GLOBAL RE-INTRODUCTION PERSPECTIVES

Re-introduction case-studies from around the globe

Edited by

Pritpal S. Soorae

RSG

Environment Agency ABU DHABI
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Prepared by the
IUCN/SSC Re-introduction Specialist Group
in conjunction with the
Environment Agency-Abu Dhabi, UAE
and the Denver Zoological Foundation, USA

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Cover photo: Clockwise starting from top-left:

- Formosan salmon stream, Taiwan
- Students in Madagascar with tree seedlings
- Virgin Islands boa

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H.E. Majid Al Mansouri
Secretary General
Environment Agency-Abu Dhabi

The Environment Agency in Abu Dhabi has been the host of the IUCN/SSC Re-introduction Specialist Group since the year 2000. When we were asked to host the group, it did not take us long to accept as the aims and aspirations of the Re-introduction Specialist Group are so closely related with our own. The Emirate of Abu Dhabi, and its people, are dedicated to the preservation and restoration of wildlife in the wild.

For many conservationists, the perception on the United Arab Emirates is negative and linked to hunting, wildlife trade issues and an unsustainable way of life. Without denying that challenges exist within the UAE when it comes to conservation and the environment, as with many other countries, there is a need to look at the overall situation and also acknowledge that there are many positive aspects within the country in regard to conservation. The UAE, and in particular the Abu Dhabi Emirate, is a pioneer in the Arabian Peninsula by the size and importance of its environmental institutions and legislation for protecting the environment. One of the flagship projects is the conservation work on the houbara bustard, which started in 1977 and culminated in 2007 by the first breeding in the wild of released captive bred houbara in the UAE. Also in 2007, the first group of houbara bustard from Pakistan and bred in captivity in the UAE, were released in Pakistan. The National Avian Research Centre, responsible for this project, is now breeding in excess of 900 houbara chicks a year and has established collaboration for research and conservation of this emblematic bird species in over 14 countries of the houbara range. Similarly, in Morocco, the Emirates Center for Wildlife Propagation, is protecting a vast area of over 40,000 km² where over 5,000 houbara bustards have already been re-introduced in the wild. The Centre is also assisting the Moroccan authority in reforestation projects and the protection and re-introduction of gazelles.

Abu Dhabi is probably the home of the largest population of Arabian Oryx with an estimation of over 4,000 individuals. In 2007, a first herd of 40 individuals was released in a newly created protected area at the edge of the Rub-Al Khali. The marine environment is not forgotten with the creation of two marine protected areas within Abu Dhabi Emirates that contribute to the conservation of dugongs, marine turtles, extensive sea grass beds and corals, as well as providing a safe refuge for the local fishes. Throughout our endeavors we have been striving to follow the highest international standards, and we see our contribution and support to the Re-introduction Specialist Group as one of the ways we can attain excellence.

Dr. Holly T. Dublin
Chair
IUCN Species Survival Commission

The IUCN Species Survival Commission (SSC) – the oldest and largest of IUCN's six volunteer Commissions – turns 60 years old in 2009. It has a proud history of species conservation over these decades, a history that includes the development of the IUCN Red List of Threatened Species™, and various tools and guidelines for conservation practitioners. The SSC has over 7,500 members in over 100 Specialist Groups. Some of these Specialist Groups focus on conservation issues for a specific species or taxa, while other groups tackle broader thematic issues such as conservation breeding, the impacts of alien invasive species, wildlife health and sustainable use.

The Re-introduction Specialist Group (RSG) of the SSC was created in 1988 to bring together expert knowledge on matters of re-introducing species into their natural habitats. The work was timely and much needed as the practice began a phase of rapid, yet often uninformed expansion.

Since then, the RSG has provided advice on the application of this important conservation tool and in 1995 produced the now widely-used IUCN Guidelines for Re-introduction and taxon-specific guidelines for a number of species such as non-human primates, African elephants and Galliformes.

This collection of over 60 case studies on reintroduction of a variety of taxa is a major achievement in the field as it will provide species conservationists, government departments and protected area managers with an unparalleled reference document on best practices in the field of re-introduction. It will also encourage interaction amongst practitioners - hopefully leading to many more sound and successful re-introduction projects in the future.

I congratulate the IUCN SSC RSG for bringing their information to the global conservation community through the production of this excellent special edition.

