Environmental Impact Assessment: Proposal to return giant tortoises to Madagascar to conserve threatened forests

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Summary

Madagascar's fragile ecosystems have been severely degraded and the future survival of some species and ecosystems appears bleak, despite concerted conservation efforts. The extinction of key species has upset the ecological balance and left remnant ecosystems and their inhabitants poorly adapted to future pressures such as habitat destruction, fire, climate change and invasive species.

Restoring the large grazers and seed dispersers which once created and maintained Madagascar's ecosystems and their inhabitants is vital for their future persistence. In this document, we propose to reintroduce a surviving lineage of one of the Madagascan giant tortoises to Beanka Protected Area in western Madagascar. Reintroducing giant tortoises has shown to be a low-cost, landscape based approach to conserving endemic forests which are threatened by annual wildfires. We, Biodiversity Conservation Madagascar, La Vanille Nature Park and Bioculture (Mauritius) Ltd, believe that this innovative approach to aiding in the long-term restoration of threatened habitats will attract global attention and provide a useful framework for managing similarly threatened habitats across Madagascar.

The purpose of this document is to explain the project and to provide an environmental impact assessment of the reintroduction evaluating any potential risk and how these can be mitigated.

Introduction

The richness and spectacular array of Madagascar's native wildlife is just a fraction of what once resided on the island. Elephant birds, pygmy hippos, giant lemurs and giant tortoises shaped the landscape before the arrival of humans. Subsequently, all disappeared, and until recently were believed to be extinct. However, there is evidence that a surviving lineage of one of Madagascar's extinct giant tortoises is alive today in the form of the Aldabra giant tortoise.

Biodiversity Conservation Madagascar (BCM) in collaboration with La Vanille Nature Park in Mauritius propose to return native giant tortoises to their Madagascan habitat after an absence of over 750 years. We propose to re-introduce captive-bred Aldabra giant tortoises to the dry deciduous forests of Beanka Protected Area (PA), managed by BCM.

Returning a surviving lineage of the extinct tortoises is expected to fulfil multiple functions:

1. Conserve the dry deciduous forests of Beanka PA by reducing the fire fuel load and thereby minimising the impact of annual fires;
2. Restore key ecosystem functions (namely grazing, seed dispersal and nutrient cycling) once performed by the two species of Madagascan giant tortoises to help preserve the remnant flora and fauna;
3. Provide a low-cost, landscape based solution to conserving Madagascar's dwindling dry deciduous forest;
4. Secure socio-economic gains for the local populace by providing jobs; and
5. Attract eco-tourists to the western forests to appreciate their rich biodiversity.

Project team

Biodiversity Conservation Madagascar

Biodiversity Conservation Madagascar (BCM, http://www.biodiversityconservationmg.com/) is a non-governmental non-profit conservation organisation established in 2002 with the support of the Bioculture Group, Mauritius. BCM works with local communities and authorities to protect ecological sites of high biodiversity value in need of protection, where there are no competing organizations and the threats are manageable. We employ 47 permanent Madagascan staff to manage our two conservation sites, Beanka Protected Area and Sahafina PA, a 2,400 ha. block of lowland rainforest west of Brickaville (central east of Madagascar). Our mission is to conserve and protect Madagascar's biodiversity and create a future in which humans live in harmony with nature.

When Beanka was identified as a potential conservation site, BCM initiated consultations with the local communities living adjacent to the forest to gain support to seek legal protection of the forest. In 2007, BCM was granted the conservation management lease of Beanka under the "Convention de Gestion 143-07/MINENV/SG/DIREEF4". With support of the local communities and government authorities, BCM upgraded Beanka's status of "forêt classée" (unprotected) to a NPA (New Protected Area) in 2015 (Decree N° 2015-727).

La Vanille Nature Park

La Vanille Nature Park (http://www.lavanille-reserve.com) has been breeding Aldabran giant tortoises in Mauritius since 1990 and is today recognized as the largest captive breeding centre for these giants. Owen and Mary-Ann Griffiths, also owners of Bioculture (Mauritius) Ltd, ensure that funds generated by this eco-tourism site are injected back into habitat conservation in Mauritius, Rodrigues and Madagascar. Owen Griffiths is a keen supporter of tortoise conservation and is an associate and affiliate of the Turtle Survival Alliance and the IUCN Tortoise and Freshwater Turtle Specialist group.

