Indonesia (1) found that in areas where farmers used tree nets, crop-raiding by orangutans *Pongo abelii* was reduced. In areas where farmers used no mitigation technique, the frequency of crop-raiding events did not change. Crop yield increased from 69 kg to 176 kg (61% increase) after trials on farms where farmers used tree nets (*n*=10 farms) and decreased from 64 kg to 47 kg (27% decrease) on farms where no mitigation technique was trialled (*n*=15 farms). In addition, interviews with 50 farmers (of which 50% participated in the trials) showed that attitudes towards orangutan management had changed after the study. The proportion of farmers who wanted orangutans removed from their farms decreased from 58% before the study to 28% after the study. However, all farmers stopped using nets as a mitigation technique five months after the study. Barrier nets of 5 x 5 cm^2 mesh stitching nylon rope were placed to partially or entirely cover the canopy of 14 separate jengkol *Archidendron pauciflorum* trees.

(1) Campbell-Smith G., Sembiring R. & Linkie M. (2012) Evaluating the effectiveness of human–orangutan conflict mitigation strategies in Sumatra. *Journal of Applied Ecology*, 49, 367–375.

2.19. Use GPS and/or VHF tracking devices on individuals of problem troops to provide farmers with early warning of crop raiding

- We found no evidence for the effects of tracking devices on crop-raiding primates to provide farmers with early warning of crop raiding on primate populations.

Background

Using telemetry tracking devices on primates to record the location of their movements can help to warn farmers when primates approach their fields. In addition, such data may become valuable in understanding spatial movement patterns and drivers of crop-raiding behaviour. Although GPS (Global Positioning System) devices have improved greatly over the past 10 years, the dense canopy cover characteristic of the habitat of many primate species can make it difficult to obtain accurate GPS readings. In addition, deploying telemetry devices to the primate usually involves tranquilizing the individual, which poses various health risks to, and may even result in the death of the primate. Primatologists generally oppose attaching telemetry devices to great apes, as these may alter their behaviour and because it is not ethical to use them on great apes (Lonsdorf *et al*. 2010).

Lonsdorf E.V., Ross S.R., Matsuzawa T. (2010) *The Mind of the Chimpanzee: Ecological and Experimental Perspectives.* University of Chicago Press, Chicago.

2.20. Chase primates using dogs

- We found no evidence for the effects of using dogs to chase crop raiding primates away on primate populations.

Background

As guarding is extremely time-consuming to the farmer, in some regions, farmers may employ dogs to frighten and chase crop raiders from their farm. However, some species, like chimpanzees *Pan troglodytes*, may not feel threatened by dogs, or may lose their fear of dogs over time (McLennon & Hill 2012).

The use of langurs (Colobinae) to deter rhesus macaques *Macaca mulatta* is discussed under 'Train langurs to deter rhesus macaques'.

Lonsdorf E.V., Ross S.R., Matsuzawa T. (2010) *The Mind of the Chimpanzee: Ecological and Experimental Perspectives.* University of Chicago Press, Chicago.

2.21. Train langur monkeys to deter rhesus macaques

- We found no evidence for the effects of training langurs to deter rhesus macaques on primate populations.

Background

This intervention involves training langurs (Colobinae) to deter rhesus macaques *Macaca mulatta* away from farms in an effort to prevent them from crop-raiding.

The use of dogs to chase primates from farms is discussed under 'Chase primates using dogs'.

2.22. Use loud-speakers to broadcast sounds of potential threats (e.g. barking dogs, explosions, gunshots)

- We found no evidence for the effects of using loud-speakers to broadcast sounds of potential threats to crop-raiding primates on primate populations.

Background

Farmers could use loud-speakers to play sounds that are perceived as threats by the problem primates to deter them from farms. These can be sounds of barking dogs, explosions, gunshots, vocalizations of predators, etc. However, one problem with this intervention is that primates could habituate to the 'false alarms' ultimately leading to a reduction in the long-term effectiveness of this method. This has been found to be the case with baboons *Papio anubis* (Strum 1994). A study that tested the influence of a combination of human and mechanical sounds, predator sounds, and vocalizations of other primates living in the same area, on primate activity budgets, found that play-backs of these sounds caused Cape baboons *Papio ursinus* to run more and feed less, but that there was no effect on the behaviour of vervet monkeys *Chlorocebus pygerythrus* (Richardson, 2014).

Using loud-speakers to broadcast primate alarm calls to crop-raiding primates is discussed under 'Use loud-speakers to broadcast primate alarm calls'.

Richardson M.R. (2014) Efficacy of an electronic scarecrow on 4 mammalian cropraiders in Limpopo province, South Africa. MSc thesis. Western Kentucky University.

Strum S.C. (1994) Prospects for management of primate pests. *Revue d'Ecologie (Terre et Vie)*, 49, 295–306.

2.23. Use loud-speakers to broadcast primate alarm calls

- We found no evidence for the effects of using loud-speakers to broadcast primate alarm calls to crop-raiding primates on primate populations.

Background

Farmers could use loud-speakers to play primate alarm calls to deter primates from farms. A study that tested the influence of a combination of human and mechanical sounds, predator sounds, and vocalizations of other primates living in the same area, on primate activity budgets, found that play-backs of these sounds caused Cape baboons *Papio ursinus* to run more and feed less, but that there was no effect on the behaviour of vervet monkeys *Chlorocebus pygerythrus* (Richardson, 2014).

Using loud-speakers to broadcast sounds of potential threats to crop-raiding primates is discussed under 'Use loud-speakers to broadcast sounds of potential threats (e.g. barking dogs, bird-fright explosions, gunshots)'.

Richardson M.R. (2014) Efficacy of an electronic scarecrow on 4 mammalian cropraiders in Limpopo province, South Africa. MSc thesis. Western Kentucky University.

2.24. Strategically lay out the scent of a primate predator (e.g. leopard, lion)

- We found no evidence for the effects of strategically laying out scent of predators to deter crop-raiding primates on primate populations.

Background

Predator scent, which is collected from animals in game farms, zoos and preserves and sold commercially, can be used to strategically lay out predator scent around agricultural fields in an attempt to deter primates from crop raiding. There is some evidence that these techniques can be effective against the more timid animals, but bolder crop raiders appear not to be put off (Sillero-Zubiri & Switzer 2001).

Sillero-Zubiri C. & Switzer D. (2001) *Crop Raiding Primates: Searching for Alternative, Humane Ways to Resolve Conflict with Farmers in Africa.* Report by the People and Wildlife Initiative. Wildlife Conservation Research Unit, Oxford University.

2.25. Humans chase primates using random loud noise

- One controlled, replicated, before-and-after study in Indonesia[1] found that in areas where noise deterrents were used, along with tree nets, crop raiding by orangutans was reduced.
- One study in the Democratic Republic Congo[2] found that chasing gorillas and using random noise resulted in the return of gorillas to areas close to protected forest.

Background

Farmers chase primate crop-raiding species out of fields by shouting and banging objects to make loud noises. Farmers may use a range of noise-makers, such as beating drums and tins, bells, fire crackers, and 'cracking' whips in addition to yelling and whistling.

A controlled, replicated, before-and-after trial in 2007-2009 in an agro-forest system in Batang Serangan region, north Sumatra, Indonesia (1) found that in areas where farmers used noise deterrents and tree nets, crop-raiding by orangutans *Pongo abelii* was reduced, compared to areas where no mitigation was used. Orangutan feeding time on crops was lower on farms that used noise deterrents and tree nets (69 min, n=25) than on farms that did not (81 min, n=25). In addition, interviews with 50 farmers (of which 50% participated in the trials) showed that attitudes towards orangutan management had changed after the study. The proportion of farmers who wanted orangutans removed from their farms decreased from 58% before the study to 28% after the study. Forty per cent of farmers continued to use noise deterrents as a mitigation technique five months after the study. Hand-held firecracker cannons made out of bamboo and tin filled with calcium carbide to produce noise, and hand-held bamboo drums were used on 25 farms.

A study in 1996 in subtropical montane forest and plantation mosaic in Virunga National Park, Democratic Republic of Congo (2) found that one habituated group of mountain gorillas *Gorilla beringei beringei* that were raiding corn and banana plantations 3 km from the edge of the park were chased back into the forest using random noise. The authors provided no details on the size of the gorilla group. Rangers produced noise by banging on pots and pans to move the entire gorilla group back into the forest. Guards were dressed in civilian clothing and surrounded the group. Chasing was stopped as the gorillas where within 500 m of the park to avoid association of disturbance with the forest. The International Gorilla Conservation Programme purchased large bells for future interventions.

(1) Campbell-Smith G., Sembiring R. & Linkie M. (2012) Evaluating the effectiveness of human–orangutan conflict mitigation strategies in Sumatra. Journal of Applied Ecology, 49, 367–375.

(2) Lanjouw A., Cummings G. & Miller J. (1995) Gorilla conservation problems and activities in North Kivu, Eastern Zaire. *African Primates*, 1, 44–45.

2.26. Humans chase primates using bright light

- We found no evidence for the effects of humans chasing primates using bright light to deter crop-raiding on primate populations.

Background

Farmers can use bright light to chase crop-raiding primates away from their fields during the day. The light source is usually a spinning glass prism that reflects light (e.g. Meerkat Optical Wildlife Rerouter). The rationale is that the spinning prism reflects light and that the bright lights will scare primates away.

3. Threat: Energy and Production Mining

Background

Mining is the removal of valuable minerals or other geological materials from the earth. Materials recovered by mining include base metals (e.g. iron, nickel, lead, copper, and zinc), precious metals (e.g. gold, silver, and platinum), uranium, coal, diamonds, limestone, oil shale, rock salt, and potash. Mining in a wider sense comprises extraction of any non-renewable resource (e.g. petroleum, natural gas, or even water). Surface mining tends to involve stripping surface vegetation, soil, and, if necessary, layers of bedrock in order to reach buried ore deposits. Sub-surface mining consists of digging tunnels or shafts into the earth to reach buried ore deposits (A.P.E.S. undated). Mining can negatively affect primate populations directly through habitat loss/fragmentation/degradation, water, air and noise pollution, and increased vehicle traffic and associated collisions. It can also impact primates indirectly, where more roads and people result in increased hunting pressure, disease and disturbance. These roads, together with extractive industrie activities, can result in extensive uncontrolled immigration 'boom towns' without sufficient local food supply. Hunting and poaching follow to meet an increased demand for bushmeat (e.g. Wilkie *et al*. 2000) and this can include primates.

A.P.E.S. Portal (Undated) *Threats: Mineral Resource Extraction.* Available at http://apesportal.eva.mpg.de/status/topic/threats/direct/mining. Accessed 21 March 2017

Wilkie D., Shaw E., Rotberg F., Morelli G. & Auzel P. (2000) Roads, development, and conservation in the Congo Basin. *Conservation Biology*, 14, 1614–1622.

Key messages

Minimize ground vibrations caused by open cast mining activities

We captured no evidence for the effects of minimizing ground vibrations caused by open cast mining activities on primate populations.

Establish no-mining zones in/near watersheds so as to preserve water levels and water quality

We captured no evidence for the effects of establishing no-mining zones in/near watersheds so as to preserve water levels and water quality on primate populations.

Use 'set-aside' areas of natural habitat for primate protection within mining area

We captured no evidence for the effects of using 'set-aside' areas of natural habitat for primate protection within mining areas on primate populations.

Certify mines and market their products as 'primate friendly' (e.g. ape-friendly cellular phones)

We captured no evidence for the effects of certifying mines and marketing their products as 'primate friendly' on primate populations.

Create/preserve primate habitat on islands before dam construction

We captured no evidence for the effects of creating/preserving primate habitat on islands before dam construction on primate populations.

3.1. Minimize ground vibrations caused by open cast mining activities

- We found no evidence for the effects of minimizing ground vibrations caused by open cast mining activities on primate populations.

Background

Open cast mining is a surface mining technique of extracting rock or minerals from the earth by their removal from an open pit or borrow pit. Walls of the pit are generally blast mined, creating ground vibrations and resulting in dust generation and water, air, and noise pollution. Although we are not aware of any studies evaluating the effect of open cast mining on primates specifically, one study found that species richness was higher at the site that was more distant from the mine and that species composition and characteristics of animal calls differed between the two sites, suggesting that blasting may influence vocal communication in animals and negatively affect wildlife populations (Duarte *et al*. 2015). Minimizing ground vibrations caused by open cast mining can help to reduce pollution and lessen stress levels in resident primate populations.

Duarte M.H.L., Sousa-Lima R.S., Young R.J., Farina A., Vasconcelos M., Rodrigues M. & Pieretti N. (2015) The impact of noise from open-cast mining on Atlantic forest biophony. *Biological Conservation*, 191, 623–631.

3.2. Establish no-mining zones in/near watersheds so as to preserve water levels and water quality

- We found no evidence for the effects of establishing no-mining zones in/near watersheds so as to preserve water levels and water quality on primate populations.

Background

Watersheds in mining zones affected by active and/or abandoned hard rock mining may act as sources of metals contamination and acid mine drainage. This is because in order to cluster the mineral extractions, chemicals such as cyanide and mercury are used and are often discharged, intentionally or not, into nearby rivers and streams (A.P.E.S. undated). Establishing no mining zones in/near watersheds may help to prevent water pollution and thus help maintain primate populations.

A.P.E.S. Portal (Undated) *Threats: Mineral Resource Extraction.* Available at http://apesportal.eva.mpg.de/status/topic/threats/direct/mining. Accessed 21 March 2017

3.3. Use 'set-aside' areas of natural habitat for primate protection within mining area

- We found no evidence for the effects of using 'set-aside' areas of natural habitat for primate protection within mining areas on primate populations.

Background

Mining firms may establish 'no-go areas' within their concession where no mining activities will take place and which primates can use as refuges.

3.4. Certify mines and market their products as 'primate friendly' (e.g. ape-friendly cellular phones)

- We found no evidence for the effects of certifying mines and marketing their products as 'primate friendly' on primate populations.

Background

Several different certifications already exist that do not relate to primates or their habitats. For example, 'FAIRTRADE' certification makes certain that the producers who take part in the initiative are not being exploited by buyers in developed countries and the 'European Organic Certification' ensures that organic products are produced following strict EU rules. This intervention aims to certify mining companies that adhere to strict environmental regulations to minimize/mitigate/compensate for their impact on resident primate populations and market their products as 'primate friendly' and sell them at a premium.

3.5. Create/preserve primate habitat on islands before dam construction

- We found no evidence for the effects of creating/preserving primate habitat on islands before dam construction on primate populations.

Background

Almost 20% of the world's electricity is being provided by dams along rivers (Harrison-Levine *et al*. 2016), which can pose a severe threat to local primate population persistence (Estrada et al. 2017). In 2004, the WWF reported that 1,600 new large dams were under construction and that a high proportion of these are in primate range countries. There are also plans for 151 new dams in the Amazon basin, of which more than 80% would drive deforestation due to new roads, transmission lines, or inundation. At least 17 of the world's remaining 64 large free-flowing rivers are in danger of being dammed by 2020, including several within primate habitat countries in South America and Southeast Asia (Harrison-Levine *et al*. 2016). To reduce/avoid the drowning of primates during flooding, this intervention makes sure that there are islands covered in primate habitat that the animals can flee to in order to survive. However, there are several problems with this approach. For example, primates that flee to such islands may encounter overcrowded habitats and increased competition with conspecifics. These individuals are unfamiliar with the new habitat, resulting in difficulties to find food, water, shelter, and mates, and they may be at a higher risk of disease and predation (Harrison-Levine *et al*. 2016).

Estrada A., Garber P.A., Rylands A.B., Roos C., Fernandez-Duque E., Di Fiore A., Nekaris K.A.-I., Nijman V., Heymann E.W., Lambert J.E., Rovero F., Barelli C., Setchell J.M., Gillespie T.R., Mittermeier R.A., Verde Arregoitia L., de Guinea M., Gouveia S., Dobrovolski R., Shanee S., Shanee N., Boyle S.A., Fuentes A., MacKinnon K.C., Amato K.R., Meyer A.L.S., Wich S., Sussman R.W., Pan R., Kone I. & Li B. (2017) Impending extinction crisis of the world's primates: why primates matter. Science Advances, 3, e1600946.

Harrison-Levine A.L., Covert H.H., Norconk M.A., dos Santos R.R., Barnett A.A. & Fearnside P.M. (2016) Dams: implications of widespread anthropic flooding for primate populations. Pages 1-14 in: A.A. Barnett, I. Matsuda & K. Nowak (eds.) *Primates in Flooded Habitats: Ecology and Conservation.* Cambridge University Press, Cambridge.

4. Threat: Transportation and Service Corridors

Background

Roads present a major threat to primate populations. Laurance *et al*. (2014) estimate that at least 25 million kilometres of new roads are anticipated by 2050 globally, which is a 60% increase in the total length of roads over that in 2010. Nine-tenths of all road construction is expected to occur in developing nations, including many regions that harbour important primate populations. Roads threaten primate populations, because they facilitate access for people to previously inaccessible areas that may have acted as wildlife refuges, and because the building of roads often goes hand-in-hand with an influx of people into these areas. Increased human densities equate to increased protein demands, which in turn may result in increased poaching intensity. Roads have been shown to have a detrimental effect on rainforest mammals in Africa (e.g. Lahm *et al*. 1998, Laurance *et al*. 2006, Yackulic *et al*. 2011). Roads also promote habitat loss, fragmentation, and wildfires, which further impact primate populations. Furthermore, road-kills may have a profound effect on some populations. For example, road-kills along a 14 km paved road segment through Morro do Diabo State Park in Brazil have been responsible for an annual population loss of 8–20% for mid-sized to large mammals within the park, including the highly endangered black lion tamarin *Leontopithecus chrysopygus* (Caro *et al.* 2014). Roads may also cause physical disturbance, chemical and litter pollution, noise pollution, spread of invasive species and environmental degradation. Closing of non-essential roads as soon as logging operations are complete is discussed in Chapter 5.

Caro T., Dobson A., Marshall A.J. & Peres C.A. (2014) Compromise solutions between conservation and road building in the tropics. *Current Biology*, 24, 722–725.
Lahm S.A., Barnes R.F.W., Beardsley K. & Cervinka P. (1998) A method for censusing the greater white-nosed monkey in northeastern Gabon using the population density gradient in relation to roads. *Journal of Tropical Ecology*, 14, 629–645.
Laurance W.F., Croes B.M., Tchignoumba L., Lahm S., Alonso A., Lee M.E., Campbell P. & Ondzeano C. (2006) Impacts of roads and hunting on Central African rainforest mammals. *Conservation Biology*, 20, 1251–1261.
Laurance W.F., Clements G.R., Sloan S., O'Connell C.S., Mueller N.D., Goosem M., Venter O., Edwards D.P., Phalan B., Balmford A., Van Der Ree R. & Arrea I.B. (2014) A global strategy for road building. *Nature*, 513, 229–232.
Yackulic C.B., Strindberg S., Maisels F. & Blake S. (2011) The spatial structure of hunter access determines the local abundance of forest elephants (*Loxodonta africana cyclotis*). *Ecological Applications*, 21, 1296–1307.

Key messages

Install green bridges (overpasses)

We captured no evidence for the effects of installing green bridges on primate populations.

Install rope or pole (canopy) bridges to avoid primate road kills

One before-and-after study in Belize study found that howler monkey numbers increased after pole bridges were constructed over man-made gaps. Two studies in

Brazil and Madagascar found that primates used pole bridges to cross roads and pipelines.

Implement speed limits in particular areas (e.g. with high primate densities) to reduce vehicle collisions with primates

We captured no evidence for the effects of implementing speed limits in particular areas on primate populations.

Reduce road widths

We captured no evidence for the effects of reducing road widths on primate populations.

Impose fines for breaking the speed limit or colliding with primates

We captured no evidence for the effects of imposing fines for breaking the speed limit or colliding with primates on primate populations.

Avoid building roads in key habitat or migration routes

We captured no evidence for the effects of avoiding building roads in key habitat or migration routes on primate populations.

Implement a minimum number of roads (& minimize secondary roads) needed to reach mining extraction sites

We captured no evidence for the effects of implementing the minimum number of roads needed to reach mining extraction sites on primate populations.

Re-use old roads rather than building new roads

We captured no evidence for the effects of re-using old roads rather than building new roads on primate populations.

Re-route vehicles around protected areas

We captured no evidence for the effects of re-routing vehicles containing invasive species around protected areas on primate populations.

Install speed bumps to reduce vehicle collisions with primate

We captured no evidence for the effects of installing speed bumps to reduce primate collisions on primate populations.

Provide adequate signage of presence of primates on or near roads

We captured no evidence for the effects of providing adequate signage of the presence of primates on or near roads on primate populations.

4.1. Install green bridges (overpasses)

- We found no evidence for the effects of installing green bridges on primate populations.

Background

Green bridges are bridges that have natural vegetation growing on them and that are usually not accessible to humans. These bridges try to combat habitat fragmentation by allowing animals to safely cross human-made barriers (e.g. roads or rail tracks), thus re-connecting previously continuous habitats. In addition, they also help reduce collisions between vehicles and wildlife. Green bridges could be used by terrestrial or semi-terrestrial primates, such as chimpanzees *Pan troglodytes*, baboons *Papio* spp. and sooty mangabeys *Cercocebus atys*.

The use of canopy bridges to re-connect primate habitat and avoid primate road kills is discussed under 'Install rope or pole (canopy) bridges to avoid primate road kills'.

4.2. Install rope or pole (canopy) bridges

- One study in Brazil[1] found that black lion tamarins and capuchins used a pole bridge to cross a road.
- One before-and-after study in Belize[2] found that a black howler monkey population increased after the construction of pole bridges over man-made gaps.
- One before-and-after study in Madagascar[3] found that all six monitored lemur species used bridges to cross roads and pipelines.

Background

Rope and pole bridges, or so-called 'canopy bridges', allow safe crossing of human-made barriers (e.g. roads) by arboreal primates that spend most of their time in the forest canopy.

The use of green bridges (overpasses) to re-connect primate habitat and avoid primate road kills is discussed under 'Install green bridges (overpasses)'.

Teixeira F.Z., Printes R.C., Fagundes J.C.G., Alonso A.C. & Kindel A. (2013) Canopy bridges as road overpasses for wildlife in urban fragmented landscapes. *Biota Neotropica*, 13, 117–123.

A study in 1991-1994 in an Atlantic coastal forest in São Paulo State, Brazil (1) found that black lion tamarins *Leontopithecus chrysopygus* and tufted capuchins *Cebus apella* used a pole bridge to cross a service road on at least 40 occasions over 3.5 years. From the installation of the bridge in 1991 to the end of 1994, two groups of black lion tamarins and one large group of capuchins were recorded using the bridge on at least 40 occasions. The authors suggested that the groups may have used the bridge regularly, possibly daily. The bridge was installed exactly where black lion tamarins had been observed crossing the road during a long-term primate study that was conducted in the area before. The bridge was 8 m wide and 6 m high and connected naturally forested habitat on both sides of the road.

A before-and-after trial in 1985-1998 in secondary riparian forest in the Community Baboon Sanctuary, Belize (2) found black howler monkey *Alouatta pigra* numbers increased by 138% over 13 years after the construction of pole bridges over man-made gaps, alongside ten other interventions. The population increased from 840 to more than 2,000 individuals (138% increase). No statistical tests were carried out to determine whether this difference was significant. Additional interventions included the protection of the sanctuary by the communities surrounding it, preserving forest buffer strips along property boundaries, preserving a forest corridor along the river, preserving important howler monkey food trees in large clearings, involving local communities in the management of the sanctuary, creating a museum for education purposes, implementing an eco-tourism and research programme, presence of permanent staff, and monetary (income from employment, tourism and craft industries) benefits to local communities for sustainably managing their forest and its wildlife communities. The study does not distinguish between the effects of the different interventions mentioned above.

A before-and-after trial in 2009-2010 at the Ambatovy mine in humid forest in Toamasina, Madagascar (3) found that all six lemur species (Lemuroidea) monitored used canopy bridges to cross roads and pipelines around the mining area. Observed road crossings on the ground decreased from 69 during two weeks before bridge construction to six crossings during the 1.5 years after construction. Furthermore, bridges were used 63 times during the first 1.5 years. Lemurs preferred to use the mine area bridge, which the authors assumed was due to the shorter distance needed to be crossed without the shelter of the canopy. Three bridges (8–15 m in length) in the mine area and four (22-25 m in length) along the pipelines were constructed from January to February 2009. Lemur (eastern woolly lemur *Avahi laniger*, greater dwarf lemur *Cheirogaleus major*, grey bamboo lemur *Hapalemur griseus*, diademed sifaka *Propithecus diadema*, brown lemur *Eulemur fulvus*, red-bellied lemur *Eulemur rubriventer*) use of bridges was monitored 10 hours/day during four to six days/week from March 2009 until August 2010. Prior to bridge construction, mine area roads and pipelines were monitored for 14 days to detect potential crossing points.

(1) Valladarez-Padua C., Cullen L. Jr. & Padua S. (1995) A pole bridge to avoid primate road kills. *Neotropical Primates*, 3, 13–15.
(2) Horwich R.H. & J. Lyon (1998) Community-based development as a conservation tool: The Community Baboon Sanctuary and the Gales Point, Manatee project. Pages 343-363 in: R.B. Primack, D. Bray, H.A. Galletti & I. Ponciano (eds.) *Timber, Tourists and Temples. Conservation and Development in the Maya Forest of Belize, Guatemala and Mexico*. Island Press, Covelo.
(3) Mass V., Rakotomanga B., Rakotondratsimba G., Razafindramisa A., Andrianaivomahefa P., Dickinson S., Berner P.O. & Cooke A. (2011) Lemur bridges provide crossing structures over roads within a forested mining concession near Moramanga, Toasmasina province, Madagascar. *Conservation Evidence*, 8, 11–18.

4.3. Implement speed limits in particular areas (e.g. with high primate densities) to reduce vehicle collisions with primates

- We found no evidence for the effects of implementing speed limits in particular areas to reduce vehicle collisions with primates on primate populations.

Background

Speed limits in areas with high traffic and high primate densities may help to prevent vehicle collisions with primates and also reduce stress levels in primates. Furthermore, primates may be able to cross roads more easily in areas where speed limits are enforced compared to areas with no traffic regulations. However, a study investigating the barrier effect of roads on the bank vole *Myodes glareolus*, yellow-necked mouse *Apodemus flavicollis* and common shrew *Sorex araneus* found that traffic intensity did not affect crossing rates in any of these species (Rico *et al*. 2007).

Imposing fines for breaking the speed limit or for colliding with primates is discussed under 'Impose fines for breaking the speed limit or colliding with primates'.

Rico A., Kindlmann P. & Sedlácek F. (2007) Barrier effects of roads on movements of small mammals. *Folia Zoologica*, 56, 1-12.

4.4. Reduce road widths

- We found no evidence for the effects of reducing road widths on primate populations.

Background

It is likely that narrower roads are safer for primates to cross without injury compared to wider roads that they have to spend more time on. A study investigating the barrier effect of roads on the bank vole *Clethrionomys glareolus*, yellow-necked mouse *Apodemus flavicollis* and common shrew *Sorex araneus* found that species crossed narrow roads more often than wide roads (Rico *et al*. 2007). Therefore, reducing road width may help preserve habitat connectivity and prevent or reduce primate-vehicle collisions.

Rico A., Kindlmann P. & Sedlácek F. (2007) Barrier effects of roads on movements of small mammals. *Folia Zoologica*, 56, 1-12.

4.5. Impose fines for breaking the speed limit or colliding with primates

- We found no evidence for the effects of imposing fines for breaking the speed limit or colliding with primates on primate populations.

Background

Speed limits in areas with high traffic and high primate densities may help prevent vehicle collisions with primates and also to reduce stress levels in primates. Furthermore, primates may be able to cross roads more easily in areas where speed limits are enforced compared to areas with no traffic regulations. To effectively enforce existing speed limits it can help if fines are imposed for breaking the speed limit and/or for colliding with primates.

Implementing and enforcing speed limits is discussed under 'Implement speed limits in particular areas (e.g. with high primate densities) to reduce vehicle collisions with primates'.

4.6. Avoid building roads in key habitat or migration routes

- We found no evidence for the effects of avoiding building roads in key habitat or migration routes on primate populations.

Background

Not building transportation or service corridors within key primate habitat and/or migration routes helps to preserve habitat connectivity and promote primate conservation.

4.7. Implement a minimum number of roads (& minimize secondary roads) needed to reach mining extraction sites

- We found no evidence for the effects of implementing a minimum number of roads needed to reach mining sites on primate populations.

Background

The aim of this intervention is to ensure that mining operators keep the number of newly built primary and secondary roads at a minimum in order to limit negative road effects on biodiversity. This will involve careful planning prior to implementation. For this to be achieved, it is important that infrastructure engineers and natural resource managers work together to consider distributions of endangered plants and animals and their key spatial resources, habitat use during events such as wildlife migrations, as well as the economic viability when planning a new road network in an environmentally sensitive area (Caro *et al*. 2014).

Re-using existing roads instead of building new roads is discussed under 'Re-use old roads rather than building new roads'.

Caro T., Dobson A., Marshall A.J. & Pere C.A. (2014) Compromise solutions between conservation and road building in the tropics. *Current Biology*, 24, 722–725.

4.8. Re-use old roads rather than building new roads

- We found no evidence for the effects of re-using old roads rather than building new roads on primate populations.

Background

Where old roads already exist in an area where development is going to take place, it is likely to be less detrimental for biodiversity if existing roads are re-used (and repaired where necessary) instead of building new roads. This will help to ensure that negative impact of roads (and their construction) on primates and/or their habitat is kept at a minimum.

Building only the minimum number of roads that is necessary to reach sites and minimizing the construction of secondary roads is discussed under 'Implement a minimum number of roads (& minimize secondary roads) needed to reach mining sites'.

4.9. Re-route vehicles around protected areas

- We found no evidence for the effects of re-routing vehicles containing invasive species around protected areas on primate populations.

Background

Many national parks and other protected areas are intersected by roads, especially in the developed world, and more recently, in tropical nations. For example, in Indonesia, the government is planning large, paved roads through Gunung Leuser Ecosystem and Kerinci Seblat, the two most important national parks for Sumatran tiger conservation (Bass *et al*. 2010). Apart from heavy vehicle traffic and the threats associated with that, vehicles that transport goods from around protected areas (e.g. charcoal and other natural resources collected outside and inside the protected area) to cities pose an exceptional threat to primates and their habitats. First, they increase the probability of successful alien plant invasions into pristine areas (Caro *et al*. 2014). Secondly, heavy vehicles like trucks have different stopping characteristics from passenger cars and so collisions between trucks and wildlife may be particularly severe. For example, trucks may require 50% more distance to stop than passenger cars (Zimmermann 2009). This intervention involves re-routing trucks around protected areas and/or high primate density areas to prevent the spread of invasive species into natural primate habitat and to reduce primate-vehicle collisions.

Bass M.S., Finer M., Jenkins C.N., Kreft H., Cisneros-Heredia D.F., McCracken S.F., Pitman N.C.A., English P.H., Swing K., Villa G., Di Fiore A., Voigt C.C. & Kunz T.C. (2010) Global conservation significance of Ecuador's Yasuní National Park. *PLoS ONE*, 5, e8767. doi:10.1371/journal.pone.0008767.

Caro T., Dobson A., Marshall A.J. & Peres C.A. (2014) Compromise solutions between conservation and road building in the tropics. *Current Biology*, 24, 722–725.

Zimmermann K. (2009) Additional dilemma zone protection for trucks at high-speed signalized intersections. *Transportation Research Record*, 2009, 82–88.

4.10. Install speed bumps to reduce vehicle collisions with primates

- We found no evidence for the effects of installing speed bumps to reduce vehicle collisions with primates on primate populations.

Background

Speed limits in areas with high traffic and high primate densities may help to avoid vehicle collisions with primates and reduce stress levels in primates. Furthermore, primates may be able to cross roads more easily in areas where speed limits are enforced compared to areas with no traffic regulations. While the enforcement of speed limits by traffic police may not be feasible in protected areas, the implementation of speed bumps may effectively reduce vehicle speed in these areas. For example, speed bumps were found to be effective at reducing vehicle speeds on Ghanaian roads (Afukaar 2003).

Implementing and enforcing speed limits is discussed under 'Implement speed limits in particular areas (e.g. with high primate densities) to reduce vehicle collisions with primates' and imposing fines for breaking the speed limit or for colliding with primates is discussed under 'Impose fines for breaking the speed limit or colliding with primates'.

Afukaar F.K. (2003) Speed control in developing countries: issues, challenges and opportunities in reducing road traffic injuries. *Injury Control and Safety Promotion*, 10, 77–81.

4.11. Provide adequate signage of presence of primates on or near roads

- We found no evidence for the effects of providing adequate signage of presence of primates on or near roads on primate populations.

Background

Providing adequate signage of the presence of primates on or near the road may motivate drivers to reduce their speed and be alert for possible primate road crossings, thus reducing collisions. However, signs indicating primate presence may cause an increase in primate mortality if they motivate people to illegally hunt primates in the area.

5. Threat: Biological Resource Use

Background

Biological resource use (as defined in this synopsis) includes the killing of primates for food and medicinal purposes, as well as logging and wood harvesting. While hunting has a direct effect on primate survival, logging and wood harvesting indirectly threaten primates through habitat destruction and fragmentation, increased human densities and a consequent increase in hunting intensity and risk of contracting human diseases. Bushmeat consumption, which refers to the consumption of wild animal meat including primates, is widespread throughout tropical regions and common in both rural and urban areas (Davies 2002). In rural areas, bushmeat is often an essential source of animal protein that may contribute to food security. In contrast, urban consumers are likely to choose bushmeat from a number of interchangeable animal protein sources, because of its low cost, preference of taste, or perception of prestige (Nasi *et al*. 2011).

Logging occurs for many economic reasons, including agriculture, cattle-ranching, mining, oil and gas extraction, development, and subsistence-farming. Wood harvesting involves the logging of timber tree species that are sold and used to make homes, furniture, paper, wood-chips for packaging products, fuel for cooking and providing heat for homes, etc.

Studies on interventions relating to the use of natural minerals are discussed in chapter 3 'Threat: Energy and Production Mining'.

Davies G. (2002) Bushmeat and international development. *Conservation Biology*. 16, 587–589.

Nasi R., Taber A. & Van Vliet N. (2011) Empty forests, empty stomachs? Bushmeat and livelihoods in the Congo and Amazon Basins. *International Forestry Review*. 13, 355–368.

Key messages - hunting

Implement no-hunting seasons for primates

We captured no evidence for the effects of implementing no-hunting seasons for primates on primate populations.

Implement sustainable harvesting of primates (e.g. with permits, resource access agreements)

We captured no evidence for implementing the sustainable harvesting of primates on primate populations.

Encourage use of traditional hunting methods rather than using guns

We captured no evidence for the effects of encouraging the use of traditional hunting methods rather than using guns on primate populations.

Implement road blocks to inspect cars for illegal primate bushmeat

We captured no evidence for the effects of implementing road blocks to inspect cars for illegal primate bushmeat on primate populations.

Provide medicine to local communities to control killing of primates for medicinal purposes

We captured no evidence for the effects of providing medicine to local communities to control the killing of primates for medicinal purposes on primate populations.

Conduct regular anti-poaching patrols

Two of three studies found that gorilla populations increased after regular anti-poaching patrols were conducted, alongside other interventions. One study in Ghana found a decline in gorilla populations. One review on gorillas in Uganda found that no gorillas were killed after an increase in anti-poaching patrols.

Introduce ammunition tax

We captured no evidence for the effects of introducing ammunition tax on primate populations.

Inspect bushmeat markets for illegal primate species

We captured no evidence for the effects of inspecting bushmeat markets for illegal primate species on primate populations.

Regularly de-activate/remove ground snares

One of two studies found that the number of gorillas increased in an area patrolled for removing snares, alongside other interventions. One study in the Democratic Republic of Congo, Rwanda, and Uganda found that gorilla populations declined despite snare removal.

Provide better equipment (e.g. guns) to anti-poaching ranger patrols

Two studies in the Democratic Republic of Congo and Rwanda found that gorilla populations increased after providing anti-poaching guards with better equipment, alongside other interventions. One study in Uganda found that no gorillas were killed after providing game guards with better equipment.

Provide training to anti-poaching ranger patrols

Two before-and-after studies in Rwanda and India found that primate populations increased in areas where anti-poaching staff received training, alongside other interventions. Two studies in Uganda and India found that no poaching occurred following training of anti-poaching rangers, alongside other interventions.

Implement local no-hunting community policies/traditional hunting ban

Four studies, one of which had multiple interventions, in the Democratic Republic of Congo, Belize, Cameroon and Nigeria found that primate populations increased in areas where there were bans on hunting or where hunting was reduced due to local taboos. One study found that very few primates were killed in a sacred site in China where it is forbidden to kill wildlife.

Strengthen/support/re-install traditions/taboos that forbid the killing of primates

One site comparison study in Laos found that Laotian black crested gibbons occurred at higher densities in areas where they were protected by a local hunting taboo compared to sites were there was no taboo.

Inform hunters of the dangers (e.g., disease transmission) of wild primate meat

We captured no evidence for the effects of informing hunters of the dangers of consuming wild primate meat on primate populations.

Implement monitoring surveillance strategies (e.g. SMART) or use monitoring data to improve effectiveness of wildlife law enforcement patrols

One before-and-after study in Nigeria found that more gorillas and chimpanzees were observed after the implementation of law enforcement and a monitoring system.

Implement community control of patrolling, banning hunting and removing snares

One site comparison study found that there were more gorillas and chimpanzees in an area managed by a community conservation organisation than in areas not managed by local communities.

Key messages - substitution

Provide sustainable alternative livelihoods; establish fish- or domestic meat farms

We captured no evidence for the effects of providing sustainable alternative livelihoods; establishing fish- or domestic meat farms on primate populations.

Employ hunters in the conservation sector to reduce their impact

We captured no evidence for the effects of employing hunters in the conservation sector to reduce their impact on primate populations.

Key messages - logging and wood harvesting

Use selective logging instead of clear-cutting

One of two site comparison studies in Africa found that primate abundance was higher in forests that had been logged at low intensity compared to forest logged at high intensity. One study in Uganda found that primate abundances were similar in lightly and heavily logged forests. One study in Madagascar found that the number of lemurs increased following selective logging.

Use patch retention harvesting instead of clear-cutting

We captured no evidence for the effects of using patch retention harvesting instead of clear-cutting on primate populations.

Implement small and dispersed logging compartments

We captured no evidence for the effects of implementing small and dispersed logging compartments on primate populations.

Use shelter wood cutting instead of clear-cutting

We captured no evidence for the effects of using shelter wood cutting instead of clear-cutting on primate populations.

Leave hollow trees in areas of selective logging for sleeping sites

We captured no evidence for the effects of leaving hollow trees in areas of selective logging for sleeping sites on primate populations.

Clear open patches in the forest

We captured no evidence for the effects of clearing open patches in the forest on primate populations.

Thin trees within forests

We captured no evidence for the effects of thinning trees within forests on primate populations.

Coppice trees

We captured no evidence for the effects of coppicing trees on primate populations.

Manually control or remove secondary mid-storey and ground-level vegetation

We captured no evidence for the effects of manually controlling or removing secondary mid-storey and ground-level vegetation on primate populations.

Avoid slashing climbers/lianas, trees housing them, hemi-epiphytic figs, and ground vegetation

We captured no evidence for the effects of avoiding slashing climbers/lianas, trees housing them, hemi-epiphytic figs, and ground vegetation on primate populations.

Avoid/minimize logging of important food tree species for primates

One before-and-after study in Belize found that black howler monkey numbers increased over a 13 year period after trees important for food for the species were preserved, alongside other interventions.

Incorporate forested corridors or buffers into logged areas

We captured no evidence for the effects of incorporating forested corridors or buffers into logged areas on primate populations.

Close non-essential roads as soon as logging operations are complete

We captured no evidence for the effects of closing non-essential roads as soon as logging operations are complete on primate populations.

Use 'set-asides' for primate protection within logging area

We captured no evidence for the effects of using primate 'set-asides' within logging areas on primate populations.

Work inward from barriers or boundaries (e.g. river) to avoid pushing primates toward an impassable barrier or inhospitable habitat

We captured no evidence for the effects of working inward from barriers or boundaries to avoid pushing primates toward an impassable barrier or inhospitable habitat on primate populations.

Reduce the size of forestry teams to include employees only (not family members)

We captured no evidence for the effects of reducing the size of forestry teams to include employees only and not family members on primate populations.

Certify forest concessions and market their products as 'primate friendly'

We captured no evidence for the effects of certifying forest concessions and marketing their products as 'primate friendly' on primate populations.

Provide domestic meat to workers of the logging company to reduce hunting

We captured no evidence for the effects of providing domestic meat to workers of the logging company to reduce hunting on primate populations.

Hunting

5.1. Implement no-hunting seasons for primates

- We found no evidence for the effects of implementing no-hunting seasons for primates on primate populations.

Background

This intervention ensures that there are times during the year where it is illegal to kill particular species. This time period can vary from weeks, to months or even years, depending on the species, geography, and local customs. The closed season is usually timed to prevent hunting during times of peak reproductive activity, temperature extremes, low population levels and food shortage.

5.2. Implement sustainable harvesting of primates (e.g. with permits, resource access agreements)

- We found no evidence for the effects of implementing sustainable harvesting of primates on primate populations.

Background

This intervention controls primate off-take rates so that the number of individuals that are killed does not exceed the number of individuals that are born to ensure that people can continue to benefit from the resource and that the population survives in the long-term. To do this, respective authorities typically give out a fixed number of hunting permits, beyond which no further hunting is allowed. Obtaining permission to harvest primates may, or may not involve paying money, depending on the type of agreement between the hunter and the wildlife authority.

5.3. Encourage use of traditional hunting methods rather than using guns

- We found no evidence for the effects of encouraging the use of traditional hunting methods rather than using guns on primate populations.

Background

This intervention is based on the assumption that when indigenous people hunt with modern weapons (e.g. shotguns), their harvest is larger than when they hunt with traditional hunting gear (e.g. bow and arrow, blow-gun, spear). This has been shown for example for indigenous forest dwelling people in the Amazon (Alvard 1995) and in tropical rainforests of south-eastern Peru (Mena *et al*. 1999). Similarily, a ban on firearms after 1974 on Bioko Island, Equatorial Guinea, meant that by 1986 primates appeared to have increased in abundance and were recolonising some areas despite ongoing hunting for bushmeat using traps (Butynski & Koster, 1994). Based on this assumption the argument is that encouraging indigenous people to use traditional hunting methods rather than modern firearms will ultimately lead to a reduction in off-take rates and therefore more sustainable hunting practices.

Alvard M. (1995) Shotguns and sustainable hunting in the Neotropics. *Oryx*, 29, 58–66.
Butynski, T. M., & Koster, S. H. (1994). Distribution and conservation status of primates in Bioko Island, Equatorial Guinea. *Biodiversity and Conservation*, *3*, 893-909.
Mena P., Stallings J.R., Regalado J. & Cueva R. (1999) The sustainability of current practices by the Huaorani. Pages 57-78 in J.G. Robinson & E.L. Bennett (eds.) *Hunting for Sustainability in Tropical Forest*, Columbia University Press, New York.

5.4. Implement road blocks to inspect cars for illegal primate bushmeat

- We found no evidence for the effects of implementing road blocks to inspect cars for illegal primate bushmeat on primate populations.

Background

To control the illegal trade in primates, road blocks can be installed on main transport routes used by traders to bring bushmeat and live animals from their natural habitats to urban areas for sale or to hubs of international transport. Law enforcement officers posted at these roadblocks typically inspect cars that pass through, confiscate bushmeat of species that are legally protected and punish these traders (e.g. officially warn them, fine them, arrest them). One correlative study (Stokes *et al*. 2010) showed that Forestry Management Units (selective logging occurs), in which installing road blocks formed part of several conservation management strategies implemented at these sites, had higher densities for both gorillas and chimpanzees, when compared to a logging concession where no conservation management activities were in place.

Stokes E.J., Strindberg S., Bakabana P.C., Elkan P.W., Iyenguet F.C., Madzoke B., Malanda G.A.F., Mowawa B.S., Moukoumbou C., Ouakabadio F.K. & Rainey H.J. (2010) Monitoring great ape and elephant abundance at large spatial scales: measuring effectiveness of a conservation landscape. *PLoS ONE*, 5, e10294.

5.5. Provide medicine to local communities to control killing of primates for medicinal purposes

- We found no evidence for the effects of providing medicine to local communities to control the killing of primates for medicinal purposes on primate populations.

Background

A review of primates in traditional folk medicine (Alves *et al.* 2010) found that at least 101 species of primates, belonging to 38 genera and 10 families, were used in traditional folk practices and in magic–religious rituals throughout the world. By providing medicine to local communities, it is hoped that fewer/no more primates will be killed for medicinal purposes.

Alves R.R.N., Souto W.M.S., Barboza R.R.D. (2010) Primates in traditional folk medicine: a world overview. *Mammal Review*. 40, 155–180.

5.6. Conduct regular anti-poaching patrols

- Two studies in Rwanda[1, 3] found that gorilla populations increased after implementing regular anti-poaching patrols, alongside other interventions. One study in the Democratic Republic of Congo, Rwanda, and Uganda[4] found that gorilla populations declined after conducting regular anti-poaching patrols.
- A review on gorillas in Uganda found that no gorillas were killed over a 21 month period when the number of guards carrying out anti-poaching patrols increased, alongside other interventions.
- One study in Ghana[5] found a reduction in illegal primate hunting activities following conducting regular anti-poaching patrols, alongside other interventions.

Background

Anti-poaching patrols typically consist of a team of people that regularly patrol a pre-defined area to stop or reduce hunting. During patrols, teams may record spatial data on hunting or poaching activities and primate occurrence. Some teams may also capture and arrest illegal hunters on site, seize bushmeat, and destroy hunting camps. Correlative studies have shown that in areas where anti-poaching patrols were conducted, primate densities were higher (Stokes *et al*. 2010) and at sites where law enforcement guards were present, the probability that gorilla *Gorilla* spp. and chimpanzee *Pan troglodytes* populations would persist in the long-term, was higher (Tranquilli *et al*. 2012). However, while anti-poaching patrols reduced illegal hunting in Garamba National Park, Democratic Republic of Congo, including of primate species, they were inadequate to cope with higher levels of poaching pressure during armed conflict (De Merode *et al.* 2007). Removing of snares by teams that may form part of anti-poaching patrols is discussed separately under 'Regularly de-activate/remove ground snares', and the training of-, and the providing of equipment to anti-poaching patrols is discussed under 'Provide training to anti-poaching ranger patrols', and 'Provide better equipment (e.g. guns) to anti-poaching ranger patrols'. The use of monitoring surveillance strategies and/or monitoring data to improve effectiveness of wildlife law enforcement patrols is discussed under 'Implement monitoring surveillance strategies (e.g. SMART) or use monitoring data to improve effectiveness of wildlife law enforcement patrols'.

De Merode, E., Smith, K. H., Homewood, K., Pettifor, R., Rowcliffe, M., & Cowlishaw, G. (2007). The impact of armed conflict on protected-area efficacy in Central Africa. *Biology letters*, *3*(3), 299-301.

Stokes E.J., Strindberg S., Bakabana P.C., Elkan P.W., Iyenguet F.C., Madzoke B., Malanda G.A.F., Mowawa B.S., Moukoumbou C., Ouakabadio F.K. & Rainey H.J. (2010) Monitoring great ape and elephant abundance at large spatial scales: measuring effectiveness of a conservation landscape. *PLoS ONE*, 5, e10294.

Tranquilli S., Abedi-Lartey M., Amsini F., Arranz L., Asamoah A., Babafemi O., Barakabuye N., Campbell G., Chancellor R., Davenport T.R.B., Dunn A., Dupain J., Ellis C., Etoga G., Furuichi T., Gatti S., Ghiurghi A., Greengrass E., Hashimoto C., Hart J., Herbinger I., Hicks T.C., Holbech L.H., Huijbregts B., Imong I., Kumpel N., Maisels F., Marshall P., Nixon S., Normand E., Nziguyimpa L., Nzooh-Dogmo Z., Okon D.T., Plumptre A., Rundus A., Sunderland-Groves J., Todd A., Warren Y., Mundry R., Boesch C. & Kuehl H. (2012) Lack of conservation effort rapidly increases African great ape extinction risk. *Conservation Letters*, 5, 48–55.

A before-and-after trial in 1984-1987 in tropical montane forest in the Virunga ecosystem in Rwanda and the Democratic Republic of Congo (1) found that mountain gorillas *Gorilla beringei beringei* that were protected by regular anti-poaching patrols along with other interventions, increased from 242 to 279 (15% increase) individuals in 1981-1986. Average group size increased from 8.5 to 9.2 individuals (17% increase) and proportion immatures increased from 39.7 to 48.1 individuals (8% increase) over the same period. Regular total counts of this population were conducted since 1973 by research staff. Anti-poaching guards regularly removed snares. Guards were provided with cars, radio communication equipment, uniforms, more rations and other equipment, which allowed them to increase patrol frequency and effectiveness. In 1979, a multi-organisation funded conservation project was initiated. A gorilla viewing tourism programme started in 1985, during which three gorilla groups were habituated for tourist viewing. The study does not distinguish between the effects of the different interventions mentioned above.

A review on the status of mountain gorillas *Gorilla beringei beringei* in 1972-1989 in tropical montane forest in Eastern Virungas Conservation Area, Uganda (2) found that no gorillas were killed in 1989-1990 when the game guard force was increased from three to 13 men along with other interventions. Game guards were also provided with better equipment, and trained and supervised by researchers, who started working in the area in 1989 when a permanent research project was established. Human settlers were relocated from an area (3 km^2) that represented the most important gorilla habitat within the Gorilla Game Reserve, within the Eastern Virungas Conservation Area. The study does not distinguish between the effects of the different interventions mentioned above.

A before-and-after trial and site comparison in 1976-1988 in tropical forest in Volcanoes National Park, Rwanda (3) found that the number of immature mountain gorillas *Gorilla beringei beringei* on the Rwandan side of the park increased and snares decreased after the implementation of regular anti-poaching patrols along with other interventions. Two years after the implementation of regular anti-poaching patrols, 30% of sampled quadrats on the Rwandan side of the park contained snares, compared to 70% of the sampled quadrats on the Ugandan and Congolese side. Numbers of immature individuals increased by 22% in Rwanda, but declined by 30% in the other two countries. No statistical tests were carried out to determine whether these differences were significant. Patrols were initiated in 1979, however, the study did not report on further details relating to the methods used to implement the anti-poaching patrols. Funds provided by the income of a tourist programme enabled the training, equipping and management of the anti-poaching patrols. In 1976, all cattle were removed from the park in Rwanda. A conservation education programme was also implemented, but no further details were reported. The study does not distinguish between the effects of the different interventions mentioned above.

A before-and-after study in 1967-2008 in tropical montane forest in Volcanoes-, Mgahinga-, and Virunga National Parks located in Rwanda, Uganda, and the Democratic Republic of Congo, respectively (4), found that despite regular anti-poaching patrols along with other interventions, the mountain gorilla *Gorilla beringei beringei* population decreased over time. Annual population decline was 0.7%, resulting in an overall population decrease of 28.7% over the entire study period. No statistical tests were carried out to determine whether this decrease was significant. Anti-poaching patrols were carried out throughout the entire study area. Rangers mostly used established trails, but made their own trails if signs of poaching were observed and followed these signs until they located the illegal activity. Patrol teams also regularly removed snares and herded live-stock out of the park. Additional interventions included local conservation education and community development projects. The study does not distinguish between the effects of the different interventions mentioned above.

A before-and-after trial in 2007-2009 in tropical forest in Kakum Conservation Area, Ghana (5) found that regular anti-poaching patrols along with other interventions, led to a decrease in illegal hunting activities for six primate species (bush baby *Galagoides demidoff*, Bossmann potto *Perodicticus potto*, Lowe's monkey *Cercopithecus campbelli lowei*, spot-nose monkey *Cercopithecus petaurista petaurista*, olive colobus *Procolobus verus* and Geoffroy's pied colobus *Colobus vellerosus*). In 2008-2009, the number of illegal hunting activities and hunting attempts decreased from 1182 to 874 (26% decrease). Monitoring consisted of foot patrols with randomized movements. Monitored illegal activities included the number of poachers arrested and escaped, gunshots heard, firearms confiscated, skins confiscated, poacher's camps, animals killed, snares found, empty cartridges found and human footprints. Teams also regularly de-activated or removed ground snares. The study does not distinguish between the effects of the different interventions mentioned above.

(1) Aveling R. & Aveling C. (1987) Report from the Zaire Gorilla Conservation Project. *Primate Conservation*, 8, 162–164.
(2) Butynski T.M., Werikhe S.E. & Kalina J. (1990) Status, distribution and conservation of the mountain gorilla in the Gorilla Game Reserve, Uganda. *Primate Conservation*, 11, 31–41.
(3) Harcourt A.H. (2001) The benefits of mountain gorilla tourism. *Gorilla Journal*, 22, 36–37.
(4) Robbins M.M., Gray M., Fawcett K.A., Nutter F.B., Uwingeli P., Mburanumwe I., Kagoda E., Basabose A., Stoinski T.S., Cranfield M.R., Byamukama J., Spelman L.H. & Robbins A.M. (2011) Extreme conservation leads to recovery of the Virunga Mountain Gorillas. *PLoS ONE*, 6, e19788.
(5) Wiafe E.D. & Amoah M. (2012) The use of field patrol in monitoring of forest primates and illegal hunting activities in Kakum Conservation Area, Ghana. *African Primates*, 7, 238–246.

5.7. Introduce ammunition tax

- We found no evidence for the effects of introducing ammunition tax on primate populations.

Background

The concept for this intervention is that introducing a tax for ammunition and therefore making ammunition less affordable will reduce the number of cartridges that hunters can purchase and thus result in a decrease in the number of animals hunted. For example, Tweh *et al*. (2014) suggested that purchase and import taxes on ammunition and rifles, and the introduction of certified gun permits may help to control hunting with guns in Liberia.

Tweh C., Lormie M., Kouakou C., Hillers A., Kuehl H. & Junker J. (2014) Conservation status of chimpanzees (*Pan troglodytes verus*) and other large mammals across Liberia: results from a nationwide survey. *Oryx*, 49, 710-718.

5.8. Inspect bushmeat markets for illegal primate species

- We found no evidence for the effects of inspecting bushmeat markets for illegal primate species on primate populations.

Background

Similarly to installing road blocks to inspect cars for illegal primate bushmeat, this intervention involves inspecting markets for illegal primate species.

5.9. Regularly de-activate/remove ground snares

- One before-and-after study in the Democratic Republic of Congo and Rwanda[1] found that mountain gorilla numbers increased over five years in an area that was patrolled for snares, alongside other interventions.
- One before-and-after study in the Democratic Republic of Congo, Rwanda and Uganda[2] found that a mountain gorilla population declined in an area where snares were removed regularly, alongside other interventions.
- One before-and-after study in Ghana[3] found that the number of snares declined in an area where they were regularly removed, alongside other interventions.

Background

Some primate species, especially larger and more terrestrial species, such as gorillas *Gorilla* spp. and chimpanzees *Pan troglodytes*, may be injured by getting caught in snares typically set out to catch animals such as duikers *Cephalophus* spp. and bush pigs *Potamochoerus larvatus*. These primate species can get their hands or feet trapped in snares while travelling through the forest, often resulting in life threatening injuries and even death. This intervention involves the regular patrolling of teams to de-activate/remove ground snares.

The patrolling of areas by anti-poaching teams to reduce hunting is discussed separately under 'Conduct regular anti-poaching patrols', and the providing of training and equipment to anti-poaching patrols is discussed under 'Provide training to anti-poaching ranger patrols', and 'Provide better equipment (e.g. guns) to anti-poaching ranger patrols', respectively. The use of monitoring surveillance strategies and/or monitoring data to improve effectiveness of wildlife law enforcement patrols is discussed under 'Implement monitoring surveillance strategies (e.g. SMART)/use monitoring data to improve effectiveness of wildlife law enforcement patrols'.

A before-and-after trial in 1984-1987 in tropical montane forest in the Virunga ecosystem in Rwanda and the Democratic Republic of Congo (1) found that mountain gorillas *Gorilla beringei beringei* ranging in habitat that was regularly patrolled for snares alongside other interventions, increased from 242 to 279 individuals (15% increase) in 1981-1986. Average group size increased from 8.5 to 9.2 individuals (17% increase) and immature proportion increased from 39.7 to 48.1% (8% increase) over the same time period. Regular total counts of this population were conducted since 1973. Anti-poaching guards regularly patrolled the area. Guards were provided with cars, radio communication, uniforms, more rations and other equipment that allowed them to increase patrol frequency and effectiveness. In 1985, a gorilla viewing tourism programme was started during which three gorilla groups were habituated for tourist viewing. The study does not distinguish between the effects of the different interventions mentioned above.

A before-and-after study in 1967-2008 in tropical montane forest in Volcanoes-, Mgahinga-, and Virunga National Parks located in Rwanda, Uganda, and the Democratic Republic of Congo, respectively (2), found that despite the regular removal of snares alongside other interventions, the mountain gorilla *Gorilla beringei beringei* population decreased over time. Annual population decline was 0.7%, resulting in an overall population decrease of 28.7% over the entire study period. However, no statistical tests were carried out to determine whether this decrease was significant. Rangers patrolled the whole park and confiscated more than 1,500 snares/year. They also conducted regular anti-poaching patrols and when necessary, herded livestock out of the park. Additional interventions included local conservation education and community development projects. The study does not distinguish between the effects of the different interventions mentioned above.

A before-and-after trial in 2007-2009 in tropical forest in Kakum Conservation Area in Ghana (3) found that the regular removal of ground snares alongside other interventions, led to a decrease in the number of snares recovered by teams over time as well as fewer illegal attempts to hunt primates. More specifically, the number of snares recovered decreased from 452 to 114 (75% decrease). However, no statistical tests were carried out to determine whether this difference was significant. In addition, in 2008-2009, the number of illegal hunting activities and attempts to hunt the bush baby *Galagoides demidoff*, Bossmann potto *Perodicticus potto*, Lowe's monkey *Cercopithecus campbelli lowei*, spot-nose monkey *Cercopithecus petaurista petaurista*, olive colobus *Procolobus verus*, Geoffroy's pied colobus *Colobus vellerosus* decreased from 1182 to 874 (26% decrease). Snare removal took place during foot patrols. Teams also regularly conducted randomized anti-poaching patrols. The study does not distinguish between the effects of the different interventions mentioned above.

(1) Aveling, R. & Aveling, C. (1987) Report from the Zaire Gorilla Conservation Project. *Primate Conservation*, 8, 162–164.
(2) Robbins M.M., Gray, M., Fawcett, K.A., Nutter, F.B., Uwingeli, P., Mburanumwe, I., Kagoda, E., Basabose, A., Stoinski, T.S., Cranfield, M.R., Byamukama, J., Spelman, L.H. & Robbins, A.M. (2011) Extreme conservation leads to recovery of the Virunga Mountain Gorillas. PLoS ONE, 6, e19788.
(3) Wiafe, E.D. & Amoah, M. (2012) The use of field patrol in monitoring of forest primates and illegal hunting activities in Kakum Conservation Area, Ghana. African Primates, 7, 238–246.

5.10. Provide better equipment (e.g. guns) to anti-poaching ranger patrols

- One before-and-after study in the Democratic Republic of Congo and Rwanda[1] found that gorilla populations increased after anti-poaching guard were provided with better equipment, alongside other interventions.
- One study in Uganda[2] found that no gorillas were killed for 21 months after game guards were provided with better equipment, alongside other interventions.
- One before-and-after study in Rwanda[3] found that the number of immature gorillas increased and the number of snares decreased after anti-poaching patrols were supplied with better equipment, alongside other interventions.

Background

If anti-poaching rangers are provided with better equipment (e.g. guns, or technical equipment, such as GPS, compass, hand-held data recording devices, binoculars, cameras, rain gear, etc.), they may be more effective at reducing hunting in the areas they patrol.

The patrolling of areas by anti-poaching teams to reduce hunting is discussed separately under 'Conduct regular anti-poaching patrols'. The providing of training to anti-poaching patrols and the regular removal of ground snares by snare-removal teams that may form part of anti-poaching teams is discussed under 'Provide training to anti-poaching ranger patrols' and 'Regularly de-activate/remove ground snares'. The use of monitoring surveillance strategies and/or monitoring data to improve effectiveness of wildlife law enforcement patrols is discussed under 'Implement monitoring surveillance strategies (e.g. SMART) or use monitoring data to improve effectiveness of wildlife law enforcement patrols'.

A before-and-after trial in 1984-1987 in tropical montane forest in the Virunga ecosystem in Rwanda and the Democratic Republic of Congo (1) found that after anti-poaching guards were provided with better equipment that allowed them to increase patrol frequency and effectiveness, alongside other interventions, mountain gorilla *Gorilla beringei beringei* numbers increased from 242 to 279 individuals (15% increase) from 1981-1986. In addition, average group size increased from 8.5 to 9.2 individuals (17% increase) and immature proportion increased from 39.7 to 48.1% (8% increase) over the same time period. Regular total counts of this population were conducted since 1973 by research staff. Anti-poaching guards regularly removed ground snares and conducted anti-poaching patrols. In 1979, a multi-organisation funded conservation project was initiated. In 1985, a gorilla viewing tourism programme was started during which three gorilla groups were habituated for tourist viewing. The study does not distinguish between the effects of the different interventions mentioned above.

A review on the status of mountain gorillas *Gorilla beringei beringei* in 1972-1989 in tropical montane forest in Eastern Virungas Conservation Area, Uganda (2) found that no gorillas were killed in 1989-1990 after the game guard force was provided with better equipment alongside other interventions. The number of game guards was increased from three to 13 men, who were trained and supervised by researchers. In January 1989 a permanent research project was established. Human settlers were relocated from an area (3 km^2 in size) that represented the most important gorilla habitat inside the Gorilla Game Reserve within the Eastern Virungas Conservation Area. The study does not distinguish between the effects of the different interventions mentioned above.

A before-and-after trial and site comparison in 1976-1988 in tropical forest of the Volcanoes National Park, Rwanda (3) found that the number of immature mountain gorillas *Gorilla beringei beringei* on the Rwandan side of the park increased and snares decreased after the implementation of regular anti-poaching patrols, alongside other interventions. The number of immature individuals increased by 22% on the Rwandan side of the park, but declined by 30% on the side of the park in the other two countries. However, no statistical tests were carried out to determine whether these differences were significant. Patrols were initiated in 1979, but the study did not report on further details relating to the anti-poaching methods used. Funds provided by a tourist programme enabled the training, equipping and management of the anti-poaching patrols. In 1976, all cattle were removed from the park in Rwanda. A conservation education programme was implemented, but no further details were reported in the study. The study does not distinguish between the effects of the different interventions mentioned above.

(1) Aveling, R. & Aveling, C. (1987) Report from the Zaire Gorilla Conservation Project. *Primate Conservation*, 8, 162–164.
(2) Butynski, T.M., Werikhe, S.E. & Kalina, J. (1990) Status, distribution and conservation of the mountain gorilla in the Gorilla Game Reserve, Uganda. *Primate Conservation*, 11, 31–41.
(3) Harcourt A.H. (2001) The benefits of mountain gorilla tourism. *Gorilla Journal*, 22, 36–37.

5.11. Provide training to anti-poaching ranger patrols

- One study in Uganda[1] found that no gorillas were killed over 21 months after game guards received training, alongside other interventions.
- One before-and-after study in Rwanda[2] found that the number of immature gorillas increased in areas where game guards received training, alongside other interventions.
- One before-and-after study in India[3] found that a population of hoolock gibbons increased after sanctuary staff received training, alongside other interventions.
- One before-and-after study in Cameroon[4] found that no incidents of primate poaching occurred over a three year period after anti-poaching rangers were trained, alongside other interventions.

Background

With the aim of making anti-poaching patrols more effective, this intervention involves providing training to anti-poaching patrols. Such training can involve preparing teams for encountering dangerous situations in the field, training them to navigate using the compass and GPS, collect and record data, teaching them about wildlife laws and how to enforce them, etc.

The patrolling of areas by anti-poaching teams to reduce hunting is discussed separately under 'Conduct regular anti-poaching patrols'. The providing of better equipment to anti-poaching teams and the removal of ground snares by snare-removal teams that may form part of anti-poaching teams is discussed under 'Provide better equipment (e.g. guns) to anti-poaching ranger patrols' and 'Regularly de-activate/remove ground snares'. The use of monitoring surveillance strategies and/or monitoring data to improve effectiveness of wildlife law enforcement patrols is discussed under 'Implement monitoring surveillance strategies (e.g. SMART) or use monitoring data to improve effectiveness of wildlife law enforcement patrols'.

A review on the status of mountain gorillas *Gorilla beringei beringei* in 1972-1989 in tropical montane forest in Eastern Virungas Conservation Area, Uganda (1) found that no gorillas were killed in 1989-1990 after game guards received training 1989 alongside other interventions. In 1989, the number of game guards was also increased from three to 13 men, who were provided with better equipment. At the same time, a permanent research project was established in the area. Human settlers were relocated from the most important gorilla habitat inside the Gorilla Game Reserve (an area 3 km^2 in size), within the Eastern

Virungas Conservation Area. The study does not distinguish between the effects of the different interventions mentioned above.

A before-and-after trial and site comparison in 1976-1988 in tropical forest of the Volcanoes National Park, Rwanda (2) found that the number of immature mountain gorillas *Gorilla beringei beringei* on the Rwandan side of the park increased and snares decreased alongside the removal of cattle and other interventions. The number of immature individuals increased by 22% on the Rwandan side of the park, but had declined by 30% on the side of the park in the other two countries. No statistical tests were carried out to determine whether these differences were significant. Patrols were initiated in 1979, however, the study did not report on further details on the anti-poaching patrols. Funds provided by a tourist programme enabled the training, equipping and management of the anti-poaching patrols. In 1976, all cattle were removed from the park in Rwanda. A conservation education programme was also implemented, but no further details of this programme were reported. The study does not distinguish between the effects of the different interventions mentioned above.

A before-and-after trial in 2004-2009 in tropical forest in the Gibbon Wildlife Sanctuary in Assam, India (3) found that a population of hoolock gibbons *Hoolock hoolock* increased by 66% over five years after training, monitoring and legal orientation programmes were carried out for the sanctuary staff along with other interventions. The gibbon population increased from 64 individuals in 17 groups in 2004 to 106 individuals in 26 groups (and five solitary males) in 2009. Canopy cover increased by 3.5% and degraded forest decreased by 4.1%. However, no statistical tests were carried out to determine whether these differences were significant. Families within local communities that were selected through socio-economic studies were also provided with more efficient stoves, bio-gas plants, handlooms and ducks. Local communities received alternative income-generation through training in mushroom cultivation, honeybee keeping and duck husbandry and a large-scale education and awareness programme was implemented to promote gibbon conservation within Assam and other northeastern states. The study does not distinguish between the effects of the different interventions mentioned above.

A before-and-after study in 2009-2012 in tropical forest in Takamanda National Park, southeastern Cameroon (4) found that after training anti-poaching rangers in the 'Gorilla Guardian' programme initiated in 2008 along with other interventions, no more incidents of Cross River gorilla *Gorilla gorilla diehli* poaching occurred. Guardians were selected by their respective communities and underwent training in gorilla ecology and nest identification, monitoring and data collection and Cameroon wildlife law. The programme started with six guardians from communities in three forest areas near important gorilla sites. Two other communities were added to the network in 2011 and because of increased interest in the programme, two more communities joined in 2012. Communities were put in control of the monitoring of illegal activities that threaten gorilla survival in nearby forests and were directly involved in gorilla research and conservation management. The study does not distinguish between the effects of the different interventions mentioned above.

(1) Butynski, T.M., Werikhe, S.E. & Kalina, J. (1990) Status, distribution and conservation of the mountain gorilla in the Gorilla Game Reserve, Uganda. *Primate Conservation*, 11, 31–41.
(2) Harcourt A.H. (2001) The benefits of mountain gorilla tourism. *Gorilla Journal*, 22, 36–37.
(3) Chetry, D. & Chetry, R. (2011) Hoolock gibbon conservation in India. *Gibbon Journal*, 6, 7–12.
(4) Jameson, C. (2012) Gorilla Guardian Update: Expansion of the community-based monitoring network. *Gorilla Journal*, 45, 13–15.

5.12. Implement local no-hunting community policies/traditional hunting ban

- One review[1] found that very few snub nosed monkeys were killed annually at a site in China where it is forbidden to kill wildlife.
- One controlled study in the Democratic Republic of Congo[2] found that a lowland gorilla population increased after the implementation of a local hunting ban.
- One before-and-after study in Belize[3] found that an introduced black howler monkey population increased over time in an area where hunting was controlled, alongside other interventions.
- A before-and-after study in Cameroon[4] found that a drill population increased in numbers after being protected by a hunting ban, alongside other interventions.
- A study in Nigeria[5] found that populations of Sclater's monkey increased in an area where hunting of the species was prohibited by local taboos.

Background

This intervention involves implementing no-hunting community policies or traditional hunting bans. These differ from national and international policies in that (authorities within) local communities rather than government staff enforce such policies/bans.

The enforcement of local taboos that forbid the killing of certain primate species is discussed under 'Strengthen/support/re-install traditions/taboos that forbid the killing of primates', and installing community control of anti-poaching activities is discussed under 'Implement community control of patrolling, banning hunting and removing snares'.

A review on the status of grey snub-nosed monkeys *Rhinopithecus brelichi* in 1962-1977 in tropical montane forest in Fanjingshan Nature Reserve, China (1), which is sacred to pilgrims, found that very few individuals (<1 individual annually) were killed or captured by humans. Because the area is sacred, it is forbidden to kill wildlife there. The recorded cases show that four individuals were killed in 1962, one trapped in 1964, one caught alive in 1967, one killed in 1969, one caught alive in 1970, two killed in 1975, and three trapped in 1977. The trapped animals were caught in traps meant for other animals and the killed or captured animals were crop raiders which had come down to the villages located in the valley.

A controlled study in 1984-1987 in tropical lowland forest in the Masisi Highlands in Democratic Republic of Congo (2) found that a small eastern lowland gorilla *Gorilla beringei graueri* population had increased after the implementation of a local gorilla hunting ban. The population increased and by

1987 there were 70 gorillas living in a 30 km^2 area inhabited by between 5,000-10,000 people. However, population size before the ban was not reported and no statistical tests were carried out to determine whether this difference was significant. The owner of a cattle ranch had implemented the ban and encouraged the local people to do adhere to it. Gorillas nested as close as 30 m from houses and regularly crossed fields of beans or maize without feeding on them. In addition, they were observed in pastures among cattle and seen to eat the bark of Eucalypt trees. They become partially habituated to humans and as a consequence, could easily be observed.

A before-and-after trial in 1992-1994 in tropical forest in Cockscomb Basin Wildlife Sanctuary in Belize (3) found that the black howler monkey *Alouatta pigra* population that was reintroduced into an area where hunting was largely controlled along with other interventions, showed an increase in size over time. The population increased from 62 in 1994 to >100 individuals (61% increase) in 1997. No statistical tests were carried out to determine whether this difference was significant. One-month-, 6-month-, 1-year, and 2-year survival rates for the different cohorts released in the dry seasons of 1992, 1993, and 1994, was 100%, 92%, 81%, and 86%, respectively. Birth rate was 20% (n=12) and infant survival rate was 75% (n=9). Entire social groups were reintroduced at once, and ten of the 14 groups were held in cages for 1-3 days before release within 700-1000 m to the neighbouring troop. All individuals were permanently marked, and adults were fitted with telemetry collars. The local community was educated about the reintroduction project and black howler conservation by implementing multimedia campaigns. The study does not distinguish between the effects of the different interventions mentioned above.