Richard P. Reading, Ph.D.
Director of Conservation Biology
Denver Zoological Foundation

As the world's human population continues to expand (and even the most optimistic projections suggest several more decades of population growth), we push wild plants and animals into smaller, more fragmented, and more degraded habitats. Global climate change, perhaps the most well-known environmental problem today, only exacerbates the current extinction crisis facing our planet. Conservationists, therefore, increasingly focus on restoration efforts, of which re-introductions represent one important tool. This special issue or Re-introduction News clearly illustrates the rapid increase in re-introductions as a conservation tool both geographically and among different taxa of plants and animals.

Previous assessments of re-introductions globally found that most failed, yet the case studies presented here illustrate much greater success rates. Perhaps obviously, participants in successful re-introduction programs usually are more willing to share their experiences. In addition, with the increasing attention provided to re-introductions by groups like the IUCN's Re-introduction Specialist Group (RSG), we might expect improved success, as practitioners learn from others. Many factors that influence success likely vary by taxa and geographic region, pointing out the importance of publishing case studies from a wide variety of both, as illustrated here.

Still, I encourage practitioners from failed re-introduction attempts to publish case studies about their experiences, especially the lessons they learned, as a means of further advancing the science and practice of re-introduction. Doing so will help others avoid making similar mistakes and, hopefully, result in continually improving success rates. Increasingly, the survival of wild species of plants and animals depends on our ability to restore them to places they once inhabited. This collection of case studies should facilitate that process.

I thank Fred Launay, Pritpal Soorae and the RSG, and the contributors to this special issue for this eclectic collection of case studies. I hope you find them as interesting, informative, and useful as I did.

Dr. Frederic Launay
Chair
IUCN/SSC Re-introduction Specialist Group

Since the publication of the IUCN/SSC Re-introduction guidelines in 1998, the number of re-introduction projects for animals and plants have steadily increased to cover virtually all taxa and habitats. The IUCN/SSC Re-introduction Specialist group has been created by a set of individuals dedicated to make re-introductions successful by providing clear guidelines to practitioners and various stakeholders in re-introduction efforts. The success of the guidelines is undeniable, and very few documented re-introduction projects are made without at least consulting the guidelines, and more often than none, re-introductions are making all possible efforts to follow the guidelines.

With the issue of climate change raising even more concerns on the survival in the wild of many species of animal and plants, it is easy to foresee an even increasing need and temptation to relocate, translocate and re-introduce species.

In that context, it is timely for the Re-introduction Specialist Groups to compile a set of case studies of re-introductions and translocations on animals and plants. This compilation provides fascinating insight in the successes, failures and lessons learned on these variety of initiatives.

Fifty four percent of the case studies are judge successful by their authors, a clear improvement, if we remember the earlier attempts at reintroducing animals and plants in the wild.

The case studies however highlight a number of issues from funding, resources, habitats deterioration, community support that are of critical importance for a re-introduction attempt. This is very important as too often in the past the focus was exclusively placed on the species and its biology.

We hope, that this collection of case studies will prove a useful resource, as well as provide important insight to the increasing number of peoples wishing to embark on re -introduction projects worldwide.

An overview and analysis of the re-introduction project case studies

Pritpal S. Soorae, Editor

Introduction

It was decided to publish this book in a standardized format as per the following categories: Introduction, Goals, Success Indicators, Project Summary, Major Difficulties Faced, Major Lessons Learned and Success of Project with reasons for success or failure. We were fortunate to get a number of contributors willing to submit information on their projects in this standardized format and we finally received a total of 62 case-studies. These case studies cover the following taxa as follows: invertebrates (4), fish (7), amphibians (3), reptiles (8), birds (17), mammals (13) and plants (10). I would also like to take this opportunity to thank the various authors for their patience and willingness to submit information on their projects and in many cases with a tight deadline. We hope the information presented in this book will provide a broad global perspective on challenges facing re-introduction projects trying to restore biodiversity.