La Vanille has extensive experience of translocating large numbers of tortoises having returned over 650 tortoises to its François Leguat Giant Tortoise Reserve in Rodrigues (Pedrono *et al.* 2013), and collaborated with the Mauritian Wildlife Foundation to introduce giant tortoises to Round Island, Mauritius (Griffiths 2010). The reserve has been recognized for its high welfare standards (Devaux 2007, Griffiths *et al.* 2012).

Scientific committee

Below is a list of the members of the team of scientific experts established to ensure rigorous scientific data collection and assist in the planning and assessment of the tortoise reintroduction to Beanka PA.

Dr Christine Griffiths specialises in ecosystem restoration by restoring ecological processes. She coordinated the translocation of tortoises to Round Island (Mauritius) and has an in-depth knowledge of Aldabra giant tortoise behaviour and ecology, and establishing long-term monitoring protocols to achieve restoration goals.

Mr Radosoa A. Andrianaivoarivelo is the Scientific Coordinator of Biodiversity Conservation Madagascar and has a Doctorate in Biology (2012) and a joint Diploma fromthe Universities of Renne (France) and Antananarivo (Madagascar). As well as coordinating the scientific work at Beanka PA, Rado has extensive experience in data collection, analyses and survey methods.

Mr Owen Griffiths is a Research Associate of the Australian Museum and an expert on non-marine molluscs of the Mascarene Islands, Seychelles, Madagascar and the Comoros. Owen established the NGO, Biodiversity Conservation Madagascar and has an extensive knowledge of Madagascar flora and fauna, breeding and rearing and translocating tortoises.

Dr Achille Raselimananana holds a permanent professorship at University of Antananarivo, specialising in herpetology, zoology and animal biology. He is the President of Association Vahatra, has extensive fieldwork experience.

Prof. Steven Goodman is the MacArthur Field Biologist at The Field Museum of Natural History and the Scientific Counsellor of Association Vahatra. Steven has been living and working in Madagascar for much of the last 30 years and is one of the founding members of Association Vahatra.

Dr Maria Vorontsova is a lead researcher from Kew Royal Botanical Gardens and an expert in Madagascan grassland species taxonomy and evolution.

Dr Laurent Gautier studied the ecology of forest-savannah transition in the Ivory Coast for his PhD. He is employed by the Conservatoire et Jardin botaniques Geneva and is a specialist on Madagascar flora and vegetation and monitoring the impacts of deforestation.

Proposed re-introduction site: Beanka PA

Beanka PA (140 km2) is situated 80 km east of Maintirano, in the Melaky region, and north of the Bemaraha Reserve, a UNESCO World Heritage Site. The proposed reintroduction site at Beanka PA is a grassland valley, naturally enclosed by tsingy dry forest on one side and a river on the other. Suitably sized enclosures will be constructed within this fire-prone grassland as the tsingy is difficult to navigate. The selected site is above potential cyclone flood levels**.**

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Grassland adjacent to the tsingy at Beanka PA.

What is the significance of Beanka forest?

The remnant dry deciduous forests in western Madagascar are characterized by very high local plant and animal endemism at the species, genera and family levels (WWF 2013). Surveys of Beanka PA by Professor Steve Goodman have documented 11 lemur species, 57 birds species, 42 reptile and amphibian species, and 13 bat species. Botanical surveys by the Missouri Botanical Garden in collaboration with the Parc Botanique and Zoologique de Tsimbazaza noted that the forest is dominated by *Noronhia* sp., *Commiphora* spp., *Croton* spp. and *Hildegardia* sp. Preliminary surveys in 2009 and 2011 revealed a total of at least 320 plant species, consisting of 96 families and 256 genera. Beanka possesses at least six species of wild *Coffea* species, two of which are new to science. A remarkable richness considering that similar sized forests normally possess a maximum of three *Coffea* species (Phillipson 2009). Further surveys are likely to unearth additional fauna and flora species.