A before-and-after study in 1971-2002 in tropical montane forest in Bakossiland, Cameroon (4) found that a drill *Mandrillus leucophaeus* population that was protected by a local hunting ban since 1994 along with other interventions, increased in size by 1997. However, the authors did not provide information on the magnitude of the population increase. Drill group sizes did not change over time, season, habitat, or elevation. Hunting was intense before 1994. For example, 103 adults were shot by two hunters on three occasions in 1990. After 1994, hunting was controlled and the first six drills were killed in 2002. In 1997, a group of 400 drills was observed and since the year 2000, wildlife staff and villagers regularly reported direct drill observations in the area. The drill hunting ban was initiated by the late Paramount Chief of Bakossi and subsequently supported by other Bakossi traditional chiefs. In addition, an education programme was initiated in 1992. Independent direct observations of drill groups and their size were recorded by different organizations working in the area. The study does not distinguish between the effects of the different interventions mentioned above.

A study in June-July 2010 in heavily degraded tropical forest in Lagwa and Akpugoeze communities in Igboland, southeastern Nigeria (5) found that Sclater's monkey *Cercopithecus sclateri* in both communities in which the species was informally protected by taboos, increased in numbers from 124 to 206 (66% increase) and from 193 to 249 (29% increase) individuals over four years. Average group size increased from 8.3 to 10.8 individuals in Lagwa and from 9.2 to 13.8 individuals in Akpugoeze. Proportion of dependent infants also increased from 12 to 18% in Lagwa and from 8 to 11% in Akpugoeze. Last, numbers of observed monkey groups increased from 15 to 19 in Lagwa, but decreased from 20 to 18 in Akpugoeze. However, no statistical tests were carried out to determine whether these differences were significant. Total counts of groups and numbers of monkeys in each group were conducted using direct observations over a time period of less than two weeks in each community.

(1) Bangjie, T. (1985) The status of primates in China. *Primate Conservation*, 5, 63–77.
(2) Aveling, R. & Aveling, C. (1987) Report from the Zaire Gorilla Conservation Project. *Primate Conservation*, 8, 162–164.
(3) Koontz, F., Horwich, R.H., Saqui, S., Saqui, H., Glander, K., Koontz, C. & Westrom, W. (1994) *Reintroduction of black howler monkeys (Alouatta pigra) into the Cockscomb Basin Wildlife Sanctuary, Belize*. Proceedings - American Zoo and Aquarium Association Annual Conference, USA.
(4) Wild, C., Morgan, B.J. & Dixson, A. (2005) Conservation of drill populations in Bakossiland, Cameroon: historical trends and current status. *International Journal of Primatology*, 26, 759–773.
(5) Baker, L.R., Tanimola, A.A. & Olubode, O.S. (2014) Sacred populations of *Cercopithecus sclateri*: Analysis of apparent population increases from census counts. *American Journal of Primatology*, 76, 303–312.

5.13. Strengthen/support/re-install traditions/taboos that forbid the killing of primates

- One site comparison in Laos[1] found that Laotian black crested gibbons occurred at higher densities in areas where they were protected by a local hunting taboo than at sites were there was no taboo.

Background

We know that in many areas of the world, people, communities and religions have taboos against the killing and/or eating of certain primate species (e.g. Brncic *et al*. 2010, Costa 2010, Jimoh *et al*. 2012, Xiang et al. 2013). However, it has also been suggested that the presence of other ethnic groups, new religions/westernization, use of modern hunting equipment and poverty pose a threat to the effectiveness of taboos as a conservation tool (Jimoh *et al*. 2012). The strengthening, supporting or re-installing of traditions/taboos that forbid the killing of primates may therefore lead to a reduction in hunting rates.

The implementation of community policies/traditional hunting ban is discussed under 'Implement local no-hunting community policies/traditional hunting ban', and installing community control of anti-poaching activities is discussed under 'Implement community control of patrolling, banning hunting and removing snares'.

Brncic T.M., Amarasekaran B. & McKenna A. (2010) *Sierra Leone national chimpanzee census, September 2010*. Tacugama Chimpanzee Sanctuary unpublished report.
Costa S.G. (2010) *Social perceptions of nonhumans in Tombali (Guinea-Bissau, West Africa): a contribution to Chimpanzee (Pan troglodytes verus) conservation.* PhD thesis. University of Stirling.
Jimoh S.O., Ikyaagba E.T., Alarape A.A., Obioha E.E. & Adeyemi A.A. (2012) The role of traditional laws and taboos in wildlife conservation in the Oban Hill Sector of Cross River national park (CRNP), Nigeria. *Journal of Human Ecology*, 39, 209–219.

Xiang, Z., Xiao, W., Huo, S. and Li, M., (2013) Ranging pattern and population composition of Rhinopithecus bieti at Xiaochangdu, Tibet: Implications for conservation. *Chinese Science Bulletin*, *58*(18), pp.2212-2219.

A site comparison in 2007 in tropical forest in Nam Kan Valley in Nam Kan Provincial Protected Area, Laos (1) found that Laotian black crested gibbons *Nomascus concolor lu* that were protected by a local hunting taboo occurred at higher group densities compared to other sites. In the survey area, average group density was estimated at 2.2 groups/km^2 compared to 0.43 to 0.82 and 1.6 groups/km^2 in Yunnan Province and Che Tao in northern Vietnam, respectively. However, no statistical tests were carried out to determine whether this difference was significant. The ban was implemented in 1975 by one of the local village heads. In Yunnan Province and Che Tao no hunting bans were reported to exist. An auditory survey was conducted in the survey area using eight single listening points stationed roughly 0.5-2 km apart, each of which were used on one to five days.

(1) Geissmann, T. (2007) First field data on the Laotian black crested gibbon (*Nomascus concolor lu*) of the Nam Kan area of Laos. *Gibbon Journal*, 3, 56–65.

5.14. Inform hunters of the dangers (e.g., disease transmission) of wild primate meat

- We found no evidence for the effects of informing hunters of the dangers of wild primate meat on primate populations.

Background

For this intervention, hunters are informed about the health risks associated with handling wild primate meat. Although the study did not link bushmeat consumption to primate offtake rates by hunters, Ordaz-Németh *et al*. (2017) found that Liberian households informed about the health risks of preparing/consuming bushmeat, decreased their bushmeat consumption significantly more during the Ebola crisis (compared to before the crisis) than households that were not informed about these risks.

Ordaz-Németh I., Arandjelovic M., Boesch L., Gatiso T., Grymes T., Kuehl H. S., Lormie M., Stephens C., Tweh C., Junker J. (2017) The socio-economic drivers of bushmeat consumption during the West African Ebola crisis. *PLOS Neglected Tropical Diseases*, 11, e0005450.

5.15. Implement monitoring surveillance strategies (e.g. SMART) or use monitoring data to improve effectiveness of wildlife law enforcement patrols

- One before-and-after study in Nigeria[1] found that more gorillas and chimpanzees were observed after the implementation of law enforcement and a monitoring system.

Background

This intervention entails using surveillance strategies, such as SMART (http://smartconservationtools.org/), or monitoring data, such as spatial data on hunting intensity and/or primate density, to improve the efficiency of law enforcement patrols. For example, an analysis by N'Goran et al. (2012) of monitoring and patrol data from Taï National Park, Côte d'Ivoire, found that patrol teams spent more time in areas of high human activity and poaching, implying that the monitoring data helped to guide law enforcement patrols to areas where hunting was concentrated, thereby increasing their efficiency. However, the study did not relate patrol effort to primate densities and therefore conclusions could not be drawn about the effectiveness of patrols.

The regular patrolling of primate habitat by anti-poaching teams and the removing of snares by snare-removal teams that may form part of anti-poaching patrols are discussed separately under 'Conduct regular anti-poaching patrols' and 'Regularly de-activate/remove ground snares'. The training and the providing of equipment to anti-poaching patrols is discussed under 'Provide training to anti-poaching ranger patrols', and 'Provide better equipment (e.g. guns) to anti-poaching ranger patrols'.

N'Goran P., Boesch C., Mundry R., N'Goran E.N., Herbinger I., Yapi F.A. & Kühl H.S. (2012) Hunting, law enforcement, and African primate conservation. *Conservation Biology*, 3, 565–571.

A before-and-after trial in 2009-2013 in tropical forest in the Mbe Mountains, Nigeria (1) found that more Cross River gorilla *Gorilla gorilla diehli* and Nigeria-Cameroon chimpanzee *Pan troglodytes ellioti* groups were observed after the implementation of a system for law enforcement and monitoring. The number of observed gorilla groups and sleeping nests increased from 4 to 22 groups and from 29 to 80 nests. The number of chimpanzee groups and sleeping nests increased from 4 to 15 groups and 3 to 53 nests. The number of patrol days increased from 343 to 830 days, and patrol effort increased from 1,500 to 5,000 km/year. Encounter rates of wire snares, gunshots heard, used cartridges, and hunting camps, decreased from 1.3 to 0.27/km, 0.45 to 0.02/km, 1.56 to 0.08/km, and 0.05 to 0.002/km, respectively. No statistical tests were carried out to determine whether this difference was significant. The system used the Cyber Tracker software run on handheld computers with GPS capabilities for field data collection. Data collected with this system can be downloaded directly to computers and quickly analysed allowing timely production of feedback for patrol planning and implementation.

(1) Imong, I., Eban, J. & Mengjo, C. (2014) Using technology to save gorillas in the Mbe Mountains. *Gorilla Journal*, 48, 16–17.

5.16. Implement community control of patrolling, banning hunting and removing snares

- A site comparison study in the Democratic Republic of Congo[1] found that community control was more effective at reducing illegal bushmeat hunting, including primates, compared to the nearby national park.

- A before-and-after study in Cameroon[2] found that no incidents of gorilla poaching occurred over three years after implementation of community control and monitoring of illegal activities.
- A site comparison in Nigeria[3] found that there were more gorillas and chimpanzees in an area managed by a community conservation organisation than in areas not managed by local communities.

Background

For this intervention, it is the community and not government staff, which implements all patrolling activities (including snare removals) and controls hunting bans.

The enforcement of local taboos that forbid the killing of certain primate species is discussed under 'Strengthen/support/re-install traditions/taboos that forbid the killing of primates', and the implementation of community policies/traditional hunting ban is discussed under 'Implement local no-hunting community policies/traditional hunting ban'.

A site comparison study in 1996-1997 in localities near Garamba National Park and Azande Hunting Reserve, Democratic Republic of Congo (1) found that traditional community control discouraged more efffectively illegal bushmeat hunting of protected species, including chimpanzee *Pan troglodytes*, during both times of peace and war, compared to the centrally run national park. In village markets, where the community village chief regulated bushmeat hunting, protected species represented a low proportion of total bushmeat quantity (21% in peacetime; 18% during the war) while in urban markets, bushmeat originating from the centrally-run national park was mostly illegally-hunted protected species (68% of total quantity in peacetime; 91% during the war). The village chief discouraged owning of automatic weapons, needed for large-bodied protected species, and hunters relied on shotguns, snares and nets. Legally hunted bushmeat included nine species of primates (*Cercopithecus sp.,* guereza colobus *Colobus guereza*, olive baboon *Papio anubis*, etc) while most illegal bushmeat included elephant *Loxodonta africana*, buffalo *Syncerus caffer*, etc. Five bushmeat markets were monitored over 15 months for the urban trade and the two markets for the rural trade.

A before-and-after study in 2009-2012 in tropical forest near Takamanda National Park, southeastern Cameroon (2) found that after implementing community control and monitoring of illegal activities as part of the Gorilla Guardian programme, no incidents of Cross River gorilla *Gorilla gorilla diehli* poaching occurred over three years. Guardians were selected by their respective communities and collaborated with local hunters and served as informants reporting threats to gorillas. The programme was started with six guardians from communities in three forest areas near important gorilla sites. Two other communities were added to the network in 2011 and because of increased interest in the programme, yet another two communities joined in 2012. Guardians fulfilled the role of anti-poaching rangers and communities were directly involved in gorilla research and conservation management. The study does not distinguish between the effects of the different interventions mentioned above.

A site comparison in 1983-2013 in tropical forest in the Cross River area, Nigeria (3) found that Cross River gorilla *Gorilla gorilla diehli* and Nigeria-Cameroon chimpanzee *Pan troglodytes ellioti* densities were higher in the Mbe Mountains, a site managed by a community conservation association than in adjacent sites (Afi Mountain Wildlife Sanctuary and the Cross River National Park) which were not managed by local communities. Furthermore, levels of wildlife hunting in the Mbe Mountains were relatively low compared to the other two sites and no reports of hunting of either gorilla or chimpanzees had been reported over 30 years. However, no figures were provided and no statistical tests were carried out to determine whether this difference was significant. At Mbe Mountains there was strong community support for conservation, As part of the community programme, 13 trained eco-guards regularly carry out anti-poaching and monitoring patrols in the area.

(1) De Merode, E., & Cowlishaw, G. U. Y. (2006). Species protection, the changing informal economy, and the politics of access to the bushmeat trade in the Democratic Republic of Congo. *Conservation Biology*, 20, 1262-1271.

(2) Jameson, C. (2012) Gorilla Guardian Update: Expansion of the community-based monitoring network. *Gorilla Journal*, 45, 13–15.

(3) Imong, I., Eban, J. & Mengjo, C. (2014) Using technology to save gorillas in the Mbe Mountains. *Gorilla Journal*, 48, 16–17.

Substitution

5.17. Provide sustainable alternative livelihoods; establish fish- or domestic meat farms

- We found no evidence for the effects of providing sustainable alternative livelihoods; establish fish- or domestic meat farms on primate populations.

Background

This intervention aims to replace primate bushmeat with other domestic- or wild animal protein sources, such as e.g. fish, snails, chickens, pigs, or goats, which are bred and raised at small-scale animal farms. Some very abundant wild mammal species (e.g. agricultural pests) may also be used as a food source and potentially serve as substitutes for primate bushmeat. An example of such a species is the greater cane rat *Thryonomys swinderianus*, which is raised in cages and sold for meat in many African countries. A correlative study by Junker *et al*. (2015) found that in areas where fish protein was relatively affordable to people, chimpanzee density was higher than in other areas, suggesting that people may replace bushmeat with fish protein when they can afford it.

Junker J., Boesch C., Mundry R., Stephens C., Lormie M., Tweh C. & Kühl H.S. (2015) Education and access to fish but not economic development predict chimpanzee and mammal occurrence in West Africa. *Biological Conservation*, 182, 27–35.

5.18. Employ hunters in the conservation sector to reduce their impact

- We found no evidence for the effects of employing hunters in the conservation sector to reduce their impact on primate populations.

Background

It is believed that one way to control the hunting of primates is to offer employment to hunters in the conservation sector, for instance as anti-poaching rangers, monitoring and data collection officers, or eco-tourist guides. Employment provides the hunter with a regular income source and the hunter will gain knowledge on the importance of conserving primates and potentially pass this knowledge on to other hunters/members in the community. Furthermore, employing hunters as conservation practitioners makes use of the excellent tracking skills and large knowledge base.

Logging and wood harvesting

5.19. Use selective logging instead of clear-cutting

- One site comparison in Sierra Leone[1] found that primate densities were higher in forest that had been logged at low intensity than in a forest logged at high intensity.
- One before-and-after study in Madagascar[2] found that the number of lemurs increased following selective logging.
- One site comparison study in Uganda[3] found that primate densities were similar in forest that had been logged at low intensity and forest logged at high intensity.

Background

Logging is the third greatest threat to primates in all regions worldwide (Estrada *et al*. 2017). Selective logging is a more ecologically sustainable practice than clear-cutting, which entails removing all trees at the same time. The idea behind selective logging is to maintain an uneven or all-aged forest of trees varying not only in age, but in size and species as well. Selectively logged areas can sustain primates at varying densities, depending on the logging intensity and history (e.g. Bortolamiol *et al*. 2014). Although several correlative studies have shown that high logging intensity spatially correlates with low primate density (e.g. Weisenseel *et al*. 1993) and local extinction in very heavily-logged or clear-cut areas (e.g. Ancrenaz *et al*. 2010), in some moderately-logged areas, densities of some primate species, including eastern chimpanzees *Pan troglodytes schweinfurthii* and western gorilla *Gorilla gorilla gorilla* for example, were reported to be relatively high (e.g. Bortolamiol *et al*. 2014, Stokes *et al*. 2010). For orangutans *Pongo pygmaeus morio*, a simulation study by Wilson *et al*. (2014) has suggested that reduced-impact logging practices, coupled with additional protection may be a strategy that could even outperform habitat protection.

For best 'Best Practice Guidelines for Reducing the Impact of Commercial Logging on Great Apes in Western Equatorial Africa' published by the IUCN SSC Primate Specialist Group (PSG), please refer to Morgan & Sanz (2007).

Ancrenaz M., Ambu L., Sunjoto I., Ahmad E., Manokaran K., Meijaard E. & Lackman I. (2010) Recent surveys in the forests of Ulu Segama Malua, Sabah, Malaysia, show that orang-utans (*P. p. morio*) can be maintained in slightly logged forests. *PLoS ONE*, 5, e11510.

Bortolamiol S., Cohen M., Potts K., Pennec F., Rwaburindore P., Kasenene J., Seguya A., Vignaud Q. & Krief S. (2014) Suitable habitats for endangered frugivorous mammals: small-scale comparison, regeneration forest and chimpanzee density in Kibale National Park, Uganda. *PLoS ONE*, 9, e102177.

Estrada A., Garber P.A., Rylands A.B., Roos C., Fernandez-Duque E., Di Fiore A., Nekaris K.A.-I., Nijman V., Heymann E.W., Lambert J.E., Rovero F., Barelli C., Setchell J.M., Gillespie T.R., Mittermeier R.A., Verde Arregoitia L., de Guinea M., Gouveia S., Dobrovolski R., Shanee S., Shanee N., Boyle S.A., Fuentes A., MacKinnon K.C., Amato K.R., Meyer A.L.S., Wich S., Sussman R.W., Pan R., Kone I. & Li B. (2017) Impending extinction crisis of the world's primates: why primates matter. *Science Advances,* 3, e1600946.

Morgan D. & Sanz C. (2007) *Best Practice Guidelines for Reducing the Impact of Commercial Logging on Great Apes in Western Equatorial Africa.* Gland, Switzerland: IUCN SSC Primate Specialist Group (PSG), 32 pp.

Stokes E.J., Strindberg S., Bakabana P.C., Elkan P.W., Iyenguet F.C., Madzoke B., Malanda G.A.F., Mowawa B.S., Moukoumbou C., Ouakabadio F.K. & Rainey H.J. (2010) Monitoring great ape and elephant abundance at large spatial scales: measuring effectiveness of a conservation landscape. *PLoS ONE*, 5, e10294.

Weisenseel K., Chapman C.A. & Chapman L.J. (1993) Nocturnal primates of Kibale forest: effects of selective logging on prosimian densities. *Primates*, 34, 445–450.

Wilson H.B., Meijaard E., Venter O., Ancrenaz M. & Possingham H.P. (2014) Conservation strategies for orangutans: reintroduction versus habitat preservation and the benefits of sustainably logged forest. *PLoS ONE*, 9, e102174.

A site comparison in 1984-1985 in rainforest in Gola Forest Reserves, Sierra Leone (1) found that group densities of three out of six primate species were lower in selectively logged than in unlogged forests. Diana monkeys *Cercopithecus diana*, spot-nosed monkeys *Cercopithecus petaurista*, and Campbell's monkeys *Cercopithecus campbelli* had similar group densities in low-intensity selectively logged and unlogged forest patches. In contrast, group densities of red colobus *Procolobus badius*, black-and-white colobus *Colobus polykomos*, and olive colobus *Procolobus verus* appeared lower in selectively logged than in unlogged forests. Group densities of all species were lower in heavily selectively logged forest than in unlogged or low-intensity selectively logged forests. Group densities for Campbell's monkeys were similar in unlogged and logged forests. Hunting rate was highest in high-intensity selectively logged forests, moderate in selectively logged forests and low in unlogged forests. However, no statistical tests were carried out to determine whether this difference was significant. Sample sizes were small and ranged from one to seven groups. Selective logging involved the cutting of commercial tree species with a girth larger than 2-2.6 m. Three unlogged sites, one low-intensity selectively logged site (eight logged trees/8 ha plot), and one heavily selectively logged site (51 logged trees/8 ha plot) were surveyed by walking a rectangular 2 km trail and mapping primate groups and their calls.

A before-and-after trial in 1990-1992 in tropical dry forest in Fôret de Kirindy, western Madagascar (2) found that lemur encounter rates increased two years after low-intensity selective logging (<or=10% of crown area removed) for

the fat-tailed dwarf lemur *Cheirogaleus medius,* the mouse lemurs *Microcebus* spp., and the Masoala fork-marked lemur *Phaner furcifer*. Encounter rates did not change for the brown lemur *Eulemur fulvus*, Verreaux's sifaka *Propithecus verreauxi*, *Lepilelur mustelinus*, and Coquerel's giant mouse lemur *Mirza coquereli*. Encounter rates increased from 0 to 2.8 sightings/km for the mouse lemurs *Microcebus* spp., from 1.5 to 4.1 sightings/km for the western fat-tailed dwarf lemur *Cheirogaleus medius* and from 0.5 to 0.9 sightings/km for the Masoala fork-marked lemur *Phaner furcifer*. However, the authors speculated that the increase was a consequence of a shift in home ranges between surveys, rather than population growth, as most of the species reproduce too slowly to cause a noticeable effect within two years. The same site was surveyed during the day and at night repeatedly and along the same trails in 1990 before logging and in 1992 after low-intensity selective logging. Authors also surveyed two additional sites, one logged in 1985-1986 and one unlogged area to control for potential year-to-year population variation.

A site comparison in 1968-1996 in three evergreen forests in Uganda (3) found that light selective logging (5.1 stems/ha) did not affect average primate group densities and group sizes of blue monkey *Cercopithecus mitis*, redtail monkey *Cercopithecus ascanius*, Ugandan red colobus *Procolobus tephrosceles*, and grey-cheeked mangabey *Lophocebus albigena* when compared to populations in heavy selected logging (7.4 stems/ha) areas. However, group density of eastern black-and-white colobus (BWC) *Colobus guereza* was lower in the light selective logging area in 1980-1981 (3.31 vs 4.81 groups/km^2) and in 1996-1997 (4.83 vs 9.12 groups/km^2) than in the heavily logged area. BWC had higher group densities in the light selective logging area than in the unlogged area (1980/81: 3.31 vs 0.89 groups/km^2; 1996/97: 4.83 vs 2.00 groups/km^2). Heavy selective logging resulted in lower group densities compared to unlogged and light selective logging for red colobus (1980-1981: 3.08 vs 5.46 and 5.78 groups/km^2) and redtail monkeys (1980-1981: 2.21 vs 5.58 and 7.03 groups/km^2; 1996-1997: 1.04 vs 4.83 and 11.48 groups/km^2). Relative abundance (number of groups seen/ km surveyed) in heavy selective logging decreased between surveys conducted in 1980-1981 to 1996-1997 for red colobus (0.567 vs 0.292), BWC (1.144 vs 0.542), redtail monkey (0.589 vs 0.094), and blue monkey (0.337 vs 0.021), but only for red colobus in lightly logged forests (0.710 vs 0.459) over the same period. BWC relative abundance decreased in unlogged areas from 0.23 in 1970-1972 to 0.11 in 1974-1967 and 0.11 in 1980-1981 but increased for grey-cheeked mangabeys (1970-1972: 0.12; 1980-1981: 0.16). Surveys used line transects to assess primate densities across three forestry compartments with heavy-, light- and no selective logging in the late 1960s. The unlogged area was surveyed in 1970-1976. Survey effort and data collection methods were comparable.

(1) Davies, A.G. (1987) Conservation of primates in the Gola Forest Reserves, Sierra Leone. *Primate Conservation*, 8, 151–153.

(2) Ganzhorn, J.U. (1995) Low-level forest disturbance effects on primary production, leaf chemistry, and lemur populations. *Ecology*, 76, 2084–2096.

(3) Chapman, C.A., Balcomb, S.R., Gillespie, T.R., Skorupa, J.P. & Struhsaker, T.T. (2000) Long-term effects of logging on African primate communities: a 28-year comparison from Kibale National Park, Uganda. *Conservation Biology*, 14, 207–217.

5.20. Use patch retention harvesting instead of clear-cutting

- We found no evidence for the effects of using patch retention harvesting instead of clear-cutting on primate populations.

Background

Patch-retention harvesting, also called 'clear-cutting with reserves', entails retaining a certain percentage (typically 10%) of a harvested unit within discrete patches of mature and/or immature trees. It is hoped that primates will resettle and survive in these patches in the long-term. Clear-cut logging (i.e. the removal of all trees at the same time) is practiced on the remaining e.g. 90% of the harvesting unit. The spatial properties of the patches (i.e. size, shape and distance between patches) need to be considered as they are likely to play an important role for their effectiveness in ensuring the long-term survival of the displaced primate populations (Diamond 1975). This logging strategy has been applied mostly in the sub-boreal Spruce Bioclimatic zone.

Diamond J.M. (1975) The island dilemma: lessons of modern biogeographic studies for the design of natural reserves. *Biological Conservation*, 7, 129–146.

5.21. Implement small and dispersed logging compartments

- We found no evidence for the effects of implementing small and dispersed logging compartments on primate populations.

Background

This intervention is particularly important for territorial primate species that live in social groups with spatially well-defined home ranges. If logging were conducted at multiple sites within an area similar to the size of the primate species core range and over a short span of time, then an entire social group could be displaced. It has therefore been recommended that relatively small logging compartments that will be exploited simultaneously should lie at a distance of each other that equals at least the distance between different groups/communities (Morgan & Sanz 2007).

Morgan D. & Sanz C. (2007). *Best Practice Guidelines for Reducing the Impact of Commercial Logging on Great Apes in Western Equatorial Africa*. IUCN SSC Primate Specialist Group (PSG).

5.22. Use shelter wood cutting instead of clear-cutting

- We found no evidence for the effects of using shelter wood cutting instead of clear-cutting on primate populations.

Background

Shelterwood cutting is a management technique designed to avoid clear-cutting, but to provide even-aged timber. It involves cutting trees in a series of cuttings, allowing new seedlings to grow from the seeds of older trees.

5.23. Leave hollow trees in areas of selective logging for sleeping sites

- We found no evidence for the effects of leaving hollow trees in areas on primate populations.

Background

Several primate species, such as lemurs and lorises (Strepsirrhini), may seek shelter at night and/or during the day in tree hollows. It is therefore believed that leaving hollow trees in areas of selective logging will promote the survival of these species.

5.24. Clear open patches in the forest

- We found no evidence for the effects of clearing open patches in the forest on primate populations.

Background

Selective logging can substantially change the forest structure. For example, Thiollay (1997) showed that regenerating stands in northern French Guiana (northeastern Amazonia) had dense undergrowth and an open canopy, which was the inverse of that of the primary forest, which typically has an open understorey and a closed canopy. This change in forest structure as a result of selective logging may negatively affect primates, both arboreal and terrestrial in acquiring resources, shelter and their ability to move through the forest. This intervention aims at reducing part of the impact described above (at least for the more terrestrial primate species) by clearing open patches in the forest to get rid of the dense undergrowth.

The removal of trees to reduce density is discussed under 'Thin trees within forests'. The clearing of secondary mid-storey and ground-level vegetation is discussed under 'Manually control or remove secondary mid-storey and ground-level vegetation'.

Thiollay J.-M. (2007) Disturbance, selective logging and bird diversity: a Neotropical forest study. *Biodiversity and Conservation*, 6, 1155–1173.

5.25. Thin trees within forests

- We found no evidence for the effects of thinning trees within forests on primate populations.

Background

Thinning of trees entails the removal of trees to reduce density. This intervention, which is usually undertaken in commercial forestry to ensure that stands are made up of healthy even-spaced trees, aims to restore more natural open forest by increasing structural diversity in young even-aged stands and promoting the development of larger trees, multi-level canopies, and understorey vegetation. Although originally used in the context of commercial forestry, this intervention is believed to also promote primate conservation in selectively-logged forest.

The clearing of open patches in the forest to reduce undergrowth density is discussed under 'Clear open patches in the forest'. The clearing of secondary mid-storey and ground-level vegetation is discussed under 'Manually control or remove secondary mid-storey and ground-level vegetation'.

5.26. Coppice trees

- We found no evidence for the effects of coppicing trees on primate populations.

Background

Coppicing takes advantage of the fact that many trees make new growth from the stump or roots if cut down. It is a pruning technique where a tree or shrub is cut to near ground level, or higher, before bud break to encourage vigorous young shoots. In subsequent growth years, many new shoots will emerge, and, after a number of years the coppiced tree is ready to be harvested and the cycle begins again. This intervention could help to reduce the loss of mature trees, thereby reducing the negative impact of wood harvesting on the intactness of primate habitat.

5.27. Manually control or remove secondary mid-storey and ground-level vegetation

- We found no evidence for the effects of manually controlling or removing secondary mid-storey and ground-level vegetation on primate populations.

Background

To avoid overgrowth of the vegetation in the understorey that is typical for many selectively logged forests, this intervention involves manually controlling or removing secondary mid-storey and ground-level re-growth.

The clearing of open patches in the forest to reduce undergrowth density is discussed under 'Clear open patches in the forest'. The removal of trees to reduce density is discussed under 'Thin trees within forests'.

5.28. Avoid slashing climbers/lianas, trees housing them, hemi-epiphytic figs, and ground vegetation

- We found no evidence for the effects of avoiding slashing climbers/lianas, trees housing them, hemi-epiphytic figs, and ground vegetation on primate populations.

Background

Climbers, lianas, hemi-epiphytic figs *Ficus* spp. and ground vegetation represent important food sources to many primate species. As lianas physically link trees together, they also provide canopy-to-canopy access for many arboreal primates. This intervention aims to prevent cutting or damaging of these plants during selective logging activities in the hope that this will also promote primate conservation.

The avoidance of important primate food tree species during selective logging operations is discussed under 'Avoid/minimize logging of important food tree species for primates'.

5.29. Avoid/minimize logging of important food tree species for primates

- One before-and-after study in Belize[1] found that a black howler monkey population increased over 13 years after trees important for food for the species were preserved, alongside other interventions.

Background

This intervention aims to reduce the impact of selective logging on primates by avoiding/minimizing the removal of tree species that represent important food sources to primates.

The avoidance of slashing climbers or lianas, trees housing them, hemi-epiphytic figs, and ground vegetation is discussed under 'Avoid slashing climbers/lianas, trees housing them, hemi-epiphytic figs, and ground vegetation'.

A before-and-after trial in 1985-1998 in secondary riparian forest in the Community Baboon Sanctuary, Belize, South America (1) found that a population of black howler monkey *Alouatta pigra*, for which important food trees were preserved in large clearings alongside ten other interventions, increased by 138% over 13 years. The population increased from 840 to over 2,000 individuals (138% increase), although no statistical tests were carried out to determine whether this difference was significant. Additional interventions included the protection of the sanctuary by the communities surrounding it, preserving forest buffer strips along property boundaries and a forest corridor along the river, constructing pole bridges over man-made gaps, involving local communities in the management of the sanctuary, creation of a museum for education purposes, an eco-tourism and research programme, presence of permanent staff, and monetary (income from employment, tourism and craft industries) and non-monetary (e.g. better education) benefits to local communities for sustainably managing their forest and its wildlife communities.

The study does not distinguish between the effects of the different interventions mentioned above.

(1) Horwich, R.H. & J. Lyon (1998) Community-based development as a conservation tool: The Community Baboon Sanctuary and the Gales Point, Manatee project. Pages 343-363 in: R.B. Primack, D. Bray, H.A. Galletti & I. Ponciano (eds.) Timber, Tourists and Temples. Conservation and Development in the Maya Forest of Belize, Guatemala and Mexico. Island Press, Covelo.

5.30. Incorporate forested corridors or buffers into logged areas

- We found no evidence for the effects of incorporating forested corridors or buffers into logged areas on primate populations.

Background

This intervention aims at reducing the impact of primate habitat fragmentation resulted from logging by incorporating forested corridors into logged areas in order to link unlogged habitat patches or by creating buffers around natural primate habitat patches that were left unlogged.

The avoidance of critical primate habitat during logging operations is discussed under 'Use 'set-asides' for primate protection within logging area'.

5.31. Close non-essential roads as soon as logging operations are complete

- We found no evidence for the effects of closing non-essential roads as soon as logging operations are complete on primate populations.

Background

Uncontrolled roads threaten primate populations through providing access for poaching and forest encroachment (e.g. Laurance *et al*. 2009), and because they promote habitat loss, fragmentation, and wildfires. Therefore, to promote primate conservation in logging concessions, it is critical that logging companies close non-essential roads as soon as logging operations are complete.

Laurance W.F., Goosem M. & Laurance S.G.W. (2009) Impacts of roads and linear clearings on tropical forests. *Trends in Ecology and Evolution*, 24, 659–669.

5.32. Use 'set-asides' for primate protection within logging area

- We found no evidence for the effects of using 'set-asides' for primate protection within logging area on primate populations.

Background

This intervention involves creating 'set-asides' for primates, i.e. areas with critical primate habitat/important for primate conservation that are not logged, within logging areas.

The incorporation of forested corridors linking to- or buffers around critical primate habitat during logging operations is discussed under 'Incorporate forested corridors or buffers into logged areas'.

5.33. Work inward from barriers or boundaries (e.g. river) to avoid pushing primates toward an impassable barrier or inhospitable habitat

- We found no evidence for the effects of working inward from barriers or boundaries to avoid pushing primates toward an impassable barrier or inhospitable habitat on primate populations.

Background

The idea behind this intervention is to take into account physical barriers in the environment that may restrict primate movement, such as rivers, dense vegetation, mountains, steep valleys, roads or other human-made barriers, etc. when planning logging activities. In this context it is important that the logging company works inwards from such barriers to avoid pushing primates toward these, thereby allowing them to relocate to more suitable habitat.

5.34. Reduce the size of forestry teams to include employees only (not family members)

- We found no evidence for the effects of reducing the size of forestry teams to include employees only and not family members on primate populations.

Background

This intervention is based on the observation that high human densities correlate with higher primate threat intensity prevalent in these areas. In other words, primate species facing the most threat are those that occur in regions of higher than average human density (Harcourt & Parks 2003). To promote primate conservation in logging concessions, it is therefore advisable to restrict the number of people in forestry teams (only employees, not family members) and to control the influx of people into logging concessions.

The provisioning of employees with meat protein is discussed under 'Provide domestic meat to workers of the logging company to reduce hunting'.

Harcourt A.H. & Parks S.A. (2003) Threatened primates experience high human densities: adding an index of threat to the IUCN Red List criteria. *Biological Conservation*, 109, 137–149.

5.35. Certify forest concessions and market their products as 'primate friendly'

- We found no evidence for the effects of certifying forest concessions and marketing their products as 'primate friendly' on primate populations.

Background

More than fifty certification standards already exist worldwide aiming to ensure the sustainable logging of forests (e.g. Programme for the Endorsement of Forest Certification (PEFC), Forest Stewardship Council (FSC)). Forest certification verifies that forests are well-managed as defined by a particular standard, and chain-of-custody certification tracks wood and paper products from the certified forest through processing to the point of sale. None of these certifications, however, directly relate to primates or their habitats. This intervention involves the certification of wood logged by companies that adhere to strict impact minimization/mitigation/compensation schemes to promote the conservation of key primate populations and their habitat. Certified products could then be marketed as 'primate friendly' and sold at a premium.

5.36. Provide domestic meat to workers of the logging company to reduce hunting

- We found no evidence for the effects of providing domestic meat to workers of the logging company to reduce hunting on primate populations.

Background

Several studies have shown that bushmeat consumption is not solely taste-driven (e.g. Jenkins *et al*. 2011), but that other factors, such as price (Schenck *et al*. 2006) and availability (e.g. Fa *et al*. 2003) may play an important role in human meat choice. Because of this, it is believed that providing workers employed by the logging company with alternative domestic meat sources will reduce illegal hunting for bushmeat.

Reducing the size of forestry teams in an effort to reduce human density-dependent threat levels to primates and their habitat, particularly poaching, is discussed under 'Reduce the size of forestry teams to include employees only (not family members)'.

Fa J.E., Currie D. & Meeuwig J. (2003) Bushmeat and food security in the Congo Basin: linkages between wildlife and people's future. *Environmental Conservation*, 30, 71–78.

Jenkins R.K.B., Keane A., Rakotoarivelo A.R., Rakotomboavonjy V., Randrianandrianina F.H., Razafimanahaka H.J., Ralaiarimalala S.R. & Jones J.P.G. (2011) Analysis of patterns of bushmeat consumption reveals extensive exploitation of protected species in eastern Madagascar. *PLoS ONE*, 6, e27570.

Schenck M., Nsame Effa E., Starkey M., Wilkie D., Abernethy K., Telfer P., Godoy R. & Treves A. (2006) Why people eat bushmeat: results from two-choice, taste tests in Gabon, Central Africa. *Human Ecology*, 34, 433–445.

6. Threat: Human Intrusions & Disturbance

Background

In addition to large-scale disturbances from activities such as agriculture, biological resource use and infrastructure development, disturbance of primate populations can be caused by smaller scale human intrusions as a result of tourism, civil conflict, or other motivations for people to intrude primate habitat. For example, Berman *et al*. (2007) found that primate tourism at Mt. Huangshan in China, led to increases in infant mortality of Tibetan macaques *Macaca thibetana* via increases in adult aggression. Large numbers of tourists in boats altered the behavior of proboscis monkeys in Kinabatagan, Borneo, with reduced time spent grooming and playing compared to when no boats were present (Leasor & McGregor 2014). Another study from Ecuador (de la Torre *et al*. 2000) demonstrated that groups of pygmy marmosets *Cebuella pygmaea* that were exposed to tourism showed lower reproductive performances than those of the other groups. A study in conflict-ridden Democratic Republic of the Congo found that the recent political and economic crises in and around Kahuzi-Biega National Park greatly contributed to the loss of half of the resident gorilla *Gorilla beringei graueri* population (Yamagiwa 2003).

Berman C.M., Li J., Ogawa H., Ionica C. & Yin H. (2007) Primate tourism, range restriction, and infant risk among *Macaca thibetana* at Mt. Huangshan, China. *International Journal of Primatology*, 28, 1123–1141.

de la Torre S., Snowdon C.T. & Bejarano M. (2000) Effects of human activities on wild pygmy marmosets in Ecuadorian Amazonia. *Biological Conservation*, 94, 153–163.

Leasor & McGregor (2014) Proboscis monkey tourism: can we make it “ecotourism”? *Primate Tourism: A tool for Conservation?,* 56-75.

Yamagiwa J. (2003) Bushmeat poaching and the conservation crisis in Kahuzi-Biega National Park, Democratic Republic of the Congo. *Journal of Sustainable Forestry*, 16, 111–130.

Key messages

Implement a ‘no-feeding of wild primates’ policy

A controlled before-and-after study in Japan found that reducing food provisioning of macaques progressively reduced productivity and reversed population increases and crop and forest damage.

Build fences to keep humans out

We captured no evidence for the effects of building fences to keep humans out on primate populations.

Restrict number of people that are allowed access to the site

We captured no evidence for the effects of restricting the number of people that are allowed access to the site on primate populations.

Install ‘primate-proof’ garbage bins

We captured no evidence for the effects of installing ‘primate-proof’ garbage bins on primate populations.

Put up signs to warn people about not feeding primates

One review study in Japan found that after macaque feeding by tourists was banned and advertised, the number of aggressive incidents between people and macaques decreased as well as the number of road collisions with macaques that used to be fed from cars.

Do not allow people to consume food within natural areas where primates can view them

We captured no evidence for the effects of not allowing people to consume food within natural areas where primates can view them on primate populations.

Resettle illegal human communities (i.e. in a protected area) to another location

One review on gorillas in Uganda found that no more gorillas were killed after human settlers were relocated outside the protected area, alongside other interventions. One before-and-after study in the Republic of Congo found that most reintroduced chimpanzees survived over five years after human communities were resettled, alongside other interventions.

6.1. Implement a 'no-feeding of wild primates' policy

- One controlled before-and-after study in Japan[1] found that several previously increasing Japanese macaque populations declined in size and productivity after limiting and then prohibiting food provisioning.

Background

The deliberate and long-term provision of food to wildlife by people, e.g. tourists, or for attracting tourists, can have a variety of negative impacts. For example, it can alter natural behavioural patterns and wildlife population levels, has resulted in the dependency of animals on the human provided food and their habituation to human contact, has increased intra and inter-species aggression, and has various health implications arising from artificial food sources causing injury and disease (Orams 2002). In some cases, enforcement can be poor; e.g. one study found that despite a policy not allowing it, orangutans were regularly provided food by both tourists and guides, resulting in modified behaviours compared to wild orangutans and aggressive human-orangutan interactions (Dellatore et al. 2014). This intervention involves enforcing a 'no-feeding of wild primates' policy to prohibit the provision of food to primates.

The use of signage to warn people not to feed primates is discussed under 'Put up signs to warn people about not feeding primates'. The use of garbage bins inaccessible to primates is discussed under 'Install 'primate-proof' garbage bins'. Prohibiting people from consuming food in natural primate habitat is discussed under 'Do not allow people to consume food within natural areas where primates can view them'.

Orams M.B. (2002) Feeding wildlife as a tourism attraction: a review of issues and impacts. *Tourism Management*, 23, 281–293.
Dellatore, D. F., Waitt, C. D., & Foitovà, I. (2014). The impact of tourism on the behavior of rehabilitated orangutans (Pongo abelii) in Bukit Lawang, North Sumatra, Indonesia. Primate tourism: A tool for conservation, 98-120.

A controlled before-and-after study in 1950-2010 at multiple sites in Japan (1) found that Japanese macaques *Macaca fuscata* were rapidly increasing in population size, conflict rate with farmers and forest damage at food-provisioned sites compared to non-provisioned sites, but reducing feeding resulted in lower productivity, population decreases, less crop-raiding and forest damage in the long term. The Takasakiyama population increased from 166 macaques in 1950, before food provisioning, to over 2000 in 1990, but then declined by almost 50% by 2011 after food provisioning was progressively reduced in 1973-1989 and then stopped (data in graphs). Reducing provisioning resulted initially in higher crop damage (data not provided). Birth rate was higher in sites with food provisioning (0.49-0.54 births/female/year) than in non-provisioned sites (0.27-0.35) but productivity declined after provisioning was limited and annual population growth reduced from 13% in 1952-1962 to 4% in 1965-1970, 3% in 1970-1980, 1.1% in 1980-1990 and -0.65% in 1990-2000. In 1952-1972 food provisioning took place at 41 free-ranging monkey parks to attract tourists and reduce crop damage; 30 naturally occurring populations and 11 sites with translocated 'problem' macaques. Provisioned foods (sweet potato, wheat, soybean and peanuts) were far more energy-rich than natural macaque food. Food provisioning by staff was reduced since 1965 and food provisioning by visitors was prohibited in 1993 at Takasakiyama.

(1) Kurita, H. (2014) Provisioning and tourism in free-ranging Japanese macaques. *Primate tourism: a tool for conservation*, 44-56.

6.2. Build fences to keep humans out

- We found no evidence for the effects of building fences to keep humans out on primate populations.

Background

This intervention aims to keep people out of primate habitat with the aid of fences to avoid direct negative impacts on primates due to human activities.

Restricting human access to primate habitat is discussed under 'Restrict number of people that are allowed access to site'.

6.3. Restrict the number of people that are allowed access to site

- We found no evidence for the effects of restricting the number of people that are allowed access to the site on primate populations.

Background

Primates are able to tolerate different levels of disturbance. For species that are relatively sensitive to human disturbance, it may be possible to reduce human impact with access restrictions. Reducing access may help to reduce the risk of human introduction of disease, stress, and any physical destruction of primate habitat and resources.

Prohibiting people from accessing primate habitat altogether is discussed under 'Build fences to keep humans out'.

6.4. Install 'primate-proof' garbage bins

- We found no evidence for the effects of installing 'primate-proof' garbage bins on primate populations.

Background

Because primates have opposable digits, they can easily open garbage bins that are inaccessible to other wildlife species and therefore, garbage bins at tourist sites or other areas that are frequented by both humans and other primates are frequently raided by the latter. The consumption of human food wastes by primates can result in their dependency on the human provided food, their habituation to human contact, increased intra and inter-species aggression, and various health implications arising from artificial food sources causing injury and disease (Orams 2002). This intervention aims to reduce the raiding of garbage bins by primates by designing garbage bins in such a way that their content becomes inaccessible to them (e.g. mounting bins to the ground, adding lids and locks to prevent primates from opening the lids).

The use of signage to inform people about not being allowed to feed primates is discussed under 'Put up signs to warn people about not feeding primates'. The implementation and enforcement of 'no-feeding' policies is discussed under 'Implement a 'no-feeding of wild primates' policy'. Prohibiting people from consuming food in natural primate habitat is discussed under 'Do not allow people to consume food within natural areas where primates can view them'.

Orams M.B. (2002) Feeding wildlife as a tourism attraction: a review of issues and impacts. *Tourism Management*, 23, 281–293.

6.5. Put up signs to warn people about not feeding primates

- One review study in Japan[1] found that aggressive interactions between Japanese macaques and humans declined after prohibiting tourists from feeding of monkeys.

Background

The consumption of human food wastes or the feeding by tourists of primates can result in their dependency on the human provided food, their habituation to human contact, increased intra and inter-species aggression, and various health implications arising from artificial food sources causing injury and disease (Orams 2002). This intervention aims to reduce the negative impact of consumption of human food wastes by primates, by installing signage to warn people about not feeding primates.

The implementation and enforcement of 'no-feeding' policies is discussed under 'Implement a 'no-feeding of wild primates' policy'. The use of garbage bins inaccessible to primates is discussed under 'Install 'primate-proof' garbage bins'. Prohibiting people from consuming food in natural primate habitat is discussed under ‘Do not allow people to consume food within natural areas where primates can view them’.

Orams M.B. (2002) Feeding wildlife as a tourism attraction: a review of issues and impacts. *Tourism Management*, 23, 281–293.

A review in 2010 at multiple sites in Japan (1) found that aggressive interractions between free-ranging Japanese macaques *Macaca fuscata* and humans decreased after food provision by tourists was prohibited and the message was clearly transmitted. After decades of primate feeding by tourists, the practice was banned and the number of aggressive incidents of macaques on people decreased at multiple sites as well as the macaque road collisions at sites where tourists used to feed monkeys from the cars (no data included). The distance to tourists also increased after the ban (no data provided). No statistical tests were carried out to determine whether these differences were significant. The shop used by tourists to buy food for macaques at Takasakiyama Nature Zoo was closed in 1993 and the feeding of primates was prohibited and advertised using signs and direct advice by rangers during educational talks. In 1952-1972 food provisioning took place at 41 free-ranging monkey parks to attract tourists and reduce crop damage but resulted in rapidly increasing populations, crop and forest damage and the need to control macaques. Food provisioning by tourists was prohibited in the 1990s.

(1) Kurita, H. (2014) Provisioning and tourism in free-ranging Japanese macaques. *Primate tourism: a tool for conservation*, 44-56.

6.6. Do not allow people to consume food within natural areas where primates can view them

- We found no evidence for the effects of not allowing people to consume food within natural areas where primates can view them on primate populations.

Background

In areas where primates and humans come into close contact with one another, such as at tourist sites, some primate species may develop extremely effective strategies to access the food that is eaten by humans at these sites. However, the consumption of human food wastes by primates can result in their dependency on the human provided food, their habituation to human contact, increased intra and inter-species aggression, and various health implications arising from artificial food sources causing injury and disease (Orams 2002). This intervention aims to reduce the negative impact of consumption of human foods by primates, by disallowing people to consume food within natural areas where primates can view them.

The use of signage to inform people not to feed primates is discussed under ‘Put up signs to warn people about not feeding primates’. The use of garbage bins inaccessible to primates is discussed under ‘Install ‘primate-proof’ garbage bins'. The implementation and enforcement of 'no-feeding' policies is discussed under 'Implement a 'no-feeding of wild primates' policy'.

Orams M.B. (2002) Feeding wildlife as a tourism attraction: a review of issues and impacts. *Tourism Management*, 23, 281–293.

6.7. Resettle illegal human communities (i.e. in a protected area) to another location

- One review on mountain gorillas[1] in Uganda found that no more gorillas were killed after illegal settlers were relocated from the area, alongside other interventions.
- One before-and-after study in the Republic of Congo[2] found that most reintroduced chimpanzees survived over five years after human communities were resettled, from the protected area alongside other interventions.

Background

The resettlement of people from existing or newly-established protected areas to increase protection of the habitat and the species living in it, is inherently political and hotly debated (Adams & Hutton 2007). The intervention is based on the notion that settlements and the actions of the people living in these settlements threaten the integrity of the natural area that is under protection. Therefore, the intervention involves moving the people from inside the protected area to the outside. Examples of resettled communities include the people from the Nechasar National Park in southern Ethiopia, before handing the area over to the African Parks Foundation, displacements in Korup National Park, Cameroon, through a progressive resettlement scheme of the Ekundukundu Village, or the eviction of Bushmen from the Central Kalahari Game Reserve (Adams & Hutton 2007).

Adams W.M. & Hutton J. (2007) People, parks and poverty: political ecology and biodiversity conservation. *Conservation and Society*, 5, 147–183.

A review of mountain gorillas *Gorilla beringei beringei* in 1972-1989 in tropical montane forest in Eastern Virungas Conservation Area, Uganda (1) found that no gorillas were killed in 1989-1990 after human settlers were relocated from an area inside the Gorilla Game Reserve alongside other interventions. This area represented important gorilla habitat and was 3 km^2 in size. At the same time, the game guard force was also increased from three to 13 men, provided with better equipment, and trained and supervised by researchers who started working in the area as part of a permanent research project. The study does not distinguish between the effects of the different interventions mentioned above.

A before-and-after trial in 1994-1999 in mixed tropical dry and swamp forest in Conkouati-Douli National Park, Republic of Congo (2) found that the majority of reintroduced central chimpanzees *Pan troglodytes troglodytes* survived for at least five years when resident illegal human communities were resettled to another location along with 16 other interventions. Fourteen out of 20 reintroduced chimpanzees (70%) survived until at least the end of the study. No statistical tests were carried out to determine whether the population decrease was significant. Thirteen local people that lived at the release site were moved to a village nearby. Rehabilitated orphaned chimpanzees underwent vaccination, treatment for parasites and veterinary screens before being radio-collared and translocated in four subgroups to the release site where wild chimpanzees lived. Staff members were permanently present to monitor primate health, provide animals with additional food if necessary and detect and examine dead animals. The area status was upgraded from a reserve to a national park in 1999. Some individuals were treated when sick or injured. TV and radio advertisements were used to raise chimpanzee conservation awareness and local people were provided monetary and non-monetary benefits in exchange for their conservation support. The study does not distinguish between the effects of the different interventions mentioned above.

(1) Butynski T.M., Werikhe S.E. & Kalina J. (1990) Status, distribution and conservation of the mountain gorilla in the Gorilla Game Reserve, Uganda. *Primate Conservation*, 11, 31–41.
(2) Tutin C.E.G., Ancrenaz M., Paredes J., Vacher-Vallas M., Vidal C., Goossens B., Bruford M.W. & Jamart A. (2001) The conservation biology framework of the release of wild-born orphaned chimpanzees into the Conkouati Reserve, Congo. *Conservation Biology*, 15, 1247–1257.

7. Threat: Natural System Modifications

Background

This chapter refers to the use of controlled fires. Controlled burns are used in forest management, including those inhabited by primates, to reduce the risk of more damaging uncontrolled natural fires and to stimulate tree germination. They may also be used to maintain or restore habitats that historically were subject to occasional 'wildfires' that have been suppressed through management.

Key messages

Use prescribed burning within the context of home range size and use

We captured no evidence for the effects of using prescribed burning within the context of home range size and use on primate populations.

Control fires

We captured no evidence for the effects of controlling fires on primate populations.

Protect important food/nest trees before burning

We captured no evidence for the effects of protecting important food/nest trees before burning on primate populations.

7.1. Use prescribed burning within the context of home range size and use

- We found no evidence for the effects of using prescribed burning within the context of home range size and use on primate populations.

Background

Controlled burning alters forest structure and opens up the tree canopy, which can affect primates in different ways, depending on their habitat and ecology, as well as fire intensity, frequency and size of the burnt area. While some species, like the Siamang *Symphalangus syndactylus*, avoid fires, others, like some baboon- *Papio* spp., Guenon- *Cercopithecus* spp. and Macaque species *Macaca* spp., as well as western chimpanzees *Pan troglodytes verus*, forage in burns and consume cooked fruits and seeds (Herzog *et al*. 2014). Furthermore, fire-induced primate range expansions have been observed and documented for yellow baboons *Papio cynocephalus* and vervet monkeys *Chlorocebus aethiops.* Prescribed burning may result in immediate foraging improvements post-fire, as well as delayed foraging opportunities in burned habitats. Therefore, controlled burning could potentially be used to promote primate conservation through improving foraging opportunities.

Herzog N.M., Parker C.H., Keefe E.R., Coxworth J., Barrett A. & Hawkes K. (2014) Fire and home range expansion: a behavioral response to burning among savanna dwelling vervet monkeys (*Chlorocebus aethiops*). *American Journal of Physical Anthropology*, 154, 554–560.

7.2. Protect important food/nest trees before burning

- We found no evidence for the effects of protecting important food/nest trees before burning on primate populations.

Background

Primates depend on trees for finding food, building nests and seeking shelter. These species may suffer population declines if fires damage the trees they depend on for survival. Protecting important food/nest trees may help reduce this negative effect.

8. Threat: Invasive & Other Problematic Species & Genes

Background

In the context of this primate synopsis, this chapter deals mostly with the threat of disease contamination to primates. We therefore separated this chapter into two sections: 'problematic animal/plant species & genes' and 'disease transmission'. We found no evidence for interventions featuring in the first section, involving mainly strategies to reduce primate predation, habitat alteration, and competition caused by other species, and the impact of vegetation and genes introduced by alien plant- and primate species. The section on disease transmission includes mostly (but not exclusively) conservation interventions aiming to control diseases transmitted from humans to primates. Disease represents an important threat to primates specifically, because they are our closest living relatives and therefore can contract many of the diseases that also affect humans. This threat has been increasing over the past forty years as humans have encroached deeper into previously inaccessible primate habitat, bringing along pathogens that may spread across to resident primate populations. Many of the interventions listed below form part of reintroduction and relocation studies, which are described separately in the chapter 'Action: Species Management'.

For guidelines on preventing disease transmission and veterinary requirements in the context of primate reintroductions, please refer to 'The Guidelines for Nonhuman primate Re-introductions' developed by the 'Re-introduction Specialist Group of IUCN's Species Survival Commission (SSC)' (Soorae & Baker 2002). For best practice guidelines for disease control in great apes specifically, please refer to the 'Best practice guidelines for health monitoring and disease control in great ape populations' developed by the IUCN's Species Survival Commission (SSC)/Primate Specialist Group (PSG) (Gilardi *et al*. 2015).

Gilardi K.V., Gillespie T.R., Leendertz F.H., Macfie E.J., Travis D.A., Whittier C.A. & Williamson, E.A. (2015) *Best Practice Guidelines for Health Monitoring and Disease Control in Great Ape Populations*. IUCN SSC Primate Specialist Group, Gland.

Soorae P.S. & Baker L.R. (2002) *Re-introduction NEWS: Special Primate Issue*. Newsletter of the IUCN/SSC Re-introduction Specialist Group, Abu Dhabi, United Arab Emirates. No. 21.

Key messages – problematic animal/plant species & genes

Reduce primate predation by non-primate species through exclusion (e.g. fences) or translocation

We captured no evidence for the effects of reducing primate predation by non-primate species through exclusion or translocation on primate populations.

Reduce primate predation by other primate species through exclusion (e.g. fences) or translocation

We captured no evidence for the effects of reducing primate predation by other primate species through exclusion or translocation on primate populations.

Control habitat-altering mammals (e.g. elephants) through exclusion (e.g. fences) or translocation
We captured no evidence for the effects of controlling habitat-altering mammals through exclusion or translocation on primate populations.
Control inter-specific competition for food through exclusion (e.g. fences) or translocation
We captured no evidence for the effects of controlling inter-specific competition for food through exclusion or translocation on primate populations.
Remove alien invasive vegetation where the latter has a clear negative effect on the primate species in question
We captured no evidence for the effects of removing alien invasive vegetation on primate populations.
Prevent gene contamination by alien primate species introduced by humans, through exclusion (e.g. fences) or translocation
We captured no evidence for the effects of preventing gene contamination by alien primate species introduced by humans, through exclusion or translocation on primate populations.

Key messages – disease transmission

Wear face-masks to avoid transmission of viral and bacterial diseases to primates
One before-and-after study in Rwanda, Uganda and the Democratic Republic of Congo found that gorilla numbers increased while being visited by researchers and visitors wearing face-masks, alongside other interventions. One study in Uganda found that a confiscated chimpanzee was successfully reunited with his mother after being handled by caretakers wearing face-masks, alongside other interventions.
Keep safety distance to habituated animals
One before-and-after study in the Republic of Congo found that most reintroduced chimpanzees survived over five years while being routinely followed from a safety distance, alongside other interventions. One before-and-after study in Rwanda, Uganda and the Democratic Republic of Congo found that gorilla numbers increased while being routinely visited from a safety distance, alongside other interventions. However, one study in Malaysia found that orangutan numbers declined while being routinely visited from a safety distance.
Limit time that researchers/tourists are allowed to spend with habituated animals
One before-and-after study in Rwanda, Uganda and the Democratic Republic of Congo found that gorilla numbers increased while being routinely visited during limited time, alongside other interventions. One controlled study in Indonesia found that the behaviour of orangutans that spent limited time with caretakers was more similar to the behaviour of wild orangutans than that of individuals that spent more time with caretakers.
Implement quarantine for people arriving at, and leaving the site
We captured no evidence for the effects of implementing quarantine for people arriving at, and leaving the site on primate populations.
Implement quarantine for primates before reintroduction/translocation
Six studies, including four before-and-after studies, in Brazil, Madagascar, Malaysia and Indonesia have found that most reintroduced primates did not survive or their

population size decreased over periods ranging from months up to seven years post-release, despite being quarantined before release, alongside other interventions. However, two before-and-after studies in Indonesia, the Republic of Congo and Gabon found that most orangutans and gorillas that underwent quarantine survived over a period ranging from three months to 10 years. One before-and-after study in Uganda found that one reintroduced chimpanzee repeatedly returned to human settlements after being quarantined before release alongside other interventions.

Ensure that researchers/tourists are up-to-date with vaccinations and healthy

One before-and-after study in Rwanda, Uganda and the Republic of Congo found that gorilla numbers increased while being visited by healthy researchers and visitors, alongside other interventions. However, one controlled study in Malaysia found that orangutan numbers decreased despite being visited by healthy researchers and visitors, alongside other interventions.

Regularly disinfect clothes, boots etc.

One before-and-after study in Rwanda, Uganda and the Democratic Republic of Congo found that gorilla numbers increased while being regularly visited by researchers and visitors whose clothes were disinfected, alongside other interventions.

Wear gloves when handling primate food, tool items, etc.

We captured no evidence for the effects of wearing gloves when handling food, toll items, etc. on primate populations.

Preventative vaccination of habituated or wild primates

Three before-and-after studies in the Republic of Congo and Gabon, two focusing on chimpanzees and one in gorillas, found that most reintroduced individuals survived over 3.5-10 years after being vaccinated, alongside other interventions.

Treat sick/injured animals

Eight studies, including four before-and-after studies, in Brazil, Malaysia, Liberia, the Democratic Republic of Congo, The Gambia and South Africa found that most reintroduced or translocated primates that were treated when sick or injured, alongside other interventions, survived being released and up to at least five years. However, five studies, including one review and four before-and-after studies, in Brazil, Thailand, Malaysia and Madagascar found that most reintroduced or translocated primates did not survive or their numbers declined despite being treated when sick or injured, alongside other interventions. One study in Uganda found that several infected gorillas were medically treated after receiving treatment, alongside other interventions. One study in Senegal found that one chimpanzee was reunited with his mother after being treated for injuries, alongside other interventions.

Remove/treat external/internal parasites to increase reproductive success/survival

Five studies, including four before-and-after studies, in the Republic of Congo, The Gambia and Gabon found that most reintroduced or translocated primates that were treated for parasites, alongside other interventions, survived periods of at least five years. However, four studies, including one before-and-after study, in Brazil, Gabon and Vietnam found that most reintroduced primates did not survive or their numbers declined after being treated for parasites, alongside other interventions.

Control 'reservoir' species to reduce parasite burdens/pathogen sources

We captured no evidence for the effects of controlling 'reservoir' species to reduce parasite/pathogen sources on primate populations.

Conduct veterinary screens of animals before reintroducing/translocating them

Twelve studies, including seven before-and-after studies, in Brazil, Malaysia, Indonesia, Liberia, the Republic of Congo, Guinea, Belize, French Guiana and Madagascar found that most reintroduced or translocated primates that underwent pre-release veterinary screens, alongside other interventions, survived, in some situations, up to at least five years or increased in population size. However, 10 studies, including six before-and-after studies, in Brazil, Malaysia, French Guiana, Madagascar, Kenya, South Africa and Vietnam found that most reintroduced or translocated primates did not survive or their numbers declined after undergoing pre-release veterinary screens, alongside other interventions. One before-and-after study in Uganda, found that one reintroduced chimpanzee repeatedly returned to human settlements after undergoing pre-release veterinary screens, alongside other interventions. One controlled study in Indonesia found that gibbons that underwent pre-release veterinary screens, alongside other interventions, behaved similarly to wild gibbons.

Implement continuous health monitoring with permanent vet on site

One controlled, before-and-after study in Rwanda, Uganda and the Republic of Congo found that numbers of gorillas that were continuously monitored by vets, alongside other interventions, increased over 41 years.

Avoid contact between wild primates and human-raised primates

We captured no evidence for the effects of avoiding contact between wild primates and human-raised primates on primate populations.

Detect & report dead primates and clinically determine their cause of death to avoid disease transmission

Four studies, including two before-and-after studies, in Madagascar, Vietnam and Indonesia found that most reintroduced primates did not survive after dead individuals were examined to determine their cause of death, alongside other interventions. Two before-and-after studies in Congo and French Guiana found that most reintroduced chimpanzees and translocated sakis survived between five months and at least five years while dead individuals were examined to determine their cause of death, alongside other interventions. One before-and-after, site comparison study in Gabon and the Republic of Congo found that most gorillas survived over four years when dead individuals were examined to determine their cause of death, alongside other interventions.

Implement a health programme for local communities

We captured no evidence for the effects of implementing a health programme for local communities on primate populations.

8.1. Reduce primate predation by non-primate species through exclusion (e.g. fences) or translocation

- We found no evidence for the effects of reducing primate predation by other non-primate species through exclusion or translocation on primate populations.

Background

This intervention is important for primate species that are predated upon by non-primate species, such as large cats like leopards *Panthera pardus*, jaguars *Panthera onca*, cougars *Puma concolor*, raptors such as eagles *Aquila* spp., big snakes like pythons (Pythonidae) and *Boa constrictor*, as well as crocodiles (Crocodylinae) and caimans (Caimaninae). By excluding predator species by e.g., building predator-proof fences, or translocating predators elsewhere, this intervention may benefit the conservation of the primate population that the intervention is intended for. This is an invasive intervention and its usefulness should be carefully considered from an ethical perspective before implementing it.

Controlling predation by other primate species is discussed under 'Reduce primate predation by other primate species through exclusion (e.g. fences) or translocation', controlling mammals that may alter the primate species' habitat is discussed under 'Control habitat-altering mammals (e.g. elephants) through exclusion (e.g. fences) or translocation', and controlling competition for food with other species is discussed under 'Control inter-specific competition for food through exclusion (e.g. fences) or translocation'.

8.2. Reduce primate predation by other primate species through exclusion (e.g. fences) or translocation

- We found no evidence for the effects of reducing primate predation by other primate species through exclusion or translocation on primate populations.

Background

This intervention applies to primate species that are predated upon by other primate species, such as chimpanzees *Pan troglodytes* predating on colobus monkeys (*Colobus* spp.) (e.g. Boesch & Boesch 1989). Excluding these species by building predator-proof fences or translocating them elsewhere may benefit the conservation of the primate population this intervention is intended for. This is an invasive intervention and its usefulness should be carefully considered from an ethical perspective before implementing it.

Controlling predation by non-primate species is discussed under 'Reduce primate predation by non-primate species through exclusion (e.g. fences) or translocation', controlling mammals that may alter the primate species' habitat is discussed under 'Control habitat-altering mammals (e.g. elephants) through exclusion (e.g. fences) or translocation', and controlling competition for food with other species is discussed under 'Control inter-specific competition for food through exclusion (e.g. fences) or translocation'.

Boesch C. & Boesch H. (1989) Hunting behavior of wild chimpanzees in the Taï National Park. *American Journal of Physical Anthropology*, 78, 547–573.

8.3. Control habitat-altering mammals (e.g. elephants) through exclusion (e.g. fences) or translocation

- We found no evidence for the effects of controlling habitat-altering mammals through exclusion or translocation on primate populations.

Background

This intervention involves excluding mammals that alter the habitat in such a way that it may negatively affect primate populations. For example, elephants may destroy large numbers of trees when they occur at very high densities (e.g. Laws 1970). If, for example, the destruction of trees by elephants resulted in food shortages for resident primate population, then this intervention may indirectly benefit primates that depend on these plants for food through allowing the habitat to recover, once the elephants are removed. This is an invasive intervention and its usefulness should be carefully considered from an ethical perspective before implementing it.

Controlling predation by non-primate species is discussed under 'Reduce primate predation by non-primate species through exclusion (e.g. fences) or translocation', controlling predation by other primate species is discussed under 'Reduce primate predation by other primate species through exclusion (e.g. fences) or translocation', and controlling competition for food with other species is discussed under 'Control inter-specific competition for food through exclusion (e.g. fences) or translocation'.

Laws R.M. (1970) Elephants as agents of habitat and landscape change in East Africa. *Oikos*, 21, 1–15.

8.4. Control inter-specific competition for food through exclusion (e.g. fences) or translocation

- We found no evidence for the effects of controlling inter-specific competition for food through exclusion or translocation on primate populations.

Background

This intervention involves removing animal species that compete with primates for food. This is an invasive intervention and its usefulness should be carefully considered from an ethical perspective before implementing it.

Controlling predation by non-primate species is discussed under 'Reduce primate predation by non-primate species through exclusion (e.g. fences) or translocation', controlling predation by other primate species is discussed under 'Reduce primate predation by other primate species through exclusion (e.g. fences) or translocation', and controlling mammals that may alter the primate species' habitat is discussed under 'Control habitat-altering mammals (e.g. elephants) through exclusion (e.g. fences) or translocation'.

8.5. Remove alien invasive vegetation where the latter has a clear negative effect on the primate species in question

- We found no evidence for the effects of removing alien invasive vegetation on primate populations.

Background

The negative impact of alien invasive vegetation on resident native species, communities or ecosystems has been demonstrated by a wide range of studies (Vilà *et al*. 2011). This intervention involves the removal of alien invasive vegetation and could be implemented in the cases where such vegetation has a negative effect on the primate species in question. For example, alien invasive vegetation may replace native plant species that present important food sources to primates or that were used for shelter by the primate species in question. Furthermore, alien invasive vegetation may also alter fire regimes thereby representing a direct (death or injury) and indirect (habitat destruction) threat to resident primate populations (Brooks *et al*. 2004).

Brooks M.L, D'antonio C.M., Richardson D.M., Grace J.B., Keeley J.E., Ditomaso J.M., Hobbs R.J., Pellant M. & Pyke D. (2004) Effects of invasive alien plants on fire regimes. *BioScience*, 54, 677–688.
Vilà M., Espinar J.L, Hejda M., Hulme P.E., Vojtěch J., Maron J.L., Pergl J., Schaffner U., Sun Y. & Pyšek P. (2011) Ecological impacts of invasive alien plants: a meta-analysis of their effects on species, communities and ecosystems. *Ecology Letters*, 14, 702–708.

8.6. Prevent gene contamination by alien primate species introduced by humans, through exclusion (e.g. fences) or translocation

- We found no evidence for the effects of preventing gene contamination by alien primate species introduced by humans, through exclusion or translocation on primate populations.

Background

This intervention aims to prevent the breeding/mixing of genes (hybridizing) of alien (non-native) and native primate species through exclusion by e.g. primate-proof fences or by translocation of the alien species. There are not many cases in the world where alien and native primate species co-occur and breed with one another. One example is the threatened golden-headed lion tamarin *Leonthopithecus chrysomelas* that was introduced in Niterói city forests (Rocha *et al*. 2011). *L. chrysomelas* hybridizes with the native species *L. rosalia* thereby weakening the latter's gene pool (Rocha *et al*. 2011). Rocha and Bergallo (2012) recommend that for populations of threatened species in areas outside their original distribution, a programme is needed that includes identification of areas within the natural range where the species is extinct, removal of the causes of extinction in those areas, then gradual removal of the species from its introduced range and release in the relocation areas following the IUCN guidelines for reintroduction of species.'

Rocha C.F.D., Bergallo H.G. & Mazzoni R. (2011) Invasive vertebrates in Brazil. Pages 53–103 in: D. Pimentel (ed.) *Biological Invasions: Economic and Environmental Costs of Alien Plant, Animal and Microbe Species*. Taylor and Francis, New York.
Rocha C.F.D. & Bergallo H.G. (2012) When invasive exotic populations are threatened with extinction. *Biodiversity Conservation*, 21, 3729–3730.

Disease transmission

8.7. Wear face-masks to avoid transmission of viral and bacterial diseases to primates

- One study in Uganda[1] found that a confiscated young chimpanzee was reunited with its mother after being handled by caretakers wearing face-masks, alongside other interventions.
- One before-and-after study in Rwanda, Uganda and the Democratic Republic of Congo[2] found that numbers of mountain gorillas increased by 168% over 41 years while being visited by researchers and visitors wearing face-masks, alongside other interventions.

Background

This intervention aims to prevent the spread of viral and bacterial diseases from humans to primates and may be especially important in situations where humans come into close contact with primates. Examples include researchers and tourists that observe habituated primates in their natural habitat, but also management/research staff involved in primate translocations, captive breeding, etc.

Other means of preventing the spread of bacterial and viral diseases from researchers/tourists/managers to primates are discussed under 'Keep safety distance to habituated animals', 'Limit time that researchers/tourists are allowed to spend with habituated animals', 'Implement quarantine for people arriving at, and leaving the site', 'Ensure that researchers/tourists are up-to-date with vaccinations and healthy', 'Regularly disinfect clothes, boots etc.', and 'Wear gloves when handling primate food, tool items, etc.'.

A study in 2009 in savanna-woodland mosaic in Niokolo-Koba National Park, Senegal (1) found that a confiscated 9-months old female infant chimpanzee *Pan troglodytes verus* that was handled by caretakers wearing face-masks along with other interventions, was reunited with its mother in the wild. Four days after confiscation, the chimpanzee was released in the vicinity of its natal group, which retrieved it immediately. The author wore a surgical mask and sanitized her hands when handling the infant and its food to prevent disease transmission. The infant's natal group was located with the aid of poachers, after which it was released close to the group. The infant was also treated for its injured eye. The study does not distinguish between the effects of the different interventions mentioned above.

A controlled, before-and-after study in 1967-2008 in tropical moist montane forest in Volcanoes-, Mgahinga-, and Virunga National Parks in Rwanda, Uganda, and the Democratic Republic of Congo (2) found that the mountain gorilla *Gorilla beringei beringei* population that was regularly visited by tourists and researchers that wore face-masks to avoid disease transmission along with ten other interventions, increased in size over time. Annual population growth was 4.1%, resulting in an overall population increase of 168% over 41 years. No statistical tests were carried out to determine whether this increase was significant. All visitors/researchers were recommended to wear N95 masks (when available) or a surgical mask when visiting the gorillas. Gorillas were habituated to human presence as part of the ecotourism and research programmes and visitors/researchers had to follow strict health procedures; these included keeping a safety distance to the gorillas, spending only a limited amount of time with gorilla groups, ensuring that visitors/researchers were healthy, and disinfecting visitor's/researcher's clothes, boots etc. In addition, the population was continuously monitored by vets and gorillas received medical treatment if necessary. When gorillas died, their cause of death was clinically determined. The study does not distinguish between the effects of the different interventions mentioned above.