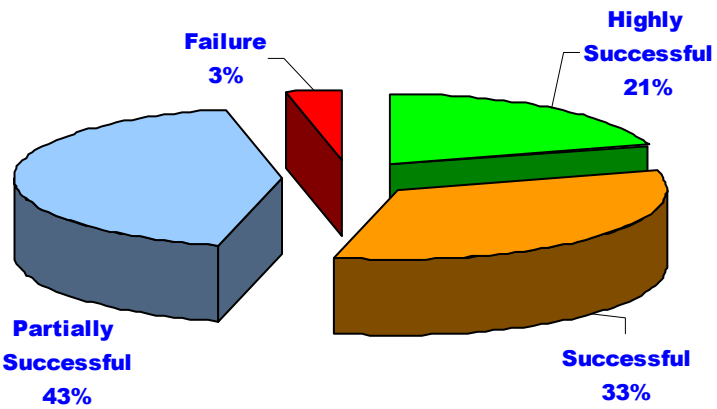
IUCN Statutory Regions

The IUCN statues have established a total of 8 global regions for the purposes of its representation in council. The IUCN's "statutory regions" are a list of States by Region, as per article 16 and 17 of the Statutes and Regulation 36 of the Regulations. All eight global regions are represented within these case studies and the regions are as follows: North America & Caribbean - 14, West Europe - 13, South & East Asia - 10, Oceania - 9, West Asia - 7, Africa - 6, Meso & South America - 2 and East Europe, North & Central Asia - 1.

Success of Projects

The projects presented here were ranked as Highly Successful, Successful, Partially Successful and Failure. Out of the 62 projects only one did not provide any ranking as the project was still in the initial stages so any deduction on its outcome could not be determined. As can be seen in figure 1, 21% of projects were Highly Successful, 33% were Successful, 43% were Partially Successful and

Figure 1. Success of re-introduction projects

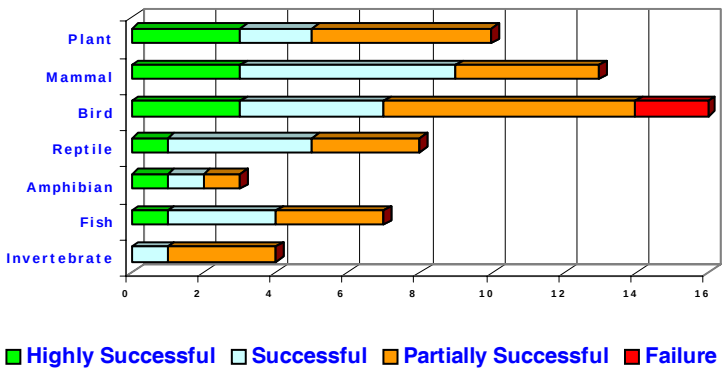


3% were Failures. Some reasons for success were good rearing techniques, increase in species distribution range and increased socio-political awareness. Some reasons for partial success or failure were that re-introductions were done unscientifically, no post-release monitoring, slow reproduction rates, poor habitat quality and a failure to establish a viable population.

Success according to the taxa

An analysis was done to gauge the three different levels of success and failure according to the seven major taxa i.e. invertebrates, fish, amphibians, reptiles, birds, mammals and plants. The results are shown in figure 2 and as can be seen in the figure all but one of the major taxa recorded their projects as highly successful besides invertebrates. Failures were only recorded in the bird re-introduction projects with the majority of projects falling under Partially Successful. As can be seen in figure 2 re-introductions are not easy to conduct and a lot of trial and error is needed to get a viable population established into the wild.

Figure 2. Success of re-introduction projects according to major taxa



Type of project according to re-introduction terminology

An analysis was done to place the different projects in one of these five categories i) introduction (IUCN, 1987 - **see pg. 266**), ii) re-introduction, iii) re-enforcement / supplementation, iv) conservation/benign introduction (for ii, iii, iv - IUCN, 1995 - **see pg. 278**) and v) substitution (Seddon & Soorae, 1999). As a note in some projects there were both re-introductions and supplementations taking place.

The analysis shows that 68% of projects are re-introductions, 27% are Re-enforcements / Supplementations, 3% are Conservation / Benign Introductions with 1% Introduction and 1% Substitution.

References

Seddon, P. J. & P. S. Soorae (1999) Guidelines for Subspecific Substitutions in Wildlife Restoration Projects. Conservation Biology, Vol. 13(1): 177-184.