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Dry deciduous forest

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Wildfires destroy large areas of native forest annually

What are the habitat threats?

Over 97% of Madagascar's dry deciduous forests have been destroyed by uncontrolled burning and clearing for grazing and agriculture (Smith 1997, Whitehurst *et al.* 2009). Fires, which are often started deliberately in the surrounding grasslands to improve pasture for cattle, spread to the adjacent forests due to the dry and continuous leaf litter cover. As the trees and shrubs of this critically endangered habitat are very susceptible to fire damage being generally thin-barked, there is little potential for the forest flora to regenerate after wildfire damaged (Bloesch 1999).

The resultant secondary grassland savannas are dominated by grasses, namely *Heteropogon contortus, Aristida barbicollis* and *Hyparrhenia rufa* (Bloesch 1999, Pons & Wendenberg 2005). These extensive fire-prone savannas have low faunal and floral diversity and have been described as virtually sterile landscapes (WWF 2013). With an expanding rural population and increasing degradation of existing arable lands, the pressure on the island's remaining dry forests is forecast to increase and the remnants of this critically endangered habitat is likely to disappear. Finding long-term, low cost solutions to conserve the dry deciduous forests of western Madagascar is paramount as this unique ecosystem is now so fragmented and degraded that many native large animal species have been lost, and the remainder are unlikely to maintain viable populations beyond 2020±2040 (Ganzhorn *et al.* 2001, Irwin *et al.* 2010).

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Widespread grasslands have replaced what was once dry deciduous forest

Another threat to Madagascar's forests, albeit less obvious, has been the loss of large seed dispersers due to hunting and habitat loss (Dirzo & Miranda 1990, Wright 2003; Stoner *et al.* 2007). Large-seeded plants which are reliant on large frugivores for the dispersal of their seeds are especially at risk following the extinction or decline in abundance of large frugivores. In Madagascar, the largest frugivore, the Madagascar Elephant bird (*Aepyornis maximus*) at 450 kg, has been replaced by the Ploughshare tortoise (*Astrochelys yniphora*) at 10 kg. Given that this species itself is vulnerable to extinction and is limited in distribution (Pedrono 2008), the future of many large-seeded Madagascan species dependent on animals for dispersal is bleak. Since seed dispersal is critical for healthy plant populations as it allows plants to colonise new areas or recolonize degraded areas, preserving and restoring plant-frugivore interactions is thus a key priority for biodiversity maintenance (Jordano 2000).

What can be done?

By employing local people as guards and conservationists, illegal logging and hunting declined significantly at Beanka. While the reserve is now a sanctuary for plants and animals which have disappeared from surrounding areas, wildfires remain a constant and increasing threat to the fire-sensitive forest. Controlling wildfires is essential to protect native biodiversity (Pons & Wendenberg 2005, Whitehurst *et al.* 2009), as well as livelihoods of the local human communities (Bloesch 1999). As fire is an integral part of Malagasy culture, instigating control measures is difficult and in part counterproductive. One solution is to reduce the fuel load so that the intensity and frequency of wildfires is lessened.

This project proposes to re-introduce giant tortoises to protect Beanka forest. Giant Madagascan tortoises, once abundant in these forests, played an integral role in grazing combustible material, thereby indirectly regulating fire regimes, and dispersing native seeds (Burney *et al.*, 2004).

Aims of tortoise reintroduction to Beanka PA

The primary aims of reintroducing giant tortoises are to investigate whether tortoises can:

1. Reduce fuel loads in grassland savannas and dry forests and ultimately reduce the damage caused by wildfires.
2. Reinstate missing seed dispersal interactions to help restore the forests.

Rationale for re-introduction of giant tortoises

Throughout this proposal, the Madagascan giant tortoises and Aldabra giant tortoises are distinguished using different nomenclature. Nevertheless, as explained below, genetic and morphological evidence show that one of the Madagascan giant tortoises (*Aldabrachelys abrupta*) is in fact a conspecific to the last remaining giant tortoises in the Indian Ocean, the Aldabra giant tortoises (*Aldabrachelys gigantea*) of the Seychelles. Hence, the proposed translocation of Aldabra giant tortoises to Beanka PA will be a **re-introduction** as defined by the IUCN (2013).