(1) Pruetz J.D. & Kante D. (2010) Successful return of a wild infant chimpanzee (*Pan troglodytes verus*) to its natal group after capture by poachers. *African Primates*, 7, 35–41.

(2) Robbins M.M., Gray M., Fawcett K.A., Nutter F.B., Uwingeli P., Mburanumwe I., Kagoda E., Basabose A., Stoinski T.S., Cranfield M.R., Byamukama J., Spelman L.H., Robbins A.M. (2011) Extreme conservation leads to recovery of the Virunga mountain gorillas. *PLoS ONE*, 6, e19788.

8.8. Keep safety distance to habituated animals

- One before-and-after study in the Democratic Republic of Congo[1] found that most reintroduced chimpanzees survived over five years after being followed from a distance of 5–100 m, alongside other interventions.
- One controlled study in Malaysia[2] found that the number of reintroduced orangutans declined by 33% over 31 years despite visitors being required to keep a safety distance to the animals, alongside other interventions.
- One before-and-after study in Rwanda, Uganda and Congo[3] found that numbers of mountain gorillas increased by 168% over 41 years while being observed from a safety distance, alongside other interventions.

Background

This intervention aims to prevent the spread of viral and bacterial diseases from humans to primates and can be implemented in situations where humans regularly come into close contact with primates, such as when researchers or tourists observe habituated primates in their natural habitat.

Other means of preventing the spread of bacterial and viral diseases from researchers/tourists/managers to primates are discussed under 'Wear face-masks to avoid transmission of viral and bacterial diseases to primates', 'Limit time that researchers/tourists are allowed to spend with habituated animals', 'Implement quarantine for people arriving at, and leaving the site', 'Ensure that researchers/tourists are up-to-date with vaccinations and healthy', 'Regularly disinfect clothes, boots etc.', and 'Wear gloves when handling primate food, tool items, etc.'.

A before-and-after trial in 1994-1999 in mixed tropical forest in Conkouati-Douli National Park, Republic of Congo (1) found that the majority of reintroduced central chimpanzees *Pan troglodytes troglodytes* that were monitored directly while maintaining a safety distance along with 16 other interventions, survived over five years. Out of 20 reintroduced chimpanzees that were radio-collared and followed at distances of 5-100 m, fourteen (70%) survived over five years after which the study ended. No statistical tests were carried out to determine whether the population decrease was significant. Rehabilitated orphaned chimpanzees underwent vaccination, treatment for parasites and veterinary screens before being translocated in four subgroups from the sanctuary to the release site with resident wild chimpanzees. Staff members were permanently present to monitor primate health, provide additional food if necessary, and detect and examine dead animals. The area status was upgraded from a reserve to a national park in 1999. People were relocated from the release site to a nearby village. Some chimpanzees were treated when sick or injured. TV and radio advertisements were used to raise chimpanzee conservation awareness and local people were provided monetary and non-monetary benefits in exchange for their conservation support. The study does not distinguish between the effects of the different interventions mentioned above.

A controlled study in 1964-2004 in tropical forest in Kabili-Sepilok Forest Reserve, Malaysia (2) found that rehabilitated and reintroduced orangutans *Pongo pygmaeus morio* that were visited by tourists that had to keep safety distances to the animals along with eight other interventions, decreased by 33% over 33 years (1964-1997). Infant mortality (57%) was higher than in other wild and captive populations, and the sex ratio at birth was strongly biased towards females (proportion males=0.11) compared to other wild and captive populations. Inter-birth-interval (6.1 years) was shorter than in other orangutan subspecies or species in the wild and in captivity, but similar to wild populations of the same subspecies. Mean age at first reproduction (11.6 years) was lower than in other wild and captive populations. More than 100 tourists/day visited the rehabilitation centre, but were prohibited from touching orangutans and had to keep a minimum distance of 5 m at all times. Orangutans were provided with daily supplementary food from 2-7 feeding platforms. Individuals underwent in-depth veterinary checks and were kept in quarantine for 90 days before release into the reserve, in which other rehabilitated orangutans lived. Staff and volunteers underwent medical checks. The study does not distinguish between the effects of the different interventions mentioned above.

A controlled, before-and-after study in 1967-2008 in tropical montane forest in Volcanoes-, Mgahinga-, and Virunga National Parks in Rwanda, Uganda, and the Democratic Republic of Congo (3) found that the mountain gorilla *Gorilla beringei beringei* population that was regularly visited by tourists and researchers which kept a safety distance to the animals along with ten other interventions, increased in size over time. Annual population growth was 4.1%, resulting in an overall population increase of 168% over 41 years. No statistical tests were carried out to determine whether this increase was significant. All visitors/researchers were expected to maintain a 7 m distance from the gorillas. As part of the ecotourism- and research programmes, gorillas were habituated to human presence, where visitors/researchers had to follow strict health procedures; these included wearing face-masks, spending only limited amounts of time with gorillas, ensuring that visitors/researchers were healthy, disinfecting visitor's/researcher's clothes, boots etc. Gorillas were continuously monitored by vets and received medical treatment if necessary. When gorillas died, their cause of death was clinically determined. The study does not distinguish between the effects of the different interventions mentioned above.

(1) Tutin C.E.G., Ancrenaz M., Paredes J., Vacher-Vallas M., Vidal C., Goossens B., Bruford M.W. & Jamart A. (2001) The conservation biology framework of the release of wild-born orphaned chimpanzees into the Conkouati Reserve, Congo. *Conservation Biology*, 15, 1247–1257.
(2) Kuze, N., Sipangkui S., Malim T.P., Bernard H., Ambu L.N. & Kohshima S. (2008) Reproductive parameters over a 37-year period of free-ranging female Borneo orangutans at Sepilok Orangutan Rehabilitation Centre. *Primates*, 49, 126–134.
(3) Robbins M.M., Gray M., Fawcett K.A., Nutter F.B., Uwingeli P., Mburanumwe I., Kagoda E., Basabose A., Stoinski T.S., Cranfield M.R., Byamukama J., Spelman L.H., Robbins A.M. (2011) Extreme conservation leads to recovery of the Virunga mountain gorillas. *PLoS ONE*, 6, e19788.

8.9. Limit time that researchers/tourists are allowed to spend with habituated animals

- One controlled study in Indonesia[1] found that reintroduced Sumatran orangutans that spent limited time with caretakers acted more similar to wild orangutans than orangutans that spend more time with caretakers, alongside other interventions.
- One before-and-after study in Rwanda, Uganda and the Democratic Republic of Congo[2] found that numbers of mountain gorillas increased by 168% over 41 years while being visited by researchers and visitors during a restricted amount of time, alongside other interventions.

Background

This intervention aims to prevent the spread of viral and bacterial diseases from humans to primates and can be implemented in situations where humans regularly come into close contact with primates, such as when researchers or tourists observe habituated primates in their natural habitat. Another argument for limiting human-primate interactions is that regular contact with humans may influence the behaviour of primates. For example, Riedler *et al*. (2010) could show that Sumatran orangutans *Pongo abelii* that were allowed to spend only a limited amount of time with the caretakers, acted more like wild orangutans after release than individuals that had regular and close contact to them.

Other means of preventing the spread of bacterial and viral diseases from researchers/tourists/managers to primates is discussed under 'Wear face-masks to avoid transmission of viral and bacterial diseases to primates', 'Keep safety distance to habituated animals', 'Implement quarantine for people arriving at, and leaving the site', 'Ensure that researchers/tourists are up-to-date with vaccinations and healthy', 'Regularly disinfect clothes, boots etc.', and 'Wear gloves when handling primate food, tool items, etc.'.

Riedler B., Millesi E. & Pratje P.H. (2010) Adaption to forest life during the reintroduction process of immature *Pongo abelii*. *International Journal of Primatology*, 31, 647–663.

A controlled study in 2004-2005 in a mosaic of logged and secondary tropical forest in Bukit Tigapuluh National Park, Indonesia (1) found that reintroduced

Sumatran orangutans *Pongo abelii* that spent only a limited amount of time with their caretakers along with other interventions, acted more like wild orangutans after release compared to individuals that had regular and close contact to caretakers. The behaviour of the three non-habituated orangutans with minimal human contact resembled that of wild orangutans more than that of the five habituated individuals in the way that they built nests, their food choice and canopy use. Furthermore, the former spent more time interacting socially with previously released orangutans. Non-habituated orangutans were released after they spent 6-month at a sanctuary to acclimatize. Human-habituated individuals were kept in semi-free conditions for 7-9 months prior to release where staff members guided them to the forest on a daily basis and tried to foster natural behaviour. The study does not distinguish between the effects of the different interventions mentioned above.

A controlled before-and-after study in 1967-2008 in tropical montane forest in Volcanoes-, Mgahinga-, and Virunga National Parks in Rwanda, Uganda, and the Democratic Republic of Congo (2) found that the mountain gorilla *Gorilla beringei beringei* population that was regularly visited by tourists and researchers that were restricted in the amount of time they were allowed to spend with them alongside ten other interventions, increased over time. Annual population growth was 4.1%, resulting in an overall population increase of 168% over 41 years. No statistical tests were carried out to determine whether this increase was significant. One-hour visits were made to each gorilla group daily by tourists. Researchers typically spent no more than four hours with the research-habituated groups. As part of the ecotourism- and research programmes, gorillas were habituated to human presence, where visitors/researchers had to follow strict health procedures; these included keeping a safety distance to the gorillas, wearing face-masks, ensuring that visitors/researchers were healthy, disinfecting visitor's/researcher's clothes, boots etc. Gorillas were continuously monitored by vets and received medical treatment if necessary. When gorillas died, their cause of death was clinically determined. The study does not distinguish between the effects of the different interventions mentioned above.

(1) Riedler B., Millesi E. & Pratje P.H. (2010) Adaption to forest life during the reintroduction process of immature *Pongo abelii*. *International Journal of Primatology*, 31, 647–663.
(2) Robbins M.M., Gray M., Fawcett K.A., Nutter F.B., Uwingeli P., Mburanumwe I., Kagoda E., Basabose A., Stoinski T.S., Cranfield M.R., Byamukama J., Spelman L.H., Robbins A.M. (2011) Extreme conservation leads to recovery of the Virunga mountain gorillas. *PLoS ONE*, 6, e19788.

8.10. Implement quarantine for people arriving at, and leaving the site

- We found no evidence for the effects of implementing quarantine for people arriving at, and leaving the site on primate populations.

Background

This intervention aims to prevent the spread of viral and bacterial diseases from humans to primates and can be implemented in situations where humans regularly come into close contact with primates, such as when researchers or tourists observe habituated primates in their natural habitat. For example, a study by Grützmacher *et al*. 2017 that assessed the impact of implementing quarantine for people working with habituated chimpanzees *Pan troglodytes verus* in Taï National Park, Côte d'Ivoire, found that only one of 262 persons tested positive for a respiratory virus (HRSV). However, another 17 persons developed symptoms of infection while in quarantine and were subsequently kept from approaching the chimpanzees, preventing potential disease exposure in 18 cases.

Other means of preventing the spread of bacterial and viral diseases from researchers/tourists/managers to primates are discussed under 'Wear face-masks to avoid transmission of viral and bacterial diseases to primates', 'Keep safety distance to habituated animals', 'Limit time that researchers/tourists are allowed to spend with habituated animals', 'Ensure that researchers/tourists are up-to-date with vaccinations and healthy', 'Regularly disinfect clothes, boots etc.', and 'Wear gloves when handling primate food, tool items, etc.'.

Implementing quarantine for primates to prevent the spread of viral and bacterial diseases from newly introduced primates to resident primate populations is discussed under 'Implement quarantine for primates before reintroduction/translocation'.

Grützmacher K., Keil V., Leinert V., Leguillon F., Henlin A., Couacy-Hymann E., Köndgen S., Lang A., Deschner T., Wittig R.M., Leendertz F.H. (2017) Human quarantine: toward reducing infectious pressure on chimpanzees at the Taï Chimpanzee Project, Côte d'Ivoire. *International Journal of Primatology*, 9999, 1–6.

8.11. Implement quarantine for primates before reintroduction/translocation

- One before-and-after study in Brazil[1] found that most reintroduced golden lion tamarins did not survive over seven years despite being quarantined before release, alongside other interventions.
- One before-and-after study in Uganda[2] found that a reintroduced chimpanzee repeatedly returned to human settlements after being quarantined before release, alongside other interventions.
- One before-and-after study in Madagascar[3] found that most reintroduced black-and-white ruffed lemurs did not survive over five years despite being quarantined before release, alongside other interventions.
- One before-and-after study in Malaysia[4] found that a population of reintroduced orangutans decreased by 33% over 40 years despite individuals being quarantined before release, alongside other interventions. A controlled study in Indonesia[5] found that all orangutans that underwent quarantine prior to release, alongside other interventions, survived over three months.
- One before-and-after, side comparison study in the Republic of Congo and Gabon[6] found that more than 80% of the reintroduced gorillas that underwent quarantine, alongside other interventions, survived over a ten year period.

- Two site comparison studies in Vietnam[7a, 7b] and a before-and-after study in Indonesia[8] found that most reintroduced lorises either died or their radio signal was lost despite being quarantined before release, alongside other interventions.

Background

This intervention aims to prevent the spread of viral and bacterial diseases from newly introduced primates to resident primate populations. Quarantine programmes are designed to facilitate the detection of transmittable diseases and make accurate assessments of the overall health status of individuals and/or groups coming into contact with a new population. They are defined by their duration and by the activities and procedures practised to assess health status.

Implementing quarantine for people to prevent the spread of viral and bacterial diseases from humans to primates is discussed under 'Implement quarantine for people arriving at, and leaving the site'.

A before-and-after trial in 1984-1991 in coastal forest in Poço das Antas Reserve, Brazil (1) found that the majority of reintroduced golden lion tamarins *Leontopithecus rosalia* that were quarantined before release alongside 14 other interventions, did not survive over seven years. Fifty-eight out of 91 (64%) reintroduced tamarins did not survive in the wild. However, 57 infants were born (reproductive rate=63%) during the study period, of which 38 (67%) survived. Tamarins were quarantined for six months before they would qualify for reintroduction. During quarantine their health was monitored continuously. Different groups of captive-bred or orphaned tamarins were introduced in different years into habitat already occupied by the species and predators. Groups were provided with supplementary food, water and nesting boxes, and allowed to adapt to local habitat conditions before release. Tamarins underwent veterinary checks and were treated for parasites before release. Sick or injured reintroduced tamarins were captured, treated and re-released. The reserve became officially protected in 1983 when a long-term research study was implemented. The study does not distinguish between the effects of the different interventions mentioned above.

A before-and-after-trial in 1995 in Kibale National Park, Uganda (2) found that a female captive, 4-6 year old wild-born chimpanzee *Pan troglodytes schweinfurthii* that was quarantined before reintroduction into a human-habituated community of wild chimpanzees alongside other interventions, repeatedly returned to human settlements post-release and was subsequently returned to captivity. Eight days after the initial release, she left the forest for the first time and was brought back into the forest. For the following ten days, she travelled, fed, nested and engaged in social activities with the wild chimpanzees. During this time, she increased ranging distance to humans and use of height, and visually monitored humans less regularly. However, the proportion of adult males in her vicinity decreased and she increasingly spent time alone. She was returned to captivity six weeks after her release. She was quarantined from humans, other than her caretakers, and wild chimpanzees and underwent a tuberculosis test. During this time, she also underwent pre-release training for three weeks before reintroduction into habitat with a resident wild community. At least ten community members worked on the project. The study does not distinguish between the effects of the different interventions mentioned above.

A before-and-after trial in 1997-2002 in primary forest in Betampona Reserve, Madagascar (3) found that less than half of all captive-bred, parent-reared reintroduced black-and-white ruffed lemurs *Varecia variegata variegata* that were quarantined before release alongside ten other interventions, survived until the end of the study period of five years. Over five years, five of 13 individuals (38.5%) survived in the wild and six individuals were born, of which four survived. One female and one male of the group reproduced with wild resident lemurs and the male became fully integrated into the wild group. The on-site quarantine period combined with the pre-shipment quarantine period totalled 30 days. All released animals were radio-collared for post-release monitoring. Captive lemurs had limited semi-free-ranging experience and underwent veterinary screens before their reintroduction in groups into habitat with predators and wild resident lemurs. They were recaptured and treated when sick and provided with supplementary food and water for a certain period. They were allowed to adapt to local habitat conditions before release. Dead lemurs were clinically examined. The study does not distinguish between the effects of the different interventions mentioned above.

A controlled study in 1964-2004 in tropical forest in Kabili-Sepilok Forest Reserve, Malaysia (4) found that rehabilitated orangutans *Pongo pygmaeus morio* that were kept in quarantine for 90 days before their reintroduction along with eight other interventions, decreased in numbers by 33% over 33 years (1964-1997). Infant mortality (57%) was higher than in other wild and captive populations, and the sex ratio at birth was strongly biased towards females (proportion males=0.11) compared to wild and captive populations. Orangutans were daily provided with supplementary food from 2-7 feeding platforms. Inter-birth-interval (6.1 years) was similar to wild populations of the same subspecies. Mean age at first reproduction (11.6 years) was lower than in other wild and captive populations. Individuals underwent in-depth veterinary checks before release into the reserve, where other rehabilitated orangutans lived. Individuals were captured and treated when injured or sick. Staff and volunteers received medical checks and tourists had to keep safety distances (>5 m) at all times. The study does not distinguish between the effects of the different interventions mentioned above.

A controlled study in 2004-2005 in secondary tropical forest in Bukit Tigapuluh National Park, Central Sumatra, Indonesia (5) found that all reintroduced Sumatran orangutans *Pongo abelii* that underwent quarantine prior to release alongside other interventions, survived for at least three months. Al eight captive orphaned orangutans with largely unknown histories survived for at least three months post-release. Before transportation to the reintroduction centre, orangutans were quarantined and underwent medical screens and clearance at a quarantine centre. All activities and procedures at the quarantine and reintroduction centres followed national and international regulations and guidelines, including IUCN reintroduction guidelines. Orangutans were released into habitat where previously-released orangutans lived to re-establish populations. Supplementary food was provided regularly. One group was directly released into the forest after a 6-month acclimatization phase at a sanctuary. Another group was kept in semi-free conditions for 7-9 months prior to release and allowed to overnight in the enclosure. Staff members guided daily the latter group to the forest. The study does not distinguish between the effects of the different interventions mentioned above.

A before-and-after, site comparison study in 1996-2006 in tropical forests of Lesio-Louna Wildlife Reserve, Republic of Congo (Congo) and Batéké Plateau National Park, Gabon (6) found that the majority of reintroduced western lowland gorillas *Gorilla gorilla gorilla* that underwent quarantine prior to release alongside 14 other interventions, survived over four years. Twenty-one of 25 gorillas (84%) released in Congo and 22 of 26 gorillas (85%) released in Gabon survived at least four years. Nine females gave birth to 11 infants, of which nine survived. Before release, gorillas underwent disease screening and received preventative vaccinations. Gorillas were released in groups and allowed to adapt to local environment and supplemented with food prior to release. Gorillas were released into habitat with no resident gorillas to re-establish populations. Released gorillas were monitored frequently, treated for parasites, recaptured when sick, treated and released again. So-called 'problem-animals' were removed and relocated and dead gorillas were clinically examined. Forty-three individuals were rehabilitated wild-born orphaned gorillas and eight gorillas were ex-situ captive-borns. Both sites became protected areas before reintroduction commenced. The study does not distinguish between the effects of the different interventions mentioned above.

A site comparison in 2008-2012 in bamboo thicket-dominated forest at Dao Tien Island (DTI) and mixed forest in Dong Nai Biosphere Reserve (DNBR), South Vietnam (7a) found that several pygmy slow lorises *Nycticebus pygmaeus* that underwent quarantine before release alongside eight other interventions, survived for at least two months. Four out of eight lorises survived for at least two months after release, whereas remaining ones died or their radio-collar signal was lost soon post-release. All lorises underwent a 6-week quarantine, veterinary screens and treatment for parasites and were released in groups during the wet season. Both release sites were protected, no wild resident lorises occurred there and predators were present. Lorises were kept in an in situ cage for either <2 months or two days, and were subsequently supplemented with food for 7-30 days in DTI and DNBR. Dead animals were detected and examined. The study does not distinguish between the effects of the different interventions mentioned above.

A site comparison in 2008-2012 in mosaic forest at two sites in Cat Tien National Park, South Vietnam (7b) found that all pygmy slow lorises *Nycticebus pygmaeus* that were screened for diseases prior to translocation alongside other interventions either died or disappeared. All five lorises died or their radio-collar signal was lost soon post-release. Each loris was examined under anaesthesia and an intradermal tuberculosis test was conducted. All individuals underwent a 6-week quarantine and parasite treatment. Lorises were released as multiple individuals into habitat with no wild resident lorises present but with predators. Three lorises were released at Cat Tien National Park during the dry season. Two individuals were held in a semi-wild enclosure for one month to foster behaviour that would facilitate their survival in the wild and were released during the wet season. Dead lorises were detected and examined. The study does not distinguish between the effects of the different interventions mentioned above.

A before-and-after trial in 2006-2011 in tropical forest at Gunung Halimun Salak National Park and Batutegi Nature Reserve, Indonesia (8) found that only few reintroduced greater slow lorises *Nycticebus coucang* and Javan slow lorises *N. javanicus* that were quarantined prior to release alongside other interventions, survived for at least 146 and 22-382 days, respectively. Out of five reintroduced greater slow lorises, only one survived over 146 days and out of 18 reintroduced Javan slow lorises, only five individuals (28%) survived for at least 22-382 days. The study did not report more details about their fate. All lorises were quarantined for six weeks and underwent veterinary screens prior to single releases. Sick individuals were recaptured and treated. All but two lorises were held in enclosures at the release site to adapt to local habitat, where conspecifics and predators occurred. Dead lorises were examined to determine cause of death. The study does not distinguish between the effects of the different interventions mentioned above.

(1) Beck B.B., Kleiman D.G., Dietz J.M., Castro I., Carvalho C. & Rettberg-Beck B. (1991) Losses and reproduction of reintroduced golden lion tamarins *Leontopithecus rosalia*. *Dodo*, 27, 50–61.

(2) Treves A. & Naughton-Treves L. (1997) Case study of a chimpanzee recovered from poachers and temporarily released with wild conspecifics. *Primates*, 38, 315–324.

(3) Britt A., Welch C., Katz A., Iambana B., Porton I., Junge R., Crawford G., Williams C. & Haring D. (2004) The re-stocking of captive-bred ruffed lemurs (*Varecia variegata variegata*) into the Betampona Reserve, Madagascar: methodology and recommendations. *Biodiversity and Conservation*, 13, 635–657.

(4) Kuze N., Sipangkui S., Malim T.P., Bernard H., Ambu L.N. & Kohshima S. (2008) Reproductive parameters over a 37-year period of free-ranging female Borneo orangutans at Sepilok Orangutan Rehabilitation Centre. *Primates*, 49, 126–134.

(5) Riedler B., Millesi E. & Pratje P.H. (2010) Adaption to forest life during the reintroduction process of immature *Pongo abelii*. *International Journal of Primatology*, 31, 647–663.

(6) King T., Chamberlan C. & Courage A. (2012) Assessing initial reintroduction success on long-lived primates by quantifying survival, reproduction, and dispersal parameters: western lowland gorillas (*Gorilla gorilla gorilla*) in Congo and Gabon. *International Journal of Primatology*, 33, 134–149.

(7) Kenyon M., Streicher U., Loung H., Tran T., Vo B. & Cronin A. (2014) Survival of reintroduced pygmy slow loris *Nycticebus pygmaeus* in South Vietnam. *Endangered Species Research*, 25, 185–195.

(8) Moore R., Wihermanto S. & Nekaris K.A.I. (2014) Compassionate conservation, rehabilitation and translocation of Indonesian slow lorises. *Endangered Species Research*, 26, 93–102.

8.12. Ensure that researchers/tourists are up-to-date with vaccinations and healthy

- One controlled study in Malaysia[1] found that a population of reintroduced orangutans decreased by 33% over 33 years despite staff and volunteers having received medical checks, alongside other interventions.
- One before-and-after study in Rwanda, Uganda and Congo[2] found that mountain gorilla numbers increased by 168% over 41 years while sick/unwell researchers and visitors were not allowed to visit gorillas, alongside other interventions.

Background

Several studies have demonstrated that a significant proportion of travellers at wildlife sanctuaries/ecotourism sites may be ill, potentially infectious and not protected against vaccine-preventable illnesses, creating unnecessary risk of pathogen transmission to the primates that are housed/live there (Muehlenbein *et al*. 2008, Muehlenbein *et al*. 2010). This intervention aims to prevent the spread of viral and bacterial diseases from humans to primates and can be implemented in situations where humans regularly come into close contact with primates, such as when researchers or tourists observe habituated primates in their natural habitat.

Other means of preventing the spread of bacterial and viral diseases from researchers/tourists/managers to primates are discussed under 'Wear face-masks to avoid transmission of viral and bacterial diseases to primates', 'Keep safety distance to habituated animals', 'Limit time that researchers/tourists are allowed to spend with habituated animals', 'Implement quarantine for people arriving at, and leaving the site', 'Regularly disinfect clothes, boots etc.', and 'Wear gloves when handling primate food, tool items, etc.'.

Muehlenbein M.P., Martinez L.A., Lemke A.A., Ambu L., Nathan S., Alsisto S., Andau P. & Sakong R. (2008) Perceived vaccination status in ecotourists and risks of anthropozoonoses. *EcoHealth*, 5, 371–378.

Muehlenbein M.P., Martinez L.A., Lemke A.A., Ambu L., Nathan S., Alsisto S. & Sakong R. (2010) Unhealthy travelers present challenges to sustainable primate ecotourism. *Travel Medicine and Infectious Disease*, 8, 169–175.

A controlled study in 1967-2004 in tropical forest in Kabili-Sepilok Forest Reserve, Malaysia (1) found that rehabilitated and reintroduced orangutans *Pongo pygmaeus morio* decreased by 33% over 33 years (1964-1997), although staff and volunteers received medical checks to avoid disease transmission alongside eight other interventions. In addition, infant mortality (57%) was higher than in other wild and captive populations, and the sex ratio at birth was strongly biased towards females (proportion males=0.11) compared to other wild and captive populations. Inter-birth-interval (6.1 years) was similar to wild populations of the same subspecies. Mean age at first reproduction (11.6 years) was lower than in other wild and captive populations. Orangutans were daily provided supplementary food from 2-7 feeding platforms. Individuals underwent in-depth veterinary checks and were kept in quarantine for 90 days before release into the reserve, in which other rehabilitated orangutans lived. Sick or injured individuals were captured and treated. Tourists had to keep safety distances (>5 m) at all times. The study does not distinguish between the effects of the different interventions mentioned above.

A controlled, before-and-after study in 1967-2008 in tropical montane forest in Volcanoes-, Mgahinga-, and Virunga National Parks in Rwanda, Uganda, and the Democratic Republic of Congo (2) found that the mountain gorilla *Gorilla beringei beringei* population that was regularly visited by healthy tourists and researchers alongside ten other interventions, increased in size over time. Annual population growth was 4.1%, resulting in an overall population increase of 168% over 41 years. No statistical tests were carried out to determine whether this increase was significant. Visitors/researchers were asked to report if they were not feeling well and were not allowed to visit the gorillas if they felt sick. As part of the ecotourism- and research programmes, gorillas were habituated to human presence, where visitors/researchers had to follow strict health procedures; these included keeping a safety distance to the gorillas, wearing face-masks, spending only a limited amount of time with gorilla groups, disinfecting visitor's/researcher's clothes, boots etc. The population was continuously monitored by vets and individuals received medical treatment if necessary. When gorillas died, their cause of death was examined. The study only tests for the effect of veterinary interventions, but does not distinguish between the effects of the other interventions mentioned above.

(1) Kuze N., Sipangkui S., Malim T.P., Bernard H., Ambu L.N. & Kohshima S. (2008) Reproductive parameters over a 37-year period of free-ranging female Borneo orangutans at Sepilok Orangutan Rehabilitation Centre. *Primates*, 49, 126–134.

(2) Robbins M.M., Gray M., Fawcett K.A., Nutter F.B., Uwingeli P., Mburanumwe I., Kagoda E., Basabose A., Stoinski T.S., Cranfield M.R., Byamukama J., Spelman L.H., Robbins A.M. (2011) Extreme conservation leads to recovery of the Virunga mountain gorillas. *PloS ONE*, 6, e19788.

8.13. Regularly disinfect clothes, boots etc.

- One controlled, before-and-after study in Rwanda, Uganda and Congo[1] found that numbers of mountain gorillas increased by 168% over 41 years while being visited by researchers and tourists whose clothes were disinfected, alongside other interventions.

Background

This intervention aims to prevent the spread of viral and bacterial diseases from humans to primates and can be implemented in situations where humans regularly come into close contact with primates, such as when researchers or tourists observe habituated primates in their natural habitat.

Other means of preventing the spread of bacterial and viral diseases from researchers/tourists/managers to primates are discussed under 'Wear face-masks to avoid transmission of viral and bacterial diseases to primates', 'Keep safety distance to habituated animals', 'Limit time that researchers/tourists are allowed to spend with habituated animals', 'Implement quarantine for people arriving at, and leaving the site', 'Ensure that researchers/tourists are up-to-date with vaccinations and healthy', and 'Wear gloves when handling primate food, tool items, etc.'.

A controlled, before-and-after study in 1967-2008 in tropical forest in Volcanoes-, Mgahinga-, and Virunga National Parks in Rwanda, Uganda, and the Democratic Republic of Congo (1) found that the habituated mountain gorilla *Gorilla beringei beringei* population that was regularly visited by tourists and researchers whose clothes were disinfected to avoid disease transmission along with other interventions, increased in size over time. Habituated gorillas that were regularly visited by researchers/tourists that adhere to strict hygiene rules (treatment) grew at a higher rate than unhabituated gorillas (control) (4.1% increase vs 0.7% decline/year). Overall, the habituated population increased by 168% over 41 years. No statistical tests were carried out to determine whether this increase was significant. Visitors/researchers were requested to wash their hands, wear clean clothes, and wash their shoes before entering the forest. As part of the ecotourism- and research programmes, gorillas were habituated to human presence, where visitors/researchers had to follow strict health procedures; these included keeping a safety distance to the gorillas, wearing face-masks, ensuring that visitors/researchers were healthy, and spending a limited amount of time with gorilla groups. The population was continuously monitored by vets and gorillas received medical treatment if necessary. When gorillas died, their cause of death was examined. The study only tests for the effect of veterinary interventions, but does not distinguish between the effects of the other interventions mentioned above.

(1) Robbins M.M., Gray M., Fawcett K.A., Nutter F.B., Uwingeli P., Mburanumwe I., Kagoda E., Basabose A., Stoinski T.S., Cranfield M.R., Byamukama J., Spelman L.H., Robbins A.M. (2011) Extreme conservation leads to recovery of the Virunga mountain gorillas. *PloS ONE*, 6, e19788.

8.14. Wear gloves when handling primate food, tool items, etc.

- We found no evidence for the effects of wearing gloves when handling primate food, tool items, etc. on primate populations.

Background

This intervention aims to prevent the spread of viral and bacterial diseases from humans to primates and can be implemented in situations where humans regularly come into close contact with primate food, tools and other items that may be handled by both humans and primates. For example, researchers and tourist guides may handle such items to collect information on primate behaviour, presence and spatial distribution.

Other means of preventing the spread of bacterial and viral diseases from researchers/tourists/managers to primates are discussed under 'Wear face-masks to avoid transmission of viral and bacterial diseases to primates', 'Keep safety distance to habituated animals', 'Limit time that researchers/tourists are allowed to spend with habituated animals', 'Implement quarantine for people arriving at, and leaving the site', 'Ensure that researchers/tourists are up-to-date with vaccinations and healthy', and 'Regularly disinfect clothes, boots etc.'.

8.15. Preventative vaccination of habituated or wild primates

- One before-and-after study in Puerto Rico[1] found that annual mortality of rhesus macaques decreased after a preventive tetanus vaccine campaign, alongside other interventions.
- Two before-and-after studies in the Republic of Congo[2, 3] found that 70% of reintroduced chimpanzees vaccinated against poliomyelitis and tetanus, alongside other interventions, survived over 3.5-5 years after release.
- One before-and-after study in the Republic of Congo and Gabon[4] found that more than 80% of the reintroduced gorillas that received preventive vaccination, alongside other interventions, survived over a 10 year period.

Background

Vaccinations for primates exist for several diseases that may be transmitted to primates by humans, including e.g. measles, poliomyelitis, mumps, and rabies.

This intervention aims at preventing the spread of vaccine-preventable diseases from e.g. researchers or tourists to primates.

A before-and-after trial in 1977-1987 in tropical dry forest in Cayo Santiago, Puerto Rico (1) found that annual mortality rate of free-ranging, introduced rhesus macaques *Macaca mulatta* decreased after implementation of preventative tetanus toxoid inoculations. In 1977-1984, annual mortality of the monkeys was 6.39% of which 19.5% were caused by tetanus infections. After the implementation of yearly inoculation procedures in 1985 and 1986, annual mortality decreased to 3.69% of which only 0.8% was caused by tetanus infections. During the annual trapping in 1985 all monkeys except two new-born infants received the first dose of tetanus toxoid inoculation. In 1986, inoculated monkeys received their second inoculations and yearlings received their first inoculation. In the following years, yearlings and 2-year-old macaques were inoculated by three doses of vaccine treatments.

A before-and-after trial in 1996-1999 in a tropical rainforest in Conkouati Reserve, Republic of Congo (2) found that 14 out of 20 (70%) reintroduced wild-born orphaned chimpanzees *Pan troglodytes troglodytes* that were vaccinated against poliomyelitis and tetanus alongside eight other interventions were still alive 3.5 years post-release. None of the adult females produced offspring. Chimpanzees underwent veterinary screens and were treated for internal parasites. Before reintroduction in groups into habitat with low densities of wild chimpanzees, they spent six to nine years on one of three forested islands in the region to acclimatize. Orphan chimpanzees were rehabilitated and fostered at a nearby sanctuary. Researchers were permanently present on-site and monitored released chimpanzees with radio-collars. The study does not distinguish between the effects of the different interventions mentioned above.

A before-and-after trial in 1994-1999 in mixed tropical forest in Conkouati-Douli National Park, Republic of Congo (3) found that the majority of reintroduced central chimpanzees *Pan troglodytes troglodytes* that underwent vaccinations prior to release alongside 16 other interventions, survived over five years. Out of 20 reintroduced chimpanzees were vaccinated against polio and tetanus, 14 survived (70%). No statistical tests were carried out to determine whether the population change was significant. Individuals were radio-collared and followed at distances of 5-100 m. Rehabilitated orphaned chimpanzees underwent parasite treatment and veterinary screens before translocation in four subgroups to the release site where resident wild chimpanzees occurred. Staff members were permanently present to monitor primate health, provide additional food if necessary and cinically examine dead animals. The area status was upgraded from reserve to national park in 1999. Local people were relocated from the release site to a nearby village. Some reintroduced chimpanzees were treated when sick or injured. TV and radio advertisements were used to raise chimpanzee conservation awareness and local people were provided monetary and non-monetary benefits in exchange for their conservation support. The study does not distinguish between the effects of the different interventions mentioned above.

A before-and-after, site comparison study in 1996-2006 in tropical forests in Lesio-Louna Wildlife Reserve, Republic of Congo (Congo) and Batéké Plateau National Park, Gabon (4) found that the majority of reintroduced western lowland gorillas *Gorilla gorilla gorilla* that received preventative vaccinations prior to release alongside 14 other interventions, survived for at least four years. Twenty-one of 25 gorillas (84%) released in Congo and 22 of 26 gorillas (85%) released in Gabon survived at least four years. Nine females gave birth to 11 infants, of which nine survived. Gorillas underwent disease screening during quarantine, were released in groups, in habitat with no resident gorillas, allowed to adapt to the local environment and supplemented with food prior to release. Released gorillas were treated for parasites and when sick. So-called 'problem-animals' were removed and relocated and bodies of dead gorillas were examined to determine their cause of death. Forty-three individuals were rehabilitated wild-born orphaned gorillas and eight gorillas were ex-situ captive-born. Both sites were declared protected areas before reintroduction commenced. The study does not distinguish between the effects of the different interventions mentioned above.

(1) Kessler M.T., Berard J.D. & Rawlins R.G. (1988) Effect of tetanus toxoid inoculation on mortality in the Cayo Santiago macaque population. *American Journal of Primatology*, 15, 93–101.
(2) Goossens B., Ancrenaz M., Vidal C., Latour S., Paredes J., Vacher-Vallas M., Bonnotte S., Vial L., Farmer K., Tutin C.E.G. & Jamart A. (2001) The release of wild-born orphaned chimpanzees *Pan troglodytes* into the Conkouati Research, Republic of Congo. African *Primates*, 5, 42–45.
(3) Tutin C.E.G., Ancrenaz M., Paredes J., Vacher-Vallas M., Vidal C., Goossens B., Bruford M.W. & Jamart A. (2001) The conservation biology framework of the release of wild-born orphaned chimpanzees into the Conkouati Reserve, Congo. *Conservation Biology*, 15, 1247–1257.
(4) King T., Chamberlan C. & Courage A. (2012) Assessing initial reintroduction success on long-lived primates by quantifying survival, reproduction, and dispersal parameters: western lowland gorillas (*Gorilla gorilla gorilla*) in Congo and Gabon. *International Journal of Primatology*, 33, 134–149.

8.16. Treat sick/injured animals

- Two before-and-after studies in Brazil[1, 2] found that most reintroduced golden lion tamarins died despite being treated when sick or injured, alongside other interventions. One study in Brazil[6] found that one out of four reintroduced black lion tamarins died after being release despite receiving treatment, alongside other interventions.
- One review on reintroduced lar gibbons in Thailand[3] found that their population declined by 6% seventeen months after release despite having medical treatment available when sick or injured, alongside other interventions.
- One study in Malaysia[4] found that 98% of translocated orangutans, some of which received treatment for injuries along with other interventions, survived capture and subsequent release. One controlled study, also in Malaysia[13], found that a population of reintroduced orangutans decreased by 33% over 33 years despite receiving treatment when sick or injured, alongside other interventions.
- Four studies, including two before-and-after studies, in Liberia[5], the Republic of Congo[8, 9] and The Gambia[12] found that most reintroduced chimpanzees that were treated when sick, alongside other interventions, survived for at least 1-5 years[5,8,9] and in one case the population increased[12]. One study in Senegal[14] found that a young

chimpanzee was reunited with its mother after being treated for injuries, alongside other interventions.

- One before-and-after study in Uganda[7] found that treatment for mange, alongside other interventions, cured some infected mountain gorillas. One study in Rwanda, Uganda and the Democratic Republic of Congo[15] and one before-and-after, side comparison study in the Republic of Congo and Gabon[15] found that most western lowland gorillas treated when sick or injured, alongside other interventions, survived over 4–41 years.
- Two before-and-after studies in South Africa[17] and Indonesia[18] found that most reintroduced or translocated primates that were treated when sick, alongside other interventions, survived over six months. However, two before-and-after studies in Madagascar[10] and Kenya[11] found that most reintroduced or translocated primates did not survived over five years[10] or their population size decreased[11] despite treated when sick, alongside other interventions.

Background

This intervention involves detecting and treating sick or injured primates to increase their chance of survival. This intervention frequently forms part of-, but is not necessarily restricted to reintroduction or translocation programmes. To implement this intervention, primates may be temporarily captured, treated and re-released, or they may be treated using remote drug delivery methods.

A before-and-after trial in 1954-1985 in a degraded rainforest in Poço das Antas Reserve, Brazil (1) found that a translocated population of captive-born golden lion tamarin *Leontopithecus rosalia* of which sick or injured individuals were removed from the wild and medically treated along with nine other interventions, decreased by 57% within the first year post-release. No statistical tests were carried out to determine whether this difference was significant. Of the 14 individuals released, seven died and two were removed and treated. Three infants were born, one of which died from illness. Eight individuals were released as a family group and six individuals were released as pairs one month later. Tamarins spent an unknown amount of time in 15 x 4.5 x 3 m outside enclosures to acclimatize. They were habituated to humans and fostered to facilitate survival in the wild. The reserve included natural predators. Reintroduced tamarins were supplied with food for 10 months post-release. Artificial nesting boxes were also put up in the reserve. The study does not distinguish between the effects of the different interventions mentioned above.

A before-and-after trial in 1984-1991 in coastal forest in Poço das Antas Reserve, Brazil (2) found that the majority of reintroduced golden lion tamarins *Leontopithecus rosalia*, which were treated if sick or injured alongside 14 other interventions, did not survive over the study period of seven years. Fifty-eight out of 91 (64%) reintroduced tamarins did not survive in the wild. However, 57 infants were born (reproductive rate=63%) during the study, of which 38 (67%) survived. Reintroduced sick or injured animals were rescued, treated and only re-released once fully recovered. Tamarins were also screened and treated for parasites, infectious diseases, possible genetically-based defects. Different groups of captive-bred or orphaned tamarins were introduced in different years into habitat already occupied by the species and predators. Groups were quarantined, provided with supplementary food, water and nesting boxes, and allowed to adapt to local habitat conditions before release. The reserve became officially protected in 1983. The study does not distinguish between the effects of the different interventions mentioned above.

A study, part of a review, in 1976-1977 in Sai Yok National Park, Thailand (3) found that numbers of captive lar gibbons *Hylobates lar* that were released and treated when injured or sick alongside other interventions decreased by 6% and no infants were born 17 months post-release. No statistical tests were carried out to determine whether this decrease was significant. One male was recaptured, removed and treated after being injured by wild gibbons. Four gibbons joined wild groups. A total of 31 gibbons were introduced as individuals, pairs, or family groups into habitat with resident wild gibbons. Anaesthetized gibbons were either kept in separate cages from which they could hear, but not see each other for 14 days before release, or laid out on the forest floor. In 1961, gibbons became officially protected in Thailand. Permanent presence of area managers and other staff appeared to ensure protection from hunters. The study does not distinguish between the effects of the different interventions mentioned above.

A study in 1993 in fragmented tropical forest in Sabah State, Malaysia (4) found that 78 of 80 (98%) translocated orangutans *Pongo pygmaeus morio*, some of which were treated for injuries alongside other interventions, survived capture and subsequent release at Tabin Wildlife Reserve. Four individuals escaped from their temporary holdings before they could be transported to the release site. Of these, three individuals suffered minor injuries and one individual sustained major injury during capture, but all were treated successfully. Orangutans were either immobilized in trees or captured manually on the ground with nets. Individuals underwent veterinary screens before they were released individually into habitat already occupied by other orangutans. To avoid injury due to post-traumatic stress, females were kept in separate (but adjacent) cages from their offspring and adequate space was maintained between occupied cages during temporary holdings and transportation. The study does not distinguish between the effects of the different interventions mentioned above.

A study in 1987-1988 on an island with tropical forest in Liberia, West Africa (5) found that the majority of reintroduced western chimpanzees *Pan troglodytes verus* that were treated when sick alongside other interventions, survived for at least one year post-release. Seven out of 30 released chimpanzees had difficulties to adjust and were brought back into captivity. Three individuals were temporarily removed after release for medical treatment of injuries due to fights with other chimpanzees. Chimpanzees were screened for diseases before they were released in groups. Furthermore, they were socialized in naturalistic enclosures and were taught behaviour to facilitate their survival in the wild. On site, primates were allowed to adapt to the local habitat in enclosures for some time; younger and low-ranking individuals were released earlier to reduce stress. Released chimpanzees were continuously provided with food. The study does not distinguish between the effects of the different interventions mentioned above.

A study in 1999 in tropical forest in Morro do Diabo State Park, São Paulo, Brazil (6) found that only some of the individuals in a group of reintroduced wild and captive-bred black lion tamarins *Leontopithecus chrysopygus* had survived over four months post-release, although sick animals were treated alongside other interventions. Four months post-release of three individuals, one tamarin died. After being found weak and dehydrated nine days after his release, this male was recaptured, treated and released again 13 days later but was found dead some weeks later. Tamarins underwent veterinary screens before translocation to an enclosure at the release site where they could adapt to the local environment where predators occurred. The released group consisted of two wild females and one captive-born male raised in a free-ranging environment where he had been fostered natural behaviour to facilitate reintroduction. Monkeys were fitted with radio-transmitters and supplemented with food throughout the study. The study does not distinguish between the effects of the different interventions mentioned above.

A before-and-after trial in 2000-2001 in tropical forest in Bwindi Impenetrable National Park, Uganda (7) found that medically treating mountain gorillas *Gorilla beringei beringei* infected with mange, cured the animals. In a group consisting of 18 gorillas, some individuals were treated on site after detection of mild signs of mange. The number of treated gorillas was not included. Two doses of Ivermectin were administered by darting individual gorillas. In addition, when a skin infection was initially detected, skin scrapings were collected and biopsies conducted to confirm the preliminary diagnosis. Another five groups whose home ranges overlapped with that of the group that included individuals treated for mange, also showed signs of this disease. However, the authors mention that the infection was brought under control and that no deaths occurred.

A before-and-after study in 1994-1999 in mixed tropical forest in Conkouati-Douli National Park, Republic of Congo (8) found that the majority of reintroduced chimpanzees *Pan troglodytes troglodytes* that were treated when injured alongside 16 other interventions, survived over five years. Out of 20 reintroduced chimpanzees that were occasionally treated for injuries caused by fights with other chimpanzees, 14 survived (70%). No statistical tests were carried out to determine whether the change was significant or not. Individuals were radio-collared and followed at distances of 5-100 m. Rehabilitated orphaned chimpanzees underwent vaccination, parasite treatment and veterinary screens before translocation in four subgroups from the sanctuary to the release site where resident chimpanzees already occurred. Staff members were permanently present to monitor their health, provide additional food if necessary and detect and examine dead animals. The area status was upgraded from reserve to national park in 1999. Local people were relocated from the release site to a nearby village. TV and radio advertisements were used to raise chimpanzee conservation awareness and local people were provided monetary and non-monetary benefits in exchange for their conservation support. The study does not distinguish between the effects of the different interventions mentioned above.

A before-and-after study in 1996-2001 in tropical forest in Conkouati-Douli National Park, Republic of Congo (9) found that the majority of wild-born orphan chimpanzees *Pan troglodytes troglodytes* reintroduced into the wild and treated when injured or sick along with other interventions, survived for at least 1-5 years. Twenty-six of 36 released chimpanzees survived until the end of the study in 2001 and only three chimpanzees were confirmed dead; none were killed by predators. The remaining seven chimpanzees disappeared, giving a survival rate of 72-92%. One infant, whose parents were both released in 1996, was born in 2001. One released male was seriously injured by a wild male and another released male in 1997 and 1999 and underwent veterinary interventions on both occasions. Released individuals were radio-collared and followed. Chimpanzees were rehabilitated on islands before their introduction into habitat with both wild chimpanzees and predators. The study does not distinguish between the effects of the different interventions mentioned above.

A before-and-after study in 1997-2002 in primary forest in Betampona Reserve, Madagascar (10) found that less than half of all captive-bred, parent-reared, reintroduced black-and-white ruffed lemurs *Varecia variegata variegata*, which were recaptured and treated when sick alongside ten other interventions, survived over five years. Five of 13 individuals (38.5%) survived in the wild and six individuals were born, of which four survived. One female and one male of the group reproduced with wild resident lemurs and the male became fully integrated. Recaptures of sick animals for treatment were achieved using hand-grabbing. Released animals were monitored with radio-collars. Captive lemurs had limited semi-free-ranging experience, were quarantined and underwent veterinary screens before their reintroduction in groups into habitat with predators and wild lemurs. They were provided with supplementary food and water for a certain period of time and allowed to adapt to local habitat conditions before release. Dead lemurs were detected and their cause of death investigated. The study does not distinguish between the effects of the different interventions mentioned above.

A controlled, before-and-after trial in 1973-2001 in savannah at the Chololo ranch, Laikipia Plateau, Kenya (11) found that a population of translocated crop-raiding olive baboons *Papio anubis* survived over 17 years when some individuals received medical treatments when sick alongside with other interventions. A total of 94 baboons in two troups were translocated in 1984 and 62 individuals remained in 2001 (66% survival). One wild troop at the capture site and another resident troop at the release site served as control groups. Survival rates did not differ between control and study groups. Four females were treated for a bacterial infection but there were no other intervenitons since 1986. Both translocated troops were regarded as 'problem animals' by farmers and were released into habitat with resident wild baboons and predators. Before translocation, individuals underwent veterinary screens. In addition, a long-term research project was launched to study these animals. Post-release, baboons were briefly provided with food during periods of drought. The study does not distinguish between the effects of the different interventions mentioned above.

A study in 1979-2004 in tropical forest on Baboon Islands, River Gambia National Park, The Gambia (12) found that rehabilitated and reintroduced western chimpanzees *Pan troglodytes verus* that were treated when sick alongside other interventions, increased from 50 to 69 chimpanzees over 25 years. No statistical tests were carried out to determine whether this population increase was significant. Fertility and mortality rates were similar to that in wild chimpanzees, except for infant mortality (18%), which was lower than in wild populations. Inter-birth interval, average age at first birth, proportion males at birth, age at first sexual swelling in females, and adolescent infertility were all similar to that of wild chimpanzees. Individuals received periodic deworming and antibiotic treatment for severe colds. Chimpanzees were reintroduced in groups and into habitat with natural predators (although these were rare), but with no other chimpanzees. They were provided supplementary food every 1-2 days. The study does not distinguish between the effects of the different interventions mentioned above.

A controlled study in 1967-2004 in tropical forest in Kabili-Sepilok Forest Reserve, Malaysia (13) found that rehabilitated and reintroduced orangutans *Pongo pygmaeus morio*, which were captured and treated for injury or illness alongside eight other interventions, decreased by 33% over 33 years (1964-1997). Infant mortality (57%) was higher than in other wild and captive populations, and the sex ratio at birth was strongly biased towards females (proportion males=0.11). However, inter-birth-interval (6.1 years) was similar to wild populations of the same subspecies. Orangutans were provided with daily supplementary food from 2-7 feeding platforms. Mean age at first reproduction (11.6 years) was lower than in other wild and captive populations. Individuals underwent in-depth veterinary checks and were kept in quarantine for 90 days before they were released into the reserve, in which other rehabilitated orangutans lived. Staff and volunteers received medical checks and tourists had to keep safety distances (>5 m) at all times. The study does not distinguish between the effects of the different interventions mentioned above.

A study in 2009 in savanna-woodland mosaic in Niokolo-Koba National Park, Senegal (14) found that a confiscated female infant chimpanzee *Pan troglodytes verus* that was treated for injuries along with other interventions, was reunited with its mother in the wild. Four days after confiscation, the chimpanzee was released in the vicinity of its natal group, which retrieved it immediately. The estimated 9-months old female infant chimpanzee was treated for its injured eye which was almost completely healed before release. The infant's natal group was located with the aid of poachers, after which the infant was released close to the group. The researcher wore a surgical mask and sanitized her hands when handling the infant and its food to prevent disease transmission. The study does not distinguish between the effects of the different interventions mentioned above.

A study in 1967-2008 in tropical moist montane forest in Volcanoes-, Mgahinga-, and Virunga National Parks in Rwanda, Uganda, and the Democratic Republic of Congo (15), found that the majority of the mountain gorillas *Gorilla beringei beringei* treated for snare wounds and respiratory disease along with 14 other interventions, survived for at least 41 years. The veterinary programme started in 1986. The snare wounds of 42 habituated gorillas were treated by veterinarians. Forty-one of the 42 (98%) treated gorillas survived for at least 41 years. Furthermore, 36 (86%) of 42 gorillas that treated for respiratory disease, recovered. Only animals showing severe clinical signs of respiratory disease for several consecutive days were treated. Veterinary interventions were performed on severely ill gorillas only after careful consideration of the disease course, and the potential disruption to the gorilla group from the darting. The study included no specific information on when each gorilla was treated and there was therefore no information on how long gorillas survived after individual treatment.

A before-and-after, site comparison study in 1996-2006 in tropical forests of Lesio-Louna Wildlife Reserve, Republic of Congo (Congo) and Batéké Plateau National Park, Gabon (16) found that the majority of reintroduced western lowland gorillas *Gorilla gorilla gorilla* that were treated when sick alongside 14 other interventions, survived for at least four years. Twenty-one of 25 gorillas (84%) released in the Congo and 22 of 26 gorillas (85%) released in Gabon survived for at least four years. Nine females gave birth to 11 infants, of which nine survived. Four individuals died at each release site. Two females were removed temporarily for treatment of critical injuries, and then re-released. Prior to release, gorillas underwent disease screening during quarantine and were vaccinated and treated for parasites. Gorillas were released in groups, allowed to adapt to local environment, and supplemented with food prior to release. Gorillas were released into habitat with no resident gorillas to re-establish populations. So-called 'problem-animals' were removed and relocated and dead gorillas were examined to determine their cause of death. Forty-three individuals were rehabilitated wild-born orphaned gorillas and eight gorillas were ex-situ captive-borns. Both sites became protected areas before reintroduction. The study does not distinguish between the effects of the different interventions mentioned above.

A before-and-after trial in January-July 2008 in a coastal forest at Isishlengeni Game Farm, Kwazulu-Natal, South Africa (17) found that 62% of rehabilitated vervet monkeys *Chlorocebus aethiops* that were reintroduced into the wild and treated if they showed symptoms of disease before their release along with other interventions, survived for at least six months. Five of 29 introduced individuals (17%) were reported dead. Of these, one died of predation and four were killed by domestic hunting dogs *Canis lupus familiaris*. Six individuals (21%) went missing. No females reproduced. Medical care was provided on an 'as required' basis before release and while housed at the nearby rehabilitation centre. Monkeys were introduced as one troop of 29 individuals into habitat already occupied by wild vervets and with predators. To acclimatize, monkeys spent two nights in a release enclosure (49 m^2) before being released. Monkeys were provided daily supplementary food. The study does not distinguish between the effects of the different interventions mentioned above.

A before-and-after study in 2006-2011 in tropical forest at Gunung Halimun Salak National Park and Batutegi Nature Reserve, Indonesia (18) found that only few reintroduced greater slow lorises *Nycticebus coucang* and Javan slow lorises *N. javanicus* that were treated when sick alongside other interventions, survived for at least 146 and 22-382 days, respectively. Out of five reintroduced greater slow lorises, only one survived for at least 146 days and out of 18 reintroduced Javan slow lorises, five individuals (28%) survived for at least 22-382 days. Exact survival time was not provided. One Javan slow loris was recaptured and remained at a sanctuary after its arm was amputated. All lorises underwent quarantine and veterinary screens prior to single releases. All but two lorises were held in enclosures at the release site to adapt to local habitat conditions where conspecifics and predators occurred. Bodies of dead lorises were examined to determine their cause of death. The study does not distinguish between the effects of the different interventions mentioned above.

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8.17. Remove/treat external/internal parasites to increase reproductive success/survival

- One before-and-after study in Brazil[1] found that most reintroduced golden lion tamarins treated for parasites, alongside other interventions, did not survive over seven years post-release.
- Three studies, including two before-and-after studies, in the Republic of Congo[2, 3] and The Gambia[4] found that 70% of reintroduced chimpanzees treated for parasites,

alongside other interventions, survived for at least 3.5-5 years[2,3] and in one case the population increased[4].

- One study in Gabon[5] found that 33% of reintroduced mandrills died within one year after release despite being treated for parasites, alongside other interventions.
- Two site comparison studies in Vietnam[7a, 7b] found that most reintroduced pygmy slow lorises died or disappeared (lost radio signal soon after release) despite being treated for parasites, alongside other interventions.
- One before-and-after, side comparison study in the Republic of Congo and Gabon[6] and one before-and-after study in Gabon[8] found that most western lowland gorillas treated for parasites, alongside other interventions, survived over nine months[8] or four years[6].

Background

This intervention involves removing/treating primates to reduce their external and/or internal parasite loads to increase their chances of survival, general health status and their reproductive success. This intervention frequently forms part of, but is not necessarily restricted to reintroduction or translocation programmes. To implement this intervention, primates may be temporarily captured, treated and re-released, or they may be treated using remote drug delivery methods.

A before-and-after trial in 1984-1991 in coastal forest in Poço das Antas Reserve, Brazil (1) found that the majority of reintroduced golden lion tamarins *Leontopithecus rosalia*, which were treated for parasites before release alongside 14 other interventions, did not survive over seven years. Fifty-eight out of 91 (64%) reintroduced tamarins did not survive in the wild over seven years. However, 57 infants were born (reproductive rate=63%) during the same period, of which 38 (67%) survived. Tamarins were quarantined, screened and treated for parasites, infectious diseases, possible genetically-based defects, injuries and diaphragmatic thinning and only released if they were clear of untreatable conditions. Different groups of captive-bred or orphaned tamarins were introduced in different years into habitat already occupied by the species and predators. Groups were provided with supplementary food, water and nesting boxes, and allowed to adapt to local habitat conditions before release. All tamarin groups were quarantined before release. Sick or injured animals were rescued, treated and re-released. The reserve became officially protected in 1983 and a long-term research study was implemented. The study does not distinguish between the effects of the different interventions mentioned above.

A before-and-after trial in 1996-1999 in a tropical rainforest in Conkouati Reserve, Republic of Congo (2) found that 70% of reintroduced wild-born orphaned chimpanzees *Pan troglodytes troglodytes* that were treated for internal parasites alongside eight other interventions, were still alive 3.5 years after release. Confirmed mortality was 10%, with a possible 30%. None of the adult females reproduced. Chimpanzees fed on 137 different plant species, a variety in diet similar to that of wild chimpanzees and had activity budgets that resembled those of wild conspecifics. No statistical tests were carried out to determine whether differences were insignificant. Chimpanzees underwent veterinary screens and vaccinations for poliomyelitis and tetanus. Before reintroduction in groups into habitat with low densities of wild chimpanzees, they spent 6-9 years on forested islands in the region to acclimatize. Orphan chimpanzees were rehabilitated and fostered at a nearby sanctuary. Researchers were permanently present on-site and monitored released chimpanzees using radio-collars. The study does not distinguish between the effects of the different interventions mentioned above.

A before-and-after trial in 1994-1999 in mixed tropical forest in Conkouati-Douli National Park, Republic of Congo (3) found that the majority of reintroduced central chimpanzees *Pan troglodytes troglodytes* that were treated for parasites prior to release alongside 16 other interventions, survived for at least five years. Out of 20 reintroduced chimpanzees that were treated for intestinal parasites when necessary, 14 survived (70%). No statistical tests were carried out to determine whether the population change was significant. Individuals were radio-collared and followed at distances of 5-100 m. Rehabilitated orphaned chimpanzees underwent vaccinations and veterinary screens before being translocated in four subgroups from the sanctuary to the release site where resident chimpanzees occurred. Permanent staff monitored primate health, provided additional food if necessary and examined any dead chimpanzees. The area status was upgraded to a national park in 1999. Local people were relocated from the release site to a nearby village. In some cases, chimpanzees were treated when sick or injured. TV and radio advertisements were used to raise conservation awareness and local people were provided monetary and non-monetary benefits in exchange for their conservation support. The study does not distinguish between the effects of the different interventions mentioned above.

A study in 1979-2004 in tropical forest on Baboon Islands, River Gambia National Park, The Gambia (4) found that rehabilitated and reintroduced western chimpanzees *Pan troglodytes verus* that received periodic deworming alongside other interventions, increased from 50 to 69 chimpanzees over 25 years. No statistical tests were carried out to determine whether this increase was significant. Fertility and mortality rates were similar to that in wild chimpanzees, except for infant mortality (18%), which was lower than in wild populations. Inter-birth interval, average age at first birth, proportion males at birth, age at first sexual swelling in females, and adolescent infertility were similar to that of wild chimpanzees. In total, 50 chimpanzees from various backgrounds were released in groups on three islandsinto habitat with natural predators (although these were rare), but with no wild or previously reintroduced chimpanzees. Chimpanzees were given antibiotic treatment when they suffered from severe colds, and were provided supplementary food every 1-2 days. The study does not distinguish between the effects of the different interventions mentioned above.

A study in 2002–2006 in closed canopy forest in Lékédi Park, Gabon (5) found that one third of captive-bred reintroduced mandrills *Mandrillus sphinx* that were treated for parasites alongside other interventions, died within the first year post-release. During this year, mortality was 33% (12/36), with dependent infants being most affected. Fertility rate was 42% (5/12 females gave birth to an infant) and two of the five infants survived for longer than six months. Mortality decreased to 4% in the second year and fertility rate remained at 42%, and all five infants born in the second year survived for at least six months. Mandrill home range remained limited during the first two years after release. In 2006, the group numbered 22 individuals, including 12 of the mandrills originally released, all in good physical condition. All mandrills were treated for gastrointestinal parasites immediately before release. Mandrills were reintroduced as a group into habitat already occupied by the species and predators. They were allowed to adapt to local habitat conditions before release and supplemented with food until 2005. The study does not distinguish between the effects of the different interventions mentioned above.

A before-and-after site comparison study in 1996-2006 in tropical forests of Lesio-Louna Wildlife Reserve, Republic of Congo (Congo) and Batéké Plateau National Park, Gabon (6) found that the majority of reintroduced western lowland gorillas *Gorilla gorilla gorilla* that were treated for parasites alongside 14 other interventions, survived for at least four years. Twenty-one of 25 gorillas (84%) released in Congo and 22 of 26 gorillas (85%) released in Gabon survived over four years. Nine females gave birth to 11 infants, of which nine survived. Three groups received a deworming or a treatment for a skin condition, one and three years after release. Gorillas underwent disease screening and vaccinations during quarantine. They were released in groups, allowed to adapt to local environment and supplemented with food before release. To re-establish populations, gorillas were released into habitat with no resident conspecifics. Released gorillas were treated when sick. So-called 'problem-animals' were removed and relocated and dead gorillas were clinically examined. Forty-three individuals were rehabilitated wild-born orphaned gorillas and eight gorillas were ex-situ captive-born. Both sites became protected areas before reintroduction. The study does not distinguish between the effects of the different interventions mentioned above.

A site comparison in 2008-2012 in bamboo thicket-dominated forest at Dao Tien Island (DTI) and mixed forest in Dong Nai Biosphere Reserve (DNBR), South Vietnam (7a) found that several pygmy slow lorises *Nycticebus pygmaeus* that were treated for parasites prior to their release alongside eight other interventions, survived for at least two months. Four out of eight lorises survived for at least two months post-release, whereas the remaining individuals either died or their radio-collar signal was lost. Lorises were released in groups during the wet season after a 6-week quarantine, veterinary screens and oral treatment for parasites. Both release sites were protected, no wild resident lorises occurred there and predators were present. Lorises were kept in a cage at the release site between <2 months and two days, and were subsequently supplemented with food for 7-30 days in DTI and DNBR, respectively. Dead lorises were detected and examined. The study does not distinguish between the effects of the different interventions mentioned above.

A site comparison study in 2008-2012 in mosaic forest at two sites in Cat Tien National Park, South Vietnam (7b) found that all pygmy slow lorises *Nycticebus pygmaeus* that were treated for parasites prior to their release alongside other interventions either died or disappeared. All five lorises died or their radio-collar signal was lost soon after release. Lorises underwent a 6-week quarantine, veterinary screens and oral treatment for parasites. They were released in groups into habitat with no wild resident lorises but with predators. Three lorises were released at Cat Tien National Park during the dry season. Another two individuals were held in a semi-wild enclosure for one month to foster behaviour that would facilitate their survival in the wild and were released during the wet season. Dead animals were examined to determine the cause of death. The study does not distinguish between the effects of the different interventions mentioned above.

A before-and-after trial in 2008-2010 in tropical forest-grassland mosaic at Batéké Plateau National Park, Gabon (8) found that the majority of western lowland gorillas *Gorilla gorilla gorilla* that were treated for internal parasites alongside ten other interventions, survived for at least nine months post-release. Four out of five (80%) juvenile gorillas survived for at least nine months after release when they were dewormed every three months. Three captive-bred and two orphaned wild born individuals were reintroduced as a group into habitat with predators and without wild conspecifics after they were allowed to adapt to local habitat conditions for some time. They spent the night in an enclosure equipped with nesting platforms, nesting material, supplementary food and water. Caretakers guided them into different forest patches on a daily basis. The study does not distinguish between the effects of the different interventions mentioned above.

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8.18. Control 'reservoir' species to reduce parasite burdens/pathogen sources

- We found no evidence for the effects of controlling ‘reservoir’ species to reduce parasite burdens/pathogen sources on primate populations.

Background

The transmission of infectious agents from reservoir animal populations (e.g. domesticated species) to sympatric (occurring within the same geographical area) wildlife presents a particular threat to endangered species, because the presence of infected reservoir hosts can lower the pathogen's threshold density and lead to local wildlife population-level extinctions. For example, African wild dogs *Lycaon pictus* became extinct in the Serengeti in 1991, concurrent with epizootic canine distemper in sympatric domestic dogs (e.g. Daszak *et al*. 2000). This intervention aims to control such reservoir species to reduce parasite burdens/pathogen sources for wild primate populations.

Controlling the actions of humans as 'reservoir' species to reduce pathogen sources is discussed under: 'Ensure that researchers are up-to-date with vaccinations and healthy', 'Regularly disinfect researcher's clothes, boots etc.', 'Wear gloves when handling primate food, tool items, etc.', 'Implement quarantine for people arriving at, and leaving the site', 'Wear face-masks to avoid transmission of viral and bacterial diseases to primates', 'Keep safety distance to habituated animals', and 'Limit time that researchers are allowed to spend with habituated animals'.

Daszak P., Cunningham A.A. & Hyatt A.D. (2000) Unhealthy travelers present challenges to sustainable primate ecotourism. *Science*, 287, 443–449.

8.19. Conduct veterinary screens of animals before reintroducing/translocating them

- One before-and-after study in Brazil[1] found that most reintroduced golden lion tamarins did not survive over seven years, despite undergoing pre-release veterinary screens, alongside other interventions. One study in Brazil[9] found that most reintroduced black lion tamarins that underwent veterinary screens, alongside other interventions, survived over four months.
- One before-and-after study in Malaysia[2] found that 90% of reintroduced Müller's Bornean gibbons did not survive despite undergoing veterinary screens, alongside other interventions. One controlled study in Indonesia[15] found that reintroduced Bornean agile gibbons that underwent veterinary screens, alongside other interventions, behaved similarly to wild gibbons.
- Two studies, including one controlled, in Malaysia[4] and Indonesia[18] found that most translocated orangutans that underwent veterinary screens, along with other interventions, survived translocation[4] and the first three months post-translocation[18]. One controlled study, in Malaysia[13], found that the population size of reintroduced orangutans decreased despite individuals undergoing pre-release veterinary screens, alongside other interventions.
- Four studies, including three before-and-after studies, in Liberia[7], the Republilc of Congo[10, 11] and Guinea[21] found that most reintroduced chimpanzees that underwent veterinary screens, alongside other interventions, survived over 1-5 years. One before and after study in Uganda[6] found that a reintroduced chimpanzee repeatedly returned to human settlements after undergoing pre-release veterinary screens, alongside other interventions.

- Five studies, including four before-and-after studies, in Belize[3, 5], French Guiana[12], Madagascar[17], Congo and Gabon[22] found that most reintroduced or translocated primates that underwent veterinary screens, alongside other interventions, survived at least four months[3, 12, 14, 17, 22] or increased in population size[5].
- Seven studies, including four before-and-after studies, in French Guiana[8], Madagascar[13], South Africa[19, 20] and Vietnam[23a, 23b] found that most reintroduced or translocated primates were assumed to have died post-release[8, 13, 19, 20, 23a, 23b] despite undergoing pre-release veterinary screens, alongside other interventions.
- One controlled study in Kenya[14] found that a population of translocated olive baboons were still surviving 16 years after translocation when veterinary screens were applied alongside other interventions.

Background

This intervention aims to detect potentially dangerous diseases in primates that are being introduced/translocated to prevent disease transmission to resident, wild primates. The IUCN guidelines suggest that disease screening should test primates for infectious agents that are not found naturally in wild populations of the species/taxonomic group of concern (such as pathogens acquired from people or other animals) and agents that may result in the introduction or spread of potentially dangerous diseases. The infectious agents that are ultimately tested for depend on the geographical region, taxon of concern, available technologies, funding, and other such factors (Soorae & Baker 2002).

Soorae P.S. & Baker L.R. (2002) *Re-introduction NEWS: Special Primate Issue*. Newsletter of the IUCN/SSC Re-introduction Specialist Group, Abu Dhabi, United Arab Emirates. No. 21.

A before-and-after trial in 1984-1991 in coastal forest in Poço das Antas Reserve, Brazil (1) found that the majority of reintroduced golden lion tamarins *Leontopithecus rosalia*, which underwent extensive veterinary screens before release alongside 14 other interventions, did not survive over a study period of seven years. Fifty-eight out of 91 (64%) reintroduced tamarins did not survive in the wild. However, 57 infants were born (reproductive rate=63%) during the study, of which 38 (67%) survived. Tamarins were screened and treated for parasites, communicable diseases, possible genetically-based defects, injuries, and diaphragmatic thinning and only released if they were clear untreatable conditions. Different groups of captive-bred or orphaned tamarins were introduced in different years into habitat already occupied by the species and predators. Groups were provided with supplementary food, water and nesting boxes, and allowed to adapt to local habitat conditions before release. All tamarin groups were quarantined before release. Reintroduced sick or injured animals were rescued, treated and re-released. In 1983 the reserve became officially protected and a long-term research study was implemented. The study does not distinguish between the effects of the different interventions mentioned above.

A before-and-after trial in 1976-1988 in a degraded tropical forest in Semenggoh Forest Reserve, Malaysia (2) found that at least 77 of 87 (90%) reintroduced captive, wild-born Müller's Bornean gibbons *Hylobates muelleri* that underwent veterinary checks before release along with other interventions, did not survive after release. Confiscated gibbons were placed in holding cages in a forest clearing for an unknown amount of time prior to release. Where possible, males and females were paired in cages before release into habitat without resident gibbons. Müller's Bornean gibbons were fully protected under the Wild Life Protection Ordinance in Sarawak. Surveys of direct sightings and gibbon calls along grid squares (500 x 500 m) covering a total of 9.5 km were conducted simultaneously by 3-4 observers on non-rainy days on eight mornings in February-March 1988. The study does not distinguish between the effects of the different interventions mentioned above.

A replicated study in 1992-1993 in tropical forest at Cockscomb Basin Wildlife Sanctuary (CBWS) in Belize (3) found that the majority of translocated black howler monkeys *Alouatta pigra* that underwent veterinary checks prior to release alongside other interventions, survived for at least ten months and reproduced. Twelve out of 14 reintroduced monkeys (86%) survived for at least ten months after release. One male and one juvenile disappeared two months post-release. Two infants were born, in each of two of the three release groups. Veterinary screens included blood tests and general health checks. Wild howlers had been captured at the Community Baboon Sanctuary and were translocated to CBWS. Three groups were released into habitat without resident howlers. They were allowed to adapt to local conditions before release. Six individuals were fitted with ball-chain radio-collars and six others were implanted with radio-transmitters. Radio-collars worked for 6-10 months, but transmitter signals got lost six weeks after release. The study does not distinguish between the effects of the different interventions mentioned above.