Re-introduction and supplementation of species of *Acropora* and *Pocillopora* into the lagoons of Lakshadweep Islands, India

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Introduction

The genera ***Acropora*** and ***Pocillopora*** are represented by a large number of species in most coral reefs. They are more sensitive to environmental changes and anthropogenic effects and hence are more at risk than other coral species. For example, they are most vulnerable for bleaching which is a response to increase in sea surface temperature that eventually kills them. They are also highly sensitive to all types of pollutants. Another serious threat owes to their form. Their beautiful shapes make them much sought after for souvenir collection. They are heavily traded, even in reef areas where corals are protected. In the lagoons of Lakshadweep atolls (10-12º N; 71º 40'-74º E) of the Arabian Sea, species of ***Acropora*** and ***Pocillopora*** have for several decades been selectively and intensively removed as souvenirs from the lagoons. Dredging and destructive fishing were other causes for their loss from the lagoons. What little remained were almost totally wiped out during the 1998 bleaching event. This project qualifies both as re-introduction of the species in the sense that lagoons can be considered as a mini-ecosystem within the atolls and supplementation in the other sense that total eradication of the species, however, was not the case.

Goals

- Goal 1: Translocation of coral fragments collected from elsewhere in the reef to the lagoons and enabling their settlement and growth on artificial frames, thus repopulating areas where they were once abundant.
- Goal 2: Enhance the biodiversity locally, including fish diversity, with the translocated corals in the frames serving as niches.
- Goal 3: To demonstrate that this procedure is cost-effective

Close up of translocated coral with fish

and can be achieved with efforts even at the level of islanders (local population).

Success indicators

- Indicator 1: Fast growth as evidenced by linear increase, formation of branches and consolidation of the substratum (overgrowth of the slabs and frames).
- Indicator 2: Low levels of natural mortality.

Project Summary

Feasibility: Species of ***Acropora*** and ***Pocillopora*** occur both in the intertidal and subtidal zones of the reefs. Hence collection of fragments and translocating them in the lagoon is not technically difficult. The socio-political issues concerned with their loss and/or repopulation are related to the need of the local tuna fishers for live bait fishes. Tuna (especially the skipjack) fishing is the backbone of the islands' economy. The island fishermen practice the method of pole and line fishing wherein shoals of tuna are attracted to live baits strewn into the sea when they are sighted. At the height of feeding frenzy the tuna bite at anything and are then easily caught on hooks by fishermen lined on the deck of the boats. The fishery thus depends on a supply of live bait fish (sprats) which is commonly associated with the branching ***Acropora*** corals. Loss of ***Acropora*** species led to a decrease in the harvest of supply of live baits and a possible (but as yet unquantified) impact on tuna fisheries. As fishing is the major economic activity (other than coconut growing) and as the islands are protected territory with a greater control exercised by the local government, this issue has a socio-political dimension. The economic dimension (other than fishing) is associated with development of tourism. Abundance of branching colorful corals (and the associated biodiversity) is the driver for growth of underwater tourism – ***tourists don't pay to see a sandy bottom***!

Implementation: Corals are protected under Schedule I of the Wildlife Act of India. This act specifies that no living or dead parts of species thus protected shall be collected, traded or even simply possessed by any individual for whatever be the reason. Pilot studies (and eventually transplantation on large scale) require specific Government approval and supervision at every stage. There are no other issues such as tribal or cultural sentiments or sanitation or trans-border shipment constraints. Permits, however, need to be secured when live corals are transported from one reef region to another. The monitoring involves monthly visits

Transplanted corals on artificial frames

to the transplant sites to record linear increase, number of branches formed, mortality, if any, and assessment of the cause of mortality (artisanal fishing practices, boat movements in the vicinity) and overgrowth with algae. Such algal growth is immediately removed. Qualitative assessments of the biodiversity in the vicinity are also made. Photographic records are also made at periodic intervals.

Transplanted coral on frame

The results so far indicate that survival is more than 90% and the mortality, if any, is due more to extraneous causes rather than biological. Linear growth and branching are appreciable and comparable to those of natural populations. Transplantation sites do attract other life forms, especially fishes, cowries and holothurians.

Major difficulties faced

- None worth mentioning.

Major lessons learned

- Re-introduction of species lost from some niches in the reef is feasible and could be extended to cover several species if needed. This is a cost-effective strategy to maintain the health of the reefs.
- As the technique does not demand great skills, there is a good scope to have this reduced to a level where local population can be associated, thus evolving into a joint-management activity.

Success of project

Highly Successful	**Successful**	Partially Successful	Failure
	√		

Reasons for success/failure:

- The entire procedure can be carried out with locally available material (cement, sand, iron frames) and with minimal local help. This and the low cost were the main reasons for the success.