Megan Whittaker

Adult Aldabra giant tortoises

What evidence is there that Aldabra giant tortoises are conspecific to the extinct Madagascan giant tortoises?

Of the two species of extinct Madagascan giant tortoises, *Aldabrachelys grandidieri* and *A. abrupta*, genetic and morphological evidence indicates that *A. abrupta* is synonymous to the Aldabra tortoise, *A. gigantea* (Arnold 1979, Palkovacs *et al.* 2002, Pedrono *et al.* 2013).

Aldabra atoll in the Seychelles, the last stronghold for giant tortoises in the western Indian Ocean, has been completely submerged several times in recent geological history, eliminating all its tortoise populations (Taylor *et al.* 1979). Subsequent recolonizations have occurred on at least three separate occasions from tortoises of Madagascan origin. The large size of *A. abrupta*, with extensive fat deposits, conferred a pre-adaptive trait to support food and fresh water deprivation during long transoceanic drifts. Ocean currents which flowed northward from Madagascar would have carried floating *A. abrupta* the 400 km to the Aldabra archipelago. An insignificant distance relative to the 780 km an Aldabra tortoise floated to Tanzania in 2004 (Gerlach *et al.* 2006).

Molecular studies have confirmed the genetic similarities between extinct Madagascan *A. grandidieri* – the sister taxon of *A. abrupta* – and extant Aldabra *A. gigantea* (Austin *et al.* 2003): there is only 5.8% genetic divergence between these two tortoise species supporting the morphological evidence that the ancestors of Aldabra giant tortoises originated from Madagascar. In contrast, there is a greater genetic difference between the two extant

Madagascan tortoises, *Astrochelys radiata* and *A. yniphora*: 8.2-8.8% (Caccone *et al.* 1999). The genetic affinity between *A. abrupta*, the presumed ancestor of *A. gigantea* based on morphology, and *A. gigantea* is currently being analyzed. Previously, the poor condition of the 'subfossil' remains of *A. abrupta* prevented such investigations (Pedrono *et al.* 2013). Using novel DNA extraction techniques, genetic analysis is expected to reveal that there is less divergence between *A. abrupta* and *A. gigantea* than between *A. grandidieri* and *A. gigantea*, and that *A. abrupta* and *A. gigantea* are in fact the same species.

All the western Indian Ocean islands were once home to giant tortoises, which are believed to have originated from Madagascar. Today native giant tortoises are found only on Aldabra Atoll in the Seychelles. We propose to return giant tortoises to Madagascar, as has been done in Mauritius and Rodrigues where tortoises are now helping to restore degraded ecosystems.

What do we know about the extinct Madagascan tortoises?

The two extinct species of giant Madagascan tortoises, *Aldabrachelys grandidieri* and *A. abrupta* lived as recently as 1250±50 years and 750±370 years ago, respectively (Burleigh & Arnold 1986). Often occurring together in huge densities, they were found in the south, west and centre of the island, from coastal habitats to the central highlands (Arnold 1979, Burleigh & Arnold 1986, Pedrono 2008). Their ability to drink water through their nostrils and the absence of either species in the humid east suggests they were adapted to arid habitats. Competition between the two species was likely minimised by differences in their diet, with the larger dorsally flattened *A. grandidieri* perhaps a grazer confined to open habitats such as swampy

plains, and the slightly smaller dome shaped *A. abrupta* preferring to browse in more shrubby or forested habitats (Burleigh & Arnold 1986, Pedrono 2008). Their extinctions are attributed to human activity (hunting and habitat destruction) rather than climate change (Pedrono 2008).

Why were Madagascan giant tortoises important?