A study in June-September 1993 in three fragmented tropical forests in the State of Sabah, Malaysia (4) found that 78 of 80 (98%) translocated orangutans *Pongo pygmaeus morio* that underwent veterinary screens before their release at Tabin Wildlife Reserve along with other interventions, survived translocation. Four individuals escaped from their temporary holdings before transport to the release site. Of these, three individuals suffered minor injuries and one individual sustained major injury during capture. Individuals were either immobilized in trees or captured manually on the ground with nets. Individuals were treated before they were released individually into habitat already occupied by other orangutans. To avoid injury due to post-traumatic stress, females were kept in separate (but adjacent) cages from their offspring and adequate space was maintained between occupied cages during temporary holdings and transportation. The study does not distinguish between the effects of the different interventions mentioned above.

A before-and-after trial in 1992-1997 in tropical forest in Cockscomb Basin Wildlife Sanctuary in Belize (5) found that the population of introduced wild black howler monkeys *Alouatta pigra* that underwent extensive veterinary screens before release into the wild along with other interventions, increased in size over time. By 1997, the population increased by 61% (62 to >100 individuals). No statistical tests were carried out to determine whether this increase was significant. One-month-, 6-month-, 1-year, and 2-year survival rates for the different cohorts released in the dry seasons of 1992, 1993, and 1994, were 81-100%. Birth rate was 20% (n=12) and infant survival rate was 75% (n=9). Entire social groups were reintroduced at once over a two-year period. Ten of the 14 groups were held in cages for 1-3 days before release with a distance of 700-1000 m to the neighbouring troop. All individuals were permanently marked and adults were radio-collared. Hunting was largely controlled in the sanctuary and the local community was educated about the reintroduction project and black howler conservation through multimedia campaigns. The study does not distinguish between the effects of the different interventions mentioned above.

A before-and-after study in 1995 in Kibale National Park, Uganda (6) found that a female captive, 4-6 year old wild-born chimpanzee *Pan troglodytes schweinfurthii* that underwent veterinary screens alongside other interventions, repeatedly returned to human settlements after her release and was subsequently returned to captivity. Eight days after her initial release, she left the forest and was brought back into the forest. The following ten days, she travelled, fed, nested and engaged in social activities with the wild community. During this time, she increased ranging distance to humans and use of height, and visually monitored humans less regularly. However, the proportion of adult males in her vicinity decreased and she increasingly spent time alone. She was returned to captivity six weeks after her release. A veterinary team administered a test of skin reactivity to tuberculin antigen to which she tested negative prior to her release. She underwent pre-release training for three weeks before reintroduction into habitat with a resident wild community. During this time, she was also quarantined. At least ten community members worked on the project. The study does not distinguish between the effects of the different interventions mentioned above.

A study in 1987-1988 on an island in tropical forest in Liberia, West Africa (7) found that the majority of reintroduced western chimpanzees *Pan troglodytes verus* that underwent veterinary screens prior to release along with other interventions, survived for at least one year post-release. Seven out of 30 released chimpanzees had difficulties to adjust to the new social environment and were brought back to captivity. Prior to release, individuals were screened for diseases and only healthy chimpanzees were released. Chimpanzees were released in groups. Furthermore, they were socialized in naturalistic enclosures and were taught behaviour to facilitate their survival in the wild. On site, primates were allowed to adapt to the local habitat in enclosures for some time; younger and low-ranking individuals were released earlier to reduce stress. Released chimpanzees were continuously provided with food. Sick and injured animals were temporarily removed and treated. The study does not distinguish between the effects of the different interventions mentioned above.

A study in 1994-1995 in primary forest at the Petit Saut hydroelectric dam in French Guiana (8) found that less than half of the translocated red howler monkeys *Alouatta seniculus* that underwent veterinary screens alongside other interventions, survived for at least 18 months. Of the 16 females monitored, seven (44%) females survived to the end of the study with a possible survival rate of 63%. Deaths related to the translocation process included screwworm fly larvae infestations under radio-collars (n=2) and trauma (n=1). Three (19%) females gave birth after release, but all infants disappeared and probably died. All females studied for longer than three months (50%) settled within the release area. Of the 122 captured and translocated howlers from 28 different troops, ten out of 11 (91%) documented troops broke apart post-release. All animals were anesthetized and examined by a veterinarian. After taking biological samples, all individuals were confirmed as healthy. Monkeys were translocated and reintroduced in groups into habitat already occupied by the species. They were allowed to adapt to local habitat conditions before their release. The study does not distinguish between the effects of the different interventions mentioned above.

A study in 1999 in tropical forest of Morro do Diabo State Park, São Paulo, Brazil (9) found that only two of three reintroduced wild and captive-bred black lion tamarins *Leontopithecus chrysopygus* that underwent health checks prior to release along with other interventions, survived for at least four months. One tamarin underwent medical tests including both blood and faecal analyses, and a tuberculin test prior to transport. Prior to release, blood tests were conducted for all tamarins. Tamarins were held in an enclosure to adapt to the local environment where predators occurred. The group consisted of two wild females and one captive-born male, bred in a free-ranging environment, where natural behaviour was fostered to facilitate reintroduction. The male was treated after he was detected sick. Monkeys were fitted with radio transmitters and continuously supplemented with food until the end of the study. The study does not distinguish between the effects of the different interventions mentioned above.

A before-and-after trial in 1996-1999 in tropical rainforest in Conkouati Reserve, Republic of Congo (10) found that 70% of reintroduced wild-born orphaned central chimpanzees *Pan troglodytes troglodytes* that underwent veterinary screens along with eight other interventions, were still alive 3.5 years post-release. Confirmed mortality was 10%, with a possible 30%. None of the adult females produced offspring. Chimpanzees fed on 137 different plant species, diversity in diet similar to that of wild chimpanzees, and had activity budgets that resembled those of wild chimpanzees. No statistical tests were carried out to determine whether similarities were significant. Chimpanzees were treated for internal parasites and vaccinated for poliomyelitis and tetanus. Before reintroduction in groups into habitat with low densities of wild chimpanzees, they spent 6-9 years on one of three forested islands in the region to acclimatize. Orphan chimpanzees were rehabilitated and fostered at a nearby sanctuary. Researchers were permanently present on-site and monitored released chimpanzees using radio-collars. The study does not distinguish between the effects of the different interventions mentioned above.

A before-and-after trial in 1994-1999 in mixed tropical forest in Conkouati-Douli National Park, Republic of Congo (11) found that the majority of reintroduced central chimpanzees *Pan troglodytes troglodytes* that underwent health screens prior to release alongside 16 other interventions, survived for at least five years. Out of 20 reintroduced chimpanzees, whose body conditions were visually assessed and blood, faecal, and hair samples examined for diseases, fourteen (70%) survived. Individuals were radio-collared and followed at distances of 5-100 m. Rehabilitated orphaned chimpanzees underwent vaccination and parasite treatment before being translocated in four subgroups from the sanctuary to the release site where resident conspecifics occurred. Staff members were permanently present to monitor primate health, provide animals with additional food if necessary and examine dead animals when needed. The area status was upgraded from reserve to national park in 1999. Local people were relocated from the release site to a nearby village. Some chimpanzees were treated when sick or injured. TV and radio advertisements were used to raise chimpanzee conservation awareness and local people were provided monetary and non-monetary benefits to support conservation. The study does not distinguish between the effects of the different interventions mentioned above.

A before-and-after trial in 1994-1995 in tropical forest near Petit-Saut dam, French Guiana (12) found that two out of three translocated white-faced sakis *Pithecia pithecia* that underwent veterinary screens prior to release alongside other interventions, survived for at least four months. Three (two males and one female) out of six translocated sakis were monitored intensively for 41 weeks after release using radio-collars. Two of these survived for at least four months post-release, and one male died after 22 weeks due to a screwworm fly larvae infestation under his collar. Veterinary screens included blood and skin biopsy and general health condition checks. When dead sakis were detected, the cause of death was clinically determined. Sakis were captured at development sites using nets and released the next day as single individuals or as a group into primary rainforest habitat already occupied by wild resident sakis. The study does not distinguish between the effects of the different interventions mentioned above.

A before-and-after trial in 1997-2002 in primary forest in Betampona Reserve, Madagascar (13) found that less than half of all captive-bred, parent-reared reintroduced black-and-white ruffed lemurs *Varecia variegata variegata* that underwent veterinary screens before their release alongside ten other interventions, survived over five years. Five of 13 individuals (38.5%) survived in the wild and six individuals were born, of which only four survived. One female and one male of the group reproduced with wild resident lemurs and the male became fully integrated into the wild group. Veterinary examinations included physical examinations, complete blood cell count, serum biochemical profile, viral serology, Toxoplasma antibody level, trace mineral determination, fat soluble vitamin determination, faecal parasite examination, and faecal culture. Released animals were radio-collared. Captive lemurs had limited semi-free-ranging experience and were quarantined before their reintroduction in groups into habitat with predators and wild conspecifics. They were recaptured and treated when sick and provided supplementary food and water. They were allowed to adapt to local habitat conditions before release. Dead lemurs were clinically examined. The study does not distinguish between the effects of the different interventions mentioned above.

A controlled, before-and-after trial in 1973-2001 in savannah at the Chololo ranch, Laikipia Plateau, Kenya (14) found that the populations of translocated crop-raiding olive baboons *Papio anubis* had survived over 17 years when individuals underwent veterinary screens prior to release, alongside other interventions. Survival rate of individuals in two translocated troops of a total of 94 baboons in 1984 was 66%, where 62 individuals remained in 2001. One wild troop at the capture site and another resident troop at the release site served as control groups. Survival rates did not differ between control and study groups. Both troops, regarded as 'problem animals' by farmers, were translocated into habitat with resident wild baboons and predators. A long-term research project studied these animals. After their release, baboons were frequently monitored by researchers and were briefly provided with food during periods of drought. Some sick baboons were treated. The study does not distinguish between the effects of the different interventions mentioned above.

A controlled study in 2002-2003 in swamp forest on Mintin Island, Borneo, Indonesia (15) found that wild-born, captive-raised Bornean agile gibbons *Hylobates albibarbis* that underwent veterinary screens before reintroduction alongside other interventions, shared a similar diet, spent similar amounts of time feeding, resting, and arm-swinging and at similar canopy heights as wild gibbons. However, wild gibbons spent more time singing and socializing and travelling, which can be explained by the fact that the reintroduced gibbon pair split up almost immediately after their release. Gibbons were quarantined for at least 12 months before reintroduction. They were kept in enclosures (3 x 3 x 3 m) to socialize and acclimatize to the natural environment and were supplemented with vitamins and leaves once a week. They were introduced in pairs and into habitat in which wild gibbons were present. Only one reintroduced pair of gibbons was compared to a pair of wild gibbons at another site. The study does not distinguish between the effects of the different interventions mentioned above.

A controlled study in 1967-2004 in tropical forest in Kabili-Sepilok Forest Reserve, Malaysia (16) found that a rehabilitated orangutan *Pongo pygmaeus morio* population that underwent in-depth veterinary checks before their reintroduction alongside eight other interventions, decreased by 33% over 33 years (1964-1997). Infant mortality was higher (57%) than in other wild and captive populations, and the sex ratio at birth was strongly biased towards females (proportion males=0.11) compared to other wild and captive populations. Orangutans were provided daily with supplementary food from 2-7 feeding platforms. Inter-birth-interval was (6.1 years) similar to wild populations of the same subspecies. Mean age at first reproduction was lower (11.6 years) than in other wild and captive orangutan populations. Individuals were kept in quarantine for 90 days before they were released into the reserve, in which other rehabilitated orangutans lived. Individuals were captured and treated when injured or ill. Staff and volunteers received medical checks and tourists had to keep safety distances (> 5 m) at all times. The study does not distinguish between the effects of the different interventions mentioned above.

A before-and-after study in 2006-2007 in rainforest in Analamazaotra Special Reserve, Madagascar (17) found that black-and-white ruffed lemurs (BWRL) *Varecia variegata variegata* and diademed sifakas *Propithecus diadema* survived for at least 30 months and reproduced after they underwent veterinary screens 2-8 months before release along with other interventions. No mortalities were recorded for BWRL over a 30-month observation period, and only one diademed sifaka died from natural causes. Two sets of BWRL twins (reproductive rate=57%) and seven diademed sifaka infants were born (reproductive rate=26%), the latter of which only two survived. A total of seven BWRL and 27 diademed sifakas were captured at four disturbed forest sites and released in their social units to the reserve where the species had locally gone extinct and that included natural predators. Released primates were habituated to human presence and relocated and monitored using radio-collars. The study does not distinguish between the effects of the different interventions mentioned above.

A controlled study in 2004-2005 in secondary tropical forest in Bukit Tigapuluh National Park, Indonesia (18) found that all reintroduced Sumatran orangutans *Pongo abelii* that underwent veterinary screens prior to release alongside other interventions, survived for at least three months. All eight captive orphaned orangutans with largely unknown histories survived for at least three months post-introduction, after which monitoring ceased. Before transportation to the reintroduction centre, orangutans were quarantined and underwent medical screens and clearance. Quarantine and reintroduction followed guidelines, including relevant IUCN guidelines. Orangutans were released to re-establish populations into habitat where previously-translocated orangutans occurred. Supplementary food was provided regularly. One group was directly released into the forest after a 6-month acclimatization phase at a sanctuary. Another group of individuals was kept in semi-free conditions for 7-9 months prior to release and allowed to overnight in the enclosure. Staff members guided the latter to the forest on a daily basis. The study does not distinguish between the effects of the different interventions mentioned above.

A before-and-after trial in 2007-2008 in forest-grassland mosaic near Richmond, KwaZulu-Natal, South Africa (19) found that only a small proportion of vervet monkeys *Chlorocebus aethiops* that underwent veterinary checks prior to their release in two troops along with other interventions, survived for at least 10 months. Out of 35 monkeys released in troop one, only six (17%) survived for 10 months after release, after which monitoring ceased. Twenty-two (63%) vervets went missing and seven (20%) died. However, two infants were born ten and 11 months post-release. Out of 24 vervets released in troop two, 12 (50%) survived, seven (29%) went missing and five (21%) died. Two blood samples were taken for haematological and biochemical analysis. Monkeys underwent veterinary checks, and were allowed to adapt to local environmental conditions before their release in groups into habitat already occupied by conspecifics. All monkeys were supplemented with food after release and one troop also received water. The study does not distinguish between the effects of the different interventions mentioned above.

A study in 2007-2010 in forest-shrubland mosaic within the Mondi forestry in KwaZulu-Natal, South Africa (20) found that only a small portion of the 31 rehabilitated and reintroduced vervet monkeys *Chlorocebus aethiops* that underwent veterinary screens alongside other interventions, survived for at least one year. One year post-release, ten (32%) individuals had survived and 20 (65%) could not be tracked. One individual was euthanized three days after release after raiding houses and acting aggressively towards people. Veterinary screens included physical examination to determine health condition. The release group included both wild captured (61%) (due to injury) and hand-raised orphaned (39%) vervets. They were held in an enclosure at the release site to adapt to local habitat, released as a group, and supplemented with food for eight weeks. Eleven individuals were fitted with radio-collars that worked nine months after release. The study does not distinguish between the effects of the different interventions mentioned above.

A before-and-after trial in 2008-2010 in forest-savanna mosaic in Mafou forest in Haut Niger National Park, Guinea (21) found that the majority of wild-born orphaned western chimpanzees *Pan troglodytes verus* that underwent veterinary screens prior to release alongside other interventions, survived reintroduction and remained free-living for at least 27 months. Only one out of 12 (8.3%) released chimpanzees died from anaesthesia during a recovery. One female returned to the sanctuary voluntarily and one male was returned after suffering injuries during another recovery mission. Five chimpanzees (42%) remained together at the release site and two females gave birth to an infant, both of which survived. Health checks included examination of faecal samples for parasites, tuberculosis tests and haematological and serotological analyses. All chimpanzees were released together into habitat with resident wild chimpanzees and predators. Some chimpanzees were allowed to acclimatize to local habitat conditions prior to release. Chimpanzees were initially daily supplemented with food and later on, weekly. The study does not distinguish between the effects of the different interventions mentioned above.

A before-and-after, site comparison study in 1996-2006 in tropical forests of Lesio-Louna Wildlife Reserve, Republic of Congo (Congo) and Batéké Plateau National Park, Gabon (22) found that the majority of reintroduced western lowland gorillas *Gorilla gorilla gorilla* that underwent veterinary checks prior to release alongside 14 other interventions, survived over four years. Twenty-one of 25 gorillas (84%) released in the Congo and 22 of 26 gorillas (85%) released in Gabon survived for at least four years. Nine females gave birth to 11 infants, of which nine survived. Gorillas underwent disease screening and vaccinations during quarantine. Gorillas were released in groups and allowed to adapt to local environment and supplemented with food before release into habitat with no resident gorillas. Released gorillas were treated for parasites and when sick. So-called 'problem-animals' were removed and relocated and bodies of dead gorillas were examined to determine their cause of death. Forty-three individuals were rehabilitated wild-born orphaned gorillas and eight were ex-situ captive-born gorillas. Both sites became protected areas before reintroduction. The study does not distinguish between the effects of the different interventions mentioned above.

A site comparison in 2008-2012 in bamboo thicket-dominated forest at Dao Tien Island (DTI) and mixed forest in Dong Nai Biosphere Reserve (DNBR), South Vietnam (23a) found that half of the pygmy slow lorises *Nycticebus pygmaeus* that were screened for diseases before translocation alongside eight other interventions, survived for at least two months. Four out of eight lorises survived for at least two months post-release, whereas remaining individuals either died or their radio-collar signal was lost at an early stage. Lorises were released in groups during the wet season after all monkeys had undergone a 6-week quarantine, veterinary screens and treatment for parasites. Both release sites were protected, no wild resident lorises occurred there and predators were present. Lorises were kept in an in situ cage for between < 2 months or two days, and were subsequently supplemented with food for 7-30 days in DTI and DNBR, respectively. Bodies of dead animals were examined to determine the cause of death. The study does not distinguish between the effects of the different interventions mentioned above.

A site comparison in 2008-2012 in mosaic forest at two sites in Cat Tien National Park, South Vietnam (23b) found that all pygmy slow lorises *Nycticebus pygmaeus* that were screened for diseases prior to their translocation alongside other interventions either died or disappeared. All five lorises died or their radio collar signal was lost at an early stage after release. Each loris was examined under anaesthesia and an intradermal tuberculosis test was conducted. All monkeys underwent a 6-week quarantine and treatment for parasites. Lorises were released in groups into habitat with no wild resident lorises. Three lorises were released at Cat Tien National Park during the dry season. Two other individuals were held in a semi-wild enclosure for one month to foster behaviour that would facilitate their survival in the wild. The latter were released during the wet season. Bodies of dead animals were detected and examined to determine the cause of death. The study does not distinguish between the effects of the different interventions mentioned above.

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(22) King T., Chamberlan C. & Courage A. (2012) Assessing initial reintroduction success on long-lived primates by quantifying survival, reproduction, and dispersal parameters: western lowland gorillas (*Gorilla gorilla gorilla*) in Congo and Gabon. *International Journal of Primatology*, 33, 134–149.
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8.20. Implement continuous health monitoring with permanent vet on site

- One controlled, before-and-after study in Rwanda, Uganda and the Democratic Republic of Congo[1] found that the population size of mountain gorillas that were continuously monitored by vets, alongside other interventions, increased by 168% over 41 years.

Background

This intervention involves the continuous health monitoring of primates by vets who are permanently based on site. There are only few organizations that provide *in situ* veterinary treatment for wild animals (e.g. Robbins *et al*. 2011). The Mountain Gorilla Veterinary Program, for example, intervenes in cases of human-induced illnesses, such as injuries incurred by snares or respiratory disease, as well as when the life of an individual is at risk and there is the chance that the illness can spread to other individuals.

Robbins M.M., Gray M., Fawcett K.A., Nutter F.B., Uwingeli P., Mburanumwe I., Kagoda E., Basabose A., Stoinski T.S., Cranfield M.R., Byamukama J., Spelman L.H., Robbins A.M. (2011) Extreme conservation leads to recovery of the Virunga mountain gorillas. *PLoS ONE*, 6, e19788.

A controlled, before-and-after study in 1967-2008 in tropical montane forest in Volcanoes-, Mgahinga-, and Virunga National Parks in Rwanda, Uganda, and the Democratic Republic of Congo (1) found that a mountain gorilla *Gorilla beringei beringei* population that was continuously monitored by vets alongside ten other interventions, increased in size over time. Annual population growth was 4.1%, resulting in an overall population increase of 168% over 41 years. No statistical tests were carried out to determine whether this increase was significant. Veterinary treatment for snares, respiratory disease, and other life-threatening conditions explained up to 40% of the difference in growth rates between this population and another population in the same area, which did not receive veterinary care. The remaining 60% were likely due to increased protection against poachers. As part of an ecotourism- and research project, gorillas in the treatment population were habituated to human presence where visitors/researchers had to follow strict health procedures; these included keeping a safety distance to the gorillas, wearing face-masks, spending only limited amounts of time with gorillas, ensuring that visitors/researchers were healthy and disinfecting visitor's/researcher's clothes, boots etc. Dead gorillas were clinically examined. The study does not distinguish between the effects of the other interventions mentioned above

(1) Robbins M.M., Gray M., Fawcett K.A., Nutter F.B., Uwingeli P., Mburanumwe I., Kagoda E., Basabose A., Stoinski T.S., Cranfield M.R., Byamukama J., Spelman L.H., Robbins A.M. (2011) Extreme conservation leads to recovery of the Virunga mountain gorillas. *PLoS ONE*, 6, e19788.

8.21. Avoid contact between wild primates and human-raised primates

- We found no evidence for the effects of avoiding contact between wild primates and human-raised primates on primate populations.

Background

To minimize the risk of disease transmission, this intervention aims to avoid contact between wild primates and human-raised primates, the latter of which may act as carriers for human diseases that may spread to wild primate populations.

8.22. Detect & report dead primates and clinically determine their cause of death to avoid disease transmission

- One before-and-after study in the Republic of Congo[1] found that most reintroduced chimpanzees survived over five years when dead chimpanzees were examined to determine their cause of death, alongside other interventions.
- One before-and-after study in French Guiana[2] found that most translocated white-faced sakis survived over four months when dead sakis were examined to determine their cause of death, alongside other interventions.
- One before-and-after study in Madagascar[3] found that most black-and-white ruffed lemurs did not survive over five years despite the fact that dead lemurs were clinically examined to determine their cause of death, alongside other interventions.
- One controlled, before-and-after study in Rwanda, Uganda and the Democratic Republic of Congo[4] found that the population size of mountain gorillas where dead animals were examined to determine the cause of death, alongside other interventions, increased by 168% over 41 years.
- One before-and-after, side comparison study in Congo and Gabon[5] found that most western lowland gorillas survived over four years when dead individuals were examined to determine their cause of death, alongside other interventions.

- Three studies, including a before-and-after, in Vietnam[6] and Indonesia[7] found that most reintroduced pygmy slow lorises either died or disappeared despite the fact that dead lorises were examined to determine their cause of death, alongside other interventions.

Background

This intervention entails that dead primates are detected in the field, clinically examined, and their cause of death reported. This information may serve as an early warning system to prevent/minimize disease transmission to other primates in the population by e.g. isolating infected or dead individuals or by allowing management to medically intervene. The intervention is important in cases where primates contract highly infectious and life-threatening diseases.

A before-and-after trial in 1994-1999 in mixed tropical forest in Conkouati-Douli National Park, Republic of Congo (1) found that the majority of reintroduced central chimpanzees *Pan troglodytes troglodytes* survived over five years when dead chimpanzees were examined to determine their cause of death alongside 16 other interventions. Out of 20 reintroduced chimpanzees, two juveniles were confirmed dead, and one male and three females disappeared. No statistical tests were carried out to determine whether the population decrease was significant. Chimpanzees were radio-collared and followed at distances of 5-100 m. Rehabilitated orphaned chimpanzees underwent vaccination, parasite treatment and veterinary screens before being translocated in four subgroups from the sanctuary to habitat where resident conspecifics occurred. Staff members were permanently present to monitor primate health and provide with additional food if necessary. The area status was upgraded from reserve to national park in 1999. Local people were relocated to a nearby village. Sick or injured chimpanzees were treated. TV and radio advertisements were used to raise chimpanzee conservation awareness and local people were provided monetary and non-monetary benefits in exchange for their conservation support. The study does not distinguish between the effects of the different interventions mentioned above.

A before-and-after trial in 1994-1995 in tropical forest near Petit-Saut dam, French Guiana (2) found that most of the translocated white-faced sakis *Pithecia pithecia* survived for at least four months when dead sakis were examined to determine their cause of death along with other interventions. Two out of three translocated sakis survived for at least four months after release, one individual died after circa 22 weeks. One male died following a new world screwworm fly larvae *Cochliomya hominivorax* that developed under its radio-collar. Veterinary screens included blood and skin biopsy and general health checks. Three out of six translocated wild sakis where monitored over 41 weeks after their release, which took place one day after capture. Monkeys were captured at development sites by nets and tagged with radio transmitters prior to release as single individuals or as a group into habitat already occupied by resident sakis. The study does not distinguish between the effects of the different interventions mentioned above.

A before-and-after trial in 1997-2002 in primary forest in Betampona Reserve, Madagascar (3) found that more than half of all captive-bred, parent-reared black-and-white ruffed lemurs *Varecia variegata variegata* did not survive until the end of the study period of five years, although each dead lemur's cause of death was clinically determined upon its detection alongside ten other interventions. Five of 13 individuals (38.5%) survived in the wild and six individuals were born, of which only four survived. One female and one male of the group reproduced with wild resident lemurs and the male became fully integrated in the wild group. All dead lemurs underwent a post-mortem examination. Released animals were fitted with radio-collars. Captive lemurs had limited semi-free-ranging experience, were quarantined and underwent veterinary screens before their reintroduction in groups into habitat with predators and wild resident lemurs. They were recaptured and treated when sick and provided with supplementary food and water for a certain period. They were allowed to adapt to local habitat conditions before release. The study does not distinguish between the effects of the different interventions mentioned above.

A controlled, before-and-after study in 1967-2008 in tropical moist montane forest in Volcanoes-, Mgahinga-, and Virunga National Parks in Rwanda, Uganda, and the Democratic Republic of Congo, respectively (4) found that a mountain gorilla *Gorilla beringei beringei* population increased in size over time, when dead individuals were examined and their cause of death investigated alongside ten other interventions,. Annual population growth was 4.1%, resulting in an overall population increase of 168% over 41 years. No statistical tests were carried out to determine whether this difference was significant. When a gorilla death was detected, the cause of death was clinically determined by an on-site vet. The population was continuously monitored by vets and individuals received medical treatment if necessary. As part of an ecotourism- and research project, gorillas were habituated to human presence, where visitors/researchers had to follow strict health procedures; these included keeping a safety distance to the gorillas, wearing face-masks, spending only a limited amount of time with gorillas, ensuring that visitors/researchers were healthy, and disinfecting visitors'/ researchers' clothes, boots etc. The study does not distinguish between the effects of the other interventions mentioned above.

A before-and-after site comparison study in 1996-2006 in tropical forests of Lesio-Louna Wildlife Reserve, Republic of Congo (Congo) and Batéké Plateau National Park, Gabon (5) found that the majority of reintroduced western lowland gorillas *Gorilla gorilla gorilla* survived over four years when dead individuals were examined to determine their cause of death alongside 14 other interventions. Twenty-one of 25 gorillas (84%) released in Congo and 22 of 26 gorillas (85%) released in Gabon survived for at least four years. Nine females gave birth to 11 infants, of which nine survived. Four individuals died at each release site; three individuals died of natural causes, two died after fights with other gorillas and three disappeared and were pressumed dead. Gorillas underwent disease screening and vaccinations during quarantine. Gorillas were released in groups in habitats with no resident gorillas, allowed to adapt to local environment and supplemented with food prior to release. Released gorillas were treated for parasites and when sick. So-called 'problem-animals' were removed and relocated. Forty-three individuals were rehabilitated wild-born orphaned gorillas and eight gorillas were ex-situ captive-born. Both sites were proclaimed protected areas before reintroduction procedures. The study does not distinguish between the effects of the different interventions mentioned above.

A site comparison study in 2008-2012 in bamboo thicket-dominated forest at Dao Tien Island (DTI) and mixed forest in Dong Nai Biosphere Reserve (DNBR), South Vietnam (6a) found that several pygmy slow lorises *Nycticebus pygmaeus*, survived reintroduction while dead individuals were examined to determine their cause of death alongside eight other interventions. Four out of eight lorises survived for at least two months post-release. One individual died due to assumed hyperthermia, a predator killed another and the remaining two lost their collar soon after release. Lorises were released as multiple individuals during the wet season after a 6-week quarantine, veterinary screens and treatment for parasites. Both release sites were protected, no wild resident lorises occurred there and predators were present. Lorises were kept in an in situ cage between <2 months and two days, and were subsequently supplemented with food for 7-30 days in DTI and DNBR, respectively. The study does not distinguish between the effects of the different interventions mentioned above.

A site comparison in 2008-2012 in mosaic forest at two sites in Cat Tien National Park, South Vietnam (6b) found that all reintroduced pygmy slow lorises *Nycticebus pygmaeus* either died or disappeared; dead individuals were examined to determine their cause of death along with other interventions. Three individuals were killed by predators and two others disappeared and were assumed dead. All individuals underwent a 6-week quarantine, veterinary screens and treatment for parasites. Lorises were released as multiple individuals during the dry season into habitat with no wild resident lorises but with predators. Another two individuals were held in a semi-wild enclosure for one month to foster behaviour that would facilitate their survival in the wild and were released during the wet season. The study does not distinguish between the effects of the different interventions mentioned above.

A before-and-after trial in 2006-2011 in tropical forest at Gunung Halimun Salak National Park and Batutegi Nature Reserve, Indonesia (7) found that only few reintroduced Javan slow lorises *Nycticebus javanicus* and greater slow lorises *N. coucang* survived for at least 146 and 22-382 days, respectively, when dead individuals were examined to determine their cause of death along with other interventions. Out of five reintroduced greater slow lorises, only one survived for at least 146 days and out of 18 reintroduced Javan slow lorises only five individuals (28%) survived for at least 22-382 days. The study did not report more details about survival time. Two Javan slow lorises died of septicemia, one of electrocution and three of unknown causes. Three greater slow lorises were killed by predators and one died of unknown causes. All lorises underwent quarantine and veterinary screens prior to single releases. Sick individuals were recaptured and treated. All but two lorises were held in enclosures at the release site to adapt to local habitat where conspecifics and predators occurred. The study does not distinguish between the effects of the different interventions mentioned above.

(1) Tutin C.E.G., Ancrenaz M., Paredes J., Vacher-Vallas M., Vidal C., Goossens B., Bruford M.W. & Jamart A. (2001) The conservation biology framework of the release of wild-born orphaned chimpanzees into the Conkouati Reserve, Congo. *Conservation Biology*, 15, 1247–1257.

(2) Vié J.C., Richard-Hansen C. & Fournier-Chambrillon C. (2001) Abundance, use of space and activity patterns of white-faced sakis (*Pithecia pithecia*) in French Guiana. *American Journal of Primatology*, 55, 203–221.
(3) Britt A., Welch C., Katz A., Iambana B., Porton I., Junge R., Crawford G., Williams C. & Haring D. (2004) The re-stocking of captive-bred ruffed lemurs (*Varecia variegata variegata*) into the Betampona Reserve, Madagascar: methodology and recommendations. *Biodiversity and Conservation*, 13, 635–657.
(4) Robbins M.M., Gray M., Fawcett K.A., Nutter F.B., Uwingeli P., Mburanumwe I., Kagoda E., Basabose A., Stoinski T.S., Cranfield M.R., Byamukama J., Spelman L.H., Robbins A.M. (2011) Extreme conservation leads to recovery of the Virunga mountain gorillas. PLoS ONE, 6, e19788.
(5) King T., Chamberlan C. & Courage A. (2012) Assessing initial reintroduction success on long-lived primates by quantifying survival, reproduction, and dispersal parameters: western lowland gorillas (*Gorilla gorilla gorilla*) in Congo and Gabon. *International Journal of Primatology*, 33, 134–149.
(6) Kenyon M., Streicher U., Loung H., Tran T., Vo B. & Cronin A. (2014) Survival of reintroduced pygmy slow loris Nycticebus pygmaeus in South Vietnam. Endangered Species Research, 25, 185–195.
(7) Moore R.S., Wihermanto & Nekaris K.A.I. (2014) Compassionate conservation, rehabilitation and translocation of Indonesian slow lorises. Endangered Species Research, 26, 93–102.

8.23. Implement a health programme for local communities

- We found no evidence for the effects of implementing a health programme for local communities on primate populations.

Background

This intervention aims to indirectly prevent disease transmission from humans to primates by ensuring that humans do not carry diseases that can be contracted by primates and negatively affect their populations. It would be implemented in human communities that live in or close to primate habitat and should specifically focus on diseases that affect both humans and non-human primates.

9. Threat: Pollution

Background

Pollution can take the form of 1) chemical substances or 2) excess energy. The first category includes land-, water- and radioactive pollution, and the second category includes noise-, heat- and light pollution. Pollution can impact primates in different ways. For example, garbage in the form of human food refuse can increase the risk of contracting disease (Sengupta *et al*. 2015, Beisner *et al*. 2016) and alter gut bacteria (e.g. Rolland *et al*. 1985), change individual activity patterns (e.g. Altmann & Muruthi 1988), increase intra-group aggression levels (e.g. Brennan *et al*. 1985), and increase human-animal conflict (e.g. Brennan *et al*. 1985, Altmann & Muruthi 1988) that may ultimately lead to the killing of individuals. Other forms of land and water pollution through chemical effluents discharged for instance during the process of mineral resource extraction or industrial agricultural practices that use of herbicides and pesticides, can directly affect primate health. Chronic noise pollution through transportation networks, resource extraction, motorized recreation and urban development may have an effect on animal foraging and anti-predator behaviour, reproductive success, population density and community structure (Barber *et al*. 2010). Light pollution may alter daily rhythms of locomotor activity and core temperature, nocturnal activity and feeding behavioral patterns in nocturnal primates, as has been shown for the grey mouse lemur *Microcebus murinus* (Le Tallec *et al*. 2013). However, of the 76 studies testing conservation interventions for primates that were included in this synopsis, none reported pollution as a threat to primates and we could find no evidence for the effectiveness of the interventions listed in this chapter.

Altmann J. & Muruthi P. (1988) Differences in daily life between semiprovisioned and wild-feeding baboons. *American Journal of Primatology*, 15, 213–221.Brennan E.J., Else J.G. & Altmann J. (1985) Ecology and behaviour of a pest primate: vervet monkeys in a tourist-lodge habitat. *African Journal of Ecology*, 23, 35–44.

Barber J.R., Crooks K.R. & Fristrup K.M. (2010) The costs of chronic noise exposure for terrestrial organisms. *Trends in Ecology and Evolution*, 25, 180–189.

Beisner B.A., Balasubramaniam K.N., Fernandez K., Heagerty A., Seil S.K., Atwill E.R., Gupta B.K., Tyagi P.C., Chauhan N.P.S., Bonal B.S., Sinha P.R. & McCowan B. (2016) Prevalence of enteric bacterial parasites with respect to anthropogenic factors among commensal rhesus macaques in Dehradun, India. *Primates*, 57, 459–469.

Brennan E.J., Else J.G. & Altmann J. (1985) Ecology and behaviour of a pest primate: vervet monkeys in a tourist-lodge habitat. *African Journal of Ecology*, 23, 35–44.

Le Tallec T., Perret M. & Théry M. (2013) Light pollution modifies the expression of daily rhythms and behavior patterns in a nocturnal primate. *PLoS ONE* 8, e79250. doi:10.1371/journal.pone.0079250.

Rolland R.M., Hausfater G. & Levy S.B. (1985) Antibiotic-resistant bacteria in wild primates: increased prevalence in baboons feeding on human refuse. *Applied and Environmental Microbiology*, 49, 791–794.

Sengupta A., McConkey K.R., Radhakrishna S. (2015) Primates, provisioning and plants: impacts of human cultural behaviours on primate ecological functions. *PLoS ONE* 10, e0140961.

Key messages – garbage/solid waste

Reduce garbage/solid waste to avoid primate injuries

We captured no evidence for the effects of reducing garbage/solid waste to avoid primate injuries on primate populations.

Remove human wastes that may potentially serve as food sources for primates to avoid disease transmission and conflict with humans

We captured no evidence for the effects of removing human wastes that may potentially serve as food sources for primates to avoid disease transmission and conflict with humans, on primate populations.

Key messages – excess energy

Reduce noise pollution by restricting development activities to certain times of the day/night

We captured no evidence for the effects of reducing noise pollution by restricting development activities to certain times of the day/night on primate populations.

Garbage/solid waste

9.1. Reduce garbage/solid waste to avoid primate injuries

- We found no evidence for the effects of reducing garbage/solid waste to avoid primate injuries on primate populations.

Background

This intervention aims to protect primates from inflicting injuries by reducing the amount of garbage/solid waste that is dumped in primate habitat.

9.2. Remove human food waste that may potentially serve as food sources for primates to avoid disease transmission and conflict with humans

- We found no evidence for the effects of removing human wastes that may potentially serve as food sources for primates to avoid disease transmission and conflict with humans, on primate populations.

Background

Food provisioning to primates in the form of human food waste is a common problem in tourist areas/near tourist lodges and in other areas where primates and humans co-occur (e.g. urban areas). It can lead to an increased risk of human-primate disease transmission (Beisner *et al*. 2016), changes in individual activity and ranging patterns (e.g. Altmann & Muruthi 1988, Sengupta *et al*. 2015), an increase in intra-group aggression levels (e.g. Brennan et al. 1985), and increased human-animal conflict (e.g. Brennan *et al*. 1985, Altmann & Muruthi 1988), all of which may have negative consequences for the primate individuals involved. Furthermore, provisioning may result in a decrease in the efficiency of primates in dispersing seeds, thereby indirectly altering the entire ecosystem (Sengupta *et al*. 2015). This intervention aims to prevent primates from consuming human food waste by removing it before it can serve as potential food sources to primates.

Altmann J. & Muruthi P. (1988) Differences in daily life between semiprovisioned and wild-feeding baboons. *American Journal of Primatology*, 15, 213–221.Brennan E.J., Else J.G. & Altmann J. (1985) Ecology and behaviour of a pest primate: vervet monkeys in a tourist-lodge habitat. *African Journal of Ecology*, 23, 35–44.
Beisner B.A., Balasubramaniam K.N., Fernandez K., Heagerty A., Seil S.K., Atwill E.R., Gupta B.K., Tyagi P.C., Chauhan N.P.S., Bonal B.S., Sinha P.R. & McCowan B. (2016) Prevalence of enteric bacterial parasites with respect to anthropogenic factors among commensal rhesus macaques in Dehradun, India. *Primates*, 57, 459–469.
Brennan E.J., Else J.G. & Altmann J. (1985) Ecology and behaviour of a pest primate: vervet monkeys in a tourist-lodge habitat. *African Journal of Ecology*, 23, 35–44.
Sengupta A., McConkey K.R., Radhakrishna S. (2015) Primates, provisioning and plants: impacts of human cultural behaviours on primate ecological functions. *PLoS ONE* 10, e0140961.

Excess energy

9.3. Reduce noise pollution by restricting development activities to certain times of the day/night

- We found no evidence for the effects of reducing noise pollution by restricting development activities to certain times of the day/night on primate populations.

Background

Noise pollution is produced by motorized vehicles, trains and planes on and near transportation routes, resource extraction activities (i.e. mining, logging), motorized recreation (i.e. 'driving-safaris') and urban development. Noise pollution can cause hearing loss, elevated stress hormone levels, and hypertension in humans and other animals. This in turn, can affect animal foraging and anti-predator behaviour, reproductive success, population density and community structure (Barber *et al*. 2010). Therefore, this intervention restricts noise to only certain periods of the day to reduce the potential effect of noise pollution on the primate species of interest. For example, development activities may be limited to times of the day/night where the primate is active (depending on the species), so that it can rest during quiet time periods. Alternatively/additionally, it may be decided that development activities are prohibited during sensitive time periods, such as the mating season or hibernation, during which it is crucial that the species can vocalize effectively and efficiently and is not exposed to any additional stress factors.

Barber J.R., Crooks K.R. & Fristrup K.M. (2010) The costs of chronic noise exposure for terrestrial organisms. *Trends in Ecology and Evolution*, 25, 180–189.

10. Education & Awareness

Background

Education can take many forms, such as literacy and formal education through schooling, education programmes specifically focusing on primate conservation, education through public media and multimedia campaigns (e.g. TV, radio), and the involvement of communities into primate research, conservation and management. But why would education benefit the conservation of primates? Educated people may be more likely to generate income through employment and may therefore be wealthier, which makes them less dependent on local wildlife resources for food compared to people with no formal education. This is supported by a study from Liberia (Junker *et al*. 2015), which showed that chimpanzees *Pan troglodytes verus* occurred at higher densities in areas with high literacy rates than in areas with low literacy rates.

Another explanation for why education and awareness-raising may positively influence people's behavior towards primates may be that more educated people might have higher awareness of the potential negative environmental consequences of their actions or possible health hazards related to preparing and eating primate meat. They may therefore employ more sustainable or alternative ways to satisfy their needs. The problem with this hypothesis is that people's attitudes alone generally do not seem to predict behavior very well (Holmes 2003, Heberlein 2012) and so knowledge gain is by no means a guarantee that appropriate behaviors will be performed (Kuhar *et al*. 2010). However, a study conducted during the Ebola crisis in Liberia showed that people who had knowledge on the health risks associated with the consumption and preparation of bushmeat, reduced their bushmeat consumption more during the crisis compared to those that did not have this knowledge (Ordaz-Németh *et al*. 2017). There are few studies that evaluated the effect of education on people's behavior and none that we could find in relation to primates, potentially because it may take years before the effect of education and awareness-raising programmes on people's behavior/wildlife populations becomes noticeable.

Heberlein T.A. (2012) *Navigating Environmental Attitudes*. Oxford University Press, Oxford.

Holmes C.M. (2003) The influence of protected area outreach on conservation attitudes and resource use patterns: a case study from western Tanzania. *Oryx*, 37, 305–315.

Junker J., Boesch C., Mundry R., Stephens C., Lormie M., Tweh C. & Kühl H.S. (2015) Education and access to fish but not economic development predict chimpanzee and mammal occurrence in West Africa. *Biological Conservation*, 182, 27–35.

Kuhar C.W., Bettinger T.L., Lehnhardt K., Tracy O. & D. Cox (2010) Evaluating for long-term impact of an environmental education program at the Kalinzu Forest Reserve, Uganda. *American Journal of Primatology*, 72, 407–413.

Ordaz-Németh I., Arandjelovic M., Boesch L., Gatiso T., Grymes T., Kuehl H. S., Lormie M., Stephens C., Tweh C., Junker J. (2017) The socio-economic drivers of bushmeat consumption during the West African Ebola crisis. *PLOS Neglected Tropical Diseases*, 11, e0005450.

Key messages – awareness & communications

Educate local communities about primates and sustainable use

One before-and-after study in Cameroon found that numbers of drills increased after the implementation of an education programme, alongside one other intervention.

Involve local community in primate research and conservation management

One before-and-after study in Rwanda, Uganda and the Democratic Republic of Congo found that gorilla numbers decreased despite the implementation of an environmental education programme, alongside other interventions. However, one before-and-after study in Cameroon found that gorilla poaching stopped after the implementation of a community-based monitoring scheme, alongside other interventions. One before-and-after study in Belize found that numbers of howler monkeys increased while local communities were involved in the management of the sanctuary, alongside other interventions. One before-and-after study in Uganda found that a reintroduced chimpanzee repeatedly returned to human settlements despite the involvement of local communities in the reintroduction project, alongside other interventions.

Install billboards to raise primate conservation awareness

We captured no evidence for the effects of installing billboards to raise primate conservation awareness on primate populations.

Regularly play TV & radio announcements to raise primate conservation awareness

One before-and-after study in Congo found that most reintroduced chimpanzees whose release was covered by media, alongside other interventions, survived over five years.

Implement multimedia campaigns using theatre, film, print media, discussions

Three before-and-after studies in Belize and India found that primate numbers increased after the implementation of education programs, alongside other interventions. Three before-and-after studies found that the knowledge about primates increased after the implementation of education programmes. One before-and-after study in Madagascar found that lemur poaching appeared to have ceased after the distribution of conservation books in schools. One study in four African countries found that large numbers of people were informed about gorillas through multimedia campaigns using theatre and film.

Integrate local religion/taboos into conservation education

We captured no evidence for the effects of integrating religion/local taboos into conservation education on primate populations.

Awareness & communications

10.1. Educate local communities about primates and sustainable use

- One before-and-after study in Cameroon[1] found that numbers of drills increased after the implementation of an education programme, alongside one other intervention.

Background

Through passing knowledge on to communities living in/near primate habitat and raising their awareness about primate conservation, this intervention aims to develop changes in people’s behaviour that will benefit wild primate populations. Anticipated effects may include people adopting strategies for more sustainable resource use, making use of alternative meat protein sources (Wilkie *et al.* 2005, Junker *et al.* 2015), refusing to keep primates as pets (Akparawa 2006) or trade wild primates.

Akparawa J. (2006) World environment day - utilizing national event days for popular primate conservation education. *International Journal of Primatology*, 27, 238.

Junker J., Boesch C., Mundry R., Stephens C., Lormie M., Tweh C. & Kühl H.S. (2015) Education and access to fish but not economic development predict chimpanzee and mammal occurrence in West Africa. *Biological Conservation*, 182, 27–35.

Wilkie D.S., Starkey M., Abernethy K., Effa E.N., Telfer P. & Godoy R. (2005) Role of prices and wealth in consumer demand for bushmeat in Gabon, central Africa. *Conservation Biology*, 19, 268–274.

A before-and-after study in 1971-2002 in tropical montane forest in Bakossiland, Cameroon (1) found that after the implementation of an education programme by the International Council for Bird Preservation (ICBP) in 1992 alongside one other intervention, drills *Mandrillus leucophaeus* increased in population size by 1997. However, the authors did not provide information on the magnitude of the population increase. Drill group sizes did not change over time, season, habitat, or elevation. In addition, a drill hunting ban was initiated by Bakossi traditional chiefs in 1994. In 1997, a group of 400 drills was observed and since the year 2000, wildlife staff and villagers regularly reported direct drill observations in the area. Independent direct observations of drill groups and their size were recorded by different organizations working in the area. No data were provided on the impact of the education campaign on the species' conservation. The study does not distinguish between the effects of the different interventions mentioned above.

(1) Wild C., Morgan B.J. & Dixson A. (2005) Conservation of drill populations in Bakossiland, Cameroon: historical trends and current status. *International Journal of Primatology*, 26, 759–773.

10.2. Involve local community in primate research and conservation management

- One before-and-after study in Uganda[1] found that a reintroduced chimpanzee repeatedly returned to human settlements despite the involvement of local communities in the reintroduction project, alongside other interventions.
- One before-and-after study in Belize[2] found that numbers of black howler monkeys increased over 13 years while local communities were involved in the management of the sanctuary, alongside other interventions.
- One before-and-after study in Rwanda, Uganda and the Democratic Republic of Congo[3] found that mountain gorilla numbers decreased over 41 years despite the implementation of an environmental education programme, alongside other interventions.
- One before-and-after study in Cameroon[4] found that incidents of gorilla poaching stopped after the implementation of a community-based monitoring scheme, alongside other interventions.

Background

This intervention involves local communities in the management of natural primate habitat and/or primate research in an attempt to reduce unsustainable resource use and habitat degradation. A correlative study by Stokes *et al*. (2010) found that sites with a higher conservation management status in the Congo Basin in northern Republic of Congo were more densely populated by elephants *Loxodonta africana*, gorillas *Gorilla gorilla gorilla* and chimpanzees *Pan troglodytes troglodytes*. In this case, wildlife management strategies included, among others, community-based conservation and management of wildlife and other natural resources.

Stokes E.J., Strindberg S., Bakabana P.C., Elkan P.W., Iyenguet F.C., Madzoke B., Malanda G.A.F., Mowawa B.S., Moukoumbou C., Ouakabadio F.K. & Rainey H.J. (2010) Monitoring great ape and elephant abundance at large spatial scales: measuring effectiveness of a conservation landscape. *PLoS ONE*, 5, e10294.

A before-and-after-trial in 1995 in Kibale National Park, Uganda (1) found that a female captive, wild-born chimpanzee *Pan troglodytes schweinfurthii* that was part of a reintroduction project into which the local community was involved alongside other interventions, repeatedly returned to human settlements post-release and was subsequently returned to captivity. Eight days after her initial release, the 4-6 year old chimpanzee left the forest and was subsequently returned into the forest by project staff. For the following ten days, she travelled, fed, nested and engaged in social activities with the wild chimpanzee group. During this time, she increased ranging distance to humans and use of height, and visually monitored humans less regularly. However, the proportion of adult males in her vicinity decreased and she increasingly spent time alone. She was returned to captivity six weeks post-release. From the local community that initiated her confiscation from illegal captivity as a pet, at least ten community members worked directly and indirectly on the project. She was quarantined from humans, other than her caretakers, and wild chimpanzees, underwent pre-release training for three weeks before reintroduction into habitat with a resident wild population and had a tuberculosis test. The study does not distinguish between the effects of the different interventions mentioned above.

A before-and-after trial in 1985-1998 in riparian forest in the Community Baboon Sanctuary, Belize (2) found that when local communities were involved in the management of the sanctuary alongside 11 other interventions, the population of black howler monkey *Alouatta pigra*, increased over 13 years. The howler monkey population increased from 840 to over 2,000 individuals (138%). No statistical tests were carried out to determine whether this difference was significant. Additional interventions included the protection of the sanctuary by the communities surrounding it, preserving forest buffer strips along property boundaries and a forest corridor along the river, constructing pole bridges over man-made gaps, preserving important howler food trees in large clearings, creation of a museum for education purposes, an eco-tourism and research programme, presence of permanent staff, and monetary (income from employment, tourism and craft industries) and non-monetary (e.g. better education) benefits to local communities for sustainably managing their forest and its wildlife communities. The study does not distinguish between the effects of the different interventions mentioned above.

A before-and-after study in 1967-2008 in tropical montane forest in Volcanoes-, Mgahinga-, and Virunga National Parks located in Rwanda, Uganda, and the Democratic Republic of Congo, respectively (3), found that despite the implementation of an environmental education programme in local communities along with other interventions, the mountain gorilla *Gorilla beringei beringei* population decreased over time. Annual population decline was 0.7%, resulting in an overall population decrease of 28.7% over 31 years. However, no statistical tests were carried out to determine whether this difference was significant. Details on the local conservation education programme were not provided in the study. Additional interventions included regular anti-poaching patrols, the removal of snares and when necessary, the herding of live-stock out of the park, and the implementation of development projects in nearby communities. The study does not distinguish between the effects of the different interventions mentioned above.

A before-and-after study in 2009-2012 in tropical forest near Takamanda National Park, Cameroon (4) found that after implementing a community-based monitoring network called 'Gorilla Guardians' along with other interventions, incidents of Cross River gorilla *Gorilla gorilla diehli* poaching stopped. Gorilla guardians were selected by their respective communities. Their duties included regularly collecting data on the status and distribution of gorillas, facilitating communication between conservation authorities and their communities, and raising awareness within their communities. The programme was started with six guardians from villages in three forest areas near important gorilla sites. Two other villages were added to the network in 2011 and because of increased interest two more villages joined in 2012. Guardians fulfilled the role of anti-poaching rangers and communities were put in control of the monitoring of illegal activities that threaten gorilla survival in nearby forests. The study does not distinguish between the effects of the different interventions mentioned above.

(1) Treves A. & Naughton-Treves L. (1997) Case study of a chimpanzee recovered from poachers and temporarily released with wild conspecifics. *Primates*, 38, 315–324.

(2) Horwich, R.H. & Lyon J. (1998) Community-based development as a conservation tool: the Community Baboon Sanctuary and the Gales Point Manatee project. Pages 343-363 in: R.B. Primack, D. Bray, H.A. Galletti and I. Ponciano (eds.) *Timber, tourists and temples. Conservation and development in the Maya Forest of Belize, Guatemala and Mexico*. Island Press, Covelo.

(3) Robbins M.M., Gray M., Fawcett K.A., Nutter F.B., Uwingeli P., Mburanumwe I., Kagoda E., Basabose A., Stoinski T.S., Cranfield M.R., Byamukama J., Spelman L.H., Robbins A.M. (2011) Extreme conservation leads to recovery of the Virunga mountain gorillas. *PLoS ONE*, 6, e19788.

(4) Jameson, C. (2012) Gorilla Guardian update: expansion of the community-based monitoring network. *Gorilla Journal*, 45, 13–15.

10.3. Install billboards to raise primate conservation awareness

- We found no evidence for the effects of installing billboards to raise primate conservation awareness on primate populations.

Background

Billboards may be an effective medium to inform and raise awareness about primates, their habitat, threats to their survival and conservation strategies to a potentially large number of people, as billboards are easily visible and repeatedly read by people travelling on roads in urban areas.

10.4. Regularly play TV & radio announcements to raise primate conservation awareness

- One before-and-after study in the Republic of Congo[1] found that most reintroduced central chimpanzees whose release was broadcasted by multiple media means, alongside other interventions, survived over five years post-reintroduction.

Background

TV and radio announcements can be used to inform the population and raise their awareness about primate conservation on a more national level. In many developing countries, radio represents the most accessible medium to people in both urban and rural areas. For example, Mathod & Puit (2008) describe how national radio broadcasts in the Republic of Congo is used to regularly (twice a week) broadcast announcements that highlight the importance of great apes and their status as protected species in three different languages. In addition to the radio broadcast, four films were regularly shown on television. These programmes produced by the national channel 'TV Congo', showcased the activities connected with gorilla reintroduction, the management of the Lésio-Louna Reserve, the protected status of great apes, and the issues associated with the trafficking of these species.

Mathot L., & Puit M. (2008) Educational activities in the Republic of Congo. *Gorilla Journal*, 36, 20–22.

A before-and-after study in 1994-1999 in tropical forest in Conkouati-Douli National Park, Republic of Congo (1) found that the majority of reintroduced central chimpanzees *Pan troglodytes troglodytes* whose release was broadcasted using various media instruments alongside 16 other interventions, survived over five years. Out of 20 reintroduced chimpanzees, 14 (70%) survived over five years. No statistical tests were carried out to determine whether the decrease was significant. Their release was broadcasted on TV and several illustrated newspaper articles, aiming at raising awareness towards chimpanzee conservation. Individuals were radio-collared and followed at distances of 5-100 m. Rehabilitated orphaned chimpanzees underwent vaccination, parasite treatment and veterinary screens before translocation in four subgroups to habitat where resident chimpanzees occurred. Staff members were permanently present during to monitor primate health, provide additional food if necessary and examine any dead animals. The area status was upgraded from reserve to national park in 1999. Local people were relocated from the release site to a nearby village. Some chimpanzees were treated when sick or injured. Local people were provided monetary and non-monetary benefits in exchange for their conservation support. The study does not distinguish between the effects of the different interventions mentioned above.

(1) Tutin C.E.G., Ancrenaz M., Paredes J., Vacher-Vallas M., Vidal C., Goossens B., Bruford M.W. & Jamart A. (2001) The conservation biology framework of the release of wild-born orphaned chimpanzees into the Conkouati Reserve, Congo. *Conservation Biology*, 15, 1247–1257.

10.5. Implement multimedia campaigns using theatre, film, print media, discussions

- Two before-and-after studies in Belize[1, 3] found that black howler monkey numbers increased by 58–61% over 3–13 years after the implementation of a multimedia campaign[1] or the opening of a museum for wildlife education[3], alongside other interventions.
- Two before-and-after studies in Brazil[2] and Colombia[6] found that the implementation of education programs focusing on tamarins improved attitudes[2] towards- and knowledge[2, 6] about tamarins.
- One study in the Republic of Congo[4] found that large numbers of people were informed about lowland gorillas through multimedia campaigns using theatre and film.
- One before-and-after study in Madagascar[5] found that poaching of diademed sifakas and black and white ruffed lemurs appeared to have ceased after the distribution of conservation books in local primary schools.
- One before-and-after study in India[7] found that numbers of hoolock gibbons increased by 66% over five years after the implementation of an education and awareness programme, alongside other interventions.
- One before-and-after study in four African countries found that the level of knowledge about primates of visitors to a sanctuary housing guenons, mangabeys, chimpanzees and bonobos increased after the implementation of an education programme.

Background

There are different types of media that can be used to inform people and raise their awareness about threats to primates and their conservation. Environmental education campaigns frequently use film or print media, theatre plays, group discussions, or a combination of these. For example, Mujaasi *et al.* (2006) found that after an education programme that involved lectures, distributed working papers, cross word puzzles, discussions, debates, and a visit to the Limbe Wildlife Centre in Cameroon where a wide variety of primate orphans, including chimpanzees *Pan troglodytes* and gorillas *Gorilla gorilla gorilla* were housed, was implemented, students were able to list at least three endangered primate species in Cameroon. They also learnt which human activities had negative impact on the environment and many agreed that keeping primates as pets was wrong. An education and outreach programme implemented by CERCOPAN, a non-profit, non-governmental sanctuary, resulted in increased knowledge of students about primates after participating in the programme. The data also showed that the number of students that thought that primates made good pets, decreased significantly after participating in the programme and students were able to give examples of why primates should remain in the wild (Akparawa 2006). The results of an evaluation study of an education programme implemented across 14 schools outside the Kalinzu Forest Reserve, Uganda (Kuhar *et al*. 2010) demonstrated both long-term consistency in the effectiveness of delivering conservation-related knowledge and long-term retention of that information. Another study from Uganda showed that the 'Great Ape Education Project' designed to educate children and rural communities about the threats to great apes through ape-focused conservation films and supporting educational materials (magazines, brochures, posters), resulted in children being able to identify with and frequently cheer on the main characters in the film and encouraging them to save the great apes in their communities (Slavin 2014).

The above studies were not included in the synopsis, because their measure of effectiveness of the intervention was too indirect (Mujaasi *et al*. 2006), the study was not available as a full-text document thus lacking detailed information on results (Akparawa 2006), or the intervention did not specifically address primate species (Kuhar *et al*. 2010).

Mujaasi I., Cartwright B. & Kemigisa M. (2006) Integrating environmental education into primary school curriculum. *International Journal of Primatology*, 27, 196.

Akparawa J. (2006) World environment day - utilizing national event days for popular primate conservation education. *International Journal of Primatology*, 27, 238.

Kuhar C.W., Bettinger T.L., Lehnhardt K., Tracy O. & D. Cox (2010) Evaluating for long-term impact of an environmental education program at the Kalinzu Forest Reserve, Uganda. *American Journal of Primatology*, 72, 407–413.

Slavin M. (2014) Effective conveying conservation messages through the use of films. *Gorilla Journal*, 48 14–15.

A before-and-after study in 1992-1994 in tropical forest in Cockscomb Basin Wildlife Sanctuary, Belize (1) found that a population of wild black howler monkeys *Alouatta pigra* translocated into an area where the local human community was educated about this project by multimedia campaigns alongside other interventions, increased by 61% over three years. The black howler population increased from 62 in 1994 to >100 individuals in 1997. No statistical tests were carried out to determine whether this increase was significant. One-month-, 6-month-, 1-year, and 2-year survival rates for the different cohorts released in the dry seasons of 1992, 1993, and 1994, was 81-100%. Birth rate was 20% (*n*=12) and infant survival rate was 75% (*n*=9). Education campaigns used TV, radio, print media, lectures and discussions. Entire howler social groups were reintroduced together, and ten of the 14 groups were held in cages for 1-3 days before release with a distance of 700-1000 m to the neighbouring troop. All individuals were individually and permanently marked, and adults were fitted with radio-collars. Hunting was largely controlled in the sanctuary since its establishment. The study does not distinguish between the effects of the different interventions mentioned above.

A controlled, before-and-after-trial in 1988-1994 in subtropical forest at Morro do Diabo State Park, São Paulo, Brazil (2) found that an environmental education programme led to an improvement in student attitudes towards- and knowledge about black lion tamarin *Leontopithecus chrysopygus*. The average student test score increased from 74% before treatment to 92% after treatment. Control groups that were not exposed to the programme scored 73% before and 76% after treatment. From a total of 144 students aged 10-14 years, 70 were assigned to experimental- and 74 to control groups. Experimental groups were given a slide show about the park, its value, ecological concepts and how to identify plant and animal species. They were then taken on a guided visit to the state park. The attitudes and knowledge of both groups were measured before, directly after and one month after the experimental groups' visit to the park. Changes in knowledge of ecological concepts and attitude towards nature were measured using questionnaires. No data were provided on the impact of the education campaign on the species' conservation.

A before-and-after study in 1985-1998 in secondary forest in the Community Baboon Sanctuary, Belize (3) found that after creating a sanctuary museum for wildlife education purposes along with eleven other interventions, the sanctuary's black howler monkey *Alouatta pigra* population increased by 138% over 13 years. The population increased from 840 to more than 2,000 individuals, although no statistical tests were carried out to determine whether this difference was significant. Additional interventions included the protection of the sanctuary by the surrounding communities, preserving forest buffer strips along property boundaries and a forest corridor along the river, constructing pole bridges over man-made gaps, involving local communities in the management of the sanctuary, preserving important howler food trees in large clearings, an eco-tourism and research programme, presence of permanent staff, and monetary (income from employment, tourism and craft industries) and non-monetary (e.g. better education) benefits to local communities for sustainably managing their forest and its wildlife communities. The study does not distinguish between the effects of the different interventions mentioned above.

A study in 2008 in communities surrounding the Lésio-Louna Wildlife Reserve, Republic of Congo (4) reported that through multimedia campaigns using theatre and film, a large audience of people was informed about lowland gorilla *Gorilla gorilla gorilla* protection laws and their status of protection. Conservation awareness programmes in nine schools reached nearly 1,000 students and trained 300 police officers via films and theatre plays addressing protection laws regarding great apes among other species. An awareness campaign at the Rural Development Institute was attended by 63 students. Also, nearly 1,300 people visited an exhibition about threats facing great apes; 770 students of primary schools were given a guided tour. Sixty people attended the conference of lawyers which addressed wildlife law enforcement issues in Central Africa. No statistical tests were carried out to determine whether there was a significant change of awareness towards primate conservation before and after the intervention was implemented. Regularly broadcasted national radio announcements and films reached a large audience of people and informing them about gorilla conservation needs and current conservation actions. No data were provided on the impact of the education campaign on the species' conservation.

A before-and-after trial in 2006-2007 in subtropical forest in Analamazaotra Special Reserve, Madagascar (5) found that after the distribution of conservation-based activity books at two primary schools close to the reserve, poaching of diademed sifakas *Propithecus diadema* and black and white ruffed lemurs *Varecia variegata editorum* appeared to have ceased. Both species were hunted to extinction in the past and reintroduced into the reserve. Furthermore, two black and white ruffed lemurs were presumably poached before the project had been launched. A total of 350 activity books for pupils and 22 teacher guides were distributed. No further details were provided.

A before-and-after trial in 2010 in Los Limites, northern Colombia (6) found that an education programme using print media, led to an increase in knowledge about cotton-top tamarin *Saguinus oedipus* identification, understanding of its limited distribution in Colombia and its main threats. The programme resulted in an 81% increase in knowledge about species identification, 77% about its distribution and 65% about threats to cotton-top tamarin survival, although no statistical tests were carried out to determine whether these differences were significant. An evaluation tool was used to test approximately 3,000 students from 15 schools before and after the programme. The programme, run in collaboration with Baranquilla Zoo, used a series of classroom workbooks that focused on the cotton-top tamarin and its habitat.

A before-and-after trial in 2004-2009 in tropical forest in the Gibbon Wildlife Sanctuary in Assam, India (7) found that hoolock gibbons *Hoolock hoolock* increased by 66% over five years after implementing an education and awareness programme along with other interventions. The gibbon population increased from 64 individuals in 17 groups in 2004 to 106 individuals in 26 groups (and five solitary males) in 2009. Also, canopy cover increased by 3.5% and degraded forest decreased by 4.1%. However, no statistical tests were carried out to determine whether these differences were significant. The programme reached a total of 33,425 students from primary to college-level within Assam and other northeastern states. Two published books on hoolock gibbons provided the basis for the education programme. In addition, families within local communities that were selected through socio-economic studies were provided with more efficient stoves, bio-gas plants, handlooms and domestic ducks as farm animals in order to improve economic conditions. Local communities also received alternative income-generation through training in mushroom cultivation, honeybee keeping and duck husbandry. Training, monitoring and legal orientation programmes were also carried out for the sanctuary staff. The study does not distinguish between the effects of the different interventions mentioned above.

A before-and-after study (8) that evaluated education programmes implemented by five primate sanctuaries housing guenons *Cercopithecus erythrogaster* and mangabeys *Cercopithecus* sp. (Cercopan in Nigeria), chimpanzees *Pan troglodytes* (HELP-Congo and Tchimpounga Chimpanzee Rehabilitation Center in the Republic of Congo, Ngamba Island Chimpanzee Sanctuary in Uganda), and bonobos *Pan paniscus* (Lola ya Bonobo in the Democratic Republic of Congo) found that participants had increased knowledge of primates. Nearly three-quarters (74%) of participants were able to answer the questions correctly after participating in the programme. Furthermore, an increase in the proportion of individuals that correctly answered a question ('performance') (effect size measured by Cohen's h >0.78) could be observed across all but one programme content category. The largest increase in performance was observed in community adults and the best overall programme performance in secondary school pupils. Questions to evaluate the education programme that were individually designed by each sanctuary were separated into one of five content categories addressing basic biological knowledge, threats and conservation actions.

(1) Koontz, F., Horwich R.H., Saqui S., Saqui H., Glander K., Koontz C. & Westrom W. (1994) *Reintroduction of black howler monkeys (Alouatta pigra) into the Cockscomb Basin Wildlife Sanctuary, Belize.* Proceedings - American Zoo and Aquarium Association annual Conference, Bethesda, MD, 104-111.
(2) Padua S. (1994) Conservation awareness through an environmental education programme in the Atlantic forest in Brazil. *Environmental Conservation*, 21, 145–151.
(3) Horwich, R.H. & Lyon J. (1998) Community-based development as a conservation tool: the Community Baboon Sanctuary and the Gales Point Manatee project. Pages 343-363 in: R.B. Primack, D. Bray, H.A. Galletti and I. Ponciano (eds.) *Timber, tourists and temples. Conservation and development in the Maya Forest of Belize, Guatemala and Mexico*. Island Press, Covelo.
(4) Mathot L. & Puit M. (2008) Educational activities in the Republic of Congo. *Gorilla Journal*, 36, 20–22.
(5) McGuire S.M., Sitzmann B.D., Herrington K., Day S.R., Ramarokoto R.E.A.F. & Louis Jr. E.E. (2009) Distribution of a conservation-based activity book at two primary schools near Analamazaotra Special Reserve, Madagascar. *Lemur News*, 14, 38–41.
(6) Savage A., Guillen R., Lamilla I. & Soto L. (2010) Developing an effective community conservation program for cotton-top tamarins (*Saguinus oedipus*) in Colombia. *American Journal of Primatology*, 72, 379–390.
(7) Chetry D. & Chetry R. (2011) Hoolock gibbon conservation in India. *Gibbon Journal*, 6, 7–12.
(8) Kuhar C.W., Bettinger T.L., Lehnhardt K., Cartwright B. & Cress D. (2012) Education program evaluation at multiple primate sanctuaries in Equatorial Africa. *International Journal of Primatology*, 33, 208–217.

10.6. Integrate religion/local taboos into conservation education

- We found no evidence for the effects of integrating religion/local taboos into conservation education.

Background
Several studies have demonstrated the positive influence that taboos may have on primate populations (Colding & Folke 2001, Jones *et al*. 2008, Jimoh *et al*. 2012). Religion may also contribute to the protection of particular primate species. For example, Muslims do not generally consume chimpanzee *Pan troglodytes*/primate meat (East *et al*. 2005, Costa 2010). This, however, does not necessarily imply that Muslims do not kill primates for example to sell the meat to those who eat it, or to control crop-raiding (Brugiere & Magassouba 2009). This intervention integrates religion/local taboos into conservation education programmes to re-enforce/strengthen local taboos against the killing and consumption of primates.

Brugiere D. & Magassouba B. (2009) Pattern and sustainability of the bushmeat trade in the Haut Niger National Park, Republic of Guinea. *African Journal of Ecology*, 44, 630–639.
Colding, J. & Folke C. (2001) Social taboos: ''invisible'' systems of local resource management and biological conservation. *Ecological Applications*, 11, 584–600.

Costa S.G. (2010) Social perceptions of nonhumans in Tombali (Guinea-Bissau, West Africa): a contribution to Chimpanzee (*Pan troglodytes verus*) conservation. PhD thesis. University of Stirling.

East T., Kümpel N.F., Milner-Gulland E.J. & Rowcliffe J.M. (2005) Determinants of urban bushmeat consumption in Río Muni, Equatorial Guinea. *Biological Conservation*, 126, 206–215.

Jimoh S.O., Ikyaagba E.T., Alarape A.A., Obioha E.E. & Adeyemi A.A. (2012) The role of traditional laws and taboos in wildlife conservation in the Oban Hill Sector of Cross River national park (CRNP), Nigeria. *Journal of Human Ecology*, 39, 209–219.

Jones J.P.G., Andriamarovololona M.A., & Hockey N.J. (2008) The importance of taboos and social norms to conservation in Madagascar. *Conservation Biology*, 22, 976–986.

11. Habitat Protection

Background

Habitat destruction presents the largest threat to primate species and their populations. Habitat loss due to agriculture affects 76% of primate species, and habitat loss due to road and rail construction, oil and gas drilling, and mining affect 2-13% of primate species (Estrada *et al*. 2017). Long-term deforestation has resulted in the fragmentation of 58% of subtropical and 46% of tropical forests, forcing primates to live in isolated forest patches, including protected areas (Estrada *et al*. 2017). Habitat protection remains one of the most frequently-used conservation interventions. Since 1990, the number of nationally designated protected areas increased by roughly 54,000 sites until 2011, adding more than 14 million km^2 to the total area protected (Chape *et al*. 2005). However, many of these areas currently do not have sound management, rendering them ineffective in protecting the wildlife populations that live within them (Di Minin & Toivonen 2015). Habitat protection can be proposed through the designation of legally protected areas using national or local legislation. It can also be undertaken through the designation of community conservation areas or similar schemes, which do not provide formal protection, but may increase the profile of a site and make its destruction less likely (e.g. offset sites, sanctuaries). In some of these areas, natural resource use may be permitted to some extent (e.g. buffer zones, community reserves). Alternatively, habitat protection may involve ensuring that areas of important primate habitat are retained during extractive (e.g. logging, mining) and agricultural activities. In many parts of the world, restoring damaged habitats or creating new habitat patches may also be possible. This may entail e.g. planting of indigenous trees and weeding to promote regeneration of indigenous tree communities.

It can be difficult to measure the effectiveness of legally protected areas because there may be no suitable controls. This is because existing reserve systems throughout the world contain a biased sample of biodiversity, usually that of remote places and other areas that are unsuitable for commercial activities and/or human habitation (Margules & Pressey 2000) and thus many of these areas would be less likely to be cleared even if they were not protected.

Chape S., Harrison J., Spalding M. & Lysenko I. (2005) Measuring the extent and effectiveness of protected areas as an indicator for meeting global biodiversity targets. *Philosophical Transactions of the Royal Society B: Biological Sciences*, 360, 443–455.

Di Minin E. & Toivonen T. (2015) Global protected area expansion: creating more than paper parks. *BioScience*, 65, 637–638.

Estrada A., Garber P.A., Rylands A.B., Roos C., Fernandez-Duque E., Di Fiore A., Nekaris K.A.-I., Nijman V., Heymann E.W., Lambert J.E., Rovero F., Barelli C., Setchell J.M., Gillespie T.R., Mittermeier R.A., Verde Arregoitia L., de Guinea M., Gouveia S., Dobrovolski R., Shanee S., Shanee N., Boyle S.A., Fuentes A., MacKinnon K.C., Amato K.R., Meyer A.L.S., Wich S., Sussman R.W., Pan R., Kone I. & Li B. (2017) Impending extinction crisis of the world's primates: why primates matter. *Science Advances,* 3, e1600946.