Re-introduction of giant clams in the Indo-Pacific

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Introduction

Giant clams (Tridacnidae) are the largest marine bivalves found in coastal areas of the Indo-Pacific region. Eight species of giant clam of varying size and habitat preference have been described (***Tridacna gigas, T. derasa, T. squamosa, T. maxima, T. crocea, T. tevora, Hippopus hippopus*** and ***H. porcellanus***). In addition to the colourful smaller boring clams such as ***T. maxima*** and ***T. crocea*** which are found within limestone substrates, larger free living species such as ***T. squamosa, T. derasa*** and ***T. gigas*** are usually recorded near reef or over sand. Similarly, ***Hippopus*** spp. are often found on soft substrata, e.g. within seagrass beds. These bivalves are unusual in that they host symbiotic zooxanthellae within their mantle tissue, and benefit from the products of photosynthesis which provides part of their nutrition. Giant clams are a highly prized food source, and both exports of clam meat and harvesting by subsistence fishers has been responsible for stock depletion across their range. Giant clams are also harvested for their shells and for live export to the marine aquarium trade. Although fishing by foreign vessels (for adductor muscle) caused much of the depletion of the largest species, today giant clams are mostly under pressure from subsistence and semi-commercial (artisanal) fishers.

Giant clams have been depleted from coral reefs because they are slow growing, non cryptic and generally easily accessible to fishers. Habitat degradation is also responsible for declines in abundance, especially close to larger urban centres. Due to these pressures, their depletion and slow recovery from overfishing, giant clams are listed under Annex II of CITES, and are considered vulnerable under IUCN Red List of threatened species. Although there are examples of local extinctions (***T. gigas*** at Guam and the Mariana Islands, the Federated States of Micronesia, New Caledonia, Taiwan, the Ryukyu Islands and Vanuatu; ***T. derasa***, at Vanuatu; and ***H. hippopus***, at Fiji, Tonga, Western and American Samoa, Guam, Mariana Islands and Taiwan) in most cases giant clams are not eradicated through fishing and habitat change. In

WorldFish Broodstock at Nusatupe Island, Solomon Islands

general, declines in the abundance result in a pronounced constriction in range, and reduced spawning success as giant clams are sessile and cannot actively aggregate for sexual reproduction.

Efforts to re-establish or supplement depleted populations of giant clams have centred around two main activities. The first is to protect and aggregate remaining wild adults, in order to facilitate spawning and fertilisation success and subsequent 'downstream' recruitment. The second group of programs concentrated on breeding and releasing hatchery reared clams. In the early 1980's, several governmental and private institutions throughout the Indo-Pacific region agreed to a joint effort to propagate giant clams and restock the reefs of Pacific Island Nations (Bell ***et al.***, 2005). Initially, the organizations involved in hatchery and early culture research were the Okinawa Prefectural Fisheries Experimental Station, The University of Papua New Guinea, the Micronesian Mariculture Demonstration Center, the Australian Center for International Agricultural Research, the Marine Science Institute at the University of Philippines and the WorldFish Center (formerly known as ICLARM). Re-establishment, re-enforcement and increased awareness of the plight of giant clams stemmed from these initiatives.

Goals

- Goal 1: Preserve through re-enforcement (restocking) giant clams at overfished sites in the Indo-Pacific region. This goal cannot succeed in isolation of general management of remaining stocks which is not covered in this submission.
- Goal 2: Re-introduce giant clam species where they have become extinct.
- Goal 3: Improve aquaculture technology and early grow-out systems to assist restocking stocks.

Success Indicators

- Indicator 1: Supplementation (and related protection) of larger, more viable giant clam populations in the Indo-Pacific region.
- Indicator 2: Re-establishment of giant clam populations, capable of effective self-replenishment.
- Indicator 3: Successful long-term breeding and early grow-out program developed.