Giant tortoises are ecological keystone species and ecosystem engineers, particularly in island communities (e.g., Hansen *et al.* 2010, Griffiths *et al.* 2011). This means that they have a disproportionately large effect on their environment and play a critical role in maintaining the structure of an ecological community. The loss of such important species can lead to the extinction of other species and considerable changes in the ecosystem. For instance, it has been documented that the loss or decline in abundance of giant tortoises, often concurrent with the loss of other large-bodied terrestrial vertebrates, has disrupted ecosystem functioning and caused other extinctions (Owen 1980, Eskildsen *et al.* 2004, Hansen *et al.* 2008, Hansen & Galetti 2009, Griffiths *et al.* 2010, Hansen *et al.* 2010, Griffiths *et al.* 2011).

In Madagascar, giant tortoises would have influenced plant species composition and structure and nutrient cycling by seed dispersal, grazing, browsing, trampling, digging, urinating, and defecating (Andriantsaralaza *et al.* 2013, Gibson & Hamilton 1983; Griffiths *et al.* 2010, 2011, 2013; Griffiths 2013; Pedrono *et al.* 2013). By consuming the vegetation and leaf litter, they played a crucial role in reducing the amount of flammable above ground biomass and as a consequence reduced the intensity and frequency of fires (Burney *et al.*, 2004).

What are the benefits of returning giant tortoises?

Arnaud Meunier

Aldabra giant tortoises restoring grazing and seed dispersal functions at François Leguat Giant Tortoise and Cave Reserve

Similar projects in the Mascarenes have seen giant tortoises returned to endangered habitats in Mauritius (Ile aux Aigrettes and Round Island) and Rodrigues (François Leguat Giant Tortoise and Cave Reserve, Anse Quittor) after an absence of over 400 years (Griffiths *et al.* 2010; Pedrono *et al.* 2013). Since their introduction, Aldabra giant tortoises have had a profound positive impact on the dispersal of endangered endemic seeds (Griffiths *et al.* 2011, Griffiths 2013). In Madagascar, as observed in the Mascarenes, it is likely that many native species may be partially dependent on ingestion by giant tortoises, with which they co-evolved. Indeed, feeding experiments with Aldabra tortoises at the Tsimbazaza Zoo, Antananarivo, have already shown that these tortoises eagerly consume baobab seeds (*Adansonia* spp.), which readily germinate post gut passage (Andriantsaralaza *et al*. 2013).

Aldabra tortoises introduced to Round Island, Mauritius, in 2007 control invasive grasses which were previously suppressing native vegetation. The tortoises selectively consume exotic plants and avoid the natives which evolved in the presence of Mauritian giant tortoises (Griffiths *et al.* 2013). During the dry season, tortoise diet is composed mainly of leaf litter (Griffiths 2005).

Removal of the leaf litter by grazing herbivores is vital to reduce the frequency and intensity of fire outbreaks, as noted in Galapagos (Froyd *et al.* 2014).

Why not use locally available cattle and goats to graze the grassland savanna?

Reducing the fire fuel load is essential to help protect the dry forest. Cattle and goats however will not have the same impact on the vegetation as tortoises. This is because herbivores differ in what plants they eat and their impacts (trampling, urination, defecation) due to differences in their physiology and feeding behaviour. For example, goats and cattle invariably destroy seeds by chewing on them, whereas giant tortoises swallow large seeds whole. Cattle and goats are also not selective in what they eat consuming many native plants which tortoises avoid (Griffiths *et al.* 2013). Perhaps of most importance is that goats and cattle do not consume leaf litter, whereas this is a key component of giant tortoise diet (Gibson & Hamilton 1983, Griffiths 2005, Griffiths *et al.* 2013). Goats and cattle would thus not contribute to reducing the fuel load, a key criteria in helping to protect Madagascar's dry deciduous forests.

Why not use Madagascan tortoises?

Madagascar is home to five endemic tortoises (Radiated, Ploughshare, Spider, Flat-tailed, Bell's hinged), of which four appear on the IUCN Red List of threatened species. Thus, from a logistic perspective, sourcing these endemic tortoises would not be practical or of sound conservation practice due to their rapidly declining populations. There is currently no evidence that any of these species ever occurred at Beanka PA and introducing them into new areas would not aid in their current conservation status.