Margules C.R. & Pressey R.L. (2000) Systematic conservation planning. *Nature*, 405, 243–253.

Key messages – habitat protection

Create buffer zones around protected primate habitat

We captured no evidence for the effects of creating buffer zones around protected primate habitat on primate populations.

Legally protect primate habitat

Two reviews and a before-and-after study in China found that primate numbers increased or their killing was halted after their habitat became legally protected, alongside other interventions. However, one before-and-after study in Kenya found that colobus and mangabey numbers decreased despite the area being declared legally protected, alongside other interventions. Two before-and-after studies found that most chimpanzees and gorillas reintroduced to areas that received legal protection, alongside other interventions, survived over 4–5 years. However, one before-and-after study in Brazil found that most golden lion tamarins did not survive over seven years despite being reintroduced to a legally protected area, alongside other interventions, yet produced offspring that partly compensated the mortality. One controlled, site comparison study in Mexico found that howler monkeys in protected areas had lower stress levels than individuals living in unprotected forest fragments.

Establish areas for conservation which are not protected by national or international legislation (e.g. private sector standards & codes)

Two before-and-after studies in Rwanda, Republic of Congo and Belize found that gorilla and howler monkey numbers increased after the implementation of a conservation project funded by a consortium of organizations or after being protected by local communities, alongside other interventions.

Create/protect habitat corridors

One before-and-after study in Belize found that howler monkey numbers increased after the protection of a forest corridor, alongside other interventions.

Create/protect forest patches in highly fragmented landscapes

One before-and-after study in Belize found that howler monkey numbers increased after the protection of forest along property boundaries and across cleared areas, alongside other interventions.

Demarcate and enforce boundaries of protected areas

We captured no evidence for the effects of demarcating and enforcing boundaries of protected areas on primate populations.

Key messages – habitat creation or restoration

Restore habitat corridors

We captured no evidence for the effects of restoring habitat corridors on primate populations.

Plant indigenous trees to re-establish natural tree communities in clear-cut areas

One site comparison study in Kenya found that group densities of two out of three primate species were lower in planted forests than in natural forests.

Plant indigenous fast-growing trees (will not necessarily resemble original community) in clear-cut areas

We captured no evidence for the effects of planting indigenous fast-growing trees in clear-cut areas on primate populations.

Use weeding to promote regeneration of indigenous tree communities

We captured no evidence for the effects of using weeding to promote regeneration of indigenous tree communities on primate populations.

Habitat protection

11.1. Create buffer zones around protected primate habitat

- We found no evidence for the effects of creating buffer zones around protected primate habitat on primate populations.

Background

Buffer zones are areas peripheral to a specific protected area, where restrictions on resource use and special development measures are undertaken in order to enhance the conservation value of the protected area. Buffer zones therefore act as a transition zone between the protected area where no/very limited resource use is permitted and the area outside the protected area where no resource use restrictions are enforced. Buffer zones have been suggested as a particularly suitable practice for climate change mitigation, as they may facilitate the shifting of populations from reserves to adjacent areas according to the climatic needs of species.

11.2. Legally protect primate habitat

- Two reviews on the status of rhesus monkeys[1a] and grey snub-monkeys[1b] in China found that primate numbers increased[1a] or no more individuals were killed[1b] after the area was legally protected, alongside other interventions.
- One before-and-after study Kenya[2] found that Tana River red colobus monkey and crested mangabey numbers decreased despite the area being declared legally protected, alongside other interventions.
- One before-and-after study in China[3] found that Hainan gibbon numbers increased by 34% over nine years after the area was declared legally protected.
- One before-and-after study in Brazil[4] found that most golden lion tamarins did not survive over seven years despite being reintroduced to a legally protected area, alongside other interventions yet they reproduced and surviving offspring partly compensated adult mortality.
- Two before-and-after studies in the Republic of Congo and Gabon found that most central chimpanzees[5] and lowland gorillas[6] reintroduced to areas that received legal protection, alongside other interventions, survived over 4–5 years.
- One controlled, site comparison study in Mexico[7] found that black howler monkeys in protected areas had lower stress levels than individuals living in unprotected forest fragments.

Background

Efforts to reduce habitat destruction rely heavily on the establishment of protected areas. However, conventional methods of evaluating the effectiveness of protected areas can be biased, because protection is not randomly assigned and because humans can respond to protection in one location by changing land uses in neighboring locations, and thereofore protection can induce habitat destruction of neighboring forests. Such 'spillovers' can also be positive, for example enhanced law enforcement on private lands or establishment of private reserves nearby (Andam *et al*. 2008). Andam and colleagues (2008) controlled for these biases and found that in 1960-1997 about 10% of the protected forests in Costa Rica would have been deforested had they not been protected. Protection therefore seems to reduce deforestation, but does it also protect primate populations? A correlative study in northern Republic of Congo by Stokes *et al*. (2010) compared wildlife densities and distributions among areas with varying degrees of conservation management. The authors found that both elephant *Loxodonta africana* and chimpanzee *Pan troglodytes troglodytes* density decreased with increasing distance to Nouabalé-Ndoki National Park, the only protected area included in their study. The study found no permanent human habitation or roads and no sign of poaching in the national park during their survey. Furthermore, a modelling and decision analysis study that compared two conservation strategies for orangutans *Pongo* spp., namely rehabilitation and reintroduction of ex-captive or displaced individuals; and protection of their forest habitat, found that reintroduction, which costs twelve times as much per animal as compared to protection of forest, was only a cost-effective strategy at very short timescales. For time scales longer than 10-20 years, forest protection was the more cost-efficient strategy for maintaining wild orangutan populations (Wilson *et al*. 2014).

Andam K.S., Ferraro P.J., Pfaff A., Sanchez-Azofeifa G.A. & Robalino J.A. (2008) Measuring the effectiveness of protected area networks in reducing deforestation. *Proceedings of the National Academy of Sciences*, 105, 16089–16094.

Stokes E.J., Strindberg S., Bakabana P.C., Elkan P.W., Iyenguet F.C., Madzoke B., Malanda G.A.F., Mowawa B.S., Moukoumbou C., Ouakabadio F.K. & Rainey H.J. (2010) Monitoring great ape and elephant abundance at large spatial scales: measuring effectiveness of a conservation landscape. *PLoS ONE*, 5, e10294.

Wilson H.B., Meijaard E., Venter O., Ancrenaz M. & Possingham H.P. (2014) Conservation strategies for orangutans: reintroduction versus habitat preservation and the benefits of sustainably logged forest. *PLoS ONE* 9, e102174.

A review on the status of rhesus monkeys *Macaca mulatta* in 1976-1983 in tropical montane forest in Nanwan Nature Reserve, China (1a) found that their population increased in numbers by more than 90% over seven years after the area was proclaimed an internationally protected nature reserve along with provisioning monkeys with supplementary food. Their numbers increased from 'a few dozen' in 1976 to 600-700 individuals by 1983, excluding the >100 monkeys that were captured and supplied to scientific and medical institutions. However, no statistical tests were carried out to determine whether this difference was significant. The study does not distinguish between the effects of the different interventions mentioned above.

A review on the status of grey snub-nosed monkeys *Rhinopithecus brelichi* in 1978-1985 in tropical montane forest in Fanjingshan Nature Reserve, China (1b) found that no individuals were killed or captured in the area after it was proclaimed a provincial nature reserve in 1978, although 13 individuals were trapped and/or killed by poachers in 1962-1977. The population was reported to be young or sub-adult, further indicating that it was increasing in size. The reserve administration appeared to be preserving the virgin forests effectively. The area also represents a sacred mountain for pilgrims, which forbids the killing of wildlife. There were few killings (<1 individual annually) of grey snub-nosed monkeys reported in the area even before it was proclaimed a nature reserve. Surveys conducted in 1981-1983 had discovered eight groups totalling 450-500 monkeys, and estimates of the total population in the area were as high as 2,000-3,000 animals.

A before-and-after trial in 1975-1985 in swamp and riverine forest in Tana River Primate Reserve, Kenya (2) found that after proclaiming the study area a National Reserve alongside other interventions, resident populations of Tana River red colobus *Colobus badius rufomitratus* and crested mangabeys *Cercocebus galeritus galeritus* decreased over ten years. Overall population size decreased from 1,200-1,800 to 200-300 individuals (83% decrease) for colobus and from 1,100-1,500 to 800-1,100 (25% decrease) individuals for mangabeys. In addition, the number of forest patches inhabited by these two species also decreased over time. No statistical tests were carried out to determine whether these decreases were significant. Results of total counts in 1985 and in 1973-1975 were compared to estimated population changes. A permanent ranger post was built in 1976 and from 1977-1981, a tourism enterprise with a permanent lodge was established in the reserve. The study does not distinguish between the effects of the different interventions mentioned above.

A before-and-after trial in 1978-1987 in tropical montane forest on Hainan Island, China (3) found that the population of the Hainan gibbon *Hylobates concolor hainanus* increased from 7-8 individuals to 22 gibbons (34% increase) over nine years after the area was proclaimed the Bawanglin Nature Reserve. However, no statistical tests were carried out to determine whether this increase was significant. The total breeding population consisted of four adult males and seven adult females. In 1980, an area of 13 km^2 was declared protected from hunting and logging activities. Three of the four remaining groups had a composition that was unusual for this species; they consisted of one adult male and two adult females with 2-4 young per group. The authors suggested that this may be a result of the small size of the group's habitat, which may have encouraged individuals to remain in their natal group instead of dispersing to establish new territories.

A before-and-after trial in 1984-1991 in coastal forest in Poço das Antas Reserve, Brazil (4), which was proclaimed a protected area in 1983 alongside 14 other interventions, found that the majority of reintroduced golden lion *tamarins Leontopithecus rosalia*, did not survive over seven years. Fifty-eight out of 91 (64%) reintroduced tamarins did not survive in the wild. However, 57 infants were born (reproductive rate=63%) during the study period, of which 38 (67%) survived. The Reserve falls into the IUCN category 1a and has the protective status of a 'Strict Nature Reserve'. Different groups of captive-bred or orphaned tamarins were introduced in different years into habitat already occupied by the species and predators. Groups were provided with supplementary food, water and nesting boxes, and allowed to adapt to local habitat conditions before release. Tamarins were quarantined, underwent veterinary checks and were treated for parasites before release. Sick or injured animals were rescued, treated and rereleased. In 1983, a long-term research study was implemented.

The study does not distinguish between the effects of the different interventions mentioned above.

A before-and-after trial in 1994-1999 in mixed tropical forest in Conkouati-Douli National Park, Republic of Congo (5), which was upgraded from reserve to national park in 1999 alongside 16 other interventions, found that the majority of reintroduced central chimpanzees *Pan troglodytes troglodytes* survived over five years. Out of 20 reintroduced chimpanzees released into the legally protected area, 14 (70%) survived. No statistical tests were carried out to determine whether the population decrease was significant. Individuals were radio-collared. Rehabilitated orphaned chimpanzees underwent vaccination, parasite treatments and veterinary screens before being translocated in four subgroups from the sanctuary to the release site where resident conspecifics occurred. Staff members were permanently present to monitor primate health, provide animals with additional food if necessary and detect and examine dead animals. Local people were relocated from the release site to a nearby village. TV and radio advertisements were used to raise chimpanzee conservation awareness and local people were provided monetary and non-monetary benefits in exchange for their conservation support. The study does not distinguish between the effects of the different interventions mentioned above.

A before-and-after site comparison study in 1996-2006 in tropical forests of Lesio-Louna Wildlife Reserve, Republic of Congo (Congo) and Batéké Plateau National Park, Gabon (6) found that the majority of reintroduced western lowland gorillas *Gorilla gorilla gorilla* that were released into regions that received protected status alongside other interventions, survived for at least four years. Twenty-one of 25 gorillas (84%) released in Congo and 22 of 26 gorillas (85%) released in Gabon survived for at least four years. Nine females gave birth to 11 infants, of which nine survived. Released gorillas underwent disease screening and vaccinations during quarantine. Gorillas were released in groups, allowed to adapt to the local environment and supplemented with food prior to release. Gorillas were released into habitat with no resident gorillas to re-establish populations. Released gorillas were treated for parasites and when sick. So-called 'problem-animals' were removed and relocated and bodies of dead gorillas were examined to determine their cause of death. Forty-three individuals were rehabilitated wild-born orphaned gorillas and eight gorillas were ex-situ captive-borns. Both sites were proclaimed protected areas before reintroduction procedures commenced. The study does not distinguish between the effects of the different interventions mentioned above.

A controlled, site comparison study in 2006-2007 in tropical forest in Campeche State, Mexico (7) found that stress levels of black howler monkeys *Alouatta pigra* that lived in protected areas were lower than of those living in highly fragmented and unprotected forest patches. Overall mean stress levels, measured by faecal glucocorticoid metabolite (FGM), of individuals living in unprotected habitats were about 20% higher (338.9 ng/g) than those of individuals living in protected habitats (266.2 ng/g). However, agonistic interactions among group members occurred at similar frequencies during sampling weeks in both habitats (protected: 57.1%, unprotected: 62%). Furthermore, seasonal variation in FGM concentrations was only detected in protected habitats. The results of this study were based on 371 faecal samples from 21 adults belonging to five groups, two from protected habitats and three from unprotected habitats. FGM concentrations were determined with radioimmunoassays and 1,200 h of agonistic within-group and between-group interactions were recorded in total.

(1) Bangjie T. (1985) The status of primates in China. *Primate Conservation*, 5, 63–77.
(2) Else J.G. (1987) Conservation efforts at the Tana River Primate Reserve, Kenya. *Primate Conservation*, 8, 165–166.
(3) Zhenhe L., Haisheng J., Yongzu Z., Yanhua L., Tigon C., Manry D. & Southwick C. (1987) Field report on the Hainan gibbon. *Primate Conservation*, 8, 49–50.
(4) Beck B.B., Kleiman D.G., Dietz J.M., Castro I., Carvalho C. & Rettberg-Beck B. (1991) Losses and reproduction of reintroduced golden lion tamarins *Leontopithecus rosalia*. *Dodo*, 27, 50–61.
(5) Tutin C.E.G., Ancrenaz M., Paredes J., Vacher-Vallas M., Vidal C., Goossens B., Bruford M.W. & Jamart A. (2001) The conservation biology framework of the release of wild-born orphaned chimpanzees into the Conkouati Reserve, Congo. *Conservation Biology*, 15, 1247–1257.
(6) King T., Chamberlan C. & Courage A. (2012) Assessing initial reintroduction success on long-lived primates by quantifying survival, reproduction, and dispersal parameters: western lowland gorillas (*Gorilla gorilla gorilla*) in Congo and Gabon. *International Journal of Primatology*, 33, 134–149.
(7) Rangel-Negrín A., Coyohua-Fuentes A., Chavira R., Canales-Espinosa D. & Dias P.A.D. (2014) Primates living outside protected habitats are more stressed: the case of black howler monkeys in the Yucatán Peninsula. *PLoS ONE*, 9, e112329.

11.3. Establish areas for conservation which are not protected by national or international legislation (e.g. private sector standards & codes)

- One before-and-after study in Rwanda and Republic of Congo[1] found that mountain gorilla numbers increased by 15% over five years after the implementation of a conservation project funded by a consortium of organizations, alongside other interventions.
- One before-and-after study in Belize[2] found that black howler monkey numbers increased by 138% over 13 years after being protected by the local community, alongside other interventions.

Background

This intervention includes the protection of areas through schemes other than national or international legislation. These could include e.g. community reserves, sanctuaries or offset sites.

A before-and-after trial in 1984-1987 in tropical montane forest in the Virunga ecosystem in Rwanda and the Democratic Republic of Congo (1) found that mountain gorillas *Gorilla beringei beringei*, protected by a conservation project funded by a consortium of organizations and initiated in 1979 along with other interventions, increased from 242 to 279 individuals (15% increase) from 1981 to 1986. Average group size increased by 17 % (8.5-9.2 individuals) and immature proportion increased by 8% (39.7-48.1) over the same time period. Regular total counts of this population were conducted since 1973. Anti-poaching guards regularly patrolled the area and removed snares. They were also provided with cars, a radio network, uniforms, more rations and other equipment, which allowed them to increase patrol frequency and effectiveness. In 1985, a gorilla viewing tourism program was started, during which three gorilla groups were habituated for tourist viewing. The study does not distinguish between the effects of the different interventions mentioned above.

A before-and-after trial in 1985-1998 in secondary semi deciduous riparian forest in the Community Baboon Sanctuary, Belize, South America (2) found that the black howler monkey population *Alouatta pigra*, which was protected by the local communities surrounding it alongside ten other interventions, increased by 138% over 13 years. The population increased from 840 to more than 2,000 individuals (138%), although no statistical tests were carried out to determine whether this difference was significant. Additional interventions included preserving forest buffer strips along property boundaries, strips of forest across large cleared areas and a forest corridor along the river, constructing pole bridges over man-made gaps, preserving important howler food trees in large clearings, involving local communities in the management of the sanctuary, creation of a museum for education purposes, an eco-tourism and research program, presence of permanent staff, and monetary (income from tourism and craft industries) benefits to local communities for sustainably managing their forest and its wildlife communities. The study does not distinguish between the effects of the different interventions mentioned above.

(1) Aveling, R. & Aveling C. (1987) Report from the Zaire Gorilla Conservation Project. *Primate Conservation*, 8, 162–164.
(2) Horwich, R.H. & Lyon J. (1998) Community-based development as a conservation tool: the Community Baboon Sanctuary and the Gales Point Manatee project. Pages 343-363 in: R.B. Primack, D. Bray, H.A. Galletti and I. Ponciano (eds.) *Timber, tourists and temples. Conservation and development in the Maya Forest of Belize, Guatemala and Mexico. Island Press, Covelo*.

11.4. Create/protect habitat corridors

- One before-and-after study in Belize[1] found that black howler monkey numbers increased by 138% over 13 years after the protection of a forest corridor, alongside other interventions.

Background

Corridors are areas of natural habitat that are contiguous or isolated (i.e. linkages or stepping stones) and enable particular plant and animal species to disperse and migrate, processes which are necessary for their survival (Rouget *et al*. 2006). For example, a simulation study by Bruford *et al*. (2010) examined the genetic implications of management options for the highly fragmented orangutan population in the Lower Kinabatangan Wildlife Sanctuary in Malaysia and demonstrated that a combination of modest translocation rates (one individual every 20 years) and corridor establishment enabled even the most isolated subpopulations to retain demographic stability and constrain localised inbreeding to small levels. Simiarily, a study in Kenya (Anderson *et al.* 2007) found that perennial plantations of cashew nut, mango or coconut as well as timber plantations and remnants of indigenous shrubland vegetation were frequently used by Angolan black-and-white colobus *Colobus angolensis palliatus* to move between fragments of their main coastal forest habitats.

Anderson, J., Rowcliffe, J.M. and Cowlishaw, G. (2007) Does the matrix matter? A forest primate in a complex agricultural landscape. *Biological conservation*, 135, 212-222.

Bruford M.W., Ancrenaz M., Chikhi L., Lackman-Ancrenaz I., Andau M., Ambu L. & Goossens B. (2010) Projecting genetic diversity and population viability for the fragmented orang-utan population in the Kinabatangan floodplain, Sabah, Malaysia. *Endangered Species Research*, 12, 249–261.

Rouget M., Cowling R.M., Lombard A.T., Knight A.T. & Kerley G.I.H. (2006) Designing large-scale conservation corridors for pattern and process. *Conservation Biology*, 20, 549–561.

A before-and-after trial in 1985-1998 in secondary riparian forest in the Community Baboon Sanctuary, Belize, South America (1) found that a population of black howler monkey *Alouatta pigra*, for which a forest corridor along the river was preserved alongside ten other interventions, increased by 138% over 13 years. The population increased from 840 to more than 2,000 individuals (138%), although no statistical tests were carried out to determine whether this difference was significant. Additional interventions included the protection of the sanctuary by the communities surrounding it, preserving forest buffer strips along property boundaries, constructing pole bridges over man-made gaps, preserving important howler food trees in large clearings, involving local communities in the management of the sanctuary, creation of a museum for education purposes, an eco-tourism and research program, presence of permanent staff, and monetary (income from tourism and craft industries) benefits to local communities for sustainably managing their forest and its wildlife communities. The study does not distinguish between the effects of the different interventions mentioned above.

(1) Horwich, R.H. & Lyon J. (1998) Community-based development as a conservation tool: the Community Baboon Sanctuary and the Gales Point Manatee project. Pages 343-363 in: R.B. Primack, D. Bray, H.A. Galletti and I. Ponciano (eds.) *Timber, tourists and temples. Conservation and development in the Maya Forest of Belize, Guatemala and Mexico. Island Press, Covelo*.

11.5. Create/protect forest patches in highly fragmented landscapes

- One before-and-after study in Belize[1] found that black howler monkey numbers increased by 138% over 13 years after the protection of forest along property boundaries and across cleared areas, alongside other interventions.

Background

Habitat destruction and fragmentation are important factors in the decline of primate populations. Small patches of habitat support smaller populations and if individuals are unable to move to other suitable areas of habitat, populations become isolated, which in turn can make them more vulnerable to extinction. Creating/protecting patches of suitable primate habitat (e.g. forest patches) in highly fragmented landscapes may enable them to move between these different areas and help maintain primate populations. Some primate species, such as chimpanzees *Pan troglodytes* (e.g. McLennan 2008), orangutans *Pongo* spp. (e.g. Spehar & Rayadin 2017), or samango monkeys *Cercopithecus albogularis labiatus* (e.g. Nowak *et al*. 2017) show very high behavioural flexibility enabling them to survive in human-modified landscapes. However, it remains to be seen whether such populations will also survive in the long-term.

McLennan M.R. (2008) Beleaguered chimpanzees in the agricultural district of Hoima, Western Uganda. *Primate Conservation*, 23, 45–54.

Spehar S.N. & Rayadin Y. (2017) Habitat use of Bornean orangutans (Pongo pygmaeus morio) in an industrial forestry plantation in East Kalimantan, Indonesia. *International Journal of Primatology*, 38, 358–384.

Nowak K., Wimberger K., Richards S.A., Hill R.A. & le Roux A. (2017) Samango monkeys (*Cercopithecus albogularis labiatus*) manage risk in a highly seasonal, human-modified landscape in Amathole Mountains, South Africa. *International Journal of Primatology*, 38, 194–206.

A before-and-after trial in 1985-1998 in secondary riparian forest in the Community Baboon Sanctuary, Belize, South America (1) found that a population of black howler monkey *Alouatta pigra*, for which forest buffer strips along property boundaries and strips of forest across large cleared areas were maintained alongside ten other interventions, increased by 138% over 13 years. The population increased from 840 to more than 2,000 individuals (138%), although no statistical tests were carried out to determine whether this difference was significant. Additional interventions included the protection of the sanctuary by the communities surrounding it, preserving a forest corridor along the river, constructing pole bridges over man-made gaps, preserving important howler food trees in large clearings, involving local communities in the management of the sanctuary, creation of a museum for education purposes, an eco-tourism and research program, presence of permanent staff, and monetary (income from tourism and craft industries) benefits to local communities for sustainably managing their forest and its wildlife communities. The study does not distinguish between the effects of the different interventions mentioned above.

(1) Horwich, R.H. & Lyon J. (1998) Community-based development as a conservation tool: the Community Baboon Sanctuary and the Gales Point Manatee project. Pages 343-363 in: R.B. Primack, D. Bray, H.A. Galletti and I. Ponciano (eds.) *Timber, tourists and temples. Conservation and development in the Maya Forest of Belize, Guatemala and Mexico. Island Press, Covelo*.

11.6. Demarcate and enforce boundaries of protected areas

- We found no evidence for the effects of demarcating and enforcing boundaries of protected areas on primate populations.

Background

Demarcation is the act of creating a boundary around a place, in this case a protected area. To be able to define the spatial limits of important primate habitat to be protected, it is important that the distribution and possibly abundance of the primate species is known (e.g. through survey work). Protected area boundaries can then be demarcated by physical structures, such as fences (not to keep primates in, but to keep people or livestock out), by raising awareness programmes involving communities bordering these boundaries, or by drawing the boundary only on the map. The enforcement of boundaries can be done by maintaining the physical boundary demarcation, boundary patrols by law enforcement guards, and/or continuous education of local people to environmental issues and protection. A correlative study that assessed the impacts of anthropogenic threats on 93 protected areas in 22 tropical countries found that the degree of border demarcation correlated with management effectiveness (Bruner *et al*. 2001). Another correlative study in northern Congo found that elephant *Loxodonta africana* and chimpanzee *Pan troglodytes troglodytes* density decreased with increasing distance outside the NNNP boundary. Chimpanzee density decreased rapidly outside the national park up to a distance of 40 km and increased rapidly inside its boundary. Elephant density within the national park boundary and at short distances up to about 20 km outside its border was relatively stable, but then decreased rapidly with increasing distance away from national park boundary. In contrast, gorilla *Gorilla gorilla gorilla* density increased with increasing distance outside the park boundary, up to distances of approximately 100 km (Stokes *et al*. 2010).

Bruner A.G., Gullison R.E., Rice R.E. & da Fonseca G.A.B. (2001) Effectiveness of parks in protecting tropical biodiversity. *Science*, 291, 125-128.

Stokes E.J., Strindberg S., Bakabana P.C., Elkan P.W., Iyenguet F.C., Madzoke B., Malanda G.A.F., Mowawa B.S., Moukoumbou C., Ouakabadio F.K. & Rainey H.J. (2010) Monitoring great ape and elephant abundance at large spatial scales: measuring effectiveness of a conservation landscape. *PLoS ONE*, 5, e10294.

Habitat creation or restoration

11.7. Restore habitat corridors

- We found no evidence for the effects of restoring habitat corridors on primate populations.

Background

As an alternative to protecting natural habitat for primates, restoring damaged habitats or creating new habitat patches may help to maintain/increase primate populations. Habitat restoration or creation is often required by law as a response to mining or other activities that destroy large areas of natural habitats. This intervention may entail planting vegetation, removing invasive species, or creating shelter habitats and sleeping sites for example.

11.8. Plant indigenous trees to re-establish natural tree communities in clear-cut areas

- One site comparison study in Kenya[1] found that two out of three primate species had lower group densities in planted forests than in natural forests.

Background

This intervention involves the planting of indigenous trees to re-establish natural tree communities after clear-cutting. It should be noted, however, that planting trees will almost always be more expensive than preserving natural forests from clear-cutting and that natural forests are usually more suitable as habitat for a wider range of native forest species than plantation forests (which is not to say that primates cannot survive in young regrowth forest). In addition, it can take centuries and even millennia for the forest to regrow to its pre-disturbance state. For example, an Atlantic rainforest needs about one to three hundred years to reach the proportion of animal-dispersed species (80% of the species), the proportion of non-pioneer species (90%) and of understorey species (50%) found in mature forests. On the other hand, much more time is necessary (between one and four thousand years) to reach the endemism levels (40% of the species) that exist in mature forests (Liebsch *et al*. 2008). Therefore, this intervention should only be considered if the natural habitat is already lost or if preserving it will not be possible.

Liebsch D., Marques M.C.M. & Goldenberg R. (2008) How long does the Atlantic Rain Forest take to recover after a disturbance? Changes in species composition and ecological features during secondary succession. *Biological Conservation*, 141, 1717–1725.

A site comparison in 2006-2010 in natural and planted forest in Kakamega Forest, Kenya (1) found that black and white colobus *Colobus guereza* achieved similar average group densities but smaller group size in planted as in natural forest but group densities of blue monkey *Cercopithecus mitis* and redtail monkey *Cercopithecus ascanius* were 42-45% lower in planted forest than in natural forest. Black and white colobus average group sizes in planted forest were 33% smaller than in natural forest, resulting in a population that was 35% smaller in size compared to those in natural forest. No statistical tests were carried out to determine whether these differences were significant. Natural forest included old secondary forest that connected to the remaining natural old-growth forest. Planted forest included mixed indigenous trees planted in 1930-1940 in areas where natural vegetation had been clear-cut. Monkey density was estimated based on transect observations in both forest types using the 'Whitesides' and 'Distance' methods. Transects followed pre-existing footpaths or dirt roads.

(1) Fashing P.J., Nguyen N., Luteshi P., Opondo W., Cash J.F. & Cords M. (2012) Evaluating the suitability of planted forests for African forest monkeys: a case study from Kakamega Forest, Kenya. *American Journal of Primatology*, 74, 77–90.

11.9. Plant indigenous fast-growing trees (will not necessarily resemble original community) in clear-cut areas

- We found no evidence for the effects of planting indigenous fast-growing trees in clear-cut areas on primate populations.

Background

This intervention involves the planting of indigenous fast-growing trees after clear-cutting. Because the focus of this intervention is to regrow a forest in a relatively short period of time with the aid of fast-growing indigenous trees, the planted forest will not necessarily resemble the original forest community when it has fully regrown. In addition, it should be noted that natural forests are usually more suitable as habitat for a wider range of native forest species than plantation forests. Therefore, this intervention should only be considered if the natural habitat is already lost or if preserving it will not be possible.

In terms of facilitating the establishment and growth of indigenous tree species in severely degraded areas, plantations of fast-growing trees have been shown to facilitate the establishment and growth of indigenous tree species. For example, Zanne & Chapman (2001) found that five plantations in Kibale National Park in Uganda had higher tree species richness and stem density than nearby human-modified grasslands from which they were derived.

Zanne A. & Chapman C.A. (2001) Expediting reforestation in tropical grasslands: distance and isolation from seed sources in plantations. *Ecological Applications*, 11, 1610–1621.

11.10. Use weeding to promote regeneration of indigenous tree communities

- We found no evidence for the effects of using weeding to promote regeneration of indigenous tree communities on primate populations.

Background

In the context of this synopsis, weeding refers to the removal of undesirable plants to promote regeneration of indigenous tree communities. A study that evaluated the effect of vine, grass, and shrub cutting over a 3-year period on regeneration of indigenous trees subsequent to the removal of plantation softwoods in Kibale National Park, Uganda, found no difference in the total number of stems in plots where competing weeds were removed and control plots. Furthermore, the number of stems that had reached a size of 1 cm diameter at breast height or higher was greater in the control plot than in the weeded plots, as was species richness (Chapman *et al*. 2002).

Chapman C.A., Chapman L.J., Zanne A. & Burgess M.A. (2002). *Restoration Ecology*, 10, 408–415.

12. Species Management

Background

While most of the chapters in this book aim to minimize the threats to primates, this chapter specifically aims to increase population numbers by either increasing individual reproductive rate or by decreasing mortality rate through the provisioning of food, water, minerals, and shelter. The chapter also includes intensive (and relatively invasive) management strategies, such as the habituation of primates to human presence to reduce stress from tourists/researchers, guarding of habituated primates to protect them from poachers, implementation of birth control to stabilize primate population size and reduce human-primate conflict, and introduction of wild or captive primates into areas where they were previously absent or where they occurred at low densities. Captive breeding of primates and subsequent reintroduction into natural habitat is also included in this chapter. Forty-nine (65%) of the 77 studies included in this synopsis tested conservation interventions that related to species management, -recovery, and -reintroduction, and *ex-situ* conservation strategies.

Key messages – species management

Habituate primates to human presence to reduce stress from tourists/researchers etc.

Two out of three studies in Central Africa and Madagascar found that primate populations increased or were stable following habituation to human presence, alongside other interventions. One of three studies in South America found that primate populations declined following habituation to human presence, alongside other interventions.

Implement birth control to stabilize primate community/population size

We captured no evidence for the effects of implementing birth control to stabilize primate community/population size on primate populations.

Guard habituated primate groups to ensure their safety/well-being

One study in Rwanda, Uganda and the Congo found that a population of mountain gorillas increased after being guarded against poachers, alongside other interventions.

Implement legal protection for primate species under threat

Three of four studies in India, South East Asia, and West Africa found that primate populations declined after the respective species were legally protected, alongside other interventions. One of four studies in India found that following a ban on export of rhesus macaques, their population increased. One study in Malaysia found that a minority of introduced primates survived after implementing legal protection, along with other interventions.

Key messages – species recovery

Provide salt licks for primates

We captured no evidence for the effects of providing salt licks for primates on primate populations.

Regularly and continuously provide supplementary food to primates

Two of four studies found that primate populations increased after regularly providing supplementary food, alongside other interventions, while two of four studies found that populations declined. Four of four studies found that the majority of primates survived after regularly providing supplementary food, alongside other interventions. One study found that introduced primate had different diets to wild primates after regularly being providing supplementary food, along with other interventions.

Regularly provide supplementary food to primates during resource scarce periods only

Two studies found that the majority of primates survived after supplementary feeding in resource scarce periods, alongside other interventions. One study found that the diet of introduced primates was similar to that of wild primates after supplementary feeding in resource scarce periods, alongside other interventions.

Provide supplementary food for a certain period of time only

Six of eleven studies found that a majority of primates survived after supplementary feeding, alongside other interventions. Five of eleven studies found that a minority of primates survived. One of two studies found that a reintroduced population of primates increased after supplementary feeding for two months immediately after reintroduction, alongside other interventions. One study found that a reintroduced population declined. Two studies found that abandoned primates rejoined wild groups after supplementary feeding, alongside other interventions.

Provide supplementary food to primates through the establishment of prey populations

We captured no evidence for the effects of providing supplementary food to primates through the establishment of prey populations on primate populations.

Provide additional sleeping platforms/nesting sites for primates

One study found that a translocated primate population declined despite providing artificial nest boxes, alongside other interventions. One of two studies found that the majority of primates survived for at least seven years after nesting platforms were provided, alongside other interventions. One of two studies found that a minority of primates survived for at least seven years after artificial nest boxes were provided, alongside other interventions.

Provide artificial water sources

Three of five studies found that a minority of primates survived for between 10 months and seven years when provided with supplementary water, alongside other interventions. Two of five studies found that a majority of primates survived for between nine and ten months, when provided with supplementary water, alongside other interventions.

Key messages – species reintroduction

Translocate (capture & release) wild primates from development sites to natural habitat elsewhere

Four studies found that the majority of primates survived following translocation from a development site to natural habitat, alongside other interventions. One study found that a minority of primates survived for at least 18 months. One study found that monkeys remained at sites where they were released following translocation from a development site to natural habitat, alongside other interventions.

Translocate (capture & release) wild primates from abundant population areas to non-inhabited environments

One study found that he majority of primates survived for at least 10 months after translocation from abundant population areas to an uninhabited site, along with other interventions.

Allow primates to adapt to local habitat conditions for some time before introduction to the wild

Two of three studies found that primate populations declined despite allowing individuals to adapt to local habitat conditions before introduction into the wild, along with other interventions. One study found an increase in introduced primate populations. Ten of 17 studies found that a majority of primates survived after allowing them to adapt to local habitat conditions before introduction into the wild, along with other interventions. Six studies found that a minority of primates survived and one study found that half of primates survived. One study found that a reintroduced chimpanzee repeatedly returned to human settlements after allowing it to adapt to local habitat conditions before introduction into the wild, along with other interventions. One study found that after allowing time to adapt to local habitat conditions, a pair of reintroduced Bornean agile gibbons had a similar diet to wild gibbons.

Reintroduce primates in groups

Two of four studies found that populations of introduced primates declined after reintroduction in groups, alongside other interventions, while two studies recorded increases in populations. Two studies found that primate populations persisted for at least five to 55 years after reintroduction in groups, alongside other interventions. Seven of fourteen studies found that a majority of primates survived after reintroduction in groups, alongside other interventions. Seven of fourteen studies found that a minority of primates survived after reintroduction in groups, alongside other interventions. One study found that introduced primates had a similar diet to a wild population.

Reintroduce primates as single/multiple individuals

Three of four studies found that populations of reintroduced primates declined after reintroduction as single/multiple individuals, alongside other interventions. One study found that the introduced population increased in size. Three of five studies found that a minority of primates survived after reintroduction as single/multiple individuals, alongside other interventions. One study found that a majority of primates survived and one study found that half of primates survived. Two of two studies found that abandoned primates were reunited with their mothers after reintroduction as single/multiple individuals, alongside other interventions.

Reintroduce primates into habitat where the species is absent

One of two studies found that primate populations increased after reintroduction into habitat where the species was absent, alongside other interventions. One study found that primate populations declined post-reintroduction. One study found that a primate population persisted for at least four years after reintroduction. Eight of ten studies found that a majority of primates survived after reintroduction into habitat where the species was absent, alongside other interventions. Two studies found that a minority of primates survived after reintroduction into habitat where the species was absent, alongside other interventions.

Reintroduce primates into habitat where the species is present

Ten of sixteen studies found that the majority of primates survived after reintroduction into habitat where the species was present, alongside other interventions. Six of sixteen studies found that a minority of primates survived post-reintroduction. Two of three studies found that populations of primate declined after they were reintroduced into habitat where the species was present, alongside other interventions. One of three studies found that a reintroduced primate population increased. Two of three studies found that abandoned primates were reunited with wild groups after they were reintroduced into habitat where the species was present, alongside other interventions. One of three studies found that a primate repeatedly returned to human settlements. Three of three studies found that reintroduced primates showed similar behaviour to wild primates after reintroduction into habitat where the species was present, alongside other interventions.

Reintroduce primates into habitat without predators

One study found that a population of reintroduced chimpanzees increased over 16 years following reintroduction into habitat without predators.

Reintroduce primates into habitat with predators

Eight of fourteen studies found that a majority of reintroduced primates survived after reintroduction into habitat with predators, alongside other interventions. Six studies found that a minority of primates survived. One study found that an introduced primate population increased after reintroduction into habitat with predators, alongside other interventions

Key messages – *ex-situ* conservation

Captive breeding and reintroduction of primates into the wild: born and reared in cages

One study found that the majority of reintroduced primates which were born and reared in cages, alongside other interventions, did not survive over seven years.

Two of two studies found that more reintroduced primates that were born and reared in cages, alongside other interventions, died post-reintroduction compared to wild-born monkeys.

Captive breeding and reintroduction of primates into the wild: limited free-ranging experience

Two of three studies found that the majority of captive-bred primates, with limited free-ranging experience and which were reintroduced in the wild, alongside other interventions, had survived. One study found that the minority of captive-bred primates survived reintroduction over five years. One study found that reintroduced captive-breed primates with limited free-ranging experience had a similar diet to wild primates after. Reintroduction was undertaken alongside other interventions.

Captive breeding and reintroduction of primates into the wild: born and raised in a free-ranging environment

One study found that the majority of primates survived for at least four years after being raised in a free-ranging environment, alongside other interventions. One study found that the diet of primates that were born and raised in a free-ranging environment alongside other interventions, overlapped with that of wild primates.

Rehabilitate injured/orphaned primates

Six of eight studies found that the majority of introduced primates survived after rehabilitation of injured or orphaned individuals, alongside other interventions. One study found that a minority of introduced primates survived, and one study found that half of primates survived. One of two studies found that an introduced primate population increased in size after rehabilitation of injured or orphaned individuals, alongside other interventions. One study found that an introduced rehabilitated or injured primate population declined. One review found that primates living in sanctuaries had a low reproduction rate. One study found that introduced primates had similar behaviour to wild primates after rehabilitation of injured or orphaned individuals, alongside other interventions.

Fostering appropriate behaviour to facilitate rehabilitation

Three of five studies found that a minority of primates survived after they were fostered to encourage behaviour appropriate to facilitate rehabilitation, alongside other interventions. Two studies found that the majority of reintroduced primates fostered to facilitate rehabilitation along other interventions survived. Three studies found that despite fostering to encourage behaviour appropriate to facilitate rehabilitation, alongside other interventions, primates differed in their behaviour to wild primates.

Species management

12.1. Habituate primates to human presence to reduce stress from tourists/researchers etc.

- A before-and-after study in Brazil[1] found that an introduced population of golden lion tamarins declined after one year, following habituation to human presence, alongside other interventions.
- A before and after study in Madagascar[2] found that the majority of introduced black-and-white ruffed lemurs and diademed sifakas survived over 30 months, following habituation to human presence, alongside other interventions.
- A controlled, before-and-after study in Rwanda, Uganda, and Democratic Republic of Congo[3] found that a mountain gorilla population increased over 41 years, following habituation to human presence, alongside other interventions.

Background

Habituation is key to observing and researching primates in the wild and specifically refers to the process of getting animals used to people. Because most primates live in forests (89% of the studies that tested conservation interventions for primates where located in subtropical, tropical or temperate forests) where visibility is limited, it is necessary to habituate them to human presence in order for researchers or tourists to be able to observe them. In situations where primates are frequently followed and observed by people (research, ecotourism) or regularly come into contact with people, for example during translocations and reintroductions or at sanctuaries and captive breeding facilities, habituation to humans may help to reduce stress levels in the animals in the long-term.

However, habituation may have long-term negative effects on activity and behaviour patterns of primates (Williamson & Feistner 2003). It may also increase the risk for primates (especially great apes) of contracting disease by changing the nature of contact between humans and non-human primates. In addition, primates with elevated stress levels caused by the permanent presence of humans in their immediate environment (e.g. Shutt *et al*. 2014) may have lower reproductive success and be more susceptible to falling ill. Since habituation is basically the loss of fear of humans, habituated animals are easily approachable by poachers and thus are extremely vulnerable in areas where poaching occurs (Williamson & Feistner 2003). Therefore, before implementing this intervention it should be decided if the benefits of this conservation intervention will outweigh its costs.

Guarding habituated primates to protect them from being killed by humans (e.g. poachers) is discussed under 'Guard habituated primate groups to ensure their safety/well-being.'

Shutt K., Heistermann M., Kasim A., Todd A., Kalousova B., Profosouv I., Petrzelkova K., Fuh T., Dicky J.-F., Bopalanzognako J.-B. & Setchell J.M. (2014) Effects of habituation, research and ecotourism on faecal glucocorticoid metabolites in wild western lowland gorillas: implications for conservation management *Biological Conservation*, 172, 72–79

Williamson E.A. & Feistner A.T.C. (2003) Habituating primates: processes, techniques, variables and ethics. Pages 25-39 in: J.M. Setchell & D.J. Curtis (eds.) *Field and Laboratory Methods in Primatology: A Practical Guide. Cambridge University Press*, Cambridge.

A before-and-after trial in 1954-1985 in a degraded rainforest in Poço das Antas Reserve, Brazil (1) found that a translocated captive-born golden lion tamarin *Leontopithecus rosalia* population that was habituated to human presence along with nine other interventions, decreased by more than half (57%) within the first year post-release. However, no statistical tests were carried out. to determine whether this difference was significant. Of the 14 individuals released, seven died (50%) and two were removed and treated. Three infants were born, one of which died due to illness. Eight individuals were released as a family group and six individuals were released as pairs one month later. Tamarins spent an unknown amount of time in 15 x 4.5 x 3 m outside enclosures to acclimatize. They were fostered to facilitate survival in the wild. The reserve included natural predators. Sick or injured tamarins were captured and treated. Reintroduced tamarins were supplied with food for ten months post-release. Artificial nesting boxes, which were hollow logs provided to them during training, were also set up in the reserve. The study does not distinguish between the effects of the different interventions mentioned above.

A before-and-after trial in 2006-2007 in evergreen rainforest in Analamazaotra Special Reserve, Madagascar (2) found that translocated black-and-white ruffed lemurs (BWRL) *Varecia variegata variegata* and diademed sifakas *Propithecus diadema* that were habituated to human presence before relocation along with other interventions, survived for at least 30 months and reproduced. No mortalities were recorded for BWRL over a 30-month period and only one diademed sifaka died from natural causes. In addition, two sets of BWRL twins (reproductive rate=57%) and seven diademed sifaka infants were born (reproductive rate=26%), the latter of which only two survived. A total of seven BWRL and 27 diademed sifakas were captured at four disturbed forest sites and released in their social units to the reserve where the species had locally gone extinct and that included natural predators. Released primates were monitored with radio-collars. Two to eight months before translocation, lemurs were darted and underwent veterinary checks. The study does not distinguish between the effects of the different interventions mentioned above.

A controlled, before-and-after study in 1967-2008 in tropical moist montane forest in Volcanoes-, Mgahinga-, and Virunga National Parks in Rwanda, Uganda, and the Democratic Republic of Congo, respectively (3), found that a mountain gorilla *Gorilla beringei beringei* population that was habituated to the presence of researchers and tourists alongside 10 other interventions, increased in size over time. Annual population growth was 4.1%, resulting in an overall population increase of 168% over the entire study period. No statistical tests were carried out to determine whether this increase was significant. As part of a long-term research project, habituation of gorilla groups started in 1967 and continued largely uninterrupted until the end of the study in 2008. Later on, an ecotourism project was implemented. Visitors/researchers had to follow strict health procedures; these included keeping a safety distance to the gorillas, wearing face-masks, spending only a limited amount of time with gorilla groups, ensuring that visitors/researchers were healthy and disinfecting visitor's/researcher's clothes, boots etc. The population was monitored by vets and gorillas received medical treatment if necessary and any mortality was clinically examined. The study does not distinguish between the effects of the different interventions mentioned above.

(1) Dietz L.A. (1985) Captive-born lion tamarins released into the wild: a report from the field. *Primate Conservation*, 6, 21–27.

(2) Day S.R., Ramarokoto R.E.A.F., Sitzmann B.D., Randriamboahanginjatovo R., Ramanankirija H., Randrianindrina V.R.A., Ravololonarivo G. & Louis E.E.J. (2009) Re-introduction of diademed sifaka (*Propithecus diadema*) and black and white ruffed lemurs (*Varecia variegate editorum*) at Analamazaotra Special Reserve, eastern Madagascar. *Lemur News*, 14, 32–37.

(3) Robbins M.M., Gray M., Fawcett K.A., Nutter F.B., Uwingeli P., Mburanumwe I., Kagoda E., Basabose A., Stoinski T.S., Cranfield M.R., Byamukama J., Spelman L.H., Robbins A.M. (2011) Extreme conservation leads to recovery of the Virunga mountain gorillas. *PLoS ONE*, 6, e19788.

12.2. Implement birth control to stabilize primate community/population size

- We found no evidence for the effects of implementing birth control to stabilize primate community/population size on primate populations.

Background

This intervention can be implemented to curb primate population growth, for instance in towns and cities, or in other situations where increasing primate populations may have become a 'nuisance' to people. For example, it is estimated that about 30,000 red-bottomed rhesus macaques *Macaca mulatta* currently live in New Delhi, India. They have been reported to roam through government buildings, chew internet cables, bite people and steal from people's homes and India is now planning to put its rising population of primates on contraceptives to tackle this problem (Nelson 2013). Vasectomies and sterilisation programmes are also referred to as birth control measures, however, but due to their highly invasive nature, they are excluded from this primate synopsis.

Contraceptives, however, may also have adverse effects on the animals as they can generate unexpected physical, social and ecological consequences depending on the species and its ecological history (for more information on wildlife contraceptives, see e.g. Asa & Porton 2005). In the past, contraceptives have been used for lions *Panthera leo*, African savanna elephants *Loxodonta africana*, brush-tailed possums *Trichosurus* spp., wild horses *Equus ferus*, urban deer *Odocoileus virginianus,* and American bisons *Bison bison*.

Asa C.S. & Porton I.J. (2005) *Wildlife Contraception. Issues, Methods, and Applications.* The Johns Hopkins University Press, Baltimore.

Nelson D. (2013) *India's monkeys 'to be put on the pill'*. The Telegraph, 18 Nov 2013. Available at http://www.telegraph.co.uk/news/worldnews/asia/india/10457004/Indias-monkeys-to-be-put-on-the-pill.html. Accessed 22 June 2017.

12.3. Guard habituated primate groups to ensure their safety/well-being

- A controlled, before-and-after study in Rwanda, Uganda, and the Democratic Republic of Congo[1] found that a population of mountain gorillas increased over 41 years after being guarded against poachers, alongside other interventions.

Background

Habituated primates that have lost their fear of humans are extremely vulnerable to killing by poachers as they can be approached easily and do not flee. This intervention therefore ensures the protection of habituated primates by guarding them. This can take the form of continuous guarding of habituated gorilla groups by teams of field staff during daylight hours (e.g. Robbins *et al.* 2011), or may involve measures as extreme as employing 24 hour armed guards or well-funded, heavily-armed and privately-trained anti-poaching rangers and security personnel, as is currently being done to control rhino (Rhinocerotidae) poaching in several areas across southern and east Africa (rhinos are not habituated to humans, but are increasingly being killed by poachers using modern technology and heavy weaponry).

Getting primates used to human presence to be able to observe them in the wild is discussed under 'Habituate primates to human presence to reduce stress from tourists/researchers etc.'

Robbins M.M., Gray M., Fawcett K.A., Nutter F.B., Uwingeli P., Mburanumwe I., Kagoda E., Basabose A., Stoinski T.S., Cranfield M.R., Byamukama J., Spelman L.H., Robbins A.M. (2011) Extreme conservation leads to recovery of the Virunga mountain gorillas. *PLoS ONE*, 6, e19788.

A controlled, before-and-after study in 1967-2008 in tropical moist montane forest in Volcanoes-, Mgahinga-, and Virunga National Parks in Rwanda, Uganda, and the Democratic Republic of Congo (1) found that a mountain gorilla *Gorilla beringei beringei* population where individual animals were closely guarded against poachers alongside ten other interventions, increased in size over time. Annual population growth was 4.1%, resulting in an overall population increase of 168% over 41 years. No statistical tests were carried out to determine whether this increase was significant. Increased protection through the guarding of gorillas explained 60% of the difference in growth rates between this population (treatment) and a second, unguarded population in the same area (control). The remaining 40% were likely accounted for by veterinary interventions for snares, respiratory disease, and other life-threatening conditions. As part of an ecotourism- and research project, gorillas in the guarded population were habituated to human presence, where visitors/researchers had to follow strict health procedures; these included keeping a safety distance to the gorillas, wearing face-masks, spending only a limited amount of time with gorilla groups, ensuring that visitors/researchers were healthy, and disinfecting visitor's/researcher's clothes, boots etc. Dead gorillas were clinically examined. The study does not distinguish between the effects of the different interventions mentioned above.

(1) Robbins M.M., Gray M., Fawcett K.A., Nutter F.B., Uwingeli P., Mburanumwe I., Kagoda E., Basabose A., Stoinski T.S., Cranfield M.R., Byamukama J., Spelman L.H., Robbins A.M. (2011) Extreme conservation leads to recovery of the Virunga mountain gorillas. *PLoS ONE*, 6, e19788.

12.4. Implement legal protection for primate species under threat

- A before-and-after study in India[1] found that following a ban on export of the species, a population of rhesus macaques increased over 17 years.

- Two studies in Thailand[2] and India[5] found that primate populations declined despite the respective species being legally protected, alongside other interventions.
- One before-and-after study in Malaysia[3] found that the majority of introduced Müller's Bornean gibbons died despite legal protection, along with other interventions.
- A site comparison in five sites in Cameroon[4] found that drill populations declined in four sites but increased at one, despite legal protection.

Background

This intervention includes laws and policies to protect specific primate species. The scale of these protection measures can be on the international-, national-, or sub-national level. The intervention only refers to the existence of such laws and policies, but not the implementation thereof.

A before-and-after trial in 1959-1987 in Aligarh district, Uttar Pradesh, India (1) found that a rhesus macaque *Macaca mulatta* population recovered after implementing a national ban on its commercial export. The population increased from 163 monkeys in 1970 to an average of 396 monkeys in 1985-1987 (143% increase). Furthermore, in 1985-1986, 46.1% of the total population was immature (infants or juveniles) compared to 31.1% in 1959-1960, indicating a growing population. No statistical tests were carried out to determine whether this increase was significant. During the first census in 1962, the population of 403 individuals consisted of 21 groups. Since 1970, eight groups survived for at least 18 years. The Indian government banned commercial exports of rhesus macaques in April 1978. The improvement of agricultural production could have been partly responsible for the recovery of the monkey population (no data provided). Surveys across the state of Uttar Pradesh also revealed a population increase (133% increase) as encounter rates increased from 21 monkeys/100 km in 1977-1978 to 49 monkeys/100 km in 1985-1986; no statistical tests were carried out to determine whether this increase was significant. Population censuses were conducted by car, bicycle and by foot in and around villages and forests.

A study, which was included in a review, in 1967-1970 in Koh Klet Kaeo island and Sai Yok National Park, Thailand (2) of lar gibbons *Hylobates lar* that were legally protected in 1961 along with other interventions and that were reintroduced from captivity found that the introduced population of 20 individuals decreased to eight individuals (60% decrease) over three years. No statistical tests were carried out to determine whether this difference was significant. However, four infants were born over the same time period. Gibbons were introduced in pairs into habitat that did not resemble their natural habitat and without resident gibbons. Gibbons were obtained individually from animal dealers and housed together in a laboratory for at least one month before release. They were supplemented with food and water. In dry evergreen forest in Sai Yok National Park, two introduced gibbons of a total of 31 individuals died (6% decrease) within three years post-release and no infants were born in the first 17 months. Four gibbons joined wild groups. They were introduced as individuals, pairs, or family groups into habitat with resident conspecifics. Anaesthetized gibbons were either kept in separate cages for 14 days before release, or laid out on the forest floor. Injured animals were recaptured and treated. The study does not distinguish between the effects of the different interventions.

A before-and-after trial in 1976-1988 in a degraded tropical forest in Semenggoh Forest Reserve, Malaysia (3) found that at least 77 of 87 (90%) reintroduced captive, wild-born Müller's Bornean gibbons *Hylobates muelleri* that were legally protected in the area along with other interventions, did not survive after release. Müller's Bornean gibbons were fully protected under the Wild Life Protection Ordinance in Sarawak that also forbade keeping gibbons as pets. Confiscated gibbons had undergone veterinary checks and were placed in holding cages in a forest clearing for an unknown amount of time. Where possible, males and females were paired in cages prior to release into habitat without wild resident gibbons. Surveys of direct sightings and gibbon calls along grid squares (500 x 500 m) covering a total of 9.5 km were conducted simultaneously by three or four observers on non-rainy days in February-March 1988. The study does not distinguish between the effects of the different interventions mentioned above.

A site comparison in 1971-2002 in five tropical forests with different management histories in Bakossiland, Cameroon (4) found that drill *Mandrillus leucophaeus* populations that were officially protected by government legislation, decreased in numbers on Mount Mwanenguba, the Bakossi- and Mwenzekong Mountains, became extinct in the Loum Forest Reserve, and appeared to recover only on Mount Kupe. Drill group sizes did not change significantly over time, season, habitat, or elevation for Mount Kupe, or for all sites combined. Independent direct observations of drills groups and their size were recorded at all sites by different organizations working in the region.

A study in 1991-2007 in tropical forests in Karbi Anglong district, Assam, northeast India (5) found that the hoolock gibbon *Hoolock hoolock* population decreased by 33% over 16 years, despite being officially protected in India. Overall, the population declined from 3,500-4800 gibbons in 1991-1992 to 2,400-3,200 gibbons in 2007 (33% decrease). However, no statistical tests were carried out to determine whether this decrease was significant. The species is protected under Schedule-1 of the Wild Life (Protection) Act of India, which prohibits its killing or capture, dead or alive. However, the enforcement of this act appeared virtually non-existent, even in protected areas. Data on gibbon distribution and approximate population sizes were collected through field surveys along trails, roads and rivers and interviews of local forest staff, villagers and hunters.

(1) Southwick C.H. & Siddiqi M.F. (1988) Partial recovery and a new population estimate of rhesus monkey populations in India. *American Journal of Primatology*, 16, 187–197.

(2) Eudey A.A. (1991) Captive gibbons in Thailand and the option of reintroduction to the wild. *Primate Conservation*, 12, 34–40.

(3) Bennett J. (1992) A glut of gibbons in Sarawak – is rehabilitation the answer? *Oryx*, 26, 157–164.

(4) Wild C., Morgan B.J. & Dixson A. (2005) Conservation of drill populations in Bakossiland, Cameroon: historical trends and current status. *International Journal of Primatology*, 26, 759–773.

(5) Choudhury A. (2009) The distribution, status and conservation of hoolock gibbon, *Hoolock hoolock*, in Karbi Anglong district, Assam, Northeast India. *Primate Conservation*, 24, 117–126.

Species recovery

12.5. Provide salt licks for primates

- We found no evidence for the effects of providing salt licks for primates on primate populations.

Background

Sodium (Na) is necessary for animal muscle contraction, nerve impulse transmission, acid–base balance, and metabolism. However, plants do not require it and therefore animals that feed only on plants, such as gorillas *Gorilla* spp., redtail monkeys *Cercopithecus ascanius* or other herbivorous/frugivorous primate species, typically need a sodium source other than their main food. In order to meet their sodium demands, some primates select food with high mineral content or obtain sodium from unusual feeding locations, such as swamp plants, salt licks, or eucalyptus plantations (Hanya & Chapman 2013). Thus, providing salt licks to herbivorous primates, for instance inholding cages during reintroduction programmes or placing them into the habitat that the species was released to, may be important for promoting primate health, particularly if this resource is limited or the species is unable to acquire it for other reasons.

Hanya G. & Chapman C.A. (2013) Linking feeding ecology and population abundance: a review of food resource limitation on primates. *Ecological Research,* 28, 183–190.

12.6. Regularly and continuously provide supplementary food to primates

- Two studies in China[1] and The Gambia[6] found that after regularly providing supplementary food, along with other interventions, primate populations increased. Two studies in Thailand[2] and Malaysia[7] found that populations declined after regular provision of supplementary food, alongside other interventions.
- Three studies in Brazil[4], South Africa[9], and Indonesia[8] found that the majority of primates survived after being regularly provided supplementary food, along with other interventions.
- One study in Liberia[3] found that after regular provision of supplementary food, along with other interventions, the majority of introduced chimpanzees survived for at least one year.
- One controlled study in Madagascar found that after a year of regular food supplimentation, along with other interventions, introduced black-and-white ruffed lemurs showed different diets compared to a resident wild group of the same species.

Background

This intervention involves the provisioning of supplementary food to primates to ensure their survival (e.g. after reintroductions or translocations) or to increase population size. Depending on the species and its foraging behaviour and requirements, food can be scattered on the ground or placed on feeding platforms and may consist of wild foods (leafs, fruits, nuts, roots etc. that grow in natural habitats) or human-cultivated/processed foods that are normally not available in the primate's natural habitat (e.g. oranges, bananas, pellets, milk).

For the purpose of the primate synopsis, the scientific evidence for supplementary food provisioning is separated into four different interventions, which refer to slightly different methodological approaches (see sections 12.6-12.9):

1) 'Regularly and continuously provide supplementary food to primates'
2) 'Regularly provide supplementary food to primates during resource scarce periods only'
3) 'Provide supplementary food for a certain period of time only'
4) 'Provide supplementary food to primates through the establishment of prey populations'

A review in 1985 in tropical montane forest in Nanwan Nature Reserve, China (1) on the status of rhesus monkeys *Macaca mulatta* found that regularly providing individuals with supplementary food along with designating the area an internationally protected nature reserve, resulted in an increase in their population by more than 90% over seven years. The population increased from 'a few dozen' in 1976 to 600-700 individuals by 1983, excluding the >100 monkeys that were captured and supplied to scientific and medical institutions. However, no statistical tests were carried out to determine whether this increase was significant. The area became an internationally protected nature reserve in 1976. The study does not distinguish between the effects of the different interventions mentioned above.

A study, which was included in a review, in 1967-1970 on Koh Klet Kaeo island, Thailand (2) of captive lar gibbons *Hylobates lar* that were reintroduced on the island and which were continuously provided with food along with other interventions, found that their population decreased by 60% over three years. No statistical tests were carried out to determine whether this decrease was significant. Four infants were born to the introduced population of 20 gibbons (reproductive rate=20%). They were fed and provided with water from artificial food and water stations. Gibbons were introduced in successive pairs into habitat that did not resemble their natural habitat and without resident gibbons. Gibbons were obtained individually from commercial animal dealers and housed in a laboratory for at least one month together with the gibbon individual with which they were released on the island. In 1961, gibbons were designated protected animals in Thailand. The study does not distinguish between the effects of the different interventions mentioned above.

A study in 1987-1988 on an island in tropical forest in Liberia (3) found that the majority of reintroduced western chimpanzees *Pan troglodytes verus* that were provided with food continuously after release alongside other interventions, survived for at least one year. Seven out of 30 released chimpanzees had difficulties to adjust to the new social environment and were brought back to captivity. Food was supplemented daily but chimpanzees also fed on wild food. Chimpanzees were screened for diseases before they were released in groups. Furthermore, they were socialized in naturalistic enclosures and were taught behaviour to facilitate their survival in the wild. On site, primates were allowed to adapt to the local habitat in enclosures for some time; younger and low-ranking individuals were released earlier to reduce stress. Sick and injured animals were temporarily removed to receive medical treatment. The study does not distinguish between the effects of the different interventions mentioned above.

A study in 1999 in tropical forest of Morro do Diabo State Park, São Paulo, Brazil (4) found that only some of the individuals in a group of reintroduced wild and captive-bred black lion tamarins *Leontopithecus chrysopygus* that were supplemented with food along with other interventions, survived for at least four months. Four months after the release of three individuals, one tamarin died. Supplementary food was provided twice a day for one month and then daily for another two months. Tamarins underwent veterinary screens before translocation to an enclosure at the release site where they could adapt to the local environment where predators occurred. The group consisted of two wild females and one captive-born male. The latter was bred in a free-ranging environment where he had been fostered natural behaviour to facilitate reintroduction. The male was also treated when sick. Monkeys were fitted with radio-collars. The study does not distinguish between the effects of the different interventions mentioned above.

A controlled study in 1998-2001 in tropical forest in Betampona Reserve, Madagascar (5) found that diets of captive-bred, reintroduced black-and-white ruffed lemurs *Varecia variegata variegata* provided with supplementary food during the entire study period alongside other interventions did not overlap with that of the resident wild group in the first year after release. Captive-bred lemurs (one male and two females) fed only on around half of the plant species (N=57) that the wild group (ten individuals) fed on (N=109). Captive-bred lemurs remained dependent on supplementary food as their range was too restricted to encounter sufficient food and showed no inclination to increase their range despite efforts to encourage it. Lemurs were released in groups into habitat already occupied by the species. The study does not distinguish between the effects of the different interventions mentioned above.

A study in 1979-2004 in tropical forest on Baboon Islands, River Gambia National Park, The Gambia (6) found that rehabilitated and reintroduced western chimpanzees *Pan troglodytes verus* that were regularly and continuously provided with supplementary food along with other interventions, increased from 50 to 69 chimpanzees over 25 years. No statistical tests were carried out to determine whether this increase was significant. Fertility and mortality rates were similar to wild chimpanzees, except for infant mortality (18%), which was lower than in wild populations. Inter-birth interval, average age at first birth, proportion males at birth and other reproductive parameters were similar to those of wild chimpanzees. In total, 50 chimpanzees from various backgrounds were released on three islands. Individuals were reintroduced in groups and into habitat with natural predators (although these were rare), but with no chimpanzees. Individuals received periodic deworming, and were given antibiotics for severe colds. The study does not distinguish between the effects of the different interventions mentioned above.

A controlled study in 1967-2004 in tropical forest in Kabili-Sepilok Forest Reserve, Malaysia (7) found that rehabilitated and reintroduced orangutans *Pongo pygmaeus morio* that were continuously provided with daily supplementary food alongside eight other interventions, decreased by 33% over 33 years (1964-1997). Infant mortality (57%) was higher than in other wild and captive populations, and the sex ratio at birth was strongly biased towards females (proportion males: 0.11) compared to other wild and captive populations. However, inter-birth-interval (6.1 years) was similar to wild populations of the same subspecies. Mean age at first reproduction (11.6 years) was lower than in other wild and captive populations. Individuals underwent in-depth veterinary checks and were quarantined for 90 days before release into the reserve, where other rehabilitated orangutans lived. Individuals were captured and treated when injured or sick. Staff and volunteers received medical checks and tourists had to keep safety distances (>5 m) at all times. The study does not distinguish between the effects of the different interventions mentioned above.

A controlled study in 2004-2005 in secondary tropical forest in Bukit Tigapuluh National Park, Central Sumatra, Indonesia (8) found that all captive Sumatran orangutans *Pongo abelii* that were regularly provided with food alongside other interventions, survived for at least three months post-reintroduction. Orangutans were supplemented with food during the reintroduction process at the release site. One group was guided into the forest on a daily basis where new food items were offered and their handling was demonstrated. All eight orphaned orangutans with largely unknown histories survived for at least three months post-release after which monitoring ceased. Orangutans underwent quarantine and health checks before being released into habitat to re-establish populations where previously released orangutans already occurred. One group was released after a 6-month acclimatization at a sanctuary. Another group was kept in semi-free conditions for 7-9 months prior to release and allowed overnight in the enclosure. Staff members guided the latter daily into the forest. The study does not distinguish between the effects of the different interventions mentioned above.

A before-and-after trial in 2008 in a coastal forest at Isishlengeni Game Farm, Kwazulu-Natal, South Africa (9) found that 62% of rehabilitated vervet monkeys *Chlorocebus aethiops* that were reintroduced into the wild and whose diets were supplemented with food alongside other interventions, survived for at least six months. Five of 29 introduced individuals (17%) were reported dead. Of these, one died following predation and four were killed by domestic hunting dogs *Canis lupus familiaris*. Six individuals (21%) went missing. No females reproduced. Fresh fruit, vegetables, nuts and seeds were provided daily as supplementary food. Monkeys were introduced as one troop of 29 individuals into habitat with wild resident monkeys and predators. To acclimatize, monkeys spent two nights in a release enclosure (49 m^2) before being released. Medical care was provided when necessary before release and while housed at the nearby rehabilitation centre. The study does not distinguish between the effects of the different interventions mentioned above.

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12.7. Regularly provide supplementary food to primates during resource scarce periods only

- One before-and-after study in the Republic of Congo[1] found that the majority of chimpanzees survived for at least five years after supplementary feeding in resource scarce periods, alongside other interventions.
- One before-and-after study in Kenya[3] found that wild olive baboons survived for at least 17 years after supplementary feeding in drought periods soon after translocation, alongside other interventions.
- One controlled study in Madagascar[2] found that the diet of black-and-white ruffed lemurs was similar to that of wild individuals after supplementary feeding in resource scarce periods, alongside other interventions.

A before-and-after trial in 1994-1999 in tropical forest in Conkouati-Douli National Park, Republic of Congo (1) found that the majority of reintroduced chimpanzees *Pan troglodytes troglodytes* that were supplemented with food during resource-scarce periods along with 16 other interventions, survived for at least five years. Out of 20 reintroduced chimpanzees that were provided with supplementary food, fourteen survived (70%). No statistical tests were carried out to determine whether the population decrease was significant. Individuals were radio-collared and followed at distances of 5-100 m. Rehabilitated orphaned chimpanzees underwent vaccination, treatment for parasites and veterinary screens before being translocated in four subgroups from the sanctuary to the release site with resident wild chimpanzees. Staff members were present to monitor primate health and examine any mortality. The reserve status was upgraded to national park in 1999. Local people were relocated from the release site to a nearby village. Some individuals were treated when sick or injured. TV and radio advertisements were used to raise chimpanzee conservation awareness and local people were provided monetary and non-monetary benefits in exchange for their conservation support. The study does not distinguish between the effects of the different interventions mentioned above.

A controlled study in 2001 in tropical forest in Betampona Reserve, Madagascar (2a) found that captive-bred, reintroduced black-and-white ruffed lemurs *Varecia variegata variegata* that had limited free-ranging experience before release and that were occasionally provided with supplementary food alongside other interventions, had diets that partly overlapped with that of the resident wild group. Reintroduced lemurs (three males and one female) fed on 54 species during a single year, compared to the wild group (ten individuals) that fed on 109 species over four years. Reintroduced lemurs consumed less foliage than the wild group, although no statistical tests were carried out to determine whether this difference was significant. Supplementary food was provided for three months after release and for four months during the wet/cool season during which time their body mass decreased by 300–500g (10–16%). Lemurs were introduced in groups into habitat already occupied by the species. The study does not distinguish between the effects of the different interventions mentioned above.

A controlled study in 1997-2001 in tropical forest in Betampona Reserve, Madagascar (2b) found that diets of captive-bred, reintroduced black-and-white ruffed lemurs *Varecia variegata variegata* that were born and raised in a free-ranging environment and provided with food during resource-scarce periods along with other interventions, overlapped with that of the resident wild group. No statistical tests were carried out to determine whether this overlap was significant. Reintroduced lemurs (three males and two females) fed on 92 species over three years, as compared to the wild group (ten individuals) that fed on 109 species over four years. Reintroduced lemurs consumed less foliage throughout the study and less nectar in 1998 than the wild group, although no statistical tests were carried out to determine whether this difference was significant. Two of five reintroduced individuals (both males) died of malnutrition in 1998. Supplementary food provisioning ceased two months after release, but was reinstated for four months following the death of the two males. Lemurs were introduced in groups into habitat already occupied by the species. The study does not distinguish between the effects of the different interventions mentioned above.

A controlled, before-and-after trial in 1973-2001 in savannah at Chololo ranch, Laikipia Plateau, Kenya (3) found that translocated crop-raiding wild olive baboons *Papio anubis* that were temporarily provided with food during resource scarce periods along with other interventions, survived over 17 years post-translocation. The size of the translocated population consisting of two troops totalling 94 baboons in 1984, decreased to 62 individuals in 2001 but this decrease was not statistically significant and survival rates did not differ between control and study groups. One wild troop at the capture site and another resident troop at the release site served as control groups. Immediately after translocation and in 1986, baboons were provided with cattle feed, once for three weeks and once for 13 weeks during drought. No supplementary feeding was provided after 1986. Both troops were released into habitat with resident baboons and predators. Prior to translocation of these ‘problem’-animals, individuals underwent veterinary screens and some sick baboons were treated. A long-term research study was launched after translocation. The study does not distinguish between the effects of the different interventions mentioned above.

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12.8. Provide supplementary food for a certain period of time only

- Two studies in Gabon[14,16] and the Republic of Congo[14] found that the majority of lowland gorillas survived for at least nine months to four years after provision of supplementary food, alongside other interventions
- One study in Tanzania[1] found that a chimpanzee population increased after supplementary feeding for two months immediately after reintroduction, alongside other interventions. One study found that the majority of introduced chimpanzees survived for at least 27 months following supplementary feeding, alongside other interventions. One study found that a chimpanzee was reunited with its mother after supplementary feeding, alongside other interventions.
- One before-and-after study in Brazil[2] found that a golden lion tamarin population declined after one year following supplementary feeding, alongside other interventions.
- Five studies in Brazil[3], Madagascar[7], and South Africa[10,11] found that a minority of primates survived after supplementary feeding, alongside other interventions.
- Four studies in Gabon[8], South Africa[13] and Vietnam[15] found that a majority of primates survived reintroduction while being supplimentry fed alongside other interventions.
- One study in Brazil[5] found that an abandoned infant muriqui was retrieved by its mother and rejoined the wild group after supplementary feeding, alongside other interventions.

A study in 1966-1985 in Rubondo National Park, a forested island in Lake Victoria, Tanzania (1) found that reintroduced eastern chimpanzees *Pan troglodytes schweinfurthii* that were supplemented with food for two months after the first release along with other interventions, bred and increased in numbers from 17 to at least 20 individuals over a 16-year time period. However, no statistical tests were carried out to determine whether this increase was significant. Only the first out of four release groups received supplementary food. At least two males were shot after attacking game scouts. Two new-born infants were observed in 1968 and in 1985. All of the 17 reintroduced chimpanzees were wild-born and spent various amounts of time in captivity. Their age at the time of release ranged from 4-12 years and their health from good to poor. Chimpanzees were released in four lots in 1966-1969) with considerable time intervals in between release events, and only a few had met before. The island was free of predators. The study does not distinguish between the effects of the different interventions mentioned above.