Project Summary

Feasibility: In some areas of the Indo-Pacific, natural recruitment was thought to have been almost extinguished (other than self-fertilisation events), as large mature clams were so scattered that they were thought to be beyond the threshold density required for natural cross-fertilisation (e.g. Tonga, see Chesher, 1995). Augmentation of stocks through the aggregation of adult clams was trialled, to increase the chance of successful external fertilisation, and subsequently increase downstream recruitment. In theory, aggregation of adults in 'clam circles' (Chesher, 1995) overcomes 'Allee' or 'depensatory' effects, although there are few quantitative studies that empirically show the success of

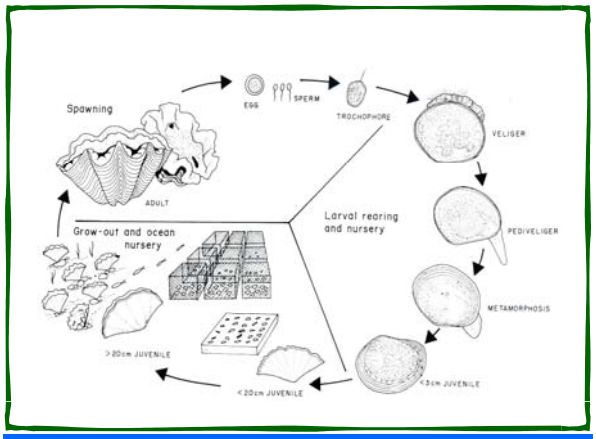

Fig. 1. Basic stages in clam Culture
Source: Adapted from Braley (1992)

this initiative. However, the simplicity of this low cost and eminently workable system encouraged the establishment of clam 'circles' in many countries (Tonga, Fiji, Vanuatu and Solomon Islands), and the practise of concentrating clams in "clam gardens" has been long documented in northern Papua New Guinea.

The availability of spat to be used for re-introduction projects generally relies on hatchery production and early grow-out technology, as most Indo-Pacific countries do not have access to sufficient juveniles from the wild (French Polynesia is an exception, using 'collectors' to settle spat of ***T. maxima*** in atolls with exceptionally large clam populations). Manuals have been produced that document hatchery and culture methods for giant clams (see Fig. 1, Braley, 1992).

According to the species and the location, it takes between eight and 14 days after fertilisation for giant clam larvae to settle on the bottom of tanks. They are then held in nursery grow-out (generally land based raceways) for around three to six months before first handling, and up to 12 months before clams are transferred to ocean nurseries. Usually, simple mesh cages, kept off the bottom, are used to protect the giant clams against most large predators, and growth varies greatly amongst species (Munro, 1993). Even in this protected environment, predatory gastropods such as ***Cymatium*** spp. and pyramidellid snails can settle into cages as larvae, making predation unpredictable until giant clams reach a larger 'escape' size where they are less susceptible. Site selection and juvenile management practices have proved to be critical factors in improving survival of cultured clams (Hart ***et al.***, 1999). A range of hatchery and nursery production systems are currently employed in over 21 Indo-Pacific countries, but even low-tech operations still require trained personnel and specialized equipment. Indirectly, the process of maintaining large numbers of broodstock for hatchery production also necessitates the holding of adults near hatchery sites. These aggregations of broodstock, in more than 11 countries in the Pacific, also have the ability to contribute to egg production and downstream settlement of clams.

Implementation: Clam re-introduction and re-enforcement projects have been carried out at various locations in the Indo-Pacific (see Table 1, pg. 16). These IUCN terms define what is termed restocking and stock enhancement in other literature. Although programs to aggregate adults have generally operated independently of commercial ventures, projects reliant on hatchery production

have generally coupled re-establishment and re-enforcement programs to commercial clam farming activities.

Post-release monitoring: After the establishment of adult clams 'circles', there has been little definitive proof of enhanced recruitment, although quantitative studies have detected increased settlement of ***T. derasa*** and ***T. squamosa*** on nearby reefs (Chesher, 1995). For example, monitoring around the clam 'circle' site of Falevai, in the Vavau Group of Tonga, showed that the number of juvenile ***T. derasa*** (individuals per hour of searching) increased following establishment of the 'circles' from 0 in 1987 to 1.48 in 1990. The increase was consistent over yearly assessments, and was even greater for the medium-sized clam, ***T. squamosa*** (there was no change in the average number of ***T. maxima*** which were not aggregated). The real number of new recruits detected after the establishment of clam 'circles' is low, but detection rates for juvenile clams is normally low, and this rate is higher than reported by some other surveys of clam recruitment elsewhere in the Pacific.