Today the largest locally extant tortoise is the Critically Endangered Ploughshare tortoise (*Astrochelys yniphora*). Even if this species was abundantly available it would not fully fulfil the role of the extinct tortoises as it is roughly ten times smaller, thereby limiting the plant biomass it can consume. For instance, its smaller size would inhibit it from dispersing large seeds once dispersed by the giant tortoises.

In addition, as the Ploughshare tortoise and other aforementioned tortoises have a more specialist diet and habitat requirements, they would only partially fulfil the missing species interactions left by the extinct giant tortoises. For example, the diets of the extinct and the remaining Madagascan tortoises probably overlap less than that of the Aldabra and extinct Madagascan giant tortoises.

A continual grazing pressure is required to achieve the aim of converting the tall homogenous grasslands into more heterogenous habitats with patches of closely cropped lawns and tussock grasses of greater species diversity. In Aldabra and the Mascarenes, Aldabra giant tortoises create and maintain these lawns because they are social gregarious animals that form relatively sedentary herds (Bourn & Coe 1978). In contrast, the smaller extant Malagasy tortoises are generally more mobile, less social animals, occupying large home ranges (Pedrono 2008). Consequently, they do not have the same impact on the vegetation.

Risk assessment of re-introduction of giant tortoises

Why are tortoise re-introductions low risk?

Any translocation bears risks that it will not achieve its objectives and/or will cause unintended damage (IUCN 2013). Previous Aldabra giant tortoise translocations have shown that the associated risks can be easily forecast, mediated and remedied with appropriate precautions and regular monitoring (Griffiths *et al.* 2010, Hansen *et al.* 2010, Griffiths *et al.* 2013). Nevertheless, a risk and feasibility assessment, as recommended by the IUCN, is needed. Lessons learnt and experience obtained from previous tortoise translocations will be adopted.

The versatility and highly generalised diets of giant tortoises enables them to be introduced into a wide range of habitats of varying qualities, including highly degraded areas (Hansen *et al.* 2010). Aldabra giant tortoises are thus an attractive option for early-stage restoration efforts in Madagascar. They have relatively few environmental requirements and are of low maintenance (Griffiths 2013). For instance, tortoises have a very simple social structure, lack maternal care and as from the sub-adult stage lack native predators, which enable them to be introduced successfully at a young age and even in small numbers. Perhaps the most important attribute is that they can be easily removed or fenced should the ecological costs outweigh the benefits of their introduction (Griffiths *et al.* 2010, Hansen *et al.* 2010).

How will the past threats to giant tortoise populations be mitigated?

A key criterium of this project's success is that the giant tortoise population will not be affected by the same threats which caused the extinction of the Madagascan giant tortoises, human hunting. BCM has already held a classical-style public forum (*kabary*) at its headquarters in Ambinda to explain the giant tortoise project and seek community approval, which was granted. BCM will continue to invest in a long-term awareness programme to educate the local communities of the importance of this species and the need to protect it. Poaching or theft for the illegal pet trade will be deterred by initially enclosing the tortoises, employing local guards, the site's isolation, by engraving each tortoise's carapace with a identity code and inserting a subcutaneous microchip for identification. Defacing the carapaces of adult Ploughshare tortoises has helped reduce their market value. To aid in the protection of this species, we will also seek to include Aldabra giant tortoises in Madagascar's protective species legislation so that theft or poaching will have greater consequences.

Proposed methodology

How many tortoises and where from?

As there are no breeding populations of Aldabra tortoises in Madagascar, tortoises will be sourced from La Vanille Nature Park. We propose a trial introduction of 20 tortoises in year 1 to assess the feasibility of the project. If preliminary results are encouraging, we propose to reintroduce up to 100 tortoises in year 2 and a further 100 in year 3.

An Aldabran giant tortoise at La Vanille being crated for translocation.

Sub-adult tortoises (8-10 years old), roughly 10-15 kg, 35-40 cm in curved carapace length of mixed sex (roughly 60% female, 40% male) would be most suitable. At this size, there is no risk of being predated or trampled by cattle. Aldabra tortoises reach sexual maturity at around 20 years of age, thus allowing sufficient time to study their impacts on the environment, before they can reproduce.