A before-and-after trial in 1954-1985 in degraded rainforest in Poço das Antas Reserve, Brazil (2) found that a translocated captive-born golden lion tamarin *Leontopithecus rosalia* population that received supplementary food for ten months after release along with nine other interventions, decreased by more than half (57%) within the first year of release. No statistical tests were carried out to determine whether this decrease was significant. Of the 14 individuals released, seven (50%) died and two (14%) were removed. Three infants were born, one of which died due to illness. Eight individuals were released as a family group and six individuals were released as pairs one month later. Tamarins spend an unknown amount of time in 15 x 4.5 x 3 m outside enclosures to acclimatize. They were habituated to humans and fostered to facilitate survival in the wild. The reserve included natural predators. Sick or injured tamarins were captured and treated in a nearby rehabilitation centre. Artificial nesting boxes, which were hollow logs provided to them during training, were also set up in the reserve. The study does not distinguish between the effects of the different interventions mentioned above.

A before-and-after trial in 1984-1991 in coastal forest in Poço das Antas Reserve, Brazil (3) found that the majority of reintroduced golden lion tamarins *Leontopithecus rosalia*, which were supplemented with food along with 14 other interventions, did not survive over a study period of seven years. Fifty-eight out of 91 (64%) reintroduced tamarins did not survive in the wild. However, 57 infants were born (reproductive rate=63%) during the study period, of which 38 (67%) survived. Supplementary feeding platforms were moved further from the tamarins to encourage them to increase their foraging range. Different groups of captive-bred or orphaned tamarins were introduced in different years into habitat with resident tamarins and predators. Some groups were provided with supplementary water and nesting boxes, and allowed to adapt to local habitat conditions before release. Tamarins were quarantined, underwent veterinary checks and parasite treatment before release. Sick or injured animals were recaptured, treated and rereleased. The reserve became officially protected in 1983 and a long-term research study was implemented. The study does not distinguish between the effects of the different interventions mentioned above.

A study in 1994 in a tropical dry forest in the Caratinga Biological Station in Minas Gerais, Brazil (4) found that an abandoned infant muriqui *Brachyteles arachnoides* that was retrieved, supplemented with food and then returned along with other interventions was reunited with its mother and re-joined the wild group. Twenty-seven hours after detection and removal of the infant, it was released in the vicinity of its mother, who retrieved it immediately. In addition to being fed milk and mashed apple, the 4-months old female infant muriqui was also given a blanket for warmth before being released again. Furthermore, some ectoparasites were collected for study. The mother answered to the infant's cries and retrieved it immediately and rejoined the group. The study does not distinguish between the effects of the different interventions mentioned above.

A before-and-after trial in 1997-2002 in primary forest in Betampona Reserve, Madagascar (5) found that less than half of all captive-bred, parent-reared, reintroduced black-and-white ruffed lemurs *Varecia variegata variegata* that were provided with supplementary food for a certain period of time along with ten other interventions, survived for five years. Five of 13 individuals (38.5%) survived in the wild and six individuals were born, of which only four survived. One female and one male of the group reproduced with wild lemurs and the male became fully integrated into the wild group. Supplementary feeding was provided for three months after release, meeting approximately 75% of each animal's daily nutritional requirements. Feeding took place in the forest canopy using suspending feeding baskets and platforms. Released animals were monitored using radio-collars. Captive lemurs had limited semi-free-ranging experience, were quarantined and underwent veterinary screens before reintroduction in groups into habitat with predators and wild resident lemurs. They were recaptured and treated when sick and provided with supplementary water for a certain period of time. They were allowed to adapt to local habitat conditions before release. Dead lemurs were examined. The study does not distinguish between the effects of the different interventions mentioned above.

A study in 2002–2006 in tropical forest in Lékédi Park, Gabon (6) found that one third of captive-bred mandrills *Mandrillus sphinx* that were provided with supplementary food along with other interventions, died within the first year post-release. Twelve out of 36 mandrills (33%) died within one year post-reintroduction, particularly dependent infants. Fertility rate was 42% (five of 12 females gave birth) and two of the five infants survived longer than six months. Mortality decreased to 4% in the second year and fertility rate remained at 42%, but all five infants born survived for over six months. Their range remained limited during the first two years post-release. In 2006, the group numbered 22 individuals, including 12 translocated mandrills, all in good physical condition. Eight weeks after release, food provisioning commenced daily from non-fixed feeding locations for one month and continued twice weekly until September 2005. The amount of food provided varied with physiological requirements and ecological conditions. Mandrills were dewormed, allowed to adapt to local conditions and reintroduced as a group into habitat with resident mandrills and predators. The study does not distinguish between the effects of the different interventions mentioned above.

A before-and-after trial in 2007-2008 in dry forest-grassland mosaic near Richmond, KwaZulu-Natal, South Africa (7) found that a small proportion of vervet monkeys *Chlorocebus aethiops*, which were provided with supplementary food after release along with other interventions, survived for at least 10 months. Out of 35 monkeys released as a first troop, six (17%) survived, 22 (63%) went missing, and seven (20%) individuals died. Two infants were born 10-11 months after release. Of 24 vervets released as a second troop, 12 (50%) survived, seven (29%) went missing and five (21%) died. Both troops were supplemented with food twice a day for 2-3 weeks, after which feeding intensity was decreased until it ceased, after three months. Monkeys underwent veterinary checks and were allowed to adapt to local environmental conditions before their release in groups into habitat with resident vervets. Supplementary water was provided post-release. The study does not distinguish between the effects of the different interventions mentioned above.

A study in 2007-2010 in subtropical forest-shrubland mosaic in Mondi forests, KwaZulu-Natal, South Africa (8) found that only a small portion of the 31 rehabilitated and reintroduced vervet monkeys *Chlorocebus aethiops* that were provided with supplementary food along with other interventions, survived for at least 12 months. Twelve months post-release, ten individuals (32%) had survived and 20 (65%) disappeared. One individual was euthanized three days after release after raiding houses and acting aggressively towards people. Supplementary food was given twice a day for 19 days, subsequently decreasing over eight weeks. The release group included both wild captured (due to injury) (61%) and hand-raised orphaned (39%) monkeys. Monkeys underwent veterinary screens, were held in an enclosure at the release site to adapt to local habitat conditions, and were released as a group. Eleven individuals were fitted with radio-collars. The study does not distinguish between the effects of the different interventions mentioned above.

A before-and-after trial in 2008-2010 in forest-savanna in Haut Niger National Park, Guinea (9) found that the majority of wild-born orphaned western chimpanzees *Pan troglodytes verus* that were supplemented with food for a certain period of time along with other interventions, survived reintroduction and remained free-living over 27 months. One out of 12 released chimpanzees died from anaesthesia during a recovery mission. One female returned to the sanctuary voluntarily and one male was returned after suffering injuries. Two females gave birth and both offspring survived. Another female integrated into a wild chimpanzee community and three chimpanzees moved to a new area. Although nutritionally independent, chimpanzees were initially supplemented with food on a daily-, and later on, a weekly basis to encourage them to remain in the area and to facilitate visual monitoring. All chimpanzees were screened for diseases before their collective release into habitat with wild chimpanzees and predators. Some chimpanzees were allowed to acclimatize to local habitat conditions prior to release. The study does not distinguish between the effects of the different interventions mentioned above.

A before-and-after trial in 2009-2010 in coastal forest in Ntendeka Wilderness Area, Kwazulu-Natal, South Africa (10) found that over half of the reintroduced, captive, wild-born vervet monkeys *Chlorocebus aethiops* that were supplemented with food along with other interventions, survived for at least six months post-release. Three individuals (19%) died, two killed by predators and one by domestic hunting dogs *Canis lupus familiaris*. Four individuals (25%) disappeared. One female gave birth to an infant two weeks after release. Supplementary food was provided from feeding stations twice per day for two weeks daily for a further three weeks. Food resembled the diet provided at the rehabilitation centre. Monkeys were introduced as one troop of 16 individuals into vacant habitat with predators. To acclimatize, monkeys spent one day in a release enclosure (49 m^2). The release site was nationally protected as a wilderness area. The study does not distinguish between the effects of the different interventions mentioned above.

A before-and-after, site comparison study in 1996-2006 in tropical forests of Lesio-Louna Wildlife Reserve, Republic of Congo (Congo) and Batéké Plateau National Park, Gabon (11) found that most reintroduced western lowland gorillas *Gorilla gorilla gorilla* that were provided with food during the release phase along with 14 other interventions, survived for at least four years. Twenty-one (84%) of 25 gorillas released in Congo and 22 (85%) of 26 gorillas released in Gabon survived for at least four years. Nine females produced 11 infants, of which nine survived. In Gabon, gorillas received daily supplementary feeding for

23 months and then for another 16 months post-release. Congo groups received minimal supplementary food. During quarantine, gorillas underwent disease screening and vaccinations. Gorillas were released in groups into habitat with no resident gorillas and allowed to adapt to local environment prior to release. Released gorillas were treated for parasites and when sick. So-called 'problem'-animals were removed and relocated and dead gorillas were examined. Forty-three individuals were rehabilitated wild-born orphaned gorillas and eight gorillas were ex-situ captive-borns. Both sites became protected areas before reintroduction. The study does not distinguish between the effects of the different interventions mentioned above.

A site comparison in 2008-2012 in bamboo thicket-dominated forest at Dao Tien Island (DTI) and mixed forest in Dong Nai Biosphere Reserve (DNBR), South Vietnam (12) found that half of reintroduced pygmy slow lorises *Nycticebus pygmaeus* that were supplemented with food for a certain period of time along with eight other interventions, survived for over two months. Four out of eight lorises survived at least two months after release, whereas others either died or their radio-collar signal was lost. Lorises were kept in a cage for between two days and 2 months and were subsequently supplemented with food for 7-30 days. Lorises were released during the wet season after a 6-week quarantine, veterinary screens and parasite treatment. Both release sites were protected, no wild resident lorises occurred there and predators were present. Bodies of dead animals were investigated to determine the cause of death. The study does not distinguish between the effects of the different interventions mentioned above.

A before-and-after trial in 2008-2010 in a tropical forest-grassland mosaic at Batéké Plateau National Park, Gabon (13) found that the majority of western lowland gorillas *Gorilla gorilla gorilla* that were provided with supplementary food for some time along with ten other interventions, survived for at least nine months. Four (80%) out of five juvenile gorillas survived for at least nine months after release. Depending on their age and ability to feed on forest vegetation, gorillas were either fed milk products developed for human infants, or cereal and milk meals, provided 3 times/day. Three captive-bred and two orphaned wild-born individuals were reintroduced as a group into habitat with predators and without resident wild gorillas after being allowed to adapt to local habitat conditions. They spent the night in an enclosure equipped with nesting platforms, nesting material and water. Gorillas were dewormed regularly. Caretakers guided them into different forest patches on a daily basis. The study does not distinguish between the effects of the different interventions mentioned above.

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12.9. Provide supplementary food to primates through the establishment of prey populations

- We found no evidence for the effects of providing supplementary food to primates through the establishment of prey populations on primate populations.

12.10. Provide additional sleeping platforms/nesting sites for primates

- One before-and-after study in Brazil[1] found that a translocated lion tamarin population declined after artificial nest boxes were provided, alongside other interventions.
- One before-and-after study in Brazil[2] found that a majority of reintroduced golden lion tamarins died seven years after artificial nest boxes were provided, alongside other interventions.
- One before-and-after trial in Gabon[3] found that a majority of juvenile western lowland gorillas survived for at least seven years after nesting platforms were provided, alongside other interventions.

Background

This intervention may be implemented during reintroduction/translocation programmes to provide shelter for primates within enclosures, but also in human-modified landscapes (e.g. forest-farm mosaics) where there may no longer be enough shelter/sleeping sites for primates (e.g. because of the removal of vegetation). For example, all great apes, including chimpanzees *Pan troglodytes*, bonobos *Pan paniscus*, gorillas *Gorilla* spp. and orangutans *Pongo* spp., but also lemurs and lorisoids (Strepsirrhines) build nests. Strepsirrhines build nests for both sleeping and for raising their families. Hominid apes build nests for sleeping at night, and in some species, for sleeping during the day. In intensively human-modified landscapes, the amount of potential nesting sites may no longer be sufficient and so providing additional sleeping platforms/nesting sites could help such species to overcome this resource limitation.

A before-and-after trial in 1954-1985 in degraded rainforest in Poço das Antas Reserve, Brazil (1) found that a translocated captive-born golden lion tamarin *Leontopithecus rosalia* population provided with artificial nestboxes, decreased by more than half (57%) within the first year post-release. No statistical tests were carried out to determine whether this decrease was significant. Of the 14 individuals released, seven died and two were removed. One female died from hypothermia, because her nestbox was occupied by another individual. Three infants were born, one of which died due to illness. Eight individuals were released as a family group and six were released as pairs one month later. Nesting boxes were hollow logs that individuals were accustomed to during training. Tamarins spent an unknown amount of time in 15 x 4.5 x 3 m outside enclosures to acclimatize. They were habituated to humans and fostered to facilitate survival post-release. The reserve harboured natural predators. Sick or injured tamarins were captured and treated. Reintroduced tamarins were supplied with food for ten months after their release. The study does not distinguish between the effects of the different interventions mentioned above.

A before-and-after trial in 1984-1991 in coastal forest in Poço das Antas Reserve, Brazil (2) found that the majority of reintroduced golden lion tamarins *Leontopithecus rosalia* that were provided with a nestbox alongside 14 other interventions, did not survive over a study period of seven years. Fifty-eight (64%) out of 91 reintroduced tamarins did not survive post-release. However, 57 infants were born (reproductive rate=63%) during the study period, of which 38 (67%) survived. Nestboxes were modified plastic picnic coolers and were initially provided to groups during quarantine, and/or in the acclimatization cages and/or post-release. Captive-bred or orphaned tamarins were introduced in different years into habitat with resident tamarins and predators. Groups were provided with supplementary food and water, and allowed to adapt to local habitat conditions before release. Tamarins were quarantined, underwent veterinary checks and were treated for parasites before release. Sick or injured animals were rescued, treated and re-released. The reserve became officially protected in 1983. The study does not distinguish between the effects of the different interventions mentioned above.

A before-and-after trial in 2008-2010 in a tropical forest-grassland mosaic at Batéké Plateau National Park, Gabon (3) found that the majority of reintroduced western lowland gorillas *Gorilla gorilla gorilla* that were provided with nesting platforms along with ten other interventions, survived for at least nine months. Four (80%) out of five juvenile gorillas survived for at least nine months after release. They spent the night in an enclosure equipped with nesting platforms and nesting material (*Aframomum* sp.). Gorillas were supplemented with additional food and water. Three captive-bred and two orphaned wild-born individuals were reintroduced as a group into habitat with predators and without resident gorillas after they were allowed to adapt to local habitat conditions for some time. Gorillas were dewormed regularly. Caretakers guided them into different forest patches on a daily basis. The study does not distinguish between the effects of the different interventions mentioned above.

(1) Dietz L.A. (1985) Captive-born lion tamarins released into the wild: a report from the field. *Primate Conservation*, 6, 21–27.
(2) Beck B.B., Kleiman D.G., Dietz J.M., Castro I., Carvalho C. & Rettberg-Beck B. (1991) Losses and reproduction of reintroduced golden lion tamarins *Leontopithecus rosalia*. *Dodo*, 27, 50–61.
(3) Le FLohic G., Motsch P., DeNys H., Childs S., Courage A. & King T. (2015) Behavioural ecology and group cohesion of juvenile western lowland gorillas (*Gorilla g. gorilla*) during rehabilitation in the Batéké Plateaux National Park, Gabon. *PLoS ONE*, 10, e0119609.

12.11. Provide artificial water sources

- One before-and-after trial in Brazil[1] found that a minority of reintroduced golden lion tamarins survived over seven years when provided with supplementary water, alongside other interventions.
- One before-and-after study in Madagascar[2] found that a minority of reintroduced black-and-white ruffed lemurs survived for five years despite being provided with supplementary water, alongside other interventions.
- A before-and-after study in South Africa[3] found that a minority of vervet monkeys had survived for 10 months when provided with supplementary water, alongside other interventions.
- A before-and-after study in Gabon[4] found that a majority of western lowland gorillas survived for at least nine months while being provided with supplementary water, alongside other interventions.

Background

Most primates drink daily or obtain water from food (Nowak 2008). In the absence of standing water, succulent foods including grasses, ripe fruits, and young leaves substitute for drinking as they can contain over 85% water. However, where habitat is disturbed, monkeys may feed mostly on foods that are rich in fibres and secondary compounds and that have low levels of moisture, forcing them to seek water. Therefore, in human-modified habitats where water or food that is rich in moisture is a limited, or in artificial settings such as temporary enclosures during reintroduction or translocation programmes, providing primates with artificial water sources may help them to survive.

Nowak K. (2008) Frequent water drinking by Zanzibar red colobus (*Procolobus kirkii*) in a mangrove forest refuge. *American Journal of Primatology*, 70, 1081–1092.

A before-and-after trial in 1984-1991 in coastal forest in Poço das Antas Reserve in Brazil, (1) found that the majority of reintroduced golden lion tamarins *Leontopithecus rosalia*, some of which were supplemented with water along with 14 other interventions, did not survive over seven years. Fifty-eight (64%) out of 91 reintroduced tamarins did not survive in the wild. However, 57 infants were born (reproductive rate=63%) during this period, of which 38 (67%) survived. Water was provided in bowls. Captive-bred or orphaned tamarins were introduced in different years into habitat already occupied by the species and predators. Groups were provided with supplementary food and nesting boxes, and allowed to adapt to local habitat conditions before release. Tamarins were quarantined, underwent veterinary checks and were treated for parasites before release. Sick or injured animals were rescued, treated and re-released. The reserve became officially protected in 1983. The study does not distinguish between the effects of the different interventions mentioned above.

A before-and-after study in 1997-2002 in primary forest in Betampona Reserve, Madagascar (2) found that less than half of all captive-bred, parent-reared reintroduced black-and-white ruffed lemurs *Varecia variegata variegata* that were provided with supplementary water for a certain period of time along with ten other interventions, survived over five years. Five (38.5%) of 13 individuals survived in the wild and six individuals were born, of which four survived. One female and one male reproduced with wild lemurs and the male became fully integrated. Artificial water sources were provided together with relatively dry supplementary food that was given for three months. All released animals were fitted with radio-collars for monitoring. Captive lemurs had limited semi-free-ranging experience, were quarantined and underwent veterinary screens before their reintroduction in groups into habitat with predators and wild conspecifics. They were recaptured and treated when sick. They were allowed to adapt to local habitat conditions before release. Dead lemurs were investigated. The study does not distinguish between the effects of the different interventions mentioned above.

A before-and-after trial in 2007-2008 in dry forest-grassland mosaic near Richmond, KwaZulu-Natal, South Africa (3) found that a small number of vervet monkeys *Chlorocebus aethiops* that were provided with supplementary water along with other interventions, survived for at least ten months after reintroduction. Out of 35 monkeys released in troop one, only six (17%) survived ten months post-release. Twenty-two (63%) vervets went missing and seven (20%) died. Two infants were born 10-11 months post-release. Out of 24 vervets released as troop two, 12 (50%) survived, seven (29%) went missing and five (21%) died. The troop that was released 100 m away from the nearest river received a water dish that was subsequently moved closer towards the river. Monkeys underwent veterinary checks and were allowed to adapt to local environmental conditions before their release in groups into habitat already occupied by conspecifics. Supplementary food was provided post-release. The study does not distinguish between the effects of the different interventions mentioned above.

A before-and-after trial in 2008-2010 in a tropical forest-grassland mosaic at Batéké Plateau National Park, Gabon (4) found that the majority of western lowland gorillas *Gorilla gorilla gorilla* that were provided with water in night enclosures alongside ten other interventions, survived for at least nine months. Four out of five (80%) juvenile gorillas survived for at least nine months after release when water was provided daily in their night enclosure. The enclosure was also equipped with nesting platforms, nesting material and supplementary food. Three captive-bred and two orphaned wild born individuals were reintroduced as a group into habitat with predators and without wild gorillas after they were allowed to adapt to local habitat conditions for some time. Gorillas were dewormed regularly on-site. Caretakers guided them into different forest patches on a daily basis. The study does not distinguish between the effects of the different interventions mentioned above.

(1) Beck B.B., Kleiman D.G., Dietz J.M., Castro I., Carvalho C. & Rettberg-Beck B. (1991) Losses and reproduction of reintroduced golden lion tamarins *Leontopithecus rosalia*. *Dodo*, 27, 50–61

(2) Horwich R.H., Koontz F, Saqui E., Saqui H. & Glander K. (1993) A reintroduction program for the conservation of the black howler monkey in Belize. *Endangered Species Update*, 10, 1–6.

(3) Britt A., Welch C., Katz A., Iambana B., Porton I., Junge R., Crawford G., Williams C. & Haring D. (2004) The re-stocking of captive-bred ruffed lemurs (*Varecia variegata variegata*) into the Betampona Reserve, Madagascar: methodology and recommendations. *Biodiversity and Conservation*, 13, 635–657.

(4) Wimberger K., Downs C.T. & Perrin M.R. (2010) Postrelease success of two rehabilitated vervet monkey (*Chlorocebus aethiops*) troops in KwaZulu-Natal, South Africa. *Folia Primatologica*, 81, 96–108.

(5) Le FLohic G., Motsch P., DeNys H., Childs S., Courage A. & King T. (2015) Behavioural ecology and group cohesion of juvenile western lowland gorillas (*Gorilla g. gorilla*) during rehabilitation in the Batéké Plateaux National Park, Gabon. *PLoS ONE*, 10, e0119609.

Species reintroduction

Background

In the context of this primate synopsis, ‘translocation’ refers to the capture, transport and release of wild free-living primates from one habitat to another (i.e. from development sites to natural habitat elsewhere or from abundant population areas to non-inhabited environments, typically in areas where the species used to exist). ‘Reintroductions’, on the other hand, generally refer to the release of captive primates to the wild from holding facilities, which can be laboratories, sanctuaries, islands, or any type of enclosure.

For more information on translocating species/primates/great apes (Hominidae), please refer to the ‘Guidelines for Reintroductions and Other Conservation Translocations’ published by the Reintroduction Specialist Group (RSG) and Invasive Species Specialist Group (ISSG) of the IUCN Species Survival Commission (SSC) (IUCN/SSC 2013), the ‘Re-introduction NEWS: Special Primate Issue’ of the Newsletter published by the IUCN/SSC Re-introduction Specialist Group (Soorae & Baker 2002) and the ‘Best Practice Guidelines for the Re-introduction of Great Apes’ published by the IUCN/SSC Primate Specialist Group (PSG), please refer to Beck *et al*. (2009).

Beck B., Walkup K., Rodrigues M., Unwin S., Travis D. & Stoinski T. (2007) *Best Practice Guidelines for the Re-introduction of Great Apes.* Gland, Switzerland: SSC Primate Specialist Group of the World Conservation Union. 48 pp.

IUCN/SSC (2013). *Guidelines for Reintroductions and Other Conservation Translocations.* Version 1.0. Gland, Switzerland: IUCN Species Survival Commission. 57 pp.

Soorae P.S. & Baker L.R. (2002) *Re-introduction NEWS: Special Primate Issue, Newsletter of the IUCN/SSC Re-introduction Specialist Group, Abu Dhabi, UAE.* No. 21:60 pp. ISSN: 1560-3709.

12.12. Translocate (capture & release) wild primates from development sites to natural habitat elsewhere

- One study in Malaysia[1] found that the majority of orangutans survived following translocation from a development site to natural habitat, alongside other interventions.
- Three before-and-after studies in Tanzania[2], French Guiana[4], and Madagascar[6] found that a majority of primates survived for 5-30 months following translocation from a development site to natural habitat, alongside other interventions. One study in French Guiana[3] found that a minority of primates survived for at least 18 months.
- One before-and-after study in India[5] found that rhesus monkeys remained at the sites where they were released following translocation from a development site to natural habitat, alongside other interventions.

A study in June-September 1993 in fragmented tropical forest in Sabah state, Malaysia (1) found that 78 of 80 (98%) orangutans *Pongo pygmaeus morio* that were translocated from a development site to natural habitat elsewhere along with other interventions, survived capture and subsequent release at Tabin Wildlife Reserve. Four individuals escaped from their temporary holdings before they could be transported to the release site. Of these, three individuals suffered minor injuries and one individual sustained major injury during capture. Individuals were either immobilized in trees or captured manually on the ground with nets. Individuals underwent veterinary screens and sick animals were treated before they were released individually into habitat already occupied by resident orangutans. To avoid stress-related injuries, females were kept in separate (but adjacent) cages from their offspring and adequate space was maintained between occupied cages during temporary holdings and transportation. The study does not distinguish between the effects of the different interventions mentioned above.

A before-and-after trial in 1977-1996 in mixed tropical forest in Masingini Forest Reserve on Unguja Island, Tanzania (2) found that groups of Zanzibar red colobus monkeys *Procolobus kirkii* survived translocation from an unprotected area to protected areas. Twenty-one of 23 translocated monkeys survived the three translocation events in 1977-1978. In 1981, 13 colobus monkeys were translocated into the Zanzibar Forest Reserve. A census in 1994 revealed the presence of 56-64 colobus monkeys, meanings a population increase of 56-78%. However, no statistical tests were carried out to determine whether this increase was significant. Monkeys were caught in nets and by hand while sleeping and were transferred directly to the release site. Surveys were conducted on eight partial days in 1991, 1994, 1995 and 1996. During another translocation of 13 colobus monkeys in 1978 to Kichwele Forest Reserve, two individuals died during the process and no surveys were conducted post-release.

A study in 1994-1995 in a primary forest at Petit Saut dam, French Guiana (3) found that less than half of all red howler monkeys *Alouatta seniculus* that were translocated to natural habitat elsewhere along with other interventions, survived over 18 months. Of the 16 females that were monitored with radio-tags over 18 months, survival rate was 44-63%. Deaths related to translocation included screwworm fly larvae infestations under radio-collars (N=2) and trauma (N=1). Three females (19%) gave birth after release, but infants disappeared and probably died. All females studied for longer than three months (50%) settled within the release area. Of the 122 captured and translocated howlers from 28 different troops, ten out of 11 (91%) documented troops broke apart after release. Monkey groups were captured manually or with nets several months after the beginning of the flooding of the hydroelectric dam. All animals underwent veterinary screens before release in groups into habitat already occupied by the species. They were allowed to adapt to local habitat conditions before release. The study does not distinguish between the effects of the different interventions mentioned above.

A before-and-after trial in 1994-1995 in tropical forest near Petit-Saut dam, French Guiana (4) found that most white-faced sakis *Pithecia pithecia* that were translocated from a development area to natural habitat nearby along with other interventions, survived for at least four months. Two out of three translocated sakis survived for at least four months after release; one individual died after circa 22 weeks. Sakis were captured during the flooding of their original habitat by nets. Three out of six translocated wild sakis where monitored over 41 weeks after their release, which took place one day after capture. The translocated sakis integrated with resident individuals. Monkeys were tagged with radio-transmitters and underwent veterinary screens prior to release as single individuals or as a group into a habitat already occupied by the species. Dead sakis were investigated to determine the cause of death. The study does not distinguish between the effects of the different interventions mentioned above.

A replicated, before-and-after-trial in 1995-2001 in temple orchards in Vrindaban, Mathura District, India (5) found that rhesus monkeys *Macaca mulatta* translocated to nearby semi-natural, fragmented forest habitat along with other interventions, remained at their release sites for at least four years. A post-translocation study in 2001 confirmed that all of the 600 monkeys captured from 12 troops (45% of the total population) and translocated to eight different forest patches, had settled down, were healthy, showed no signs of stress, and behaved normally. The activity of one of the translocated groups (150 individuals) during the first three months post-release was similar to that of wild groups in northern India. No quantitative results were provided. Release sites were administrated by Social Forestry, and were selected based on the availability of food, water, shelter, and attitude of the local people. Captured monkeys, regarded as so-called 'problem animals' by local residents, were relocated to non-residential areas, where they were reintroduced in groups into habitat without resident rhesus monkeys. The study does not distinguish between the effects of the different interventions mentioned above.

A before-and-after trial in 2006-2007 in rainforest in Analamazaotra Special Reserve, Madagascar (6) found that black-and-white ruffed lemurs (BWRL) *Varecia variegata variegata* and diademed sifakas *Propithecus diadema* survived for at least 30 months and reproduced after translocation from disturbed sites to undisturbed habitat along with other interventions. No mortalities were recorded for BWRL over a 30-month period and only one diademed sifaka died from natural causes. Two sets of BWRL twins (reproductive rate=57%) and seven diademed sifaka infants were born (reproductive rate=26%), the latter of which two survived. Seven BWRL and 27 diademed sifakas were captured at four disturbed forest sites and released in their social units to the reserve where the species had locally gone extinct and that included natural predators. Released primates were habituated to human presence and monitored with radio-collars. Two to eight months before the translocation was carried out, lemurs were darted and underwent veterinary checks. The study does not distinguish between the effects of the different interventions mentioned above.

(1) Andau, P.M., Hiong L.K. & Sale J.B. (1994) Translocation of pocketed orang-utans in Sabah. *Oryx*, 28, 263–268.
(2) Struhsaker T.T. & Siex S. (1998) Translocation and introduction of the Zanzibar red colobus monkey: success and failure with an endangered island endemic. *Oryx*, 32, 277–284.
(3) Richard-Hansen C., Vié J.C. & de Thoisy B. (2000) Translocation of red howler monkeys *Alouatta seniculus* in French Guiana. *Biological Conservation*, 93, 247–253.
(4) Vié J.-C., Richard-Hansen C. & Fournier-Chambrillon C. (2001) Abundance, use of space and activity patterns of white-faced sakis (*Pithecia pithecia*) in French Guiana. *American Journal of Primatology*, 55, 203–221.
(5) Imam E., Yahya H.S.A. & Malik I. (2002) A successful mass translocation of commensal rhesus monkeys *Macaca mulatta* in Vrindaban, India. *Oryx*, 36, 87–93.
(6) Day S.R., Ramarokoto R.E.A.F., Sitzmann B.D., Randriamboahanginjatovo R., Ramanankirija H., Randrianindrina V.R.A., Ravololonarivo G. & Louis E.E.J. (2009) Re-introduction of diademed sifaka (*Propithecus diadema*) and black and white ruffed lemurs (*Varecia variegate editorum*) at Analamazaotra Special Reserve, eastern Madagascar. *Lemur News*, 14, 32–37.

12.13. Translocate (capture & release) wild primates from abundant population areas to non-inhabited environments

- A replicated study in Belize[1] found that the majority of black howler monkeys survived for at least 10 months after translocation from abundant population areas to an uninhabited site, along with other interventions.

A replicated study in 1992–1993 in tropical forest at Cockscomb Basin Wildlife Sanctuary (CWSB), Belize (1) found that the majority of wild black howler monkeys *Alouatta pigra* captured and translocated to a site with no resident howlers along with other interventions, survived for at least ten months and reproduced. Twelve (86%) out of 14 reintroduced monkeys survived for at least ten months after release. One male and one juvenile disappeared two months post-release. Two infants were born in two of the three release groups, 3-8 months post-release. Howlers were captured at the Community Baboon

Sanctuary (CBS), 100 km north of the CWSB. Tree species diversity overlapped by 60% between both locations. Prior to release, monkeys underwent veterinary screens. Three groups were released into habitat without resident howlers. They were allowed to adapt to local conditions before release. Six individuals were fitted with ball-chain radio-collars and six were implanted with radio-transmitters, but signals got lost six weeks post-release. The study does not distinguish between the effects of the different interventions mentioned above.

(1) Horwich R.H., Koontz F, Saqui E., Saqui H. & Glander K. (1993) A reintroduction program for the conservation of the black howler monkey in Belize. *Endangered Species Update*, 10, 1–6.

12.14. Allow primates to adapt to local habitat conditions for some time before introduction to the wild

- Two studies in Brazil[1] and Thailand[3] found that reintroduced primate populations were smaller after 12-17 months and one study in Belize[6] found primate populations increased five years after allowing individuals to adapt to local habitat conditions before introduction into the wild, alongside other interventions. One study found that a reintroduced population of black howler monkeys had a birth rate of 20% after they were allowed to adapt to local habitat conditions before introduction into the wild, along with other interventions.
- Seven studies in Brazil[2], Madagascar[14], Malaysia[4], French Guiana[9,12], South Africa[18,19] found that a minority of primates survived for at least 15 weeks to 12 years after allowing them to adapt to local habitat conditions before introduction into the wild, along with other interventions. Four studies in Belize[5,6], Brazil[10], Gabon[16], South Africa[22] found that the majority of primates survived for at least four to 12 months. One study in Vietnam found that half of reintroduced pygmy slow lorises survived for at least two months.
- Two before-and-after studies in Gabon[21,25] and the Republic of Congo[21] found that a majority of western lowland gorillas survived for nine months to four years after allowing them to adapt to local habitat conditions before introduction into the wild, along with other interventions.
- Three studies in Liberia[8] and the Congo[11,13] found that a majority of chimpanzees survived for at least three to five years after allowing them to adapt to local habitat conditions before introduction into the wild, along with other interventions. One before-and-after study in Uganda found that a chimpanzee repeatedly returned to human settlements after allowing it to adapt to local habitat conditions before introduction into the wild, along with other interventions.
- A study in Indonesia[17] found that Sumatran orangutans that were allowed to adapt to local habitat conditions before introduction performed less well than individuals that were directly released into the forest, alongside other interventions.
- One controlled study in Indonesia[15] found that after being allowed to adapt to local habitat conditions a pair of introduced Bornean agile gibbons had a similar diet to wild gibbons.

Background

This intervention aims to increase the animals' chance of survival once they have been released, by holding them in enclosures at or near the reintroduction site prior to release to assist them in adjusting to their new environment. This is sometimes referred to as 'soft release'. Post-release support, such as supplementary feeding, is usually provided during this type of release. In contrast, when an animal undergoes 'hard release', it is immediately released at the reintroduction site, and generally there is no post-release support (Soorae & Baker 2002).

Soorae P.S. & Baker L.R. (2002) *Re-introduction NEWS: Special Primate Issue, Newsletter of the IUCN/SSC Re-introduction Specialist Group, Abu Dhabi, UAE.* No. 21:60 pp. ISSN: 1560-3709.

A before-and-after trial in 1954-1985 in degraded rainforest in Poço das Antas Reserve, Brazil (1) found that a translocated captive-born golden lion tamarin *Leontopithecus rosalia* population that was allowed to acclimatize to the local environment before release along with nine other interventions, decreased by more than half (57%) within the first year of release. No statistical tests were carried out to determine whether this decrease was significant. Of the 14 individuals released, seven died and two were removed. Three infants were born, one of which died. Eight individuals were released as a family group and six were released as pairs one month later. Individuals spend an unknown amount of time in 15 x 4.5 x 3 m outside forest enclosures before release. They were habituated to humans and fostered to facilitate survival in the wild. The reserve included natural predators. Sick or injured tamarins were captured and treated. Reintroduced tamarins were supplied with food for ten months post-release. Artificial nesting boxes, which were hollow logs provided to them during training, were set up in the reserve. The study does not distinguish between the effects of the different interventions mentioned above.

A before-and-after trial in 1984-1991 in coastal forest in Poço das Antas Reserve, Brazil (2) found that the majority of reintroduced golden lion tamarins *Leontopithecus rosalia*, some of which were allowed to adapt to local habitat conditions before release along with 14 other interventions, did not survive over seven years. Fifty-eight (64%) out of 91 reintroduced tamarins did not survive in the wild. However, 57 infants were born (reproductive rate=63%) during the study period, of which 38 (67%) survived. Tamarin groups (families or pairs) were kept in large forest acclimatization cages at the release sites. Different groups of captive-bred or orphaned tamarins were introduced in different years into habitat already occupied by the species and predators. Groups were provided with supplementary food, water and nesting boxes. Tamarins were quarantined, underwent veterinary checks and were treated for parasites before release. Sick or injured animals were rescued, treated and re-released. The reserve became officially protected in 1983. The study does not distinguish between the effects of the different interventions mentioned above.

A study, which was included in a review, in 1976-1977 in tropical forest in Sai Yok National Park, Thailand (3) on captive lar gibbons *Hylobates lar* that were allowed to adapt to local conditions before they were released along with other interventions found that their population decreased by 6% and no infants were born in the first 17 months post-release. No statistical tests were carried out to determine whether this decrease was significant. Four gibbons joined wild groups. Anaesthetized gibbons were either kept in separate cages from which they could hear, but not see each other for 14 days before release, or laid out on the forest floor. Thirty-one gibbons were introduced as individuals, pairs, or family groups and into habitat with resident wild gibbons. Injured animals were recaptured and treated. In 1961, gibbons became officially protected in Thailand. Reserve staff was permanently present. The study does not distinguish between the effects of the different interventions mentioned above.

A before-and-after trial in 1976-1988 in degraded tropical forest in Semenggoh Forest Reserve, Malaysia (4) found that at least 77 of 87 (90%) reintroduced captive, wild-born Müller's Bornean gibbons *Hylobates muelleri* that were allowed to adapt to local habitat conditions for some time before reintroduction along with other interventions, did not survive after release. Confiscated gibbons had undergone veterinary checks and were placed in holding cages in a forest clearing for an unknown amount of time. Some individuals were released within days of being received at the sanctuary. When possible, males and females were paired in cages prior to release into habitat without resident wild gibbons. The species was fully protected in Sarawak. Surveys of direct sightings and gibbon calls along grid squares (500 x 500 m) covering a total of 9.5 km were conducted simultaneously by three or four observers on non-rainy days on eight mornings in February-March 1988. The study does not distinguish between the effects of the different interventions mentioned above.

A replicated study in 1992–1993 in tropical forest at Cockscomb Basin Wildlife Sanctuary (CBWS), Belize (5) found that the majority of reintroduced black howler monkeys *Alouatta pigra* that were allowed to adapt to local habitat conditions prior to release along with other interventions, survived for at least ten months and reproduced. Twelve (86%) out of 14 reintroduced monkeys survived for at least ten months post-release. One male and juvenile disappeared two months post-release. Two infants were born in two of the three release groups, 3-8 months post-release. Howlers were kept in an 8 x 12 x 10 m enclosure for two days to acclimatize. Wild howlers were captured at Community Baboon Sanctuary and were translocated to CBWS. Prior to release, monkeys underwent veterinary screens. Three groups were released into habitat without resident howlers. Six individuals were fitted with ball-chain radio-collars and six were implanted with radio-transmitters, but transmitter signals got lost six weeks post-release. The study does not distinguish between the effects of the different interventions mentioned above.

A before-and-after trial in 1992-1994 in tropical forest in Cockscomb Basin Wildlife Sanctuary in Belize (6) found that a reintroduced population of black howler monkeys *Alouatta pigra* that was allowed to adapt to local habitat conditions before release into the wild along with other interventions, increased in size over time. By 1997, the population had increased by 61% (62 to > 100 individuals). No statistical tests were carried out to determine whether this increase was significant. One-month-, 6-month-, 1-year, and 2-year survival rates for the different cohorts released in the dry seasons of 1992-1994, were 81-100%. Birth rate was 20% (N=12) and infant survival rate was 75% (N=9). Entire social groups were reintroduced at once, and ten of the 14 groups were held in cages for 1-3 days before release with a distance of 700-1000 m to the neighbouring troop. All individuals underwent veterinary screens, were permanently marked, and adults were radio-collared. Hunting was largely controlled and the local community was educated about black howler conservation. The study does not distinguish between the effects of the different interventions mentioned above.

A before-and-after-trial in 1995 in tropical forest in Kibale National Park, Uganda (7) found that a female captive, 4-6 year old wild-born chimpanzee *Pan troglodytes schweinfurthii* that was allowed to adapt to local habitat conditions for three weeks before reintroduction into a human-habituated community of wild chimpanzees along with other interventions, repeatedly returned to human settlements and was subsequently returned to captivity. Eight days post-release, she left the forest for the first time and was taken back into the forest. For the following ten days, she travelled, fed, nested and engaged in social activities with the wild community. She increased ranging distance to humans and use of height, and visually monitored humans less regularly. However, she increasingly spent time alone and was returned to captivity six weeks after post-release. Three weeks before her introduction, caretakers recorded her activity, height off the ground, distance from nearest human and diet. She underwent pre-release training, a tuberculosis test and was quarantined before reintroduction into habitat with a resident wild chimpanzee community. Ten members of the local human community worked on the project. The study does not distinguish between the effects of the different interventions mentioned above.

A study in 1987-1988 on an island in tropical moist forest in Liberia (8) found that the majority of reintroduced western chimpanzees *Pan troglodytes verus* that were allowed to adapt to the local environment before being released along with other interventions, survived for at least one year. Seven out of 30 released chimpanzees had difficulties to adjust to the new social environment and were brought back to captivity. On site, chimpanzees were allowed to adapt to the local habitat in enclosures for some time; younger and low-ranking individuals were released earlier to reduce stress. Chimpanzees were screened for diseases before release in groups and socialized in naturalistic enclosures where they were taught behaviour to facilitate their survival in the wild. Released chimpanzees were continuously provided with food. Sick and injured animals were temporarily removed and treated. The study does not distinguish between the effects of the different interventions mentioned above.

A study in 1994-1995 in primary forest at Petit Saut dam, French Guiana (9) found that less than half of the translocated and monitored red howler monkeys *Alouatta seniculus* that were allowed to adapt to local habitat conditions for some time before their release along with other interventions, survived over 18 monthspost-release. Of the 16 females monitored for 18 months with radio-tags, seven females survived, with an estimated survival rate of 44-63%. Deaths related to the translocation process included screwworm fly larvae infestations under radio-collars (N=2) and trauma (N=1). Three (19%) females gave birth post-release, but all infants disappeared and probably died. All females studied for longer than three months (50%) settled within the release area. Of the 122 captured and translocated howlers from 28 different troops, ten out of 11 (91%) documented troops broke apart after release. Howlers spent up to 24 hours together in one of three forest enclosures, 3 km from the release site. All animals underwent veterinary screens before release and were reintroduced in groups into habitat already occupied by the species. The study does not distinguish between the effects of the different interventions mentioned above.

A study in 1999 in tropical forest of Morro do Diabo State Park, São Paulo, Brazil (10) found that only some of the individuals in a group of reintroduced wild and captive-bred black lion tamarins *Leontopithecus chrysopygus*, that were allowed to adapt to the local habitat before their release along with other interventions, survived over four months. Four months after release of three individuals, one tamarin died. The group was held for three weeks in an enclosure to adapt to the local environment where predators occurred. The released group consisted of two wild females and one captive-born male bred in a free-ranging environment where he had been fostered natural behaviour to facilitate reintroduction. The male was treated when sick. Tamarins underwent veterinary screens prior to transport to the release site. Monkeys were fitted with radio-transmitters and supplemented with food until the end of the study. The study does not distinguish between the effects of the different interventions mentioned above.

A before-and-after trial in 1996-1999 in tropical rainforest in Conkouati Reserve, Republic of Congo (11) found that 14 of 20 reintroduced wild-born orphaned chimpanzees *Pan troglodytes troglodytes* that were allowed to acclimatize to the local environment before their release along with other interventions, survived over three and a half years. Estimated mortality was 10-30%. None of the adult females reproduced. Chimpanzees fed on 137 different plant species, a variety similar to wild chimpanzees, and had activity budgets that resembled those of wild chimpanzees. No statistical tests were carried out to determine whether differences were statistically insignificant. Before reintroduction in groups into habitat with low densities of wild chimpanzees, individuals spent 6-9 years on one of three forested islands in the region to acclimatize. Chimpanzees underwent veterinary screens, were treated for endoparasites, and vaccinated for poliomyelitis and tetanus. Orphan chimpanzees were rehabilitated and fostered at a nearby sanctuary. Researchers were permanently on-site and monitored chimpanzees with radio-collars. The study does not distinguish between the effects of the different interventions mentioned above.

A before-and-after trial in 1998-1999 in tropical forest on an island in French Guiana (12) found that a small number of reintroduced squirrel monkeys *Saimiri sciureus* that were allowed to adapt to local habitat conditions prior to release along with other interventions, survived over 15 weeks after reintroduction. Six (43%) out of 14 released monkeys survived for at least 15 weeks. Two individuals died in release cages, and one was apparently killed by resident wild squirrel monkey. One month post-release, five monkeys (36%) were rescued and brought back to captivity. The remaining reintroduced six monkeys were all wild-born. Animals were kept as one group in an isolated cage for three months where two females gave birth. After transfer to the release site, they were held in an enclosure 6 x 4 x 4 m in size for four months to adapt to local habitat conditions. The release site was already occupied by resident conspecifics. The study does not distinguish between the effects of the different interventions mentioned above.

A before-and-after trial in 1996-2001 in tropical lowland forest in Conkouati-Douli National Park, Republic of Congo (13) found that the majority of wild-born orphan chimpanzees *Pan troglodytes troglodytes* that were allowed to adapt to local habitat conditions for some time before reintroduction, along with other interventions, survived for over five years. Twenty-six of 36 released animals survived over five years and only three died. Seven chimpanzees disappeared, resulting in an estimated survival of 72-92%. An infant was born after five years.. Chimpanzees were rehabilitated on islands where they were provided with food before their reintroduction to the mainland. After release, individuals were radio-collared and followed to record female cycling status, interactions with wild chimpanzees and sexual behaviour. Analysis of hair-extracted DNA of all released chimpanzees and infants was used to determine parentage. Chimpanzees were released into a forest where wild chimpanzees and predators were known to exist. Injured chimpanzees were treated. The study does not distinguish between the effects of the different interventions mentioned above.

A before-and-after trial in 1997-2002 in primary forest in Betampona Reserve, Madagascar (14) found that less than half of all captive-bred, parent-reared, reintroduced black-and-white ruffed lemurs *Varecia variegata variegata* that were allowed to adapt to local habitat conditions before release along with ten other interventions, survived over five years. Five (38.5%) of 13 individuals survived in the wild and six individuals were born, of which four survived. One female and one male reproduced with wild lemurs and the male became fully integrated into the wild group. Lemurs were held in a timber and chain-link wire mesh cage at the release site for 3-14 days before release. Released animals were fitted with radio- collars for monitoring. Captive lemurs had limited semi-free-ranging experience, were quarantined and underwent veterinary screens before their reintroduction in groups into habitat with predators and resident wild lemurs. They were recaptured and treated when sick and provided with supplementary food and water for a certain period of time. Dead lemurs were examined to determine the cause of death. The study does not distinguish between the effects of the different interventions mentioned above.

A controlled study in 2002-2003 in swamp forest in Mintin Island, Borneo, Indonesia (15) found that a wild-born, captive-raised Bornean agile gibbon *Hylobates albibarbis* pair that was allowed to adapt to local habitat conditions before reintroduction along with other interventions, shared a similar diet, spent similar amounts of time feeding, resting, and arm-swinging and at similar canopy heights as wild gibbons. However, the latter spent more time singing and socializing and travelling, probably because the reintroduced gibbon pair split up almost immediately after their release. The two gibbons were quarantined for at least 12 months before reintroduction and underwent veterinary screens. They were kept in enclosures (3 x 3 x 3 m) to socialize and acclimatize and during this time, were supplemented with vitamins and leaves once a week. They were introduced as a pair and into habitat with resident wild gibbons. The behaviour of the reintroduced gibbon pair was compared to a pair of wild gibbons at another site. The study does not distinguish between the effects of the different interventions mentioned above.

A study in 2002–2006 in tropical forest in Lékédi Park, Gabon (16) found that one third of captive-bred mandrills *Mandrillus sphinx* that were allowed to adapt to local habitat conditions for some time before their reintroduction into the wild along with other interventions, died within the first year after release. During this year, mortality was 33% (12 out of 36 individuals), mostly affecting dependent infants. Fertility rate was 42% (5 of 12 females), where two of the five infants survived over six months. Mortality decreased to 4% in the second year and fertility rate remained at 42%, but all five infants survived for at least six months. Their range remained limited during the first two years after release. In 2006, the group numbered 22 individuals, including 12 of the mandrills originally released, all in good physical condition. To acclimatize, mandrills were placed in a small holding enclosure of 0.5 ha for 2-4 weeks before release. They were reintroduced as a group into habitat already occupied by the species and with predators. They were treated for endoparasites before release and supplemented with food until 2005. The study does not distinguish between the effects of the different interventions mentioned above.

A controlled study in 2004-2005 in a mosaic of logged and secondary tropical forest in Bukit Tigapuluh National Park, Sumatra, Indonesia (17) found that reintroduced Sumatran orangutans *Pongo abelii* that were directly released into the forest along with other interventions, performed better after release than individuals that were allowed to adapt to local habitat conditions for some time at the release site. The behaviour of the three orangutans that were released directly into the new habitat resembled that of wild conspecifics more than that of the five individuals that were allowed to adapt for 7-9 months prior to release to local habitat conditions to adjust and learn how to built nests, select food and use the canopy. In addition to the adaptation period on-site, the latter group was guided daily into the forest by rangers trying to foster natural behaviour. The group directly released into the forest spent more time interacting socially with previously released orangutans. The group directly released into the forest spent more time interacting socially with previously-released orangutans. The orangutans in this group were housed at a sanctuary for 6-month before release. The study does not distinguish between the effects of the different interventions mentioned above.

A before-and-after trial in 2007-2008 in dry forest-grassland mosaic near Richmond, South Africa (18) found that a small number of vervet monkeys *Chlorocebus aethiops* that were allowed to adapt to local habitat conditions along with other interventions, survived for at least ten months after reintroduction. Out of 35 monkeys released in troop one, only six (17%) survived for ten months post-release, after which monitoring ceased. Twenty-two (63%) vervets went missing and seven (20%) died. However, two infants were born 10-11 months after release. Out of 24 vervets released as troop two, 12 (50%) survived, seven (29%) went missing and five (21%) died. Monkeys underwent veterinary checks, and were released in groups into habitat already occupied by the species. They also received supplementary food and water after their release. The study does not distinguish between the effects of the different interventions mentioned above.

A study in 2007-2010 in subtropical forest-shrubland mosaic in Mondi Forestry, South Africa (19) found that a small number of the 31 rehabilitated and reintroduced vervet monkeys *Chlorocebus aethiops* that were allowed to adapt to the release site in enclosures along with other interventions, survived for at least 12 months. After 12 months of post-release monitoring, ten (32%) individuals had survived and 20 (65%) could not be tracked. One (3%) individual was euthanized three days post-release after raiding houses and acting aggressively towards people. Vervets were held in a 55 m^2 and 2 m-high enclosure at the release site for four days before release. The release group included both wild captured- (61%) (due to injury) and hand-raised orphaned (39%) monkeys. Monkeys underwent veterinary screens, were released as a group and supplemented with food for eight weeks. Eleven individuals were fitted with radio collars that worked circa nine months after release. The study does not distinguish between the effects of the different interventions mentioned above.

A before-and-after trial in 2008-2010 in forest-savanna mosaic in Mafou forest, Haut Niger National Park, Guinea (20) found that the majority of wild-born orphaned western chimpanzees *Pan troglodytes verus*, some of which were allowed to acclimatize to local habitat conditions prior to release along with other interventions, survived reintroduction and remained free-living for at least 27 months. Only one of 12 released chimpanzees died after anaesthesia during a recovery mission. One female returned to the sanctuary voluntarily and one male was returned after suffering injuries. Five chimpanzees remained together at the release site and two females gave birth to an infant, both of which survived. Another female immigrated and integrated into a wild chimpanzee community and three chimpanzees moved to an area away from the release site. Five adult males were held in an enclosure (1.5 ha) with an annex cage (25 m^2) for 1-4 months prior to release. All chimpanzees were screened for diseases before their collective release into habitat with wild chimpanzees and predators. Chimpanzees were initially supplemented with food on a daily-, and later on, a weekly basis. The study does not distinguish between the effects of the different interventions mentioned above.

A before-and-after, site comparison study in 1996-2006 in tropical forests of Lesio-Louna Wildlife Reserve, Republic of Congo (Congo) and Batéké Plateau National Park, Gabon (21) found that the majority of reintroduced western lowland gorillas *Gorilla gorilla gorilla* that were allowed to adapt to local environment before release along with 14 other interventions, survived at least four years. Twenty-one (84%) of 25 gorillas released in Congo and 22 (85%) of 26 gorillas released in Gabon survived over four years. Nine females gave birth to 11 infants, of which nine (82%) survived. In Gabon, gorillas were accompanied daily to the forest and spent the night in enclosures for an average of 15 months. In Congo, groups were either walked to the release site or brought there by vehicles and familiar staff. During quarantine, gorillas underwent disease screening and vaccinations. They were supplemented with food before release and released in groups into habitat with no resident wild gorillas. Released gorillas were treated for parasites and when sick. So-called 'problem'-animals were removed and relocated and bodies of dead gorillas were examined. Forty-three individuals were rehabilitated wild-born orphaned gorillas and eight gorillas were ex-situ captive-born individuals. Both sites became protected areas before reintroduction procedures. The study does not distinguish between the effects of the different interventions mentioned above.

A before-and-after trial in January-July 2008 in a coastal forest at Isishlengeni Game Farm, South Africa (22) found that 62% of rehabilitated vervet monkeys *Chlorocebus aethiops* that were allowed to acclimatize to the new environment before being reintroduced into the wild along with other interventions, survived for at least six months. Five (17%) of 29 introduced individuals were reported dead. Of these, one was predated and four were killed by domestic hunting dogs *Canis lupus familiaris*. Six individuals (21%) went missing. No females reproduced. To acclimatize, monkeys spent two nights in a release enclosure, 49 m^2 in size, 2 m in height, with a 60% shade cloth roof and natural enrichment and roosting places, before being released. Monkeys were introduced as one troop of 29 individuals into habitat already occupied by the species and with predators. Monkeys were provided daily supplementary food. Medical care was provided when necessary before release and while housed at the nearby rehabilitation centre. The study does not distinguish between the effects of the different interventions mentioned above.

A site comparison in 2008-2012 in bamboo thicket-dominated forest at Dao Tien Island (DTI) and mixed forest in Dong Nai Biosphere Reserve (DNBR), Vietnam (23) found that several reintroduced pygmy slow lorises *Nycticebus pygmaeus* that were allowed to acclimatize to local the environment before release along with eight other interventions, survived over two months. Four out of eight lorises survived for at least two months after release, whereas the remaining lorises either died or their radio-collar signal was lost soon after release. Lorises were kept in an in situ cage for <2 months and for two days, and were subsequently supplemented with food for 7-30 days in DTI and DNBR, respectively. Lorises were released during the wet season after a 6-week quarantine, veterinary screens and treatment for parasites. Both release sites were officially protected, no resident lorises occurred there, but predators were present. Bodies of dead lorises were examined. The study does not distinguish between the effects of the different interventions mentioned above.

A before-and-after trial in 2006-2011 in tropical forest at Gunung Halimun Salak National Park and Batutegi Nature Reserve, Indonesia (24) found that using a large habituation cage increased the probability of survival of translocated Javan slow lorises *Nycticebus javanicus*, but not of greater slow lorises *Nycticebus coucang*. The size of the cage influenced survival success, with longer survival for individuals that had access to larger habituation cages. Cage size was differentiated into 'small' and 'large' cages, where the latter consisted of 50 m perimeter open-top enclosures that were situated at the release site. Time allowed to acclimatize varied from four to 123 days and had no effect on survival.

A before-and-after trial in 2008-2010 in a tropical forest-grassland mosaic at Batéké Plateau National Park, Gabon (25) found that the majority of reintroduced western lowland gorillas *Gorilla gorilla gorilla* that were allowed to adapt to local environmental conditions at the release site along with ten other interventions, survived for at least nine months. Four (80%) out of five juvenile gorillas survived for at least nine months after release when they spent the nights in a 4 x 4 x 3 m^3 wooden cage on-site. The enclosure was equipped with nesting platforms, nesting material, supplementary food and water. Gorillas were dewormed regularly on-site. Three captive-bred and two orphaned wild born individuals were reintroduced as a group into habitat with predators and without resident wild gorillas. Caretakers guided them into different forest patches on a daily basis. The study does not distinguish between the effects of the different interventions mentioned above.

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12.15. Reintroduce primates in groups

- Two studies in Brazil[2] and Thailand[4] found that populations of introduced primates declined after reintroduction in groups, alongside other interventions, while one study in Belize[7] recorded an increase in populations. Two studies in Madagascar[1] and India[14] found that primate populations persisted 4-55 years after reintroduction in groups, alongside other interventions.
- Seven studies in Brazil[3], French Guiana[9,15], Madagascar[17], and South Africa[22,23] found that a minority of primates survived for at least 15 weeks to seven years after reintroduction in groups, alongside other interventions. Seven studies in Belize[5],Brazil[6,10], French Guiana[13], Madagascar[20], and South Africa[25,27] found that a majority of primates survived after between two and thirty months.
- One study in Madagascar[16] found that introduced black-and-white ruffed lemurs *Varecia variegata* had similar diets to individuals in a wild population after reintroduction in groups, alongside other interventions.
- One study in The Gambia[18] found that a population of introduced chimpanzees increased 25 years after reintroduction in groups, alongside other interventions. Four studies in Guinea[24], Liberia[8] and the Republic of Congo[11,12] found that the majority of chimpanzees survived for at least two to five years, after reintroduction in groups, alongside other interventions.
- Two before-and-after studies in Gabon[26,28] and the Republic of Congo[26] found that the majority of western gorillas survived for at least nine months to four years, after reintroduction in groups, alongside other interventions.
- One controlled study in Indonesia[21] found that all Sumatran orangutans survived for at least three months after reintroduction in groups, alongside other interventions.

Background

For the purpose of the primate synopsis, the scientific evidence for reintroductions is separated into six different interventions, which refer to slightly different methodological approaches (see sections 12.15-12.20):

1) ‘Reintroduce primates in groups’

2) ‘Reintroduce primates as single/multiple individuals’

3) ‘Reintroduce primates into habitat where the species is absent’

4) 'Reintroduce primates into habitat where the species is present'

5) 'Reintroduce primates into habitat without predators'

6) 'Reintroduce primates into habitat with predators'

A study in 1967-1985 in a coastal rainforest on Nosy Mangabe island in Madagascar (1) found that populations of aye-ayes *Daubentonia madagascariensis*, white-fronted lemurs *Eulemur albifrons* and black-and-white ruffed lemurs *Varecia variegata variegata* that were reintroduced as groups, had persisted at least 18 years (aye-ayes) and 55 years (white-fronted lemurs, black-and-white ruffed lemurs) post-release. One aye-aye was sighted in 1975, two in 1981, a mother and her infant in 1983 and another two individuals in 1984. At least four groups of white-fronted lemurs and eight groups of black-and-white ruffed lemurs appeared live on the island in 1984. A group of nine (four females and five males) aye-ayes caught in different locations were released on the island in 1967. It is unclear whether wild aye-ayes occurred on the island before reintroduction. An unknown number of white-fronted lemurs and black-and-white ruffed lemurs were released on the island in the 1930s. No systematic surveys were conducted on the island.

A before-and-after trial in 1954-1985 in degraded rainforest in Poço das Antas Reserve, Brazil (2) found that translocated captive-born golden lion tamarin *Leontopithecus rosalia*, some of which were released in groups along with nine other interventions, decreased in numbers by more than half (57%) within the first year post-release. No statistical tests were carried out to determine whether this decrease was significant. Of the 14 individuals released, seven died (50%) and two were removed. Three infants were born, one of which died. Eight individuals were released as a family group and six individuals were released as pairs one month later. Tamarins spent an unknown amount of time in 15 x 4.5 x 3 m outside enclosures to acclimatize. They were habituated to humans and fostered to facilitate survival in the wild. The reserve included natural predators. Sick or injured tamarins were captured and treated. Reintroduced tamarins were supplied with food for ten months post-release. Artificial nesting boxes, which were hollow logs provided to them during training, were provided. The study does not distinguish between the effects of the different interventions mentioned above.

A before-and-after trial in 1984-1991 in coastal forest in Poço das Antas Reserve, Brazil (3) found that the majority of golden lion tamarins *Leontopithecus rosalia* that were reintroduced as groups into natural habitat along with 14 other interventions, did not survive over seven years. Fifty-eight out of 91 (64%) reintroduced tamarins did not survive post-release. However, 57 infants were born (reproductive rate=63%) during this period, of which 38 (67%) survived. Different groups of captive-bred or orphaned tamarin groups were introduced in 1984-85, 1987, and 1988-90 into habitat already occupied by the species and predators. Some groups were trained to learn behaviours that facilitated survival, were provided with supplementary food, water and nesting boxes, and were allowed to adapt to local habitat conditions before release. Tamarins were quarantined, underwent veterinary checks and parasite treatments before release. Reintroduced sick or injured animals were rescued, treated and re-released. The reserve became protected in 1983. The study does not distinguish between the effects of the different interventions mentioned above.

A study, which was included in a review, in 1976-1977 in dry evergreen forest in Sai Yok National Park, Thailand (4) found that captive lar gibbons *Hylobates lar* that were partially released in family groups alongside- other interventions decreased in numbers by 6% and no infants were born during 17 months post-release. No statistical tests were carried out to determine whether this decrease was significant. Four gibbons joined wild groups. A total of 31 gibbons were introduced as individuals, pairs, or family groups into habitat with resident wild gibbons. Anaesthetized gibbons were either kept in separate cages from which they could hear but not see each other for 14 days before release, or laid out on the forest floor. Injured animals were recaptured and treated. In 1961, gibbons became protected in Thailand. Reserve staff was permanently present. The study does not distinguish between the effects of the different interventions mentioned above.

A replicated study in 1992–1993 in tropical forest at Cockscomb Basin Wildlife Sanctuary (CBWS) in Belize (5) found that the majority of reintroduced black howler monkeys *Alouatta pigra* that were released in three groups alongside other interventions, survived for at least ten months and reproduced. Twelve out of 14 reintroduced monkeys (86%) survived for at least ten months post-release. One male and juvenile disappeared after two months. One group of four monkeys dissolved following aggressive interaction with another release group. One female dispersed with her infant and one female stayed alone. Two infants were born, in two release groups, 3-8 months post-release. Three groups, consisting of 3-7 individuals, were released 0.5-1 km apart into habitat without resident howlers. Wild howlers were captured at the Community Baboon Sanctuary and translocated to CBWS. Prior to release, howlers underwent veterinary screens. They were allowed to adapt to local conditions before release. Six individuals were fitted with ball-chain radio-collars and another six individuals were implanted with radio-transmitters. Radio-transmitter signals got lost six weeks after release. The study does not distinguish between the effects of the different interventions mentioned above.

A before-and-after trial in 1994 in tropical forest at Fazenda União, Rio das Ostras, Brazil (6) found that the majority of golden lion tamarins *Leontopithecus rosalia* that were translocated from small, isolated and degraded forest patches outside of the study area and reintroduced in groups into their new habitat where the species was already present, survived for at least two months. All seven monkeys (five adults and two infants) that were captured and translocated survived for at least two months after their release and extended their range over time. No statistical tests were carried out to determine whether this increase was significant. Two other individuals from another forest patch were captured, fitted with radio-collars and followed for 15 days. One tamarin was killed by a domestic dog *Canis familiaris domesticus* and the other one illegally captured before they could be translocated. Tamarin groups were captured by baited traps, weighed, tattooed and all adults were fitted with radio-collars before release.

A before-and-after trial in 1992-1994 in tropical forest in Cockscomb Basin Wildlife Sanctuary in Belize (7) found that the population of wild black howler monkeys *Alouatta pigra* that was reintroduced in groups alongside other interventions, increased by more than 60% in five years. By 1997, the population had increased from 62 to 100 individuals. However, no statistical tests were carried out to determine whether this increase was significant. One-month to 2-year survival rates for the different cohorts released in the dry seasons of 1992-1994, were 81-100%. Birth rate was 20% (N=12) and infant survival rate was 75% (N=9). Entire social groups were reintroduced together, and ten of the 14 groups were held in cages for 1-3 days before release into habitat without predators and with a distance of 700-1000 m to the neighbouring troop. All individuals underwent veterinary screens, were individually marked, and adults were fitted with radio-collars. Hunting was largely controlled in the sanctuary and the local community was educated about the reintroduction project and the importance of black howler conservation through multimedia campaigns. The study does not distinguish between the effects of the different interventions mentioned above.

A study in 1987-1988 on an island in tropical forest in Liberia (8) found that the majority of western chimpanzees *Pan troglodytes verus*, that were reintroduced in groups alongside other interventions, survived for at least one year on a natural island. Seven out of 30 released chimpanzees had difficulties to adjust to the new social environment and were brought back to captivity. Chimpanzees were reintroduced in subgroups. Before release, chimpanzees were screened for diseases, were socialized in naturalistic enclosures and were taught behaviour to facilitate their survival in the wild. On site, chimpanzees were allowed to adapt to the local habitat in enclosures for some time; younger and low-ranking individuals were released earlier to reduce stress. Released chimpanzees were continuously provided with food. Sick and injured animals were temporarily removed and treated. The study does not distinguish between the effects of the different interventions mentioned above.

A study in 1994-1995 in primary forest at Petit Saut hydroelectric dam in French Guiana (9) found that less than half of the monitored red howler monkeys *Alouatta seniculus* that were translocated and reintroduced into their new habitat in groups along with other interventions, survived over 18 months. Of the 16 females monitored for 18 months, seven (44%) females survived with a possible survival rate of 63%. Deaths included screwworm fly larvae infestations under radio-collars (N=2) and trauma (N=1). Three (19%) females gave birth after release, but all infants disappeared and probably died. All females studied for longer than three months (50%) settled within the release area. Of the 28 different translocated troops (122 individuals) ten out of 11 (91%) documented troops broke apart post-release. All animals underwent veterinary screens before t release into habitat already occupied by the species. They were allowed to adapt to local habitat conditions for some time before their release. The study does not distinguish between the effects of the different interventions mentioned above.

A study in 1999 in tropical forest of Morro do Diabo State Park, Brazil (10) found that only some of the reintroduced wild and captive-bred black lion tamarins *Leontopithecus chrysopygus* that were released in one group along with other interventions, survived over four months. Four months after the release of three individuals, one tamarin died. The group consisted of two wild females and one captive-born male which was bred in a free-ranging environment to facilitate reintroduction. The male was treated after becoming sick. Tamarins underwent veterinary screens before translocation to an enclosure at the release site where they could adapt to the local environment with predators. Tamarins were fitted with radio-transmitters and supplemented with food. The study does not distinguish between the effects of the different interventions mentioned above.

A before-and-after trial in 1996-1999 in tropical rainforest in Conkouati Reserve, Republic of Congo (11) found that 70% of reintroduced wild-born orphaned chimpanzees *Pan troglodytes troglodytes* that were released in groups along with eight other interventions, were still alive 3.5 years after release. Estimated mortality was 10-30%. None of the adult females reproduced. Chimpanzees fed on 137 different plant species, a variety similar to that of wild chimpanzees. They also had activity budgets that resembled those of wild chimpanzees. No statistical tests were carried out to determine whether these similarities were statistically valid. Before reintroduction into habitat with low densities of wild chimpanzees, they spent 6-9 years on one of three forested islands in the region to acclimatize. Release groups were small and composed of individuals that had formed strong associations during acclimatization. Chimpanzees underwent veterinary screens, were treated for endoparasites and vaccinated for poliomyelitis and tetanus. Orphan chimpanzees were rehabilitated and fostered. Researchers were permanently present on-site and monitored released chimpanzees using radio-collars. The study does not distinguish between the effects of the different interventions mentioned above.

A before-and-after trial in 1994-1999 in tropical forest in Conkouati-Douli National Park, Republic of Congo (12) found that the majority of central chimpanzees *Pan troglodytes troglodytes* that were reintroduced in groups along with 16 other interventions, survived over five years. Out of 20 reintroduced chimpanzees released in four subgroups from 1996-1999, 14 survived (70%). No statistical tests were carried out to determine whether the population decrease was significant. Individuals were radio-collared. Rehabilitated orphaned chimpanzees underwent vaccination, treatment for parasites and veterinary screens before translocation from the sanctuary to the release site where resident chimpanzees occurred. Staff members were permanently present to monitor primate health, provide additional food if necessary and examine dead animals. The area status was upgraded from reserve to national park in 1999. Local people were relocated from the release site to a nearby village. Some chimpanzees were treated when sick or injured. TV and radio advertisements were used to raise chimpanzee conservation awareness and local people were provided monetary and non-monetary benefits for their conservation support. The study does not distinguish between the effects of the different interventions mentioned above.

A before-and-after trial in 1994-1995 in tropical forest near Petit-Saut dam, French Guiana (13) found that most translocated white-faced sakis *Pithecia pithecia* that were partly released as a group along with other interventions, survived over four months. Two of six translocated sakis survived over four months after release. Three individuals released as a group dispersed separately after release and one male of this group associated temporarily with a resident couple before becoming solitary. Only three translocated wild sakis were monitored over 41 weeks post-release, which took place one day after capture. Monkeys were captured by nets, radio-collared and underwent veterinary screens prior to release. Dead sakis were examined to establish their cause of death. One male died from a parasite infection. The study does not distinguish between the effects of the different interventions mentioned above.

A replicated, before-and-after-trial in 1995-2001 in temple orchards in urban Vrindaban, Mathura District, India (14) found that rhesus monkeys *Macaca mulatta* reintroduced in groups into forest patches along with other interventions remained at their release sites over four years. A post-translocation study in 2001 confirmed that all of the 600 monkeys captured from 12 troops (45% of total population) and translocated to eight different forest patches, had settled down, were healthy and behaved normally. Time spent engaging in different activities for one of the translocated groups (150 individuals) during the first three months post-release was similar to wild groups in northern India. No quantitative results were provided in this study. Attempts were made to capture as many animals as possible from a single social group whenever a troop of monkeys was encountered. Captured monkeys, which were regarded as so-called 'problem'-animals by local residents, were translocated to non-residential, natural habitat without resident monkeys. The study does not distinguish between the effects of the different interventions mentioned above.

A before-and-after trial in 1998-1999 in tropical forest on an island in French Guiana (15) found that a small number of reintroduced squirrel monkeys *Saimiri sciureus* that were released as a group along with other interventions, survived over 15 weeks post-reintroduction. Six (43%) out of 14 released monkeys survived over 15 weeks, after which monitoring ceased. Two individuals died in their release cages, and one was apparently killed by resident wild monkeys. One month after release, five monkeys were recaptured and brought back to captivity. The remaining six monkeys were wild-born; dead and removed individuals were captive-born monkeys. Animals were kept as one group in an isolated cage at the captive colony where two females gave birth. After transfer to the release site, monkeys were held in an enclosure to adapt to local habitat conditions. The study does not distinguish between the effects of the different interventions mentioned above.

A controlled study in 1998-2001 in tropical forest in Betampona Reserve, Madagascar (16a) found that diets of captive-bred, reintroduced black-and-white ruffed lemurs *Varecia variegata variegata* that were born and reared in cages and introduced in groups along with other interventions, did not overlap with that of the resident wild group in the first year post-release. No statistical tests were carried out to determine whether this overlap was significant. Captive-bred lemurs (one male and two females) fed only on slightly more than half of the plant species (N=57 plants) that the wild group (N=10 individuals) fed on (N=109 plants). Captive-bred lemurs did not closely follow the dietary choices and seasonal changes in diet exhibited by the wild group. Lemurs were provided with supplementary food during the entire study period. They were reintroduced into habitat already occupied by the species. The study does not distinguish between the effects of the different interventions mentioned above.

A controlled study in 2001 in tropical forest in Betampona Reserve, Madagascar (16b) found that diets of captive-bred, reintroduced black-and-white ruffed lemurs *Varecia variegata variegata* that had limited free-ranging experience before release and that were reintroduced in groups along with other interventions, overlapped with that of the resident wild group. Reintroduced lemurs (three males and one female) fed on 54 species during a single year, as compared to the wild group (N=10 individuals) that fed on 109 species over four years. Furthermore, reintroduced lemurs consistently consumed less foliage than the wild group did throughout the study, although no statistical tests were carried out to determine whether this difference was significant. Lemurs were provided with supplementary food during resource-scarce periods only and were reintroduced into habitat already occupied by the species. The study does not distinguish between the effects of the different interventions mentioned above.

A controlled study in 1997-2001 in tropical forest in Betampona Reserve, Madagascar (16c) found that diets of captive-bred, black-and-white ruffed lemurs *Varecia variegata variegata* that were born and raised in a free-ranging environment and reintroduced in groups along with other interventions, overlapped with that of the resident wild group. No statistical tests were carried out to determine whether this overlap was significant. Reintroduced lemurs (three males and two females) fed on 92 species over three years, as compared to the wild group (N= 10 individuals) that fed on 109 species over four years. Reintroduced lemurs consumed less foliage throughout the study and less nectar in 1998 than the wild group did. No statistical tests were carried out to determine whether this difference was significant. Two reintroduced males died of malnutrition in 1998 due to climate change and seasonal food shortages. Lemurs were reintroduced into habitat already occupied by the species and were provided supplementary food during resource-scarce periods. The study does not distinguish between the effects of the different interventions mentioned above.

A before-and-after trial in 1997-2002 in primary forest in Betampona Reserve, Madagascar (17) found that less than half of all captive-bred, parent-reared black-and-white ruffed lemurs *Varecia variegata variegata* that were reintroduced in groups along with ten other interventions, survived until the end of the study period of five years. Five (38.5%) of 13 individuals survived in the wild and six individuals were born, of which four survived. One female and one male reproduced with resident wild lemurs and the male became fully integrated. Lemurs were released as either family groups or constructed pairings. All released animals were fitted with radio- collars. Captive lemurs had limited semi-free-ranging experience, were quarantined and underwent veterinary screens before their reintroduction into habitat with predators and resident wild lemurs. They were recaptured and treated when sick and provided with supplementary food and water for a certain period of time. They were allowed to adapt to local habitat conditions before release. Dead lemurs were examined. The study does not distinguish between the effects of the different interventions mentioned above.

A study in 1979-2004 in tropical forest on Baboon Islands, River Gambia National Park, The Gambia (19) found that rehabilitated western chimpanzees *Pan troglodytes verus* that were reintroduced in groups along with other interventions, increased from 50 to 69 chimpanzees over 25 years. No statistical tests were carried out to determine whether this increase was significant. Fertility and mortality rates were similar to wild chimpanzees, except for infant mortality (18%), which was lower than in wild populations. Inter-birth interval, average age at first birth, proportion males at birth, age at first sexual swelling in females, and adolescent infertility were similar to wild chimpanzees. In total, 50 chimpanzees from various backgrounds were released on three islands. Individuals were reintroduced into habitat with no wild or previously reintroduced chimpanzees and with small populations of natural predators. They were continuously provided supplementary food every 1-2 days. Individuals received periodic deworming and antibiotic treatment when they suffered severe colds. The study does not distinguish between the effects of the different interventions mentioned above.

A study in 2002–2006 in rainforest in Lékédi Park, Gabon (20) found that one third of captive-bred mandrills *Mandrillus sphinx* that were reintroduced in groups alongside other interventions, died within the first year post-release. Mortality was 33% (12 individuals of 36), mostly affecting infants. Fertility rate was 42% (5 of 12 females reproduced), and two of the five infants survived for longer over six months. Mortality decreased to 4% in the second year and fertility rate remained at 42%, but all five infants survived over six months. Their range remained limited during the first two years post-release. In 2006, the group numbered 22 individuals, including 12 of the mandrills originally released, all in good physical condition. Mandrills were transferred to the release site in two groups and released all together in 2002. Mandrills were reintroduced into habitat already occupied by the species and with predators; they were allowed to adapt to local habitat conditions for some time, and were treated for endoparasites before release. Mandrills were also supplemented with food until 2005. The study does not distinguish between the effects of the different interventions mentioned above.

A before-and-after trial in 2006-2007 in rainforest in Analamazaotra Special Reserve, Madagascar (21) found that black-and-white ruffed lemurs (BWRL) *Varecia variegata variegata* and diademed sifakas *Propithecus diadema* that were reintroduced in their social groups after translocation from disturbed sites to undisturbed habitat along with other interventions, survived over 30 months and reproduced. No mortalities were recorded for BWRL over a 30-month observation period and only one diademed sifaka died from natural causes. Two sets of BWRL twins (reproductive rate=57%) and seven diademed sifaka infants were born (reproductive rate=26%), the latter of which only two survived. A total of seven BWRL and 27 diademed sifakas were captured at four disturbed forest sites and released in the reserve where the species had locally gone extinct and that included natural predators. Released primates were habituated to human presence and monitored using radio-collars. Two to eight months before a translocation was carried out, lemurs were darted and underwent veterinary checks. The study does not distinguish between the effects of the different interventions mentioned above.

A controlled study in 2004-2005 in secondary tropical forest in Bukit Tigapuluh National Park, Central Sumatra, Indonesia (22) found that all reintroduced Sumatran orangutans *Pongo abelii* that were released in groups along with other interventions, survived for at least three months. Eight captive orphaned orangutans with largely unknown histories were released in two groups and all survived for at least three months post-release. One group was directly released into the forest after a 6-month acclimatization phase at a sanctuary. Another group of individuals was kept in semi-free conditions for 7-9 months prior to release and allowed to overnight in the enclosure. Staff members guided the latter group daily to the forest. Orangutans underwent quarantine and were medically screened before being released to re-establish populations in habitat where previously released orangutans occurred. Supplementary food was provided regularly. The study does not distinguish between the effects of the different interventions mentioned above.

A before-and-after trial in 2007-2008 in dry forest-grassland mosaic near Richmond, South Africa (23) found that a small number of vervet monkeys *Chlorocebus aethiops* that were released in two groups along with other interventions, survived over ten months post-reintroduction. Out of 35 monkeys released in troop one, only six (17%) survived for ten months post-release, when monitoring ceased. Twenty-two (63%) vervets went missing and seven (20%) died. However, two infants were born 10-11 months post-release. Out of 24 vervets released as troop two, 12 (50%) survived, seven (29%) went missing and five (21%) died. Groups were released five days apart. Monkeys underwent veterinary checks, and were allowed to adapt to local environmental conditions before their release into habitat already occupied by the species. They received supplementary food and water after their release. The study does not distinguish between the effects of the different interventions mentioned above.

A study in 2007-2010 in subtropical forest-shrubland mosaic in Mondi forestry, South Africa (24) found that one third of the 31 rehabilitated vervet monkeys *Chlorocebus aethiops* that were reintroduced as a group alongside other interventions, survived over 12 months. One year post-release, ten (32%) individuals had survived and 20 (65%) vervets could not be tracked. One individual was euthanized three days post-release after raiding houses and acting aggressively towards people. One week post-release, the group split into two groups. The release group included both wild captured- (61%) (due to injury) and hand-raised orphaned (39%) monkeys. Monkeys underwent veterinary screens, were held in an enclosure to adapt to local habitat, and were supplemented with food for eight weeks. Eleven individuals were fitted with radio-collars. The study does not distinguish between the effects of the different interventions mentioned above.

A before-and-after trial in 2008-2010 in dry forest-savanna mosaic in Mafou forest, Haut Niger National Park, Guinea (25) found that the majority of wild-born orphaned western chimpanzees *Pan troglodytes verus* that were reintroduced in a group along with other interventions, survived reintroduction and remained free-living for at least 27 months. One out of 12 (8.3%) released chimpanzees died from anaesthesia during a recovery mission. One female returned to the sanctuary voluntarily and one male was returned after suffering injuries. Five chimpanzees (42%) remained together at the release site and two females gave birth and both infants survived. Another female dispersed to a wild chimpanzee community and three chimpanzees moved to an area away from the release site. Chimpanzees were released simultaneously from release cages (5 adult males) or individual transport cages ca. 100 m away (6 females, 1 young male). All chimpanzees were screened for diseases before their release into habitat with wild chimpanzees and predators. Chimpanzees were initially daily supplemented with food, and later on, a weekly . The study does not distinguish between the effects of the different interventions mentioned above.

A before-and-after trial in 2009-2010 in coastal forest in Ntendeka Wilderness Area, Ngume Forest, South Africa (26) found that 56% of captive, wild-born vervet monkeys *Chlorocebus aethiops* that were reintroduced as a group along with other interventions, survived for at least six months post-release. Three (19%) individuals were reported dead, two killed by predators and one by domestic hunting dogs *Canis lupus familiaris*. Four individuals (25%) went missing. One female gave birth two weeks post-release. Monkeys were introduced as one troop of 16 individuals (11 males, 5 females) where sex and age composition of the troop was similar to wild troops. The troop was released into habitat without resident vervets, but with predators. To acclimatize, monkeys spent one day in a release enclosure (49 m^2). They were provided supplementary food twice per day for two weeks and once per day for a further three weeks post-release. The release site became a nationally protected wilderness area. The study does not distinguish between the effects of the different interventions mentioned above.

A before-and-after, site comparison study in 1996-2006 in tropical forests of Lesio-Louna Wildlife Reserve, Republic of Congo (Congo) and Batéké Plateau National Park, Gabon (27) found that the majority of western lowland gorillas *Gorilla gorilla gorilla*, reintroduced in groups along with 14 other interventions, survived for at least four years. Twenty-one (84%) of 25 gorillas released in Congo and 22 (85%) of 26 gorillas released in Gabon survived over four years. Nine females gave birth to 11 infants, of which nine survived. In Gabon, two groups were reintroduced in 2001 and 2004 and in Congo, five groups were reintroduced in 1996-2006. Gorillas underwent disease screening during quarantine and received preventative vaccinations. Gorillas were allowed to adapt to local environment and were supplemented with food prior to release. Gorillas were released into habitat with no resident gorillas. Released gorillas were treated for parasites and when sick. So-called 'problem'-animals were removed and relocated and bodies of dead gorillas were examined. Forty-three individuals were rehabilitated wild-born orphaned gorillas and eight gorillas were *ex-situ* captive-borns. Both sites became protected areas before reintroduction commenced. The study does not distinguish between the effects of the different interventions mentioned above.

A before-and-after trial in 2008 in a coastal forest at Isishlengeni Game Farm, South Africa (28) found that over 60% of rehabilitated vervet monkeys *Chlorocebus aethiops* that were reintroduced as one large troop into the wild along with other interventions, survived for at least six months. Five (17%) of 29 introduced individuals were reported dead. Of these, one was predated and four were killed by domestic hunting dogs *Canis lupus familiaris*. Six (21%) individuals went missing. No females reproduced. The release troop included 29 individuals (18 males, 10 females, 1 infant), where sex and age composition of the troop differed significantly from that of wild troops. Monkeys were released into habitat already occupied by wild vervets and with predators. To acclimatize, monkeys spent two nights in a release enclosure (49 m^2) before being released. Monkeys were provided daily supplementary food. Medical care was provided when necessary before release and while housed at the nearby rehabilitation centre. The study does not distinguish between the effects of the different interventions mentioned above.

A before-and-after trial in 2008-2010 in a tropical forest-grassland mosaic at Batéké Plateau National Park, Gabon (29) found that the majority of western lowland gorillas *Gorilla gorilla gorilla* that were reintroduced as a group alongside ten other interventions, survived for at least nine months. Four out of five (80%) juvenile gorillas survived over nine months post-release. After the death of the youngest individual, group cohesion decreased. Three captive-bred and two orphaned wild born individuals were reintroduced into habitat with predators and without resident wild gorillas after they were allowed to adapt to local habitat conditions for some time. They spent the night in an enclosure equipped with nesting platforms, nesting material, supplementary food and water. Gorillas were dewormed regularly on-site. Caretakers guided them daily into different forest patches. The study does not distinguish between the effects of the different interventions mentioned above.

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12.16. Reintroduce primates as single/multiple individuals

- Two studies in Brazil[2] and Thailand[3] found that populations of reintroduced primates declined after reintroduction as single/multiple individuals, alongside other interventions.
- Four studies in French Guiana[7], Indonesia[12], Malaysia[4], and Vietnam[11] found that a minority of primates survived after between two months and one year after reintroduction as single/multiple individuals, alongside other interventions. One study in Vietnam[11] found that half of introduced primates survived after two months.
- One study in Brazil[6] found that an abandoned infant muriqui was reunited with its mother after reintroduction as single/multiple individuals, alongside other interventions.

One study in Indonesia[8] found that Bornean agile gibbons had similar behaviour and diet to wild populations after reintroduction as single/multiple individuals, alongside other interventions.

- One study in Tanzania[1] found that a reintroduced population of chimpanzees increased in size after reintroduction as single/multiple individuals, alongside other interventions. One study in Senegal found that an infant chimpanzee was reunited with its mother after reintroduction, alongside other interventions.
- One controlled study in Malaysia[9] found that a reintroduced population of orangutans declined in size after reintroduction, alongside other interventions. One study in Malaysia[5] found that 98% of orangutans survived release after reintroduction, alongside other interventions.

A study in 1966–1985 on, a forested island in Tanzania (1) found that reintroduced eastern chimpanzees *Pan troglodytes schweinfurthii* that were released as multiple individuals during four reintroduction events (from 1966 to 1969) alongside other interventions, bred and increased in numbers from 17 to at least 20 individuals over a 16-year time period. No statistical tests were carried out to determine whether this increase was significant. At least two males were shot after attacking game scouts. Two new-born infants were seen in 1968 and in 1985. Male-to-female ratios in the four release groups differed (4.7, 1.0, 1.0, 2.2) and few individuals within each group had met before. All 17 reintroduced chimpanzees had been born in the wild and spent various amounts of time in captivity. Their age at the time of release varied from four to 12. The island was free of predators and chimpanzees. The first release group was provided with supplementary food for two months. The study does not distinguish between the effects of the different interventions mentioned above.

A before-and-after trial in 1954–1985 in a degraded rain forest in Brazil (2) found that a translocated captive-born golden lion tamarin *Leontopithecus rosalia* population, some of which were released as pairs alongside nine other interventions, decreased by more than half (57%) within the first year of release. No statistical tests were carried out to determine whether this decrease was significant. Of the 14 individuals released, seven died and two were removed. Three infants were born, one of which died. Eight individuals were released as a family group and six individuals were released as pairs one month later. Tamarins were placed in 15 x 4.5 x 3 m outside enclosures to acclimatize. They were habituated to humans and fostered to facilitate survival in the wild. The forest included natural predators. Sick or injured tamarins were captured and treated. Reintroduced tamarins were supplied with food for ten months after their release. Artificial nesting boxes, which were hollow logs provided to them during training, were also set up in the forest. The study does not distinguish between the effects of the different interventions mentioned above.

A study, which was included in a review, in 1967–1970 on lar gibbons *Hylobates lar* reintroduced in pairs at two sites in Thailand along with other interventions (3a) found that populations decreased by 6-60% over three years. At one site the population of gibbons decreased by 60% over three years, while at the other population declined by 6%. No statistical tests were carried out to determine whether these decreases were significant. At the first site four infants were born (reproductive rate =20%), while at the second site there were no births. Before release anaesthetized gibbons were either kept in separate cages for 14 days before release, or laid out on the forest floor. At the first site, 20 gibbons were introduced into habitat that did not contain resident gibbons, while at the second site 31 gibbons were introduced in an area that contained wild gibbons. Monkeys were obtained individually from animal dealers and housed together in a laboratory for at least one month before release. Gibbons were fed supplementary food and water. Four gibbons joined wild groups. Injured animals were recaptured and treated. In 1961, gibbons were officially protected by the Thai government. Neither study distinguishes between the effects of the different interventions mentioned above.

A study, which was included in a review, in 1976–1977 in dry evergreen forest in Thailand (3b) on captive lar gibbons *Hylobates lar* that were partially released as single or multiple individuals, along with other interventions, found that their population decreased by 6% and no infants were born in the first 17 months after release. No statistical tests were carried out to determine whether this decrease was significant. Four gibbons joined wild groups. A total of 31 gibbons were introduced as individuals, pairs, or family groups into habitat with resident wild gibbons. Anaesthetized gibbons were either kept in separate cages for 14 days before release, or laid on the forest floor. Injured animals were recaptured and treated. In 1961, gibbons were officially protected by the Thai government. The study does not distinguish between the effects of the different interventions mentioned above.

A before-and-after trial in 1976-1988 in a tropical forest in Malaysia (4) found that of 87 captive, wild-born Müller's Bornean gibbons *Hylobates muelleri* that were reintroduced in pairs or as single individuals along with other interventions, at least 77 (90%) died after release. When possible, males and females were paired in cages to try to establish pair bonds before to release into habitat without resident wild gibbons. Confiscated gibbons had undergone veterinary checks and were placed in holding cages in a forest clearing. Müller's Bornean gibbons were fully protected under local law. Surveys of direct sightings and gibbon calls were conducted simultaneously by three or four observers on non-rainy days on eight mornings between 4 February and 31 March 1988. The study does not distinguish between the effects of the different interventions mentioned above.

A study in 1993 in three tropical forest sites in Sabah, Malaysia (5) found that 78 of 80 (98%) orangutans *Pongo pygmaeus morio* that were translocated as single individuals, along with other interventions, survived capture and subsequent release. Orangutans were either immobilized in trees or captured manually on the ground with nets. In the absence of natural cushioning, a net was held out to catch the animal falling from the tree. Before release into habitat occupied by wild orangutans individuals were screened by vets and sick animals were treated. To avoid injury, females were kept in separate cages from their offspring and space was maintained between occupied cages during temporary holdings and transportation. The study does not distinguish between the effects of the different interventions mentioned above.

A study in 1994 in a tropical dry forest in Minas Gerais, Brazil (6) found that that an abandoned infant muriqui *Brachyteles arachnoides* that was removed from its natural habitat and then returned as a single individual, along with other interventions, was retrieved by its mother and rejoined the wild group. Twenty-seven hours after detection of the infant, it was released close to its mother who retrieved it immediately. The 4-month old female infant muriqui was removed from the forest and was first given a blanket for warmth, fed with milk and food and some ectoparasites were removed for study. The mother answered to the infant's cries and retrieved it immediately and then rejoined the group. The study does not distinguish between the effects of the different interventions mentioned above.

A before-and-after trial in 1994-1995 in tropical forest in French Guiana (7) found that most of the translocated white-faced sakis *Pithecia pithecia* that were partly released as single or multiple individuals, along with other interventions, survived for at least four months after release. One individual died after approximately 22 weeks. The female and the male that were released as single individuals bonded after release until the male died due to a parasite infection. Before release monkeys were captured by nets, were tagged with radio transmitters and underwent veterinary screens. Three out of six translocated wild sakis were monitored for 41 weeks after their release. The cause of death of dead sakis was clinically determined. The study does not distinguish between the effects of the different interventions mentioned above.

A controlled study in 2002-2003 in lowland forest in Kalimantan, Indonesia (8) found that wild-born, captive-raised Bornean agile gibbons *Hylobates albibarbis* that were reintroduced in pairs, along with other interventions, shared a similar diet, spent similar amounts of time feeding, resting, and arm-swinging and at similar canopy heights as wild gibbons. However, wild gibbons spent more time singing, socializing and travelling. Before reintroduction gibbons were quarantined at a holding facility for at least one year, where they were screened by vets. They were kept in enclosures (3 x 3 x 3 m) to socialize and acclimatize to the natural environment and, during this time, were supplemented with vitamins and leaves once a week. Comparisons were made between a reintroduced pair of gibbons and a pair of wild gibbons at another site. The study does not distinguish between the effects of the different interventions mentioned above.

A controlled study in 1967-2004 in tropical forest in Malaysia (9) found that rehabilitated and individually reintroduced orangutans *Pongo pygmaeus morio* decreased in numbers by 33% over 33 years. Infant mortality (57%) was higher than in other wild and captive populations, and the sex ratio at birth was strongly biased towards females (proportion males=0.11) compared to other wild and captive populations. Time between births (6.1 years) was shorter than for other orangutan subspecies or species in the wild and in captivity, but similar to wild populations of the same subspecies. Average age at first reproduction (11.6 years) was lower than in other wild and captive populations. Orangutans were continuously provided with supplementary food. Before release at the site which contained other orangutans individuals underwent in-depth veterinary checks and were kept in quarantine for 90 days before they were released into the reserve. Individuals were captured and treated when they displayed signs of injury or illness. Staff and volunteers received medical checks and tourists were told to keep >5 m from animals at all times. The study does not distinguish between the effects of the different interventions mentioned above.

A study in 2009 in savanna in Senegal (10) found that a confiscated 9-month old female infant chimpanzee *Pan troglodytes verus* that was reintroduced, along with other interventions, was reunited with its mother in the wild. Four days after confiscation, the chimpanzee was released close to its natal group, which retrieved it immediately. Researchers wore surgical masks and sanitized their hands when handling the infant and its food. The infant's natal group was located with the aid of poachers, after which the infant was released close to the group. The infant was also treated for its injured eye. The study does not distinguish between the effects of the different interventions mentioned above.

A site comparison in 2008-2012 in two forests in South Vietnam (11a) found that several pygmy slow lorises *Nycticebus pygmaeus* that were reintroduced as multiple individuals, along with eight other interventions, survived for at least two months. Four out of eight lorises survived for at least two months after release, whereas the remaining animals either died or their radio collar signal was lost at an early stage after release. Lorises were released during the wet season after all animals had undergone a 6-week quarantine, veterinary screens, and treatment for parasites. Both release sites were protected and no wild resident lorises occurred there, but predators were present. Lorises were kept in a cage for between two days and two months and were subsequently supplemented with food for between seven and 30 days. Bodies of dead animals were examined to determine the cause of death. The study does not distinguish between the effects of the different interventions mentioned above.

A site comparison in 2008-2012 in two forest sites in South Vietnam (11b) found that all pygmy slow lorises *Nycticebus pygmaeus* that were reintroduced as individuals, along with other interventions either died or disappeared. All five lorises died or their radio collar signal was lost at an early stage after release. Before release, lorises were quarantined for six weeks, screened by vets, and treated for parasites. No wild resident lorises occurred at either of the release sites, but predators did. Three lorises were released at one site during the dry season. Another two individuals were held in a semi-wild enclosure for one month to allow them to learn natural behaviour that would aid their survival in the wild. The latter were released during the wet season. Bodies of dead animals were examined to determine the cause of death. The study does not distinguish between the effects of the different interventions mentioned above.

A before-and-after trial in 2006-2011 in tropical forest in Indonesia (12) found that few reintroduced Javan slow lorises *Nycticebus javanicus* and greater slow lorises *N. coucang* that were released as single individuals, along with other interventions, survived for at least 146 and 22-382 days, respectively. One of five reintroduced greater slow lorises survived for at least 146 days and five of 18 reintroduced Javan slow lorises individuals survived for at least 22-382 days. Before release, lorises underwent quarantine and veterinary screens. Sick individuals were recaptured and treated. All but two lorises were held in enclosures at the release site to adapt to local habitat where resident lorises and predators occurred. Bodies of dead lorises were examined to determine their cause of death. The study does not distinguish between the effects of the different interventions mentioned above.

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12.17. Reintroduce primates into habitat where the species is absent

- One study in The Gambia[5] found that a population of reintroduced chimpanzees increased over 25 years after reintroduction into habitat where the species was absent, alongside other interventions.
- One controlled study in Indonesia[7] found that all Sumatran orangutans survived for at least three months after reintroduction into habitat where the species was absent, alongside other interventions.
- One before-and-after study in the Republic of Congo[9] found that a majority of reintroduced gorillas survived for at least four years after reintroduction into habitat where the species was absent, alongside other interventions.
- One study in Thailand[1] found that a reintroduced population of lar gibbons declined over three years following reintroduction into habitat where the species was absent, alongside other interventions. One study in India[4] found that a population of reintroduced rhesus monkeys persisted for at least four years after reintroduction.
- Six studies (including four before-and-after studies) in Belize[3], Gabon[11], Madagascar[6], Malaysia[2], South Africa[8], and Vietnam[10] found that a majority of primates survived for two to thirty months after reintroduction into habitat where the species was absent, alongside other interventions. Two studies in Malaysia[2] and Vietnam[10] found that a minority of primates survived after between three months and 12 years.

A study, which was included in a review, in 1967–1970 on the island of Koh Klet Kaeo, Thailand (1) found that reintroduction, along with other interventions, led to declines of 60% in the population of formerly captive lar gibbons *Hylobates lar* over three years. No statistical tests were carried out to determine whether this decrease was significant. Four infants were born to the introduced population of 20 gibbons (reproductive rate =20%). Twenty gibbons were introduced in pairs into habitat that did not resemble their natural habitat and without resident gibbons. Gibbons were obtained from commercial animal dealers and housed in a laboratory for at least one month along with the gibbon with whom they were released on the island. Gibbons were fed and provided with water from artificial food and water stations. In 1961, gibbons were officially protected by the Thai government. The study does not distinguish between the effects of the different interventions mentioned above.

A before-and-after trial in 1976–1988 in a degraded tropical forest in Sarawak, Malaysia (2) found that at least 77 of 87 (89%) captive, wild-born Müller's Bornean gibbons *Hylobates muelleri* that were reintroduced into habitat without resident wild gibbons along with other interventions, died after release. Confiscated gibbons had undergone veterinary checks and were placed in holding cages in a forest clearing. When possible, males and females were paired in cages prior to release. Müller's Bornean gibbons were protected under state law. Surveys of direct sightings and gibbon calls were conducted simultaneously by three or four observers on non-rainy days on eight mornings from 4 February to 31 March 1988. The study does not distinguish between the effects of the different interventions mentioned above.

A replicated study in 1992–1993 in tropical forest in Belize (3) found that the majority of reintroduced black howler monkeys *Alouatta pigra* that were released into habitat where no resident monkeys occurred, alongside other interventions, survived for at least ten months and reproduced. Twelve of 14 reintroduced monkeys (86%) survived for at least ten months after release. One monkey disappeared two months after release. Four infants were born in the release groups. Wild howlers had been captured at a sanctuary and were translocated to the site. Prior to release, monkeys were screened by vets. Monkeys were allowed to adapt to local habitat conditions before release. Six individuals were fitted with ball-chain radio collars and another six were implanted with radio-transmitters. Radio collars worked for 6-10 months, but transmitter signals were lost six weeks post-release. The study does not distinguish between the effects of the different interventions mentioned above.

A replicated, before-and-after-trial in 1995–2001 in orchards in Mathura District, India (4) found that rhesus monkeys *Macaca mulatta* reintroduced into forest patches without resident macaques along with other interventions, remained at their release sites for at least four years. A post-translocation study in 2001 confirmed that all of the 600 monkeys captured from 12 troops and translocated to eight different forest patches, had settled, were healthy, showed no signs of stress, and behaved normally. In addition, time spent engaging in different activities during the first three months after release was similar to activity budgets of wild groups in northern India. Monkeys were only moved to habitat without resident macaques, because no health checks were conducted on the captured monkeys and to avoid competition with resident troops. Captured monkeys were translocated to natural habitat, where they were reintroduced in groups. The study does not distinguish between the effects of the different interventions mentioned above.

A study in 1979–2004 in tropical forest in The Gambia (5), found that the population of rehabilitated western chimpanzees *Pan troglodytes verus* that were reintroduced into habitat with no wild or previously reintroduced chimpanzees, along with other interventions, increased from 50 to 69 over 25 years. No statistical tests were carried out to determine whether this increase was significant. Fertility and mortality rates were similar to wild chimpanzees, except for infant mortality (18%), which was lower than in wild populations. Time between births, average age at first birth, proportion of males at birth, age at first sexual swelling in females, and adolescent infertility were similar to that of wild chimpanzees. In total, 50 chimpanzees from various backgrounds were released on three islands. Individuals were reintroduced in groups and into habitat with small populations of natural predators. They were provided supplementary food daily or on every second day, depending on which one of the islands they lived on. Individuals were periodically dewormed, and given antibiotic treatment when they suffered from severe colds. The study does not distinguish between the effects of the different interventions mentioned above.

A before-and-after trial in 2006–2007 in rainforest in in Madagascar (6) found that black-and-white ruffed lemurs *Varecia variegata variegata* and diademed sifakas *Propithecus diadema* that were translocated from disturbed sites to undisturbed habitat where the species was locally extinct, along with other interventions, survived for at least 30 months and reproduced. No deaths were recorded for black-and-white ruffed lemurs over a 30-months while one diademed sifaka died from natural causes. Four black-and-white ruffed lemur offspring twins (reproductive rate=57%) and seven diademed sifaka infants (reproductive rate=26%) were born, with two of the latter surviving. A total of seven black-and-white ruffed lemurs and 27 diademed sifakas were captured at four disturbed forest sites. Before release in their social units lemurs were checked by vets in a forest that contained natural predators. Released primates were habituated to human presence and monitored with the aid of radio-collars. The study does not distinguish between the effects of the different interventions mentioned above.

A controlled study in 2004–2005 in tropical forest in Sumatra, Indonesia (7) found that all reintroduced Sumatran orangutans *Pongo abelii* that were released into habitat where the species was absent, along with other interventions, survived for at least three months. All eight captive orphaned orangutans survived for at least three months after release. Orangutans underwent quarantine and were medically screened before being released into habitat. One group was directly released into the forest after a 6-month acclimatization phase at a sanctuary. Another group of individuals was kept in semi-free conditions for 7-9 months prior to release and allowed to overnight in the enclosure. Staff members guided the latter to the forest on a daily basis. Supplementary food was provided regularly. The study does not distinguish between the effects of the different interventions mentioned above.

A before-and-after trial in 2009–2010 in South Africa (8) found that more than half of captive, wild-born vervet monkeys *Chlorocebus aethiops* that were reintroduced into habitat where the species was absent alongside other interventions, survived for at least six months after release. Three (19%)

individuals were reported dead. Of these, two were killed by predators and one by domestic hunting dogs *Canis lupus familiaris*. Four individuals (25%) went missing. One infant was born two weeks after release. The species was absent from the area of reintroduction. Monkeys were introduced as one troop of 16 individuals. To acclimatize, they spent one day in a release enclosure (49 m^2). Monkeys were provided supplementary food twice per day for two weeks and once per day for a further three weeks. The release site was a protected area. The study does not distinguish between the effects of the different interventions mentioned above.

A before-and-after, site comparison study in 1996–2006 in tropical forests of Lesio-Louna Wildlife Reserve, Republic of Congo (Congo) and Batéké Plateau National Park, Gabon (9) found that the majority of western lowland gorillas *Gorilla gorilla gorilla* that were reintroduced into habitat where the species was absent, along with 14 other interventions, survived for at least four years and some reproduced. Twenty-one of 25 gorillas (84%) released in Congo and 22 of 26 gorillas (85%) released in Gabon survived for at least four years. Eleven infants were born, of which nine survived. Gorilla populations had previously been extirpated at both release sites. Forty-three reintroduced individuals were rehabilitated wild-born orphaned gorillas and eight gorillas were born in captivity. Before release, gorillas were screened for diseases during quarantine and vaccinated. Gorillas were released in groups, allowed to adapt to the local environment, and supplemented with food prior to release. Released gorillas were treated for parasites and when sick. Bodies of dead gorillas were examined to determine their cause of death. Both sites were designated protected areas. The study does not distinguish between the effects of the different interventions mentioned above.

A site comparison in 2008–2012 in two forest sites in South Vietnam (10a) found that several pygmy slow lorises *Nycticebus pygmaeus* that were released into habitat where the species was absent, along with eight other interventions, survived for at least two months. Four of eight lorises survived for at least two months after release, whereas the remaining lorises either died or their radio-collar signal was lost at an early stage after release. Both release sites were protected and predators were present. Lorises were released during the wet season after they had undergone a 6-week quarantine, veterinary screens and treatment for parasites. Lorises were kept in a cage for between two days and 2 months, and were supplemented with food for between seven and 30 days. Bodies of dead animals were examined to determine the cause of death. The study does not distinguish between the effects of the different interventions mentioned above.

A site comparison in 2008–2012 in mosaic forest at two sites in South Vietnam (10b) found that all pygmy slow lorises *Nycticebus pygmaeus* that were released into habitat where the species was absent along with other interventions, either died or disappeared. All five lorises either died or their radio-collar signal was lost soon after release. Wild lorises were absent or had very low numbers at the sites. All lorises were quarantined for 6-weeks, were screened by vets and treated for parasites. Individual lorises were released alone. Three lorises were released during the dry season. Another two individuals were held in a semi-wild enclosure for one month to foster behaviour that would aid their survival in the wild. The latter were released during the wet season. Bodies of dead animals were examined to determine their cause of death. The study does not distinguish between the effects of the different interventions mentioned above.

A before-and-after trial in 2008–2010 in a tropical forest in Gabon (11) found that the majority of western lowland gorillas *Gorilla gorilla gorilla* that were reintroduced into habitat where the species was absent, along with ten other interventions, survived for at least nine months. Four out of five (80%) juvenile gorillas survived for at least nine months after release. Before release gorillas were allowed to adapt to local habitat conditions. Three captive-bred and two orphaned wild born individuals were reintroduced as a group into habitat with predators. Gorillas spent the night in an enclosure equipped with nesting platforms, nesting material, supplementary food and water. Gorillas were dewormed regularly on-site. Caretakers guided them into different forest patches on a daily basis. The study does not distinguish between the effects of the different interventions mentioned above.

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12.18. Reintroduce primates into habitat where the species is present

- Four before-and-after studies in Guinea[22] and the Republic of Congo[9,10,14] found that the majority of reintroduced chimpanzees survived for at least one to five years after reintroduction into habitat where the species was present, alongside other interventions. One study in Uganda[7] found that a reintroduced chimpanzee repeatedly returned to human settlements after reintroduction intro habitat where the species was present, alongside other interventions, while a study in Senegal[19] found that a reintroduced chimpanzee was reunited with its mother.
- One study in Malaysia[5] found that a majority of reintroduced orangutans survived reintroduction intro habitat where the species was present, alongside other interventions. One controlled study in Malaysia[17] found that a reintroduced population of orangutans had declined 33 years after reintroduction into habitat where the species was present, alongside other interventions.
- One study in Belize[4] found that primate population increased five years after reintroduction into habitat where the species was present, alongside other interventions, while one study in Thailand[2] found that primate population declined post-reintroduction.
- Six studies in Brazil[1], French Guiana[8,12], Indonesia[24], Madagascar[15], and South Africa[20] found that a minority of primates survived for at least fifteen weeks to seven years after reintroduction into habitat where the species was present, alongside other interventions. Five studies in Brazil[3], French Guiana[11], Gabon[18], and South Africa[22] found that a majority of primates survived for at least two months to one year.
- Two controlled studies in Madagascar[13] and Indonesia[17] found that reintroduced primates had similar diets to individuals in wild populations after reintroduction into habitat where the species was present, alongside other interventions. One controlled study in Indonesia[17] found that reintroduced primates showed similar behaviour to wild individuals after reintroduction into habitat where the species was present, alongside other interventions. One study in Brazil[6] found that a reintroduced chimpanzee rejoined a wild group after reintroduction into habitat where the species was present, alongside other interventions.

A before-and-after trial in 1984–1991 in coastal forest in Brazil (1) found that the majority of golden lion tamarins *Leontopithecus rosalia* that were reintroduced into habitat alongside 14 other interventions, did not survive for more than seven years. Fifty-eight of 91 reintroduced tamarins (64%) did not survive in the wild. Fifty-seven infants were born (reproductive rate=63%) of which 38 (67%) survived. All groups had encounters and exchanged vocalizations with wild tamarins and one reintroduced male reproduced with a wild female. Different groups of captive-bred or orphaned tamarins were introduced in different years into habitat with predators. Before release some tamarins were trained to facilitate their wild survival, provided with supplementary food, water and nesting boxes, and allowed to adapt to local habitat conditions. Tamarins were quarantined, underwent veterinary checks, and were treated for parasites before their release. Reintroduced sick or injured animals were rescued, treated and re-released. The reserve was officially protected in 1983. The study does not distinguish between the effects of the different interventions mentioned above.

A study, which was included in a review, in 1976–1977 in a protected forest in Thailand on captive lar gibbons *Hylobates lar* that were reintroduced, along with other interventions, (2) found that their population decreased by 6% and that no infants were born in the 17 months after release. No statistical tests were carried out to determine whether this decrease was significant. One male was recaptured, removed and treated after being injured by wild gibbons. Four gibbons joined wild groups. A total of 31 gibbons were introduced. Anaesthetized gibbons were either kept in separate cages for 14 days before release, or laid on the forest floor. Injured animals were recaptured and treated. In 1961, gibbons were officially protected by national legislation. The study does not distinguish between the effects of the different interventions mentioned above.

A before-and-after trial in 1994 in tropical forest in Brazil (3) found that the majority of golden lion tamarins *Leontopithecus rosalia* that were translocated from degraded forest patches to protected habitat already occupied by the species, survived for at least two months. All seven monkeys (five adults and two infants) that were captured and translocated survived for at least two months after their release and increased their range over time. No statistical tests were carried out to determine whether this increase was significant. Tamarins were captured by baited traps, weighed, tattooed and all adults were fitted with radio-collars before release. The study does not distinguish between the effects of the different interventions mentioned above.

A before-and-after trial in 1992–1997 in tropical forest in Belize (4) found that the population wild black howler monkeys *Alouatta pigra* that was reintroduced, alongside other interventions, increased over time. No statistical tests were carried out to determine whether this increase was significant. Survival rate for monkeys reintroduced in 1992–1994 after between one month and 2 years was 86–100%. Birth rate was 20% (12 monkeys) and infant survival rate was 75% (9 of 12 monkeys). After 5 years, the population had increased from 62 to >100 individuals. Social groups were reintroduced, and 10 of the 14 groups were held in cages before release into habitat. Before release all individuals were screened by vets, were individually and permanently marked, and adults were fitted with telemetry collars. Hunting was largely controlled in the area and the local community was educated about conservation through multimedia campaigns. The study does not distinguish between the effects of the different interventions mentioned above.

A study in 1993 in three tropical forest sites in Sabah, Malaysia (5) found that along with other interventions, translocation of orangutans *Pongo pygmaeus morio* to an area where resident orangutans lived resulted in the survival of 78 of 80 (98%) individuals. Orangutans were either immobilized in trees or captured manually on the ground with nets. Nets were used to catch animals falling from trees during capture. Before release orangutans were screened by vets and sick animals were treated. Females were kept in separate cages from offspring and adequate space was maintained between occupied cages during temporary holdings and transportation. The study does not distinguish between the effects of the different interventions mentioned above.

A study in 1994 in a tropical dry forest in Minas Gerais, Brazil (6) found that an abandoned infant muriqui *Brachyteles arachnoides* that was removed from its natural habitat and then returned, along with other interventions, was retrieved by its mother and re-joined the wild group. Twenty-seven hours after detection of the infant, it was released near its mother who retrieved it immediately and re-joined the group again. The 4-month old female infant muriqui was removed from the forest ground and was given a blanket for warmth, fed with milk and supplementary food, and some ectoparasites were removed for study. The study does not distinguish between the effects of the different interventions mentioned above.

A before-and-after-trial in 1995 in a montane forest in Uganda (7) found that a captive female, wild-born chimpanzee *Pan troglodytes schweinfurthii* that was, along with other interventions, reintroduced into a human-habituated community of wild chimpanzees, repeatedly returned to human settlements after its release and was subsequently returned to captivity. Eight days after its initial release, the chimpanzee left the forest for the first time and was returned to the forest. For the following ten days, it travelled, fed, nested and engaged in social activities with the wild community. During this time, it increased ranging distance to humans and use of height, and visually monitored humans less regularly. The chimpanzee was returned to captivity six weeks after her release. It underwent pre-release training for three weeks before reintroduction. During this time, it was tested for tuberculosis and was quarantined. The study does not distinguish between the effects of the different interventions mentioned above.

A study in 1994–1995 in a forest in French Guiana (8) found that less than half of the red howler monkeys *Alouatta seniculus* that were translocated and reintroduced into habitat already occupied by the species alongside other interventions, survived over 18 months. Of 16 females monitored only seven (44%) survived for 18 months. Two monkeys died from screwworm fly larvae infestations under radio-collars and one from trauma. Three of the 16 females gave birth after release, but all infants disappeared and probably died shortly afterwards. All females studied for longer than three months (50%) settled within the release area. Of the 11 documented translocated troops 10 (91%) broke apart after release. Overlapping home ranges and/or social interactions between translocated and resident animals were observed. Before release all animals were screened by vets, were allowed to adapt to local conditions, and were reintroduced in groups. The study does not distinguish between the effects of the different interventions mentioned above.

A before-and-after trial in 1996–1999 in a tropical rainforest in Conkouati Reserve, Republic of Congo (9) found that reintroduction of wild-born orphaned chimpanzees *Pan troglodytes troglodytes* alongside eight other interventions resulted in 70% survival after three and a half years. Ten percent of reintroduced chimpanzees were confirmed to have died after three and a half years but this was possibly as high as 30%. No adult females produced offspring. Chimpanzees fed on 137 different plant species, a variety in diet similar to wild chimpanzees, and had activity budgets that resembled those of wild chimpanzees. However, no tests were carried out to determine whether differences were statistically significant or not. Adult females associated regularly with wild males during periods of oestrus. Before reintroduction in groups, they spent 6–9 years on one of three forested islands in the region to acclimatize. Orphan chimpanzees were rehabilitated and fostered at a nearby sanctuary. After this, chimpanzees were screened by vets, were treated for endoparasites, and vaccinated. The study does not distinguish between the effects of the different interventions mentioned above.

A before-and-after trial in 1994–1999 in a tropical forest in Conkouati-Douli National Park, Republic of Congo (10) found that the majority of central chimpanzees *Pan troglodytes troglodytes* that, alongside 16 other interventions, were reintroduced into a habitat with resident wild chimpanzees survived for at least five years. Fourteen of the 20 (70%) reintroduced chimpanzees that had contact with resident wild chimpanzees, survived. No statistical tests were carried out to determine whether the population decrease was significant. Individuals were radio-collared and followed at distances of 5-100 m. Before being translocated rehabilitated orphaned chimpanzees were vaccinated, treated for parasites, and screened by vets. Staff members were present to monitor primate health, provide animals with additional food if necessary, and determine the cause of death of dead animals. The area was designated a national park in 1999. Local people were relocated from the release site to a nearby village. In some cases, local people were treated when sick or injured. TV and radio advertisements were used to raise awareness of chimpanzee conservation and local people were provided with monetary and non-monetary benefits in exchange for their conservation support. The study does not distinguish between the effects of the different interventions mentioned above.

A before-and-after trial in 1994–1995 in tropical forest in French Guiana (11) found that most of the translocated white-faced sakis *Pithecia pithecia* that were released into habitat with resident sakis along with other interventions, survived for at least four months. Two out of three translocated sakis survived for at least four months after release and one individual died after approximately 22 weeks. The female bonded with one of the two released males. Three out of six translocated sakis were monitored for 41 weeks after release. Sakis were captured using nets, tagged with radio transmitters and were screened by vets before release. When dead sakis were detected, the cause of death was determined. The study does not distinguish between the effects of the different interventions mentioned above.

A before-and-after trial in 1998–1999 in tropical forest on an island in French Guiana (12) found that a small number of squirrel monkeys *Saimiri scireus* that were reintroduced into a habitat already occupied by resident monkeys along with other interventions, survived for 15 weeks after reintroduction. Six of 14 released monkeys (43%) survived for 15 weeks. Two individuals died in release cages, and one was assumed to have been killed by resident squirrel monkeys. One month after release, five monkeys were rescued and brought back to captivity. All six remaining monkeys were wild-born. Eleven weeks after reintroduction, two resident monkeys entered the release group. Animals were kept as one group in a cage at the captive colony where two females gave birth. After transfer to the release site, they were held in an enclosure to adapt to local habitat conditions. The study does not distinguish between the effects of the different interventions mentioned above.

A controlled study in 1998–2001 in tropical forest in Madagascar (13a) found that captive-bred black-and-white ruffed lemurs *Varecia variegata variegata* that were reintroduced into habitat already occupied by the species, along with other interventions, did not have a similar diet to that of the resident wild group one year after release. Captive-bred lemurs (one male and two females) fed only on slightly more than half of the plant species (57 plant species) that the wild group (ten individuals) fed on (109 plant species). Captive-bred lemurs did not closely follow the dietary choices and seasonal changes in diet exhibited by the wild group, although no statistical tests were carried out to determine whether this difference was significant. Lemurs were released in groups and were provided with supplementary food. The study does not distinguish between the effects of the different interventions mentioned above.

A controlled study in 2001 in tropical forest in Madagascar (13b) found that captive-bred black-and-white ruffed lemurs *Varecia variegata variegata* that had limited free-ranging experience before they were reintroduced into habitat already occupied by the species, along with other interventions, had similar diets to that of the resident wild group. Reintroduced lemurs (three males and one female) fed on 54 species during a single year, as compared to the wild group (ten individuals) that fed on 109 species over four years. Reintroduced lemurs consumed less foliage than the wild group, although no statistical tests were carried out to determine whether this difference was significant. Lemurs were introduced in groups into habitat already occupied by the species and provided supplementary food during resource-scarce periods. The study does not distinguish between the effects of the different interventions mentioned above.

A controlled study in 1997–2001 in tropical forest in Betampona Reserve, Madagascar (13c) found that diets of captive-bred black-and-white ruffed lemurs *Varecia variegata variegata* that were born and raised in a free-ranging environment and were later reintroduced into habitat already occupied by the species along with other interventions, overlapped with that of the resident wild group. No statistical tests were carried out. Reintroduced lemurs (three males and two females) fed on 92 species over three years, while the wild group (ten individuals) fed on 109 species over four years. Reintroduced lemurs consumed less foliage throughout the study and less nectar in 1998 than the wild group did, although no statistical tests were carried out to determine whether this difference was significant. Two males died of malnutrition in 1998. Lemurs were introduced in groups and provided supplementary food during resource-scarce periods. The study does not distinguish between the effects of the different interventions mentioned above.

A before-and-after trial in 1996–2001 in a tropical forest in Republic of Congo (14) found that reintroduction, along with other interventions, resulted in the survival of the majority of 36 wild-born orphan chimpanzees *Pan troglodytes troglodytes* for at least 1-5 years. Twenty-six of 36 released animals survived, three died, and seven resulting in a minimum survival rate of 72%, with a possible 92%. One infant, whose parents were both released in 1996, was born in 2001. One released male was attacked by a wild male in 1997. Before reintroduction chimpanzees were rehabilitated on islands. Injured chimpanzees received veterinary care. After release, individuals were equipped with radio-transmitters and followed regularly by researchers to record data on cycling status, interactions with wild chimpanzees, and sexual behaviour. DNA extracted from hairs of all released chimpanzees and infants was analysed to determine parentage. The study does not distinguish between the effects of the different interventions mentioned above.

A before-and-after trial in 1997–2002 in tropical forest in Madagascar (15) found that reintroduction, along with 10 other interventions, resulted in the survival of less than half of all captive-bred, parent-reared black-and-white ruffed lemurs *Varecia variegata variegata* after five years. Five of 13 individuals (39%) survived in the wild and six individuals were born, of which four survived. One female and one male of the group reproduced with wild lemurs and the male became fully integrated into the wild group. Care was taken not to release lemurs within the home ranges of wild groups. Before reintroduction captive lemurs had limited semi-free-ranging experience, were screened by vets, were quarantined, and allowed to adapt to local habitat conditions. All released animals were fitted with radio transmitter collars for post-release monitoring. Released animals were recaptured and treated when sick and provided with supplementary food and water. When lemurs died their cause of death was determined. The study does not distinguish between the effects of the different interventions mentioned above.

A controlled study in 2002–2003 in lowland freshwater swamp forest in Borneo, Indonesia (16) found that wild-born, captive-raised Bornean agile gibbons *Hylobates albibarbis* reintroduced into habitat in which wild gibbons were present along with other interventions, shared a similar diet, spent similar amounts of time feeding, resting, and arm-swinging and at similar canopy heights as wild gibbons. However, wild gibbons spent more time singing, socializing, and travelling. Before reintroduction, gibbons were quarantined in enclosures (3 x 3 x 3 m) for at least 12 months, were screened by vets were allowed to socialize and acclimatize to the natural environment, and were supplemented with vitamins and leaves once a week. Only one reintroduced pair of gibbons was compared to a pair of wild gibbons at another site. The study does not distinguish between the effects of the different interventions mentioned above.

A controlled study in 1967–2004 in tropical forest in Kabili-Sepilok Forest Reserve, Malaysia (17) found that reintroduction, along with eight other interventions, resulted in a 33% decline in the population of reintroduced, rehabilitated orangutans *Pongo pygmaeus morio* after 33 years. Infant mortality (57%) was higher than in other wild and captive populations, and sex ratio at birth was strongly biased towards females (proportion of males=0.11) as compared to other wild and captive populations. However, the time between births (6.1 years) was shorter than in other orangutan subspecies or species in the wild and in captivity, but similar to wild populations of the same subspecies. Average age at first reproduction (11.6 years) was lower than in other wild and captive populations. Orangutans were continuously provided with supplementary food from 2-7 feeding platforms. Before release individuals underwent in-depth veterinary checks and were kept under quarantine for 90 days. Individuals were captured and treated when they displayed signs of injury or illness. Tourists were informed to keep >5 m from animals at all times. The study does not distinguish between the effects of the different interventions mentioned above.

A study in 2002–2006 in tropical forest in Gabon (18) found that approximately one third of captive-bred mandrills *Mandrillus sphinx* that were reintroduced into habitat occupied by wild mandrills, along with other interventions, had died one year after release. Mortality was 33% (12/36), with dependent infants being most affected. Fertility rate was 42% (5/12 females), and two of the five infants survived for longer than six months. Mortality decreased to 4% in the second year and fertility rate remained at 42% and all five infants born survived for at least six months. Their range remained limited during the first two years after release. In 2004, a solitary wild male took over the group, after which the group extended its range. Mandrills were reintroduced as a group into habitat with predators, allowed to adapt to local habitat conditions for some time, and treated for endoparasites before release. Supplementary feeding was provided until 2005. The study does not distinguish between the effects of the different interventions mentioned above.

A study in 2009 in savanna in Senegal (19) found that reintroducing into the wild of a confiscated 9-month old female infant chimpanzee *Pan troglodytes verus* resulted in succesul reunion with its mother in habitat where other resident wild chimpanzees occurred. Reintroduction was carried alongside other interventions. Four days after confiscation, the chimpanzee was released in the vicinity of its natal group, which retrieved it immediately. The infant's natal group was located and the infant was released close to the group. The infant was also treated for its injured eye. During handling of the infant surgical masks were worn and hands were sanitized when handling the infant and its food. The study does not distinguish between the effects of the different interventions mentioned above.

A before-and-after trial in 2007–2008 in a dry forest in KwaZulu-Natal, South Africa (20) found that vervet monkeys *Chlorocebus aethiops* that were reintroduced into habitat with resident vervets along with other interventions, survived for at least 10 months after reintroduction. Out of 35 monkeys released, six (17%) survived, 22 (63%) vervets went missing, and seven (20%) died. Two infants were born after release. Out of 24 vervets released in a second reintroduction, 12 (50%) survived, seven (29%) went missing, and five (21%) died. Both troops had aggressive interactions with resident vervets and wild males were seen near reintroduced monkeys several times. Before release, monkeys were checked by vets, and allowed to adapt to local environmental conditions. Monkeys received supplementary food and water after release. The study does not distinguish between the effects of the different interventions mentioned above.

A before-and-after trial in 2008–2010 in dry forest in Guinea (21) found that the majority of wild-born orphaned western chimpanzees *Pan troglodytes verus* that were reintroduced into habitat with wild chimpanzees along with other interventions, survived reintroduction and remained free-living for at least 27 months. One (8.3%) of the 12 released chimpanzees died. One female returned to the sanctuary voluntarily and one male was returned after suffering injuries during a recovery mission. Five chimpanzees (42%) remained together at the release site. Two infants were born, both of which survived. Another female immigrated and integrated into a wild chimpanzee community and three chimpanzees moved to an area away from the release site. One male was observed to have suffered injuries to his genitals and face that were presumably inflicted by resident wild chimpanzees. All reintroduced chimpanzees were screened for diseases before their release into habitat with predators. Some chimpanzees were allowed to acclimatize to local habitat conditions prior to release. Chimpanzees were initially supplemented with food on a daily-, and later on, a weekly basis. The study does not distinguish between the effects of the different interventions mentioned above.

A before-and-after trial in 2008 in a coastal forest in Kwazulu-Natal, South Africa (22) found that 62% of rehabilitated vervet monkeys *Chlorocebus aethiops* that were reintroduced into habitat already occupied by wild vervets along with other interventions, survived for at least six months. Five of 29 introduced individuals (17%) were reported dead. Of these, one died of predation and four were killed by domestic hunting dogs *Canis lupus familiaris*. Six individuals (21%) went missing. No females reproduced. Medical care was provided when necessary before release and while housed at the nearby rehabilitation centre. Before being released monkeys spent two nights in a release enclosure (49 m^2). Monkeys were provided daily supplementary food. The study does not distinguish between the effects of the different interventions mentioned above.

A before-and-after trial in 2006–2011 in tropical forest in Indonesia (23) found that very few reintroduced Javan slow lorises *Nycticebus javanicus* and greater slow lorises *N. coucang* that were released into habitat with resident lorises along with other interventions, survived for at least 146 and 22-382 days, respectively. Out of five reintroduced greater slow lorises, one survived for at least 146 days and out of 18 reintroduced Javan slow lorises, five individuals (28%) survived for at least 22–382 days. No interaction with wild lorises was reported. Before being released individually lorises were quarantined and screened by vets. Sick individuals were recaptured and treated. Twenty-one lorises were held in enclosures at the release site to adapt to local habitat where predators occurred. Bodies of dead lorises were examined to determine their cause of death. The study does not distinguish between the effects of the different interventions mentioned above.

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12.19. Reintroduce primates into habitat without predators

- One study in Tanzania found that a population of reintroduced chimpanzees increased over 16 years following reintroduction into habitat without predators.

A study in 1966–1985 on a forested island in Rubondo National Park, Tanzania (1) found that eastern chimpanzees *Pan troglodytes schweinfurthii* reintroduced into habitat devoid of predators along with other interventions, bred and increased in numbers from 17 to at least 20 individuals over 16 years. No statistical tests were carried out to determine whether this increase was significant. At least two males were shot after attacking game scouts. Two new-born infants were observed in 1968 and in 1985. All of the 17 reintroduced chimpanzees had been born in the wild and had spent time in captivity. Their age at the time of release varied from four to 12 years. Chimpanzees were released in four lots (from 1966 to 1969). Chimpanzees in the first release group were provided with supplementary food for two months. The study does not distinguish between the effects of the different interventions mentioned above.

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12.20. Reintroduce primates into habitat with predators

- Two before-and-after studies in Brazil[1, 2] found that most golden lion tamarins reintroduced into habitat with predators, alongside other interventions, did not survive over one to seven years but reproduced succesfully.
- Three studies, including two before-and-after studies, in the Congo[3], The Gambia[5] and Guinea[8], found that most chimpanzees reintroduced into habitat with predators, alongside other interventions, survived over one to five years[3, 8] or increased population numbers[8]. One before-and-after study in Gabon[13] found that most western lowland gorillas reintroduced into habitat with predators, alongside other interventions, survived over nine months.
- One before-and-after study in Madagascar[4] found that most black-and-white ruffed lemurs reintroduced into habitat with predators did not survive over five years. One study in Madagascar[7] found that all reintroduced lemurs survived over 30 months after being released into habitat with predators, along with other interventions.
- One study in Gabon[6] found that most mandrills reintroduced into habitat with predators, alongside other interventions, survived over 30 years.
- Two before-and-after studies in South Africa[9, 10] found that most vervet monkeys reintroduced into habitat with predators, alongside other interventions, survived over six months.
- Three studies, including one before-and-after study, in Vietnam[11a, 11b] and Indonesia[12] found that most lorises reintroduced into habitat with predators, alongside other interventions, were assumed dead within approximately one year after being released.
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A before-and-after trial in 1954–1985 in a rainforest in Poço das Antas Reserve, Brazil (1) found that translocation, alongside nine other interventions, led to a decline within one year of the population of captive-born golden lion tamarin *Leontopithecus rosalia* released into habitat with natural predators. No statistical tests were carried out to determine whether this decrease was significant. Of the 14 individuals released, seven died and two were removed. Three infants were born, one of which died due to illness. Eight individuals were released as a family group and six individuals were released as pairs one month later. Tamarins were placed in enclosures measuring 15 x 4.5 x 3 m to acclimatize. Tamarins were habituated to humans and fostered to aid survival in the wild. Sick or injured tamarins were captured and treated in a nearby rehabilitation centre. Reintroduced tamarins were supplied with food for ten months after their release. Artificial nesting boxes, which were hollow logs provided to tamarins during training, were also set up in the reserve. The study does not distinguish between the effects of the different interventions mentioned above.

A before-and-after trial in 1984–1991 in coastal forest in Poço das Antas Reserve, Brazil (2) found that the majority of golden lion tamarins *Leontopithecus rosalia* that were reintroduced into habitat with predators along with 14 other interventions, did not survive over seven years. Fifty-eight of 91 (64%) reintroduced tamarins did not survive in the wild. Over seven years 57 infants were born (reproductive rate=63%) of which 38 (67%) survived. Six reintroduced tamarins were killed by predators, but none of the wild-born offspring fell prey to predators. Different groups of captive-bred or orphaned tamarins were introduced in different years into habitat where the species was already present. All tamarins were quarantined, underwent veterinary checks and were treated for parasites before release. Reintroduced sick or injured animals were rescued, treated and re-released. Some groups were trained in behaviours that would aid their survival, provided with supplementary food, water and nesting boxes, and allowed to adapt to local habitat conditions before release. The reserve forest was officially protected in 1983. The study does not distinguish between the effects of the different interventions mentioned above.

A before-and-after trial in 1996–2001 in a tropical forest in Conkouati-Douli National Park, Republic of Congo (3) found that the majority of 36 wild-born orphan chimpanzees *Pan troglodytes troglodytes* that were reintroduced into habitat with predators along with other interventions, survived for at least 1-5 years. Twenty-six of 36 chimpanzees survived and only three were confirmed dead, of which none were reported to have been killed by predators. The remaining seven chimpanzees disappeared, resulting in a minimum survival rate of 72%, with a possible 92%. One infant, whose parents were both released in 1996, was born in 2001. Chimpanzees were rehabilitated on islands before their introduction into habitat already occupied by wild chimpanzees. After release, individuals were equipped with radio transmitters and followed regularly by local staff to record data on cycling status, interactions with resident wild chimpanzees, and sexual behaviour. Parentage was determined by analysing DNA extracted from hairs of all released chimpanzees and infants. Injured chimpanzees received veterinary care. The study does not distinguish between the effects of the different interventions mentioned above.

A before-and-after trial in 1997–2002 in forest in Betampona Reserve, Madagascar (4) found that less than half of all captive-bred, parent-reared black-and-white ruffed lemurs *Varecia variegata variegate* that were reintroduced into habitat with predators along with ten other interventions, survived for five years. Five of 13 individuals (39%) survived in the wild and six (46%) individuals were born, of which only four survived. One female and one male of the group reproduced and the male became fully integrated into the wild group. One male and one female were killed by a predator. Before release lemurs were allowed to adapt to local habitat conditions. All released animals were fitted with radio transmitter collars for post-release monitoring. Captive lemurs had limited semi-free-ranging experience, were quarantined, and underwent veterinary screens before their reintroduction in groups into habitat where the species was already present. Lemurs were recaptured and treated when sick and provided with supplementary food and water. Dead lemurs were detected and their cause of death determined. The study does not distinguish between the effects of the different interventions mentioned above.

A study in 1979–2004 in tropical forest in River Gambia National Park, The Gambia (5) found that rehabilitated western chimpanzees *Pan troglodytes verus* that were reintroduced into habitat with small populations of natural predators, alongside other interventions, increased from 50 to 69 chimpanzees over 25 years. No statistical tests were carried out to determine whether this increase was significant. Fertility and mortality rates were similar to wild chimpanzee populations, except for infant mortality (18%), which was lower. Time between births, average age at first birth, proportion of males at birth, age at first sexual swelling in females, and adolescent infertility, were similar to wild chimpanzees. In total, 50 chimpanzees were released on three islands. Individuals were reintroduced in groups and into habitat with no wild or previously reintroduced chimpanzees. Chimpanzees were provided supplementary food daily or every second day, depending on which one of the islands they lived on. Individuals received periodic deworming, and were given antibiotic treatment when they suffered from severe colds. The study does not distinguish between the effects of the different interventions mentioned above.

A study in 2002–2006 in tropical forest in Lékédi Park, Gabon (6) found that around one third of captive-bred mandrills *Mandrillus sphinx* that were reintroduced into habitat with predators along with other interventions, died within one year. Mortality was 33% (12/36), with dependent infants being most affected. Fertility rate was 42% (5/12 females), where two of the five infants survived for longer than six months. Mortality decreased to 4% in the second year and fertility rate remained at 42%, but all five infants born survived for at least six months. Their range remained limited during the first two years after release. Mandrills were reintroduced as a group into habitat already occupied by the species. Before release mandrills were allowed to adapt to local habitat conditions, and were treated for endoparasites. Mandrills received supplementary feeding until 2005. The study does not distinguish between the effects of the different interventions mentioned above.

A before-and-after trial in 2006–2007 in rainforest in Analamazaotra Special Reserve, Madagascar (7) found that habituated black-and-white ruffed lemurs *Varecia variegata variegata* and diademed sifakas *Propithecus diadema* survived for at least 30 months and reproduced after they were translocated from disturbed sites to undisturbed habitat with natural predators along with other interventions. No deaths of black-and-white ruffed lemurs were recorded over a 30-month observation period and one diademed sifaka died from natural causes. Four sets of black-and-white ruffed lemurs (reproductive rate=57%) and seven diademed sifaka infants were born (reproductive rate=26%), the latter of which only two survived. Two to eight months before a translocation was carried out, lemurs were darted and underwent veterinary checks. Released primates were habituated to human presence and relocated and monitored with the aid of radio-collars. A total of seven black-and-white ruffed lemurs and 27 diademed sifakas were captured at four disturbed forest sites and released in their social units to the reserve where the species had become locally extinct. The study does not distinguish between the effects of the different interventions mentioned above.

A before-and-after trial in 2008–2010 in dry forest in Haut Niger National Park, Guinea (8) found that the majority of wild-born orphaned western chimpanzees *Pan troglodytes verus* that were reintroduced into habitat with predators, along with other interventions, survived reintroduction and remained free-living for at least 27 months. One of 12 released chimpanzees died after failing to recover from anaesthesia during a recovery mission. One female returned to the sanctuary voluntarily and one male was returned after suffering injuries during another recovery mission. Five chimpanzees remained together at the release site and two infants were born both of which survived. Another female immigrated into a wild chimpanzee community and three chimpanzees moved to an area away from the release site. Although predators are present in the forest no observations of attacks on chimpanzees were made. Before release chimpanzees were screened for diseases and some chimpanzees were allowed to acclimatize to local habitat conditions. Chimpanzees were initially supplemented with food on a daily-, and later on, a weekly basis. The study does not distinguish between the effects of the different interventions mentioned above.

A before-and-after trial in 2009–2010 in coastal Ngume Forest, South Africa (9) found that more than half of the captive, wild-born vervet monkeys *Chlorocebus aethiops* that were reintroduced into habitat with predators, survived for at least six months after release. Three of the 16 reintroduced monkeys (19%) were reported dead. Of these, two were killed by natural predators and one by hunting dogs *Canis lupus familiaris*. Four individuals (25%) went missing. One infant was born two weeks after release. Monkeys were introduced as a troop of 16 individuals into habitat where the species was absent. To acclimatize, monkeys spent one day in a release enclosure (49 m^2). Monkeys were provided supplementary food twice a day for two weeks and once a day for a further three weeks after release. The release site was nationally protected. The study does not distinguish between the effects of the different interventions mentioned above.

A before-and-after trial in 2008 in a coastal forest in Isishlengeni Game Farm, Kwazulu-Natal, South Africa (10) found that that over 60% of rehabilitated vervet monkeys *Chlorocebus aethiops* that were reintroduced into habitat with predators, along with other interventions, survived for at least six months. Five of 29 introduced individuals (17%) were killed by predators. Six individuals (21%) went missing. No females reproduced. Monkeys were introduced as a troop of 29 individuals into habitat already occupied by the species. To acclimatize, monkeys spent two nights in a release enclosure (49 m^2). Monkeys were provided with supplementary food. Medical care was provided when necessary before release and while housed at the nearby rehabilitation centre. The study does not distinguish between the effects of the different interventions mentioned above.

A site comparison in 2008–2012 in two forests in Dao Tien Island (DTI) and mixed forest in Dong Nai Biosphere Reserve (DNBR), south Vietnam (11a) found that hyalf of pygmy slow lorises *Nycticebus pygmaeus* that were released into habitat with predators, along with eight other interventions, survived for at least two months. Four out of eight lorises survived for at least two months after release, whereas the remaining lorises died or their radio-collar signal was lost. Both release sites were protected and no wild resident lorises occurred there. Lorises were released during the wet season after all of them had undergone a 6-week quarantine, veterinary screens and treatment for parasites. Lorises were kept in a cage for between two days and two months, and were fed supplementary food for seven or 30 days. Bodies of dead animals were examined to determine their cause of death. The study does not distinguish between the effects of the different interventions mentioned above.

A site comparison in 2008–2012 in two forest sites in Cat Tien National Park, Vietnam (11b) found that all pygmy slow lorises *Nycticebus pygmaeus* that were released into habitat with predators along with other interventions either died or disappeared. Three of five reintroduced lorises were killed by predators and the radio collar signal of two lorises was lost at an early stage after release. Before release all lorises underwent a 6-week quarantine, veterinary screens, and treatment for parasites. Lorises were released into habitat with no resident wild lorises. Three lorises were released during the dry season. Another two individuals were held in a semi-wild enclosure for one month to foster behaviour that would facilitate their survival in the wild, and then released during the wet season. Bodies of dead animals were examined to determine the cause of death. The study does not distinguish between the effects of the different interventions mentioned above.

A before-and-after trial in 2006–2011 in tropical forest at Gunung Halimun Salak National Park and Batutegi Nature Reserve, Indonesia (12) found that few reintroduced Javan slow lorises *Nycticebus javanicus* and greater slow lorises *N. coucang* that were released into habitat with predators along with other interventions, survived for at least 146 and 22-382 days, respectively. One of five reintroduced greater slow lorises survived for at least 146 days and five of 18 reintroduced Javan slow lorises, survived for at least 22-382 days. Three greater slow lorises were killed by predators. Before release, lorises underwent quarantine and veterinary screens. Sick individuals were recaptured and treated. Twenty-one lorises were held in enclosures at the release site to adapt to local habitat where wild individuals occurred. Bodies of dead lorises were examined to determine their cause of death. The study does not distinguish between the effects of the different interventions mentioned above.

A before-and-after trial in 2008–2010 in a tropical forest in Batéké Plateau National Park, Gabon (13) found that the majority of western lowland gorillas *Gorilla gorilla gorilla* that were reintroduced into habitat with predators along with ten other interventions, survived for at least nine months. Four of five juvenile gorillas survived for at least nine months after release. One juvenile was killed by a wild chimpanzee. Before reintroduction chimpanzees spent the night in an enclosure equipped with nesting platforms, nesting material, supplementary food and water. Three captive-bred and two orphaned wild born individuals were reintroduced as a group into habitat where the species was absent. Gorillas were dewormed regularly on-site. Caretakers guided gorillas into different forest patches on a daily basis. The study does not distinguish between the effects of the different interventions mentioned above.

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variegate editorum) at Analamazaotra Special Reserve, eastern Madagascar. *Lemur News*, 14, 32–37.
(8) Humle T., Colin C., Laurans M. & Raballand E. (2011) Group release of sanctuary chimpanzees (*Pan troglodytes*) in the Haut Niger National Park, Guinea, West Africa: ranging patterns and lessons so far. *International Journal of Primatology*, 32, 456–473.
(9) Guy A.J., Stone O.M. & Curnoe D. (2012) Assessment of the release of rehabilitated vervet monkeys into the Ntendeka Wilderness Area, KwaZulu-Natal, South Africa: a case study. *Primates*, 53, 171–179.
(10) Guy A.J. (2013) Release of rehabilitated *Chlorocebus aethiops* to Isishlengeni Game Farm in KwaZulu-Natal, South Africa. *Journal for Nature Conservation*, 21, 214–216.
(11) Kenyon M., Streicher U., Loung H., Tran T., Vo B. & Cronin A. (2014) Survival of reintroduced pygmy slow loris *Nycticebus pygmaeus* in South Vietnam. *Endangered Species Research*, 25, 185–195.
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(13) Le FLohic G., Motsch P., DeNys H., Childs S., Courage A. & King T. (2015) Behavioural ecology and group cohesion of juvenile western lowland gorillas (*Gorilla g. gorilla*) during rehabilitation in the Batéké Plateaux National Park, Gabon. *PLoS ONE*, 10, e0119609.

Ex-situ conservation

12.21. Captive breeding and reintroduction of primates into the wild: born and reared in cages

- One before-and-after study in Brazil[1] found that most reintroduced golden lion tamarins that were born and reared in cages, alongside other interventions, did not survive over seven years[1a] or had a higher mortality than wild-born tamarins[1b].
- One controlled study in French Guiana[2] found that more squirrel monkeys which were born and reared in cages, alongside other interventions, died or were returned to captivity post-reintroduction compared to wild-born monkeys.
- One controlled study in Madagascar[3] found that the diet of reintroduced black-and-white ruffed lemurs which were born and reared in cages, alongside other interventions, did not overlap with that of wild lemurs.

Background

In this synopsis, we include captive breeding of primates and the subsequent release of individuals into the wild, but not captive breeding *per se*, because it does not benefit populations of wild primates, unless captive individuals are reintroduced into the wild. The type of holding facilities in which primates are raised, ranging from cages to environments where they can range relatively freely, may influence their likelihood of survival in the wild. We therefore separated the scientific evidence for captive breeding and subsequent reintroductions into three different interventions, which refer to different methodological approaches (see sections 12.21-12.23):

1) 'Captive breeding and reintroduction of primates into the wild: Born and reared in cages'

2) 'Captive breeding and reintroduction of primates into the wild: Limited free-ranging experience'

3) 'Captive breeding and reintroduction of primates into the wild: Born and raised in a free-ranging environment'

A before-and-after trial in 1984-1991 in coastal forest in Poço das Antas Reserve, Brazil (1a) found that over 60% of captive-bred golden lion tamarins *Leontopithecus rosalia* that were reintroduced into the wild alongside 14 other interventions, did not survive over seven years. Fifty-eight (64%) out of 91 reintroduced tamarins did not survive in the wild. However, 57 infants were born (reproductive rate=63%) during this period, of which 38 (67%) survived. In contrast to the wild-born orphaned tamarins, captive-born tamarins never became independent of food and water provisioning and daily management. Captive-bred or orphaned tamarins were introduced in different years into habitat already occupied by the species and predators. Some groups were trained in behaviours that facilitate survival, were provided supplementary food, water and nesting boxes, and allowed to adapt to local conditions before release. Tamarins were quarantined, underwent veterinary checks and were treated for parasites before release. Sick or injured animals were rescued, treated and re-released. The reserve became officially protected in 1983. The study does not distinguish between the effects of the different interventions mentioned above.

A controlled study in 1984-1991 in coastal forest in Poço das Antas Reserve, Brazil (1b) found that more wild-born lion tamarins *Leontopithecus rosalia* survived after reintroduction into the wild than captive-bred tamarins. No statistical tests were carried out to determine whether this difference was significant. Twenty-nine (34%) of 85 and four (67%) of six reintroduced captive-bred and wild-born tamarins were still alive in 1991, respectively. Captive-bred and wild-born animals survived for between 1-83 months and 43-75 months, respectively. Furthermore, captive-born tamarins depended on daily provisioning and health monitoring whereas wild-born tamarins were independent of supplementary food or managing. Wild-born tamarins had been taken by poachers and lived in private homes before they were confiscated. Captive-bred tamarins were retrieved from the National Zoological Park in Washington DC and transferred to the Rio de Janeiro Primate Centre before release.