The proposed reintroduction site at Beanka PA fulfils all tortoise habitat requirements in terms of shade, food, and water. We propose to transport the tortoises to Antananarivo by air and then truck them to Beanka, where they will be released into holding pens for one month to allow them to acclimatise and to further monitor their health before introducing them to larger pens.

What considerations will be taken to reduce risks associated with the reintroduction?

Animal welfare

The translocation will be carried out in compliance with the recommendations for the movement of animals by World Organisation for Animal Health and the International Union for the Conservation of Nature translocation guidelines (IUCN 2013). Similar protocols to those for the translocation and introduction of Aldabra tortoises in Mauritius by Griffiths *et al.* 2012 will be adopted. La Vanille has extensive experience in transporting tortoises for export to all over the world and strives to attain the highest welfare standards both of its tortoises in captivity and during the handling and transport process.

Quarantine, disease and parasite considerations

In accordance with the IUCN translocation guidelines (IUCN 2013), all animals will be quarantined and undergo health screening, including physical examination, faecal, haematological, serological and herpesviruses analyses, prior to translocation.

Tortoises will be quarantined for 2 months at La Vanille Nature Park and fed on a restricted diet to prevent seeds being introduced. Upon arrival at Madagascar, they will be held at Parc Botanique et Zoologique de Tsimbazaza before being translocated to Beanka where they will be kept in temporary holding pens for at least one month to further reduce the risk of unwanted seeds being introduced, to assess their health following the translocation and to allow them to acclimatise to their new environment.

The recommended health screening protocol has been devised by the International Zoo Veterinary Group, UK, which specialises in the diagnosis of diseases in wild animals. Details can be found in Griffiths *et al.* 2012. While the risk of inter-species disease transmission is low (Griffiths *et al.* 2010), screening will ensure that translocatees are healthy.

Impact on native tortoise population and other fauna

As there are no other land tortoises at the proposed sites or in the surrounding areas, there is no risk of inter-tortoise disease transmission or competition for resources.

Impact on flora

A key component of the project will be to monitor the impact of the reintroduction of giant tortoises on the native and exotic flora. Baseline data for the site has been collected since 2009, and prior to the reintroduction additional data will be acquired. Long-term monitoring protocols and regular surveying of the plant composition and structure, fauna (invertebrate, reptile, bird and mammal) communities and fixed point photos will be established post-introduction into penned areas. Any changes in the flora and fauna will be compared to adjacent control sites, without tortoises. As the translocated population will not be sexually mature, it will be possible to remove all individuals if necessary.

Social feasibility

Human communities in and around the proposed site were consulted in September 2012 (Ambinda) during a local kabary to seek support for the translocation and long-term sustainability of the project. We will employ at least 9 people from the local community, in addition to the 46 staff we currently employ. By providing local communities with other means of earning a living, this will help reduce the deforestation pressure on the forests (Whitehurst *et al.* 2009).

Regular awareness programmes and meetings aims to ensure that the reintroduction of giant tortoises is fully accepted by local people. We hope to encourage them to take pride in their role in helping to protect, not just the tortoises, but the forests which they heavily depend on. Malagasy student will be trained to collect data and assist in the development of the project.

Proposed research

To ensure that the introduction of tortoises is beneficial to both the translocated individuals and at ecosystem level, regular monitoring of plant-tortoise interactions (e.g. diet, seed dispersal), tortoise health, behaviour, and the impact of tortoises on the vegetation (species abundance, composition, above ground biomass, fixed point photographs, soil characteristics) and its inhabitants will be conducted. Data will be compared between tortoise and non-tortoise areas. Regular engagement with the local communities will also enable benefits and costs, direct and indirect, and attitudes towards the reintroduction to be continually assessed. We intend to work closely with BSc, MSc and PhD students from Malagasy universities.

Findings and data collected will be disseminated in peer-reviewed journals, films, radio, and newspapers to create awareness of the project and to contribute to the understanding of the importance of restoring missing interactions.

For further information contact:

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