A controlled study in 1998-1999 in tropical forest on an island in French Guiana (2) found that wild-born squirrel monkeys *Saimiri sciureus* survived for at least 15 weeks, whereas all captive-born monkeys either died or were returned to captivity. All of six wild-born monkeys survived for at least 15 weeks. In contrast, three out of eight captive-born monkeys died and five were returned to captivity. Two individuals died of starvation in release cages, and another was probably killed by resident wild monkeys. One month after release, the remaining five captive-born monkeys were captured and brought back to captivity.

A controlled study in 1998-2001 in tropical forest in Betampona Reserve, Madagascar (3) found that diets of captive-bred, reintroduced black-and-white ruffed lemurs *Varecia variegata variegata* that were born and reared in cages along with other interventions, did not overlap with that of the resident wild group in the first year after release. Captive-bred lemurs (one male and two females) fed only on approximately half of the plant species (N=57) that the wild group (ten individuals) fed on (N=109). Captive-bred lemurs did not closely follow the dietary choices and seasonal changes exhibited by the wild group, although no statistical tests were carried out to determine whether this difference was significant. Reintroduced lemurs were born and raised in cages at zoos and had limited (several months) free-ranging experience at a sanctuary before release. They were released in groups into habitat already occupied by the species and were provided with supplementary food during three years. The study does not distinguish between the effects of the different interventions mentioned above.

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(2) Vogel I., Glöwing B., Saint Pierre I., Bayart F., Contamin H. & de Thoisy B. (2002). Squirrel monkey (*Saimiri scireus*) rehabilitation in French Guiana: A case study. *Neotropical Primates*, 10, 147–149.
(3) Britt A. & Iambana B.R. (2003) Can captive-bred *Varecia variegata variegata* adapt to a natural diet on release to the wild? *International Journal of Primatology*, 24, 987–1005.

12.22. Captive breeding and reintroduction of primates into the wild: limited free-ranging experience

- One controlled study in Madagascar[1] found that the diet of reintroduced black-and-white ruffed lemurs with limited free-ranging experience, alongside other interventions, overlapped with that of wild lemurs. One before-and-after study in Madagascar[2] found that most reintroduced black-and-white ruffed lemurs with limited free-ranging experience, alongside other interventions, died over five years.
- One before-and-after and site comparison[3] and one before-and-after[4] studies in the Republic of Congo and Gabon found that most reintroduced western lowland gorillas with limited free-ranging experience, alongside other interventions, survived over a period of between 9 months and four years.

A controlled study in 2001 in tropical forest in Betampona Reserve, Madagascar (1) found that diets of captive-bred, reintroduced black-and-white ruffed lemurs *Varecia variegata variegata* with limited free-ranging experience along with other interventions, overlapped with that of the resident wild group. No statistical tests were carried out to determine whether this overlap was significant. Reintroduced lemurs (three males and one female) fed on 54 species during one year, whereas the wild group (ten individuals) fed on 109 species over four years. Reintroduced lemurs consumed less foliage than the wild group, although no statistical tests were carried out to determine whether this difference was significant. The female was born and raised in a cage at a zoo and had two years of free-ranging experience at a sanctuary before release, while all males were born and raised in a free-ranging environment at the sanctuary. Lemurs were introduced in groups into habitat already occupied by the species and were provided supplementary food during resource-scarce periods only. The study does not distinguish between the effects of the different interventions mentioned above.

A before-and-after trial in 1997-2002 in primary forest in Betampona Reserve, Madagascar (2) found that less than half of all captive-bred, parent-reared reintroduced black-and-white ruffed lemurs *Varecia variegata variegata*, which had limited semi-free-ranging experience alongside ten other interventions, survived five years. Five (38.5%) of 13 individuals survived after release and six individuals were born, of which only four survived. One female and one male reproduced with resident wild lemurs and the male became fully integrated into the wild group. Lemurs were held in outside (1.5-9.1 ha fenced forest) in the USA before reintroduction. Released animals were fitted with radio transmitters. Lemurs underwent quarantine and health checks before reintroduction in groups into habitat with predators and resident wild lemurs. They were recaptured and treated when sick and provided with supplementary food and water. They were allowed to adapt to local conditions before release. Cause of death of dead lemurs was clinically determined. The study does not distinguish between the effects of the different interventions mentioned above.

A before-and-after, site comparison study in 1996-2006 in tropical forests of Lesio-Louna Wildlife Reserve, Republic of Congo (Congo) and Batéké Plateau National Park, Gabon (3) found that the majority of reintroduced western lowland gorillas *Gorilla gorilla gorilla* including captive bred individuals alongside 14 other interventions, survived for at least four years and some reproduced. Twenty-one (84%) of 25 gorillas released in Congo and 22 (85%) of 26 gorillas released in Gabon survived for at least four years. Nine females gave birth to 11 infants, of which nine survived. One individual of the Congo group was born in captivity and seven of the Gabon group came from captive-breeding facilities. Forty-three individuals were rehabilitated wild-born orphaned gorillas. Prior to release, gorillas underwent quarantine, health checks and received preventative vaccinations. Gorillas were released in groups and allowed to adapt to local environment and supplemented with food before release. Gorillas were released into habitat with no resident gorillas. Gorillas were treated for parasites and when sick. So-called 'problem'-animals were removed and relocated. Dead gorillas were clinically examined. Both sites were proclaimed protected areas before reintroduction. The study does not distinguish between the effects of the different interventions mentioned above.

A before-and-after trial in 2008-2010 in a tropical forest-grassland mosaic at Batéké Plateau National Park, Gabon (4) found that all captive-bred reintroduced western lowland gorillas *Gorilla gorilla gorilla* along with ten other interventions, survived for at least nine months. Three hand-reared juvenile gorillas from captive-breeding facilities in the UK were reintroduced into habitat with predators and without resident wild gorillas. They were allowed to adapt to local conditions for some time. They spent the night in an enclosure equipped with nesting platforms, nesting material, supplementary food and water. Gorillas were dewormed regularly on-site. Caretakers guided them into different forest patches on a daily basis. The study does not distinguish between the effects of the different interventions mentioned above.

(1) Britt A. & Iambana B.R. (2003) Can captive-bred *Varecia variegata variegata* adapt to a natural diet on release to the wild? *International Journal of Primatology*, 24, 987–1005.

(2) Britt A., Welch C., Katz A., Iambana B., Porton I., Junge R., Crawford G., Williams C. & Haring D. (2004) The re-stocking of captive-bred ruffed lemurs (*Varecia variegata variegata*) into the Betampona Reserve, Madagascar: methodology and recommendations. *Biodiversity and Conservation*, 13, 635–657.

(3) King T., Chamberlan C. & Courage A. (2012) Assessing initial reintroduction success on long-lived primates by quantifying survival, reproduction, and dispersal parameters: western lowland gorillas (*Gorilla gorilla gorilla*) in Congo and Gabon. *International Journal of Primatology*, 33, 134–149.
(4) Le FLohic G., Motsch P., DeNys H., Childs S., Courage A. & King T. (2015) Behavioural ecology and group cohesion of juvenile western lowland gorillas (*Gorilla g. gorilla*) during rehabilitation in the Batéké Plateaux National Park, Gabon. *PLoS ONE*, 10, e0119609.

12.23. Captive breeding and reintroduction of primates into the wild: born and raised in a free-ranging environment

- One before-and-after study in Brazil[1] found that only two out of three reintroduced black lion tamarins survived over four months, despite being raised in a free-ranging environment, alongside other interventions.
- One controlled study in Madagascar[2] found that the diet of reintroduced black-and-white ruffed lemurs that were born and raised in a free-ranging environment alongside other interventions, overlapped with that of wild lemurs.

A study in 1999 in tropical forest of Morro do Diabo State Park, São Paulo, Brazil (1) found that only some of the wild and captive-bred black lion tamarins *Leontopithecus chrysopygus* that were reintroduced along with other interventions, survived for at least four months. Four months after release of three individuals, one captive-bred male died. The captive-born male was bred in a free-ranging environment, whereas the two females had been captured from the release site, forming a group of three individuals. To facilitate reintroduction, the male had been fostered natural behaviour. The male was treated when sick. Tamarins underwent veterinary screens before translocation to an enclosure at the release site where they could adapt to the local environment where predators occurred. Monkeys were fitted with radio-transmitters and supplemented with food. The study does not distinguish between the effects of the different interventions mentioned above.

A controlled study in 1997-2001 in tropical forest in Betampona Reserve, Madagascar (2) found that diets of captive-bred, reintroduced black-and-white ruffed lemurs *Varecia variegata variegata* that were born and raised in a free-ranging environment along with other interventions, overlapped with that of the resident wild group. No statistical tests were carried out to determine whether this difference was significant. Reintroduced lemurs (three males and two females) fed on 92 species over three years, as compared to the wild group (ten individuals) that fed on 109 species over four years. Furthermore, reintroduced lemurs consistently consumed less foliage throughout the study and less nectar in 1998 than the wild group did, although no statistical tests were carried out to determine whether this difference was significant. Two males (66%) died of malnutrition in 1998. Lemurs were born and raised in a free-ranging environment at a sanctuary before their reintroduced. Lemurs were introduced in groups into habitat already occupied by the species and provided supplementary food during resource-scarce periods. The study does not distinguish between the effects of the different interventions mentioned above.

(1) Valladarez-Padua C., Martins C.S., Wormell D. & Setz E. (2000) Preliminary evaluation of the reintroduction of a mixed wild-captive group of black lion tamarins *Leontopithecus chrysopygus*. *Dodo*, 36, 30–38.
(2) Britt A. & Iambana B.R. (2003) Can captive-bred *Varecia variegata variegata* adapt to a natural diet on release to the wild? *International Journal of Primatology*, 24, 987–1005.

12.24. Rehabilitate injured/orphaned primates

- One before-and-after study in Brazil[1] found that most reintroduced golden lion tamarins did not survive over seven years, despite being rehabilitated, alongside other interventions. Two before-and-after studies in South Africa[9,11] found that most reintroduced vervet monkeys survived over six months after being rehabilitated before release, alongside other interventions.
- Two before-and-after studies in the Republic of Congo[2,3] found that most reintroduced chimpanzees survived over 3.5–5 years after undergoing pre-release rehabilitation, alongside other interventions. One study in The Gambia[5] found that numbers of reintroduced chimpanzees that underwent pre-release rehabilitation, alongside other interventions, increased by 38% over 25 years.
- One review on bonobos, chimpanzees and gorillas in 13 African countries[4] found that rehabilitated bonobos living in sanctuaries did not reproduce but the reproductive rate of chimpanzees was 14% and of gorillas was 2%.
- One controlled study in Indonesia[6] found that Bornean agile gibbons that were rehabilitated before release, alongside other interventions, behaved similarly to wild gibbons.
- One controlled study in Malaysia[7] found that numbers of reintroduced orangutans decreased by 33% over 33 years, despite orangutans being rehabilitated before release. One controlled study in Indonesia[8] found that most translocated orangutans that were rehabilitated before release, along with other interventions, survived over three months.
- One before-and-after, side comparison study in the Congo and Gabon[10] found that most western lowland gorillas that were rehabilitated before release, alongside other interventions, survived over four years. One before-and-after study in Gabon[12] found that one out of two western lowland gorillas that were reintroduced died despite being rehabilitated, alongside other interventions.

Background

When primates are injured or orphaned, rehabilitating them (e.g. at a sanctuary or other facility) may increase their chance of survival. For example, primate infants are frequently captured to be sold via the illegal pet trade and many such primates underwent severe physiological and psychological stressors and thus need intensive care after being confiscated. Rehabilitation can include all activities from rescuing injured/orphaned primates, providing medical/psychological care, raising orphans, to fostering behaviour and reintroducing them back into the wild.

The fostering of certain behaviours to facilitate the species' survival in the wild (e.g. foraging, hunting, nest building, climbing) is discussed separately under ‘Fostering appropriate behaviour to facilitate rehabilitation’ and the reintroduction of primates back into the wild, using slightly different methodologies, is discussed under ‘Reintroduce primates in groups’, ‘Reintroduce primates as single/multiple individuals’, ‘Reintroduce primates into habitat where the species is absent’, ‘Reintroduce primates into habitat where the species is present’, ‘Reintroduce primates into habitat without predators’ and ‘Reintroduce primates into habitat with predators’.

A before-and-after trial in 1984-1991 in coastal forest in Poço das Antas Reserve, Brazil (1) found that over 60% of orphaned and rehabilitated golden lion tamarins *Leontopithecus rosalia* that were reintroduced into the wild alongside 14 other interventions, did not survive seven years. Fifty-eight (64%) out of 91 reintroduced tamarins did not survive over seven years. However, 57 infants were born (reproductive rate=63%), of which 38 (67%) survived. In contrast to the wild-born orphaned tamarins, captive-born tamarins never became independent of food and water provisioning and daily management. Different groups of captive-bred or orphaned tamarins were introduced in different years into habitat already occupied by the species and predators. Some groups were trained in behaviours that would facilitate survival, were provided with supplementary food, water and nesting boxes, and allowed to adapt to local conditions before release. Tamarins underwent quarantine, health checks and parasite treatment before release. Sick or injured animals were captured, treated and re-released. The reserve became officially protected in 1983. The study does not distinguish between the effects of the different interventions mentioned above.

A before-and-after trial in 1996-1999 in tropical rainforest in Conkouati Reserve, Republic of Congo (2) found that 14 out of 20 (70%) reintroduced wild-born orphaned chimpanzees *Pan troglodytes troglodytes* that were rehabilitated were still alive 3.5 years after release. Estimated mortality was 10-30%. None of the adult females reproduced. Chimpanzees fed on 137 different plant species, a variety similar to wild chimpanzees, and had activity budgets that resembled those of wild chimpanzees. No statistical tests were carried out to determine whether similarities were statistically valid. Orphan chimpanzees were rehabilitated and fostered at a sanctuary. Chimpanzees underwent veterinary screens, endoparasite treatments, and were vaccinated for poliomyelitis and tetanus. Before reintroduction in groups into habitat with low densities of resident wild chimpanzees, individuals spent 6-9 years on one of three forested islands in the region to acclimatize. Researchers were permanently on-site and monitored chimpanzees with radio-collars. The study does not distinguish between the effects of the different interventions mentioned above.

A before-and-after trial in 1994-1999 in tropical forest in Conkouati-Douli National Park, Republic of Congo (3) found that the majority of rehabilitated orphaned chimpanzees *Pan troglodytes troglodytes* that were reintroduced along with 16 other interventions, survived for at least five years. Out of 20 reintroduced chimpanzees that were rehabilitated and socialized with other orphan chimpanzees in a sanctuary before release, 14 (70%) survived. No statistical tests were carried out to determine whether this decrease was significant. Individuals were radio-collared and followed at distances of 5-100 m. Chimpanzees underwent vaccination, parasite treatments and veterinary screens before being translocated in four subgroups to the release site with resident wild chimpanzees. Staff members were present to monitor health conditions, provide additional food when needed, and to examine dead animals. The area's status was upgraded from reserve to national park in 1999. Local people were relocated from the release site to a nearby village. Some individuals were treated when sick or injured. TV and radio were used to raise awareness and local people were provided monetary and non-monetary benefits in exchange for their conservation support. The study does not distinguish between the effects of the different interventions mentioned above.

A review in 1970-2001 on wild-born captive bonobos *Pan paniscus*, chimpanzees *Pan troglodytes*, and gorillas *Gorilla* spp. in 17 sanctuaries in 13 African countries (4) found that bonobos did not produce offspring, but that overall reproductive rate of chimpanzees and gorillas in sanctuaries was 14% and 2%, respectively. In addition, 20% of great apes died prematurely. Only eight of the 17 sanctuaries in this study did not use birth control. Data were recorded with questionnaires distributed to sanctuary representatives via email. Only sanctuaries that were members of the Pan-African Sanctuary Alliance were included in the study. A total of 549 great apes were housed at the sanctuaries over the study period.

A study in 1979-2004 in tropical forest on Baboon Islands, River Gambia National Park, The Gambia (5) found that reintroduced western chimpanzees *Pan troglodytes verus* that were rehabilitated before releases along with other interventions, increased from 50 to 69 chimpanzees over 25 years. No statistical tests were carried out to determine whether this increase was significant. Fertility and mortality rates were similar to that of wild chimpanzees. However, infant mortality (18%) was lower than in wild populations. Other reproductive parameters were similar to those of wild chimpanzees. In total, 50 chimpanzees with various backgrounds and exposure to human care and handling were released on three islands. Nine of these had been received from traders, nursed back to health, and regularly taken into the forest for five years before being moved to Niokolo Koba National Park in Senegal, where they stayed for five years before being released to River Gambia National Park. Individuals were reintroduced in groups and into habitat with no chimpanzees but with predators (although these were rare) . They were provided with supplementary food daily or every second day. Individuals received periodic deworming, and were given antibiotic for severe colds. The study does not distinguish between the effects of the different interventions mentioned above.

A controlled study in 2002-2003 in a swamp forest in Mintin Island, Borneo, Indonesia (6) found that wild-born, captive-raised Bornean agile gibbons *Hylobates albibarbis* that were rehabilitated before release into the wild along with other interventions, shared a similar diet, spent similar amounts of time feeding, resting, and arm-swinging and at similar canopy heights as wild gibbons. However, the latter spent more time singing, socializing and travelling. Gibbons were quarantined for at least 12 months before reintroduction, during which they underwent veterinary screens. They were kept in in enclosures (3 x 3 x 3 m) and were supplemented with vitamins and leaves once a week. Individuals were introduced in pairs and into habitat in which wild gibbons were present. Only one reintroduced pair of gibbons was compared to a pair of wild gibbons at another site. The study does not distinguish between the effects of the different interventions mentioned above.

A controlled study in 1967-2004 in tropical forest in Kabili-Sepilok Forest Reserve, Malaysia (7) found that reintroduced orangutans *Pongo pygmaeus morio* that were rehabilitated before release into the wild along with eight other interventions, decreased by 33% over 33 years (1964-1997). Infant mortality (57%) was higher than in other wild and captive populations, and the sex ratio at birth was strongly biased towards females (proportion males: 0.11) compared to other wild and captive populations. However, inter-birth interval (6.1 years) was similar to wild populations of the same subspecies. Mean age at first reproduction (11.6 years) was lower than in other wild and captive populations. Orangutans were provided with daily supplementary food. Individuals underwent veterinary checks and 90 days of quarantine before being released into the reserve, where other rehabilitated orangutans lived. Injured or sick individuals were captured and treated. Staff and volunteers received medical checks and tourists had to keep safety distances (>5 m) at all times. The study does not distinguish between the effects of the different interventions mentioned above.

A controlled study in 2004-2005 in secondary tropical forest in Bukit Tigapuluh National Park, Central Sumatra, Indonesia (8) found that all reintroduced orphaned Sumatran orangutans *Pongo abelii* that were rehabilitated before reintroduction into the wild along with other interventions, survived for at least three months. All eight captive orphaned orangutans survived for at least three months after release. Orangutans underwent quarantine and health checks before being released to re-establish populations in habitat where previously-released orangutans occurred. Supplementary food was provided regularly. One group was released after a 6-month acclimatization phase at a sanctuary. Another group was kept in semi-free conditions for 7-9 months prior to release and could overnight in the enclosure. Staff members guided the latter to the forest on a daily basis. The study does not distinguish between the effects of the different interventions mentioned above.

A before-and-after trial in 2009-2010 in coastal forest in Ntendeka Wilderness Area, Kwazulu-Natal, South Africa (9) found that over half of reintroduced, captive, wild-born vervet monkeys *Chlorocebus aethiops* that were rehabilitated before release into the wild along with other interventions, survived for at least six months after release. Three individuals (19%) died. Two were killed by predators and one by domestic hunting dogs *Canis lupus familiaris*. Four individuals (25%) disappeared. One female gave birth to an infant two weeks after release. Individuals were rehabilitated in a 306.72 m^2, 3.2 m high enclosure built on open grassland and enriched with pole-planted trees, hanging tyres, ropes, shade cloth hammocks, and a shaded shelter. Monkeys were introduced as one troop of 16 individuals into habitat without resident vervets and with predators. Monkeys spent one day in a release enclosure (49 m^2). Supplementary food was provided twice per day for two weeks and daily during three weeks after release. The release site was protected as a wilderness area. The study does not distinguish between the effects of the different interventions mentioned above.

A before-and-after, site comparison study in 1996-2006 in tropical forests of Lesio-Louna Wildlife Reserve, Republic of Congo (Congo) and Batéké Plateau

National Park, Gabon (10) found that most of reintroduced western lowland gorillas *Gorilla gorilla gorilla* including orphaned individuals that were rehabilitated before release into the wild along with 14 other interventions, survived for at least four years and some reproduced. Twenty-one (84%) of 25 gorillas released in Congo and 22 (85%) of 26 gorillas released in Gabon survived for at least four years. Forty-three individuals were confiscated and rehabilitated orphan wild-born gorillas. Eight gorillas were *ex-situ* captive-born individuals. Prior to release, gorillas underwent quarantine, health checks and preventive vaccination. Gorillas were released in groups into habitat with no gorillas. Individuals were allowed to adapt to local environment, supplemented with food prior to release and treated for parasites and when sick. So-called 'problem'-animals were relocated and dead gorillas were examined. Both sites were proclaimed protected areas before reintroduction. The study does not distinguish between the effects of the different interventions mentioned above.

A before-and-after trial in 2008 in a coastal forest at Isishlengeni Game Farm, Kwazulu-Natal, South Africa (11) found that 62% of reintroduced vervet monkeys *Chlorocebus aethiops* that were rehabilitated before release into the wild along with other interventions, survived for at least six months. Five (17%) of 29 introduced individuals died. Of these, one died of predation and four were killed by domestic dogs *Canis lupus familiaris*. Six (21%) individuals disappeared. No females reproduced. Monkeys were rehabilitated in a 306.72 m^2, 3.2 m high enclosure built on open grassland and enriched with pole planted trees, hanging tyres, ropes, shade cloth hammocks, and a shaded shelter. Monkeys were introduced as one troop of 29 individuals into habitat with wild vervets and predators. Individuals acclimatized by spending two nights in a release enclosure (49 m^2) before being released. Monkeys were provided daily supplementary food. Medical care was provided when necessary before release and while housed. The study does not distinguish between the effects of the different interventions mentioned above.

A before-and-after trial in 2008-2010 in a tropical forest-grassland mosaic at Batéké Plateau National Park, Gabon (12) found that only one of two confiscated wild-born orphaned western lowland gorillas *Gorilla gorilla gorilla* that were rehabilitated before their reintroduction into the wild along with ten other interventions, survived for at least nine months. The group was reintroduced into habitat with predators and without resident gorillas. They were allowed to adapt to local conditions and spent the night in an enclosure equipped with nesting platforms, nesting material, supplementary food and water. Gorillas were dewormed regularly on-site. Caretakers guided them into different forest patches on a daily basis. The study does not distinguish between the effects of the different interventions mentioned above.

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12.25. Fostering appropriate behaviour to facilitate rehabilitation

- Two before-and-after studies in Brazil[1,2] found that most reintroduced golden lion tamarins did not survive over 1–7 years, despite being fostered to survive in the wild, alongside other interventions but in one study they reproduced successfully which partly compensated mortality.
- Two before-and-after studies in Liberia[4] and Congo[5] found that most reintroduced chimpanzees that were fostered to facilitate reintroduction, alongside other interventions, survived over 1-3.5 years. One before and after study in Uganda[3] found that a reintroduced chimpanzee repeatedly returned to human settlements despite being fostered to facilitate reintroduction, alongside other interventions.
- One controlled study in Indonesia[6] found that reintroduced orangutans that were fostered natural behaviour, alongside other interventions, did not act more like wild orangutans than individuals that were not fostered. One study in Indonesia[7] found that reintroduced orangutans that were fostered to facilitate reintroduction, alongside other interventions, fed on fewer plant species and spent more time building nests.
- One side comparison study in Vietnam[8] found that all reintroduced pygmy slow lorises were assumed dead despite being fostered natural behaviour prior to release, alongside other interventions.

Background

In the context of this primate synopsis, fostering refers to promoting behaviour in primates by human care-takers likely to increase their chance of survival post-reintroduction to the wild. Behaviours that may be included here are foraging on natural foods, hunting, climbing and other locomotive behaviours, building nests, grooming and other social behaviours, etc.

A before-and-after trial in 1954-1985 in a degraded rain forest in Poço das Antas Reserve, Brazil (1) found that the number of translocated captive-born golden lion tamarins *Leontopithecus rosalia* that were habituated to humans and fostered to facilitate survival in the wild along with nine other interventions, more than halved within the first year of release. No statistical tests were carried out to determine whether this decrease was significant. Of the 14 individuals released, seven died and two were removed. Three infants were born, one of which died. Eight individuals were released as a family group and six individuals were released as pairs one month later. Tamarins spend an unknown amount of time in 15 x 4.5 x 3 m outside enclosures. The reserve included natural predators. Sick or injured tamarins were captured and treated. Tamarins were supplied with food for 10 months post-release. Artificial nesting boxes, which were hollow logs provided to them during training, were set up in the reserve. The study does not distinguish between the effects of the different interventions mentioned above.

A before-and-after trial in 1984-1991 in coastal forest in Poço das Antas Reserve, Brazil (2) found that over 60% of the reintroduced golden lion tamarins *Leontopithecus rosalia*, some of which were trained in behaviours to facilitate survival alongside 14 other interventions, did not survive over seven years. Fifty-eight (64%) out of 91 individuals did not survive in the wild. However, 57 infants were born (reproductive rate=63%), of which 38 (67%) survived. Tamarins were trained in food detection, strength and locomotor ability, and predator detection and avoidance. Different groups of captive-bred or orphaned tamarins were introduced in different years into habitat already occupied by the species and predators. Some groups were provided with supplementary food, water and nesting boxes, and allowed to adapt to local conditions before release. Tamarins underwent quarantine, veterinary checks, and were treated for parasites before release. Sick or injured animals were captured treated and re-released. The reserve became officially protected in 1983s. The study does not distinguish between the effects of the different interventions mentioned above.

A before-and-after-trial in 1995 in a tropical forest in Kibale National Park, Uganda (3) found that a female captive, 4-6 year old wild-born chimpanzee *Pan troglodytes schweinfurthii* that underwent pre-release training with caretakers in the forest before reintroduction into a human-habituated community of wild chimpanzees along with other interventions, repeatedly returned to human settlements after release and was subsequently returned to captivity. Eight days post-release, the chimpanzee left the forest and was returned to the forest. For the following ten days, she travelled, fed, nested and engaged in social activities with the wild community. She increased ranging distance to humans and use of height, and visually monitored humans less regularly. However, she increasingly spent more time alone and was returned to captivity six weeks after being released. During the three weeks of pre-release training in the forest, caretakers initiated progressions (up to 6 km) to reach known food sources, increase her endurance and improve her familiarity with the habitat. The chimpanzee was quarantined before reintroduction and was tested for tuberculosis. Ten community members worked on the project. The study does not distinguish between the effects of the different interventions mentioned above.

A study in 1987-1988 on an island in tropical forest in Liberia, West Africa (4) found that the majority of reintroduced western chimpanzees *Pan troglodytes verus*, that were fostered behaviour to facilitate reintroduction along with other interventions, survived for at least one year. Seven out of 30 released chimpanzees had difficulties to adjust to the new social environment and were brought back to captivity. Chimpanzees were socialized in naturalistic enclosures and taught to find and process food and water, avoid predators, seek or make shelters, and mate and rear offspring. Chimpanzees underwent pre-release health checks and were allowed to adapt to the local habitat in enclosures. Chimpanzees were released in groups and younger and low-ranking individuals were released earlier to reduce stress. Released individuals were continuously provided with food. Sick and injured animals were temporarily removed for treatment. The study does not distinguish between the effects of the different interventions mentioned above.

A before-and-after trial in 1996-1999 in tropical rainforest in Conkouati Reserve, Republic of Congo (5) found that 70% of reintroduced wild-born orphaned chimpanzees *Pan troglodytes troglodytes* that were fostered behaviour to facilitate survival in the wild along with eight other interventions, were still alive 3.5 years after release. Estimated mortality was 10-30%. None of the adult females reproduced. Chimpanzees fed on 137 different plant species, a diet similar to wild chimpanzees. They also had activity budgets that resembled those of wild conspecifics. No statistical tests were carried out to determine whether these similarities were statistically valid. Orphan chimpanzees were rehabilitated and fostered at a nearby sanctuary and accompanied to the forest to help to aid to recover from capture and create social bonds. Chimpanzees underwent veterinary screens, endoparasite treatments and were vaccinated. Before reintroduction in groups into habitat with low densities of resident wild chimpanzees, they spent 6-9 years on one of three forested islands in the region. Researchers were present on-site and monitored chimpanzees with radio-collars. The study does not distinguish between the effects of the different interventions mentioned above.

A controlled study in 2004-2005 in secondary tropical forest in Bukit Tigapuluh National Park, Indonesia (6) found that reintroduced Sumatran orangutans *Pongo abelii* that were not fostered natural behaviour along with other interventions, acted more like wild orangutans after release than individuals that had been fostered. The behaviour of the three non-fostered orangutans resembled that of wild orangutans more than that of the five fostered individuals in the way that they built nests, selected food and used the canopy. Non-fostered individuals spent more time interacting socially with previously released orangutans. However, some individuals of the fostered group learned some natural behaviour by watching orangutans that were reintroduced earlier. Individuals in this group were guided daily from night enclosures to the forest and were shown how to handle wild food. They acclimatized to local conditions for 7-9 months before release and were free to overnight in the enclosure. The study does not distinguish between the effects of the different interventions mentioned above.

A study in the wet season in 2009 in two rainforest patches in the Orangutan Care and Quarantine Centre, Indonesia (7) found that captive orphaned juvenile Bornean orangutans *Pongo pygmaeus* that were fostered to facilitate reintroduction fed on fewer species and spent less time building nests than wild orangutans. Orphans fed on 72 different wild food species, mainly leaves (18%), fruit (15%), bark (7%), and invertebrates (7%), whereas wild orangutans fed on more than 300 different foods, mainly fruit (70%), bark (20%) and leaves (15%). Orphans spent 3% of their time building nests, which corresponded to half of the time spent by wild orangutans. In addition, orphans most commonly travelled by quadrupedal arboreal locomotion, a form of locomotion similar to that used by wild orangutans in Sumatra. Over a 5-month period, a random sample of 40 male and female juvenile orangutans of varying health was observed during three 5-hour excursions to each one of two nearby forest patches. Individuals were provided a midday feed of rice or fruit.

A site comparison in 2008-2012 in mosaic forest at two sites in Cat Tien National Park, South Vietnam (8) found that all pygmy slow lorises *Nycticebus pygmaeus* that were allowed to learn natural behaviours prior to release alongside other interventions, either died or disappeared. All five lorises that were reintroduced died or their radio collar signal was lost at an early stage after release. Two individuals were held in a semi-wild enclosure for one month to foster behaviour aimed at facilitating survival in the wild. The latter were released during the wet season. Three other lorises were released at Cat Tien National Park during the dry season. Monkeys underwent a 6-week quarantine, veterinary screens, and parasite treatment. Lorises were released as multiple individuals into habitat with no resident lorises but with predators. Bodies of dead animals were examined. The study does not distinguish between the effects of the different interventions mentioned above.

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13. Livelihood; Economic & Other Incentives

Background

Since the early 2000-s, there has been a shift away from the 'fortress conservation'-mentality that typically excluded humans and their needs from conservation planning, towards integrating conservation strategies with programs to reduce poverty and increase development (Sachs *et al*. 2009). In this chapter, we list interventions that provide monetary and non-monetary incentives to local communities in and near primate habitat in exchange for their conservation support. Although the protection of primates and their habitat was not the main focus of these interventions, we also included here long-term research and tourism projects and the permanent presence of conservation and management staff as such initiatives may have a positive effect on primate persistence (e.g. N'Goran *et al*. 2012, Tranquilli *et al*. 2012). Recent reviews have found inconclusive evidence of the benefits of primate tourism projects for the conservation of chimpanzees and orangutans, despite some targeted tourism projects operating for over three decades and the very significant threats of disease transmission from visitors and researchers to the apes (Desmond & Desmond 2014; Russon & Susilo 2014). Similarily, although orangutan tourism can generate large amounts of money, a review found little evidence of substantial economic benefits to orangutan conservation (Russon & Susilo 2014). Other studies have found significant negative effects resulting from tourism activities directed at primates, including disease transmission, food dependency, behavioural changes and high stress levels, sometimes resulting in increased mortality (Russon & Wallis 2014).

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Key messagess - Provide benefits to local communities for sustainably managing their forest and its wildlife

Provide monetary benefits to local communities for sustainably managing their forest and its wildlife (e.g. REDD, employment)

One before-and-after study in Belize found that howler monkey numbers increased after the provision of monetary benefits to local communities alongside other interventions. However, one before-and-after study in Rwanda, Uganda and the Congo found that gorilla numbers decreased despite the implementation of development projects in nearby communities, alongside other interventions. One before-and-after study in Congo found that most chimpanzees reintroduced to an area where local communities received monetary benefits, alongside other interventions, survived over five years.

Provide non-monetary benefits to local communities for sustainably managing their forest and its wildlife (e.g. better education, infrastructure development)

One before-and-after study India found that numbers of gibbons increased in areas were local communities were provided alternative income, alongside other interventions. One before-and-after study in Congo found that most chimpanzees reintroduced survived over seven years in areas where local communities were provided non-monetary benefits, alongside other interventions,.

Key messages - long-term presence of research-/tourism project

Run research project and ensure permanent human presence at site

Three before-and-after studies, in Rwanda, Uganda, Congo and Belize found that numbers of gorillas and howler monkeys increased while populations were continuously monitored by researchers, alongside other interventions. One before-and-after study in Kenya found that troops of translocated baboons survived over 16 years post-translocation while being continuously monitored by researchers, alongside other interventions. One before-and-after study in the Congo found that most reintroduced chimpanzees survived over 3.5 years while being continuously monitored by researchers, alongside other interventions. However, one before-and-after study in Brazil found that most reintroduced tamarins did not survive over 7 years, despite being continuously monitored by researchers, alongside other interventions; but tamarins reproduced sussesfully. One review on gorillas in Uganda found that no individuals were killed while gorillas were continuously being monitored by researchers, alongside other interventions.

Run tourism project and ensure permanent human presence at site

Six studies, including four before-and-after studies, in Rwanda, Uganda, Congo and Belize found that numbers of gorillas and howler monkeys increased after local tourism projects were initiated, alongside other interventions. However, two before-and-after study in Kenya and Madagascar found that numbers of colobus and mangabeys and two of three lemur species decreased after implementing tourism projects, alongside other interventions. One before-and-after study in China found that exposing macaques to intense tourism practices, especially through range restrictions to increase visibility for tourists, had increased stress levels and increased infant mortality, peaking at 100% in some years.

Permanent presence of staff/managers

Two before-and-after studies in the Congo and Gabon found that most reintroduced chimpanzees and gorillas survived over a period of between nine months to five years while having permanent presence of reserve staff. One before-and-after study in Belize found that numbers of howler monkeys increased after permanent presence of reserve staff, alongside other interventions. However, one before-and-after study in Kenya found that numbers of colobus and mangabeys decreased despite permanent presence of reserve staff, alongside other interventions.

13.1. Provide monetary benefits to local communities for sustainably managing their forest and its wildlife (e.g. REDD, employment)

- One before-and-after study in Belize[1] found that numbers of black howler monkeys increased by 138% over 13 years after local communities received monetary benefits, alongside other interventions.
- One before-and-after study in the Republic of Congo[2] found that most central chimpanzees reintroduced to an area where local communities received monetary benefits, alongside other interventions, survived over five years.
- One before-and-after study[3] in Rwanda, Uganda and the Democratic Republic of Congo found that numbers of mountain gorillas declined by 28% over 41 years despite the implementation of development projects in nearby communities, alongside other interventions.

Background

Monetary benefits can be provided to local communities in exchange for their conservation support and may include income generated through craft or other product sales, employment as anti-poaching guards, research assistants or tourist guides, or payment through initiatives to 'Reduce Carbon Emissions from Deforestation and Degradation' (REDD). REDD and REDD+ (extends REDD by conserving forest biodiversity) provide payments to developing country governments to incentivize engagement in conserving their forest ecosystems with the aim to slow down climate change and protect biodiversity (Gardner *et al*. 2012).

Providing non-monetary benefits in exchange for conservation support is discussed under 'Provide non-monetary benefits to local communities for sustainably managing their forest and its wildlife (e.g. better education, infrastructure development)'.

Gardner T.A., Burgess N.D., Aguilar-Amuchastegui N., Barlow J., Berenguer E., Clements T., Danielsen F., Ferreira J., Foden W., Kapos V., Khan S.M., Leesm A.C., Parry L., Roman-Cuesta R.M., Schmitt C.B., Strange N., Theilade I. & Vieira I.C.G. (2012) A framework for integrating biodiversity concerns into national REDD+ programmes. *Biological Conservation*, 154, 61–71.

A before-and-after trial in 1985-1998 in riparian forest in the Community Baboon Sanctuary, Belize, (1) found that when local communities received monetary benefits for sustainably managing their forest and its wildlife through tourism and craft industries alongside ten other interventions, the sanctuary's black howler monkey *Alouatta pigra* population increased by 138% over 13 years. The population increased from 840 to over 2,000 individuals, although no statistical tests were carried out to determine whether this increase was significant. Additional interventions included the protection of the sanctuary by the communities surrounding it, preserving forest buffer strips along property boundaries and a forest corridor along the river, constructing pole bridges over man-made gaps, involving local communities in the management of the sanctuary, preserving important howler food trees in large clearings, an eco-tourism and research program, creation of a museum for education purposes, presence of permanent staff. The study does not distinguish between the effects of the different interventions mentioned above.

A before-and-after trial in 1994-1999 in mixed tropical forest in Conkouati-Douli National Park, Republic of Congo (2) found that the majority of central chimpanzees *Pan troglodytes troglodytes* that were reintroduced in an area where local people were provided monetary benefits for supporting the programme alongside 16 other interventions, survived over five years. Out of 20 reintroduced chimpanzees, 14 (70%) survived over five years. No statistical tests were carried out to determine whether the population decrease was significant. To compensate former use of the site, locals received monetary support by being able to sell their products and by being employed as conservation staff. Non-monetary benefits were also provided. Rehabilitated orphaned chimpanzees underwent vaccination, treatment for parasites and veterinary screens before being radio-collared and translocated in four subgroups from the sanctuary to the release site where resident chimpanzees occurred. Staff members were permanently present to monitor primate health, provide supplementary food if necessary and examine dead animals. The area status was upgraded from reserve to national park in 1999. Local people were relocated from the release site. Some individuals were treated when sick or injured. TV and radio advertisements were used to raise chimpanzee conservation. The study does not distinguish between the effects of the different interventions mentioned above.

A before-and-after study in 1967-2008 in tropical moist montane forest in Volcanoes-, Mgahinga-, and Virunga National Parks located in Rwanda, Uganda, and the Democratic Republic of Congo (3), found that despite the implementation of development projects in nearby communities along with other interventions, the mountain gorilla *Gorilla beringei beringei* population decreased over time. Annual population decline was 0.7%, resulting in an overall population decrease of 28.7% over 41 years. However, no statistical tests were carried out to determine whether this decrease was significant. Development was promoted through providing local employment in the ecotourism sector. Additional interventions included regular anti-poaching patrols, the removal of snares and when necessary, the herding of live-stock out of the park, and the implementation of a local conservation education program. The study does not distinguish between the effects of the different interventions mentioned above.

(1) Horwich, R.H. & Lyon J. (1998) Community-based development as a conservation tool: the Community Baboon Sanctuary and the Gales Point Manatee project. Pages 343-363 in: R.B. Primack, D. Bray, H.A. Galletti and I. Ponciano (eds.) *Timber, tourists and temples. Conservation and development in the Maya Forest of Belize, Guatemala and Mexico.* Island Press, Covelo.
(2) Tutin C.E.G., Ancrenaz M., Paredes J., Vacher-Vallas M., Vidal C., Goossens B., Bruford M.W. & Jamart A. (2001) The conservation biology framework of the release of wild-born orphaned chimpanzees into the Conkouati Reserve, Congo. *Conservation Biology*, 15, 1247–1257.
(3) Robbins M.M., Gray M., Fawcett K.A., Nutter F.B., Uwingeli P., Mburanumwe I., Kagoda E., Basabose A., Stoinski T.S., Cranfield M.R., Byamukama J., Spelman L.H., Robbins A.M. (2011) Extreme conservation leads to recovery of the Virunga mountain gorillas. *PLoS ONE*, 6, e19788.

13.2. Provide non-monetary benefits to local communities for sustainably managing their forest and its wildlife (e.g. better education, infrastructure development)

- One before-and-after study in the Republic of Congo[1] found that 70% of the central chimpanzees reintroduced to an area where local people were provided non-monetary benefits, alongside other interventions, survived over seven years.
- One before-and-after study in India[2] found that numbers of hoolock gibbons increased by 66% over five years after providing local communities with alternative income, alongside other interventions.

Background

Non-monetary benefits can be provided to local communities in exchange for their conservation support and may include infrastructure development (e.g. roads), or improved education and medical services. For example, a correlative study by Junker *et al*. (2015) found that chimpanzee *Pan troglodytes verus* nest density in Liberia was higher in areas with high literacy rates. Therefore, in addition to rewarding conservation efforts of the local communities through improving education by building new schools, training teachers, or providing study equipment, better education and higher literacy rates may further promote primate conservation. However, the study also found that areas with better economic and infrastructure development coincided with reduced large mammal species richness compared to less developed areas, which stresses the need to implement appropriate control measures along with development projects to minimize potential negative effects of infrastructure growth on wildlife populations.

Providing monetary benefits in exchange for conservation support is discussed under ‘Provide monetary benefits to local communities for sustainably managing their forest and its wildlife (e.g. REDD, employment)’.

Junker J., Boesch C., Mundry R., Stephens C., Lormie M., Tweh C. & Kühl H.S. (2015) Education and access to fish but not economic development predict chimpanzee and mammal occurrence in West Africa. *Biological Conservation*, 182, 27–35.

A before-and-after trial in 1994-1999 in mixed tropical forest in Conkouati-Douli National Park, Republic of Congo (1) found that the majority of central chimpanzees *Pan troglodytes troglodytes* that were reintroduced in an area where local people were provided non-monetary benefits for supporting the programme alongside 16 other interventions, survived over five years. Out of 20 reintroduced chimpanzees, fourteen (70%) survived. No statistical tests were carried out to determine whether the population decrease was significant. Local communities were provided emergency medical care and were assisted otherwise. No further details on this intervention were given. Monetary benefits were provided to compensate people for the former use of resources at the site. Rehabilitated orphaned chimpanzees underwent vaccination, parasite treatments and veterinary screens before being radio-collared and translocated in four subgroups to the release site where resident conspecifics occurred. Staff members were permanently present to monitor primate health, provide supplementary food if necessary and examine dead animals. The area status was upgraded from reserve to national park in 1999. Local people were relocated from the release site. Some individuals were treated when sick or injured. TV and radio advertisements were used to raise chimpanzee conservation. The study does not distinguish between the effects of the different interventions mentioned above.

A before-and-after trial in 2004-2009 in tropical forest in the Gibbon Wildlife Sanctuary in Assam, India (2) found that hoolock gibbons *Hoolock hoolock* increased by 66% over five years after providing alternative income to local communities along with other interventions. The gibbon population increased from 64 individuals in 17 groups in 2004 to 106 individuals in 26 groups (and five solitary males) in 2009. Canopy cover also increased by 3.5% while degraded forest decreased by 4.1%. No statistical tests were carried out to determine whether these changes were significant. Families within local communities that were selected through socio-economic studies were provided with more efficient stoves, bio-gas plants, handlooms and domestic ducks. Local communities were trained in mushroom cultivation, honeybee keeping and duck husbandry. A large-scale education and awareness programme was implemented to promote gibbon conservation within Assam and training, monitoring and legal orientation programmes were carried out for the sanctuary staff. The study does not distinguish between the effects of the different interventions mentioned above.

(1) Tutin C.E.G., Ancrenaz M., Paredes J., Vacher-Vallas M., Vidal C., Goossens B., Bruford M.W. & Jamart A. (2001) The conservation biology framework of the release of wild-born orphaned chimpanzees into the Conkouati Reserve, Congo. *Conservation Biology*, 15, 1247–1257.

(2) Chetry D. & Chetry R. (2011) Hoolock gibbon conservation in India. *Gibbon Journal*, 6, 7–12.

Long-term presence of research-/tourism project

13.3. Run research project and ensure permanent human presence at site

- Two before-and-after studies in Rwanda, Uganda and Congo[1,7] found that numbers of mountain gorillas increased over 5-41 years while gorillas were continuously monitored by researchers, alongside other interventions. One review on mountain gorillas in Uganda[2] found that no gorilla was killed over one year while gorillas were continuously monitored by researchers, alongside other interventions.

- One before-and-after study in Brazil[3] found that most reintroduced golden lion tamarins did not survive over seven years post-release despite being permanently monitored by researchers, alongside other interventions, yet tamarins reproduced succesfully.
- One before-and-after study in Belize[4] found that numbers of black howler monkeys increased by 138% over 13 years after being permanently monitored by researchers, alongside other interventions.
- One before-and-after study in the Republic of Congo[5] found that most reintroduced chimpanzees permanently monitored by researchers, alongside other interventions, survived over 3.5 years.
- One before-and-after study in Kenya[6] found 'problem' olive baboon troops still survived over 17 years post-translocation while being permanently monitored by researchers, alongside other interventions.

Background

This intervention is based on the assumption that long-term conservation presence at a site (for example through research or eco-tourism projects) will help to protect resident primate populations. This is supported for example by a correlative study in Taï National Park, Côte d'Ivoire which found that density of monkeys irrespective of species was up to 100 times higher near a research station in the southwestern section of the park, where there was little hunting, than in the southeastern part of the park (N'Goran *et al*. 2012). Another correlative Africa-wide assessment of the relative significance of different types of conservation efforts on the persistence of ape (gorillas *Gorilla* spp., chimpanzees *Pan troglodytes*, bonobos *Pan paniscus*) populations within resource management areas found that the proportion of years with research projects present at a site had a positive and significant influence on ape persistence (Tranquilli *et al*. 2012).

Long-term presence of tourist sites or general staff and managers is discussed under 'Run tourist project and ensure permanent human presence at site' and 'Permanent presence of staff/manager', respectively.

N'Goran P., Boesch C., Mundry R., N'Goran E.N., Herbinger I., Yapi F.A. & Kühl H.S. (2012) Hunting, law enforcement, and African primate conservation. *Conservation Biology*, 3, 565–571.

Tranquilli S., Abedi-Lartey M., Amsini F., Arranz L., Asamoah A., Babafemi O., Barakabuye N., Campbell G., Chancellor R., Davenport T.R.B., Dunn A., Dupain J., Ellis C., Etoga G., Furuichi T., Gatti S., Ghiurghi A., Greengrass E., Hashimoto C., Hart J., Herbinger I., Hicks T.C., Holbech L.H., Huijbregts B., Imong I., Kumpel N., Maisels F., Marshall P., Nixon S., Normand E., Nziguyimpa L., Nzooh-Dogmo Z., Okon D.T., Plumptre A., Rundus A., Sunderland-Groves J., Todd A., Warren Y., Mundry R., Boesch C. & Kuehl H. (2012) Lack of conservation effort rapidly increases African great ape extinction risk. *Conservation Letters*, 5, 48–55.

A before-and-after trial in 1984-1987 in tropical montane forests in the Virunga ecosystem (1) found that mountain gorilla *Gorilla beringei beringei* populations that were regularly monitored by research staff since 1973 along with other interventions, increased from 242 to 279 individuals (15% increase) in 1981-1986. In addition, average group size increased by 17% (8.5 to 9.2 individuals) and the proportion of immatures increased by 8% (39.7 to 48.1) over the same period. In the same area, some groups were part of a gorilla viewing tourism program started in 1985. Anti-poaching guards regularly patrolled the area and removed snares. Guards were provided with better equipment, which allowed them to increase patrol frequency and effectiveness. An additional multi-organisational conservation project was initiated in 1979. The study does not distinguish between the effects of the different interventions mentioned above.

A review on the status of mountain gorillas in 1972-1989 in tropical montane forest in Eastern Virungas Conservation Area, Uganda (2) found that no mountain gorillas *Gorilla beringei beringei* were killed in 1989-1990 when a permanent research project was established in the area along with other interventions. In 1989, the game guard force was also increased from three to 13 men and was trained and provided with better equipment. Some locals were resettled from an area (3 km^2 in size) that represented the most important gorilla habitat within the Gorilla Game Reserve. The study does not distinguish between the effects of the different interventions mentioned above.

A before-and-after trial in 1984-1991 in coastal forest in Poço das Antas Reserve, Brazil (3), found that the majority of reintroduced golden lion tamarins *Leontopithecus rosalia*, which were monitored regularly as part of a long-term research program alongside 14 other interventions, did not survive over seven years. Fifty-eight out of 91 (64%) reintroduced tamarins did not survive post-reintroduction. However, 57 infants were born (reproductive rate=63%) of which 38 (67%) survived. In 1983, a long-term study of the wild tamarin population was implemented. Different groups of captive-bred or orphaned tamarins were introduced in different years into habitat already occupied by the species and predators. Groups were provided with supplementary food, water and nesting boxes, and allowed to adapt to local habitat conditions before release. Tamarins were quarantined, underwent veterinary checks and parasite treatments before release. Reintroduced sick or injured animals were recaptured, treated and rereleased. The reserve became officially protected in 1983. The study does not distinguish between the effects of the different interventions mentioned above.

A before-and-after trial in 1985-1998 in riparian forest at Community Baboon Sanctuary, Belize (4) found that when permanent research staff were employed along with ten other interventions, the sanctuary's black howler monkey *Alouatta pigra* population increased by 138% over 13 years. The population increased from 840 to over 2,000 individuals (138% increase), although no statistical tests were carried out to determine whether this difference was significant. Additional interventions included the protection of the sanctuary by the local communities, preserving forest buffer strips along property boundaries and a forest corridor along the river, constructing pole bridges over man-made gaps, involving local communities in the management of the sanctuary, preserving important howler food trees in large clearings, an eco-tourism program, creation of a museum for education purposes, and monetary benefits (income from tourism and craft industries) to local communities for sustainably managing their forest and its wildlife communities. The study does not distinguish between the effects of the different interventions mentioned above.

A before-and-after trial in 1996-1999 in a tropical rainforest in Conkouati Reserve, Republic of Congo (5) in which researchers were permanently based alongside eight other interventions, found that 70% of reintroduced wild-born orphaned chimpanzees *Pan troglodytes troglodytes* were still alive 3.5 years after release. No chimpanzees were illegally hunted, which the authors ascribe to the permanent research presence in the area. Estimated mortality was 10-30%. None of the adult females reproduced. Chimpanzees fed on 137 different plant species, a diet variety similar to wild chimpanzees, and had activity budgets that resembled those of wild conspecifics. No statistical tests were carried out to determine whether differences were insignificant. Chimpanzees underwent veterinary screens, were treated for endoparasites and vaccinated. Before reintroduction in groups into habitat with low densities of resident wild chimpanzees, they spent 6-9 years on one of three forested islands in the region to acclimatize. Orphan chimpanzees were rehabilitated and fostered at a nearby sanctuary. Researchers monitored released chimpanzees using radio-collars. The study does not distinguish between the effects of the different interventions mentioned above.

A controlled, before-and-after trial in 1973-2001 in savannah at Chololo ranch, Laikipia Plateau, Kenya (6) found that two troops of translocated crop-raiding olive baboons *Papio anubis* were still surviving over 16 years post-translocation while being permanently observed by researchers, along with other interventions. The size of the translocated population consisting of two troops totalling 94 baboons in 1984, was 62 individuals in 2001. However, this decrease was not statistically significant. Both troops were observed continuously for 18 years post-translocation. No further details on this intervention were reported. One wild troop at the capture site and another resident troop at the release site served as control groups. Survival rates did not differ between control and study groups. Study groups were observed 265 days/year on average in 1985-2001. Both troops were released into a habitat with resident baboons and predators. Prior to translocation of these so-called 'problem'-animals, individuals underwent veterinary screens and sick baboons were treated. Translocated baboons were briefly provided with food during periods of drought but not after 1986. The study does not distinguish between the effects of the different interventions mentioned above.

A controlled, before-and-after study in 1967-2008 in tropical montane forest in Volcanoes-, Mgahinga-, and Virunga National Parks in Rwanda, Uganda, and the Democratic Republic of Congo, respectively (7) found that a mountain gorilla *Gorilla beringei beringei* population that was continuously monitored by researchers alongside ten other interventions, increased in size over time. Annual population growth was 4.1%, resulting in an overall population increase of 168% in 41 years. No statistical tests were carried out to determine whether this increase was significant. Gorillas were habituated to human presence and monitored by researchers for four hours during mid-day. An ecotourism project was subsequently implemented. Visitors/researchers followed strict health procedures, included keeping a safety distance to the gorillas, wearing face-masks, spending only a limited amount of time with gorilla groups, ensuring that visitors/researchers were healthy, and disinfecting visitor's/researcher's clothes, boots etc. The population was continuously monitored by vets and individuals were treated if necessary. Dead gorillas in the treatment population were examined and the cause for their death determined. The study only tests for the effect of veterinary interventions, but does not distinguish between the effects of the other interventions mentioned above.

(1) Aveling, R. & Aveling C. (1987) Report from the Zaire Gorilla Conservation Project. *Primate Conservation*, 8, 162–164.
(2) Butynski, T.M., Werikhe S.E. & Kalina J. (1990) Status, distribution and conservation of the mountain gorilla in the Gorilla Game Reserve, Uganda. *Primate Conservation*, 11, 31–41.
(3) Beck B.B., Kleiman D.G., Dietz J.M., Castro I., Carvalho C. & Rettberg-Beck B. (1991) Losses and reproduction of reintroduced golden lion tamarins *Leontopithecus rosalia*. *Dodo*, 27, 50–61.
(4) Horwich, R.H. & Lyon J. (1998) Community-based development as a conservation tool: the Community Baboon Sanctuary and the Gales Point Manatee project. Pages 343-363 in: R.B. Primack, D. Bray, H.A. Galletti and I. Ponciano (eds.) *Timber, tourists and temples. Conservation and development in the Maya Forest of Belize, Guatemala and Mexico.* Island Press, Covelo.
(5) Goossens B., Ancrenaz M., Vidal C., Latour S., Paredes J., Vacher-Vallas M., Bonnotte S., Vial L., Farmer K., Tutin C.E.G. & Jamart A. (2001) The release of wild-born orphaned chimpanzees *Pan troglodytes* into the Conkouati Research, Republic of Congo. *African Primates*, 5, 42–45.
(6) Strum S.C. (2005) Measuring success in primate translocation: a baboon case study. *American Journal of Primatology*, 65, 117–140.
(7) Robbins M.M., Gray M., Fawcett K.A., Nutter F.B., Uwingeli P., Mburanumwe I., Kagoda E., Basabose A., Stoinski T.S., Cranfield M.R., Byamukama J., Spelman L.H., & Robbins A.M. (2011) Extreme conservation leads to recovery of the Virunga mountain gorillas. *PLoS ONE*, 6, e19788.

13.4. Run tourist projects and ensure permanent human presence at site

- Three studies, including two before-and-after studies[1a,5] and one controlled study[1b] in Rwanda, Uganda and the Republic of Congo found that numbers of mountain gorillas increased after touristic projects were initiated, alongside other interventions. One before-and-after and site comparison study in Rwanda[4] found that the number of immature mountain gorillas increased by 22% and the number of snares declined by 30% after a tourism project was initiated, alongside other interventions.
- One before-and-after study in Kenya[2] found that numbers of Tana River red colobus and crested mangabeys decreased despite implementing a tourism project, alongside other interventions.
- One before-and-after study in Belize[3] found that numbers of black howler monkeys increased by 138% over 13 years after a tourism project was implemented, alongside other interventions.
- One before-and-after, replicated study in China[6] found that implementing an intense tourism project for Tibetan macaques that included food provisioning and range restrictions, increased their stress levels compared to previous periods, with infant mortality reaching 100% in some years.
- One before-and-after and review study in Madagascar[7] found that after implementing a tourism project the population size and/or body size and group size declined for two lemur species but the number of individuals increased for one other lemur species.

Background

This intervention is based on the assumption that long-term conservation presence at a site (through e.g. research or eco-tourism projects) will help to protect resident primate populations. This is supported for example by a correlative study in Taï National Park, Côte d'Ivoire, which found that density of monkeys irrespective of species was up to 100 times higher near a tourism site in the southwestern section of the park, where there was little hunting, than in the southeastern part of the park (N'Goran *et al*. 2012). Another correlative Africa-wide assessment of the relative significance of different types of conservation efforts on the persistence of ape (gorillas *Gorilla* spp., chimpanzees *Pan troglodytes*, bonobos *Pan paniscus*) populations within resource management areas found that the proportion of years with tourist projects present at a site had a positive and significant influence on ape persistence (Tranquilli *et al*. 2012).

Long-term research presence or permanent presence of general staff/managers is discussed under 'Run research project and ensure permanent human presence at site' and 'Permanent presence of staff/manager', respectively.

N'Goran P., Boesch C., Mundry R., N'Goran E.N., Herbinger I., Yapi F.A. & Kühl H.S. (2012) Hunting, law enforcement, and African primate conservation. *Conservation Biology*, 3, 565–571.

Tranquilli S., Abedi-Lartey M., Amsini F., Arranz L., Asamoah A., Babafemi O., Barakabuye N., Campbell G., Chancellor R., Davenport T.R.B., Dunn A., Dupain J., Ellis C., Etoga G., Furuichi T., Gatti S., Ghiurghi A., Greengrass E., Hashimoto C., Hart J., Herbinger I., Hicks T.C., Holbech L.H., Huijbregts B., Imong I., Kumpel N., Maisels F., Marshall P., Nixon S., Normand E., Nziguyimpa L., Nzooh-Dogmo Z., Okon D.T., Plumptre A., Rundus A., Sunderland-Groves J., Todd A., Warren Y., Mundry R., Boesch C. & Kuehl H. (2012) Lack of conservation effort rapidly increases African great ape extinction risk. *Conservation Letters*, 5, 48–55.

A before-and-after trial in 1984-1987 in tropical montane forests in the Virunga ecosystem in Rwanda and the Democratic Republic of Congo (1a) found that mountain gorilla *Gorilla beringei beringei* populations involved in a tourism viewing project initiated in 1985 along with other interventions, increased from 242 to 279 individuals (15% increase) from 1981-1986. In addition, average group size increased by 17% (8.5 to 9.2 individuals) and the immature proportion increased by 8% (39.7 to 48.1) over the same time period. Regular total counts of this population were conducted since 1973 by research staff. Anti-poaching guards regularly patrolled the area and removed snares. Guards were provided with better equipment, which allowed them to increase patrol frequency and effectiveness. An additional multi-organisation conservation project started in 1979. The study does not distinguish between the effects of the different interventions mentioned above.

A controlled study in 1984-1987 in tropical montane forest in Virunga National Park in the Democratic Republic of Congo (1b) found that the resident mountain gorilla *Gorilla beringei beringei* population that was regularly visited by tourists had increased over three years. The percentage of immature gorillas in the groups regularly monitored by the tourism project was 50.8%, compared to 40.8% in groups that were not monitored. However, no statistical tests were carried out to determine whether this difference was significant. Furthermore, average group size in the monitored vs unmonitored population was 10.4 and 7.1 gorillas, respectively. Within a period of ten months, tourist receipts rose from zero to about US$1800/ month. Three gorilla groups living at the edge of the park were habituated to human presence and one of them received once-a-day visits from a maximum of six people since September 1985.

A before-and-after trial in 1975-1985 in swamp and riverine forest in Tana River Primate Reserve, Kenya (2) found that despite the establishment of a tourism enterprise in the reserve along with other interventions, Tana River red colobus *Colobus badius rufomitratus* and crested mangabeys *Cercocebus galeritus galeritus* decreased over a ten year period. Overall population size decreased from 1,200-1,800 to 200-300 individuals (83% decrease for colobus and from 1,100-1,500 to 800-1,100 (25% decrease) individuals for mangabeys. The number of forest patches inhabited by these two species also decreased over the same time period. No statistical tests were carried out to determine whether this decrease was significant. Results of total counts in 1985 and in 1973-1975 were compared to estimate population change. A permanent tourist lodge was built in 1977 and was operated until 1981, offering game drives, boat trips and guided walks. In 1976, the area became a National Reserve including a permanent ranger post to house reserve staff. The study does not distinguish between the effects of the different interventions mentioned above.

A before-and-after trial in 1985-1998 in riparian forest at Community Baboon Sanctuary, Belize (3) found that when a tourism program was implemented along with ten other interventions, the sanctuary's black howler monkey *Alouatta pigra* population increased by 138% over 13 years. The population increased from 840 to over 2,000 individuals, although no statistical tests were carried out to determine whether this increase was significant. Additional interventions included the protection of the sanctuary by the local communities, preserving forest buffer strips along property boundaries and a forest corridor along the river, constructing pole bridges over man-made gaps, involving local communities in the management of the sanctuary, preserving important howler food trees in large clearings, a research program, presence of permanent staff, creation of a museum for education purposes, and monetary benefits (income from tourism and craft industries) to local communities for sustainably managing their forest and its wildlife communities. The study does not distinguish between the effects of the different interventions mentioned above.

A before-and-after trial and site comparison in 1976-1988 in tropical forest of the Volcanoes National Park, Rwanda (4) found that the number of immature mountain gorillas *Gorilla beringei beringei* on the Rwandan side of the park increased and snares decreased after the initiation of a tourist program, along with other interventions. In 1981, sampled quadrats on the Rwandan side of the park contained 30% snares compared to 70% on the Ugandan and DRC side of the park. Immature individual numbers increased by 22% in Rwanda, but declined by 30% in the other two countries. No statistical tests were carried out to determine whether these differences were significant. In 1979, the Mountain Gorilla Project implemented a managed tourism program. Using the income generated by this program, the training, equipping and management of anti-poaching patrols was made possible. A conservation education program was also implemented, but no further details of this program were reported in the study. In 1976, all cattle were removed from the park in Rwanda. The study does not distinguish between the effects of the different interventions mentioned above.

A controlled, before-and-after study in 1967-2008 in tropical montane forest in Volcanoes-, Mgahinga-, and Virunga National Parks in Rwanda, Uganda, and the Democratic Republic of Congo, respectively (5) found that a mountain gorilla *Gorilla beringei beringei* population that was part of an ecotourism program along with ten other interventions, increased in size over time. Annual population growth was 4.1%, resulting in an overall population increase of 168% over 41 years. No statistical tests were carried out to determine whether this increase was significant. As part of this program, gorillas were habituated to human presence. A long-term research program started in 1967. Visitors/researchers had to follow strict health procedures, included keeping a safety distance to the gorillas, wearing face-masks, spending only a limited amount of time with gorilla groups, ensuring that visitors/researchers were healthy, and disinfecting visitor's/researcher's clothes, boots etc. Gorillas were continuously monitored by vets and treated if necessary. When gorillas in the treatment population died, their cause of death was investigated. The study only tests for the effect of veterinary interventions, but does not distinguish between the effects of the other interventions mentioned above.

One before-and-after study in 1986-2007 in montane evergreen forest in Huangshan, China (6) found that implementing a tourism project for Tibetan macaques *Macaca thibetana* that included intensive management and food provisioning, increased their stress levels compared to previous periods, with adult mortality and productivity unaffected but greatly increased infant mortality, reaching 100% in some years. Productivity was unaffected (adult females giving birth before tourism: 71%; after tourism management: 73%) but infant mortality increased from 14.8% in 1986-1991 to 54.6% after tourism management was implemented. Infant mortality peaked at 90-100% during intense tourism management but dropped to 16.7% after management suspension in 2003. Infants were killed through wounding by adult macaques, with rates increasing from 0% before tourism to 60% after tourism. Tourism management started in 1992 but intensified in 1994 and 2002 with range restrictions to increase macaque visibility for tourists. Long-term records from multiple researchers were used for data on group membership, births, and deaths from 1986-2007. Two monkey troups were studied and behaviour of macaques and visitors was recorded. Tourists watched macaques from wooden pavilions and feeding or touching them was prohibited but enforcement was lacking and breached even by staff. Introducing tourism was not directly aimed at primate conservation but was intended as a more conservation-oriented project compared to unregulated primate tourism targeting the same species at Mount Emei, China.

One before-and-after and review study in 1986-2010 in montane rainforest in Ranomafana National Park, Madagascar (7) found that after implementing a lemur tourism project alongside other interventions, the population size of Milne-Edwards' sifaka *Propithecus edwardsi* and greater bamboo lemur *Prolemur simus* declined severely while the golden bamboo lemur *Hapalemur aureus* had increased in population size. In 1996-2008 population size and group size of Milne-Edwards' sifaka declined, with almost 50% decline in population size in 2005-2009 (data as graphs) and a 7% reduction in body size over 21 years (5.7kg in 1987; 5.3kg in 2008). High tourist numbers in one site resulted in changed activity patterns for Milne-Edwards' sifaka, with less time spent foraging and grooming (data as graphs). Population size and group size of greater bamboo lemur also declined following the implementation of a tourism project while golden bamboo numbers increased (data not included). In 1993-2011 the number of tourists in Ranomafana increased from around 4000/year to almost 24000/year (data as graphs). Lemur behaviour and population counts were collected in several studies.

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13.5. Permanent presence of staff/manager

- One before-and-after study in Kenya[1] found that numbers of Tana River red colobus and crested mangabeys decreased despite permanent presence of reserve staff, alongside other interventions.
- One before-and-after study in Belize[2] found that numbers of black howler monkeys increased by 138% over 13 years after introducing permanent presence of reserve staff, alongside other interventions.
- One review on reintroduced lar gibbons in Thailand[3] found that their population declined by 6% seventeen months after release despite permanent presence of reserve staff, alongside other interventions..
- One before-and-after study in Congo[4] found that most reintroduced central chimpanzees survived over five years after being accompanied by reserve staff, alongside other interventions.
- One before-and-after study in Gabon[5] found that most reintroduced western lowland gorillas survived over nine months, after being accompanied by reserve staff, alongside other interventions.

Background

This intervention includes all staff not employed in the tourism or research sectors and is based on the assumption that long-term conservation presence at a site (e.g. through presence of conservation/management staff) will help to protect resident primate populations. This assumption is supported by a correlative Africa-wide assessment of the relative significance of different types of conservation efforts on the persistence of ape (gorillas *Gorilla* spp., chimpanzees *Pan troglodytes*, bonobos *Pan paniscus*) populations within resource management areas, which found that the proportion of years with presence of a conservation NGO (and presumably their staff employed on-site) had a positive and significant influence on ape persistence at a site (Tranquilli *et al*. 2012).

Long-term presence of researchers and tourist sites is discussed under 'Run research project and ensure permanent human presence at site' and 'Run tourist project and ensure permanent human presence at site', respectively.

Tranquilli S., Abedi-Lartey M., Amsini F., Arranz L., Asamoah A., Babafemi O., Barakabuye N., Campbell G., Chancellor R., Davenport T.R.B., Dunn A., Dupain J., Ellis C., Etoga G., Furuichi T., Gatti S., Ghiurghi A., Greengrass E., Hashimoto C., Hart J., Herbinger I., Hicks T.C., Holbech L.H., Huijbregts B., Imong I., Kumpel N., Maisels F., Marshall P., Nixon S., Normand E., Nziguyimpa L., Nzooh-Dogmo Z., Okon D.T., Plumptre A., Rundus A., Sunderland-Groves J., Todd A., Warren Y., Mundry R., Boesch C. & Kuehl H. (2012) Lack of conservation effort rapidly increases African great ape extinction risk. *Conservation Letters*, 5, 48–55.

A before-and-after trial in 1975-1985 in swamp and riverine forest in Tana River Primate Reserve, Kenya (1) found that despite permanent presence of reserve staff along with other interventions, Tana River red colobus *Colobus badius rufomitratus* and crested mangabeys *Cercocebus galeritus galeritus* decreased over a ten year period. Overall population size decreased from 1,200-1,800 to 200-300 individuals (83% decrease) for colobus and from 1,100-1,500 to 800-1,100 individuals (25% decrease) for mangabeys. The number of forest patches inhabited by these two species also decreased over time. No statistical tests were carried out to determine whether this decrease was significant. Results of total counts in 1985 and in 1973-1975 were compared to estimate population change. A permanent ranger post to house junior reserve staff was built in 1976. In the same year, the area became a National Reserve and from 1977-1981, a tourism enterprise with a permanent lodge was established and maintained in the reserve. The study does not distinguish between the effects of the different interventions mentioned above.

A before-and-after trial in 1985-1998 in riparian forest in the Community Baboon Sanctuary, Belize, South America (2) found that when staff were permanently present along with ten other interventions, the sanctuary's black howler monkey *Alouatta pigra* population increased by 138% over 13 years. The population increased from 840 to over 2,000 individuals, although no statistical tests were carried out to determine whether this increase was significant. Additional interventions included the protection of the sanctuary by the communities surrounding it, preserving forest buffer strips along property boundaries and a forest corridor along the river, constructing pole bridges over man-made gaps, involving local communities in the management of the sanctuary, preserving important howler food trees in large clearings, an eco-tourism and research program, creation of a museum for education purposes, and monetary benefits (income from tourism and craft industries) to local communities for sustainably managing their forest and its wildlife communities. The study does not distinguish between the effects of the different interventions mentioned above.

A study, which was included in a review, in 1976-1977 in dry evergreen forest in Sai Yok National Park, Thailand (3) on reintroduced captive lar gibbons

Hylobates lar in areas with permanent presence of area managers along with other interventions found that their population decreased by 6% and no infants were born 17 months post-release. No statistical tests were carried out to determine whether this decrease was significant. Four gibbons joined wild groups. The permanent presence of area managers and other staff appeared to ensure protection from hunters. A total of 31 gibbons were introduced as individuals, pairs, or family groups into habitat with wild conspecifics. Anaesthetized gibbons were either kept in separate cages from which they could hear, but not see each other for 14 days before release, or laid out on the forest floor. Injured animals were recaptured and treated. In 1961, gibbons were protected in Thailand. The study does not distinguish between the effects of the different interventions mentioned above.

A before-and-after trial in 1994-1999 in mixed tropical forest in Conkouati-Douli National Park, Democratic Republic of Congo (4) found that the majority of reintroduced central chimpanzees *Pan troglodytes troglodytes* that were permanently monitored by staff alongside 16 other interventions, survived over five years. Out of 20 reintroduced chimpanzees whose health condition was monitored by permanently present staff during the study, fourteen (70%) survived. No statistical tests were carried out to determine whether the population decrease was significant. Individuals were radio-collared. Rehabilitated orphan chimpanzees underwent vaccination, parasite treatments and veterinary screens before being translocated in four subgroups from the sanctuary to the release site where resident conspecifics occurred. Staff members provided supplementary food if necessary and examined dead animals. The area status was upgraded from reserve to national park in 1999. Local people were relocated from the release site. Some individuals were treated when sick or injured. TV and radio advertisements were used to raise chimpanzee conservation awareness and local people were provided monetary and non-monetary benefits in exchange for their conservation support. The study does not distinguish between the effects of the different interventions mentioned above.

A before-and-after trial in 2008-2010 in a tropical forest-grassland mosaic at Batéké Plateau National Park, Gabon (5) found that the majority of western lowland gorillas *Gorilla gorilla gorilla* that were accompanied by caretakers during the day alongside ten other interventions, survived for at least nine months. Four (80%) out of five juvenile gorillas survived for at least nine months after release when caretakers guided them into different forest patches on a daily basis. Three captive-bred and two orphan wild-born individuals were reintroduced as a group into habitat with predators and without resident gorillas after they were allowed to adapt to local habitat conditions for some time. They spent the night in an enclosure equipped with nesting platforms, nesting material, supplementary food and water. Gorillas were dewormed regularly on-site. The study does not distinguish between the effects of the different interventions mentioned above.

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