An interesting opportunity now exists for detecting increased recruitment around ***T. gigas*** release sites on Australia's Great Barrier Reef. Concentrations of hatchery reared ***T. gigas*** were relocated to reefs some distance away from the hatchery, and these clams have now had sufficient time to become egg-producing adults (giant clams mature first as males and later become functional hermaphrodites). It would be interesting to study whether additional recruitment is taking place 'downstream' of these clam concentrations. For clams restocked to the wild at the end of nursery culture, high mortality still proves to be a major problem and further husbandry, for a period of up to three years, is required to maximise survival (Bell ***et al.***, 2005). In the Philippines, where >75,000 clams have been restocked (Gomez & Mingoa-Licuanan, 2006), 10,000 were placed in the Hundred Islands National Park. From the initial 10,000 clams restocked, as many as 7,531 remained after 2.5 years, with the last inventory revealing that losses were predominantly among the juveniles size classes. Only 2% of sub-adults and 1% of broodstock were lost. Mortalities were attributed to typhoons, fouling, crowding, predation and poaching (Gomez & Mingoa-Licuanan, 2006).

T. gigas imported from Australia into the Philippines became female-phase mature as early as 1995, with second generation clams being recorded at low density (R. Braley, pers comm.). Yap is another example where re-establishment has arisen from translocated hatchery-reared clams. In the case of Yap, re-introduction of approx 25,000 ***T. derasa*** from neighbouring Palau in 1984 resulted in only ~8% survival of the introduced stock. However, these ***T. derasa*** matured, reproduced and re-established viable populations on nearby reefs. Surveys conducted by the Secretariat of the Pacific Community (PROCFish/C - COFish programs) noted the continued presence of ***T. derasa*** in low numbers in mid 2006. In the case of restocking the smaller boring species (***T. crocea***) in Japan, survival of clams ranged from 0.3% - 56% three years after release. Survival was found to be higher when individual clams were settled into pits on ***Porites*** heads or onto artificial substrates and then released ***in situ***, rather than releasing loose clams onto limestone substrates directly. In Australia, predation of ***T. gigas*** was

Table 1. Outline of Indo-Pacific[1] giant clam restocking program

Location	Organization involved	Start	Species (translocated species in brackets)
American Samoa	Office of Marine and Wildlife Resources	1986	*(T. derasa), (T. gigas)*
Australia	James Cook University, ACIAR, Private company – Aquasearch	1984	*T. gigas, T. derasa,*
Cook Islands	Ministry of Marine Resources	1986	*T. maxima, T. squamosa (T. derasa), (T. gigas) (H. hippopus)*
Fiji	Fiji Fisheries Division	1985	*T. maxima, T. derasa, T. squamosa, (T. gigas), (T. tevoroa), (H. hippopus)*
French Polynesia	Service de la Peche	2002	*T. maxima*
FSM[2]	National Aquaculture Centre, Marine and Environmental Res Institute of Phonepei	1984	*(T. derasa), (T. gigas), (H. hippopus)*
Guam	Dept of Agriculture	1982	*(T. derasa), (T. gigas), (T. squamosa)*
Japan	Okinawa Prefectural Fisheries Experimental Station, Private Company - Okinawa Kuruma-ebi Co., Ltd	1987	*T. crocea, T. squamosa, T. maxima (T. derasa)*
Kiribati	Private company – Atoll Beauties	2000	*T. maxima, T. squamosa*
Marshall Islands	Marshal Islands Marine Resource Authority Private Company x 2 – Robert Reimers Enteprises & Mili Atoll	1985	*(T. derasa), T. gigas, T. squamosa, H, hippopus*
New Caledonia	IFREMER	1993	*H. hippopus, T. derasa, T. maxima, T. crocea, T. squamosa*
Northern Mariana Islands	Dept of Lands and Natural Resources	1986	*(T. derasa) (T. gigas), (H. hippopus)*
Palau	Micronesian Mariculture Demonstration Centre	Late 1970's	*T. derasa, T. gigas, T. squamosa, T. maxima, T. crocea, H, hippopus, H, porcellanus*
Papua New Guinea	UPNG – Motupore Island Research Centre	1983	*T. gigas, T. squamosa, T. crocea, H. hippopus*
Philippines	University of the Philippines Marine Science Institute	1987	*T. maxima T. squamosa, H. hippopus, (T. derasa), (T. gigas)*
Samoa	Samoan Fisheries Dept, SPADP	1988	*T. maxima T. squamosa, (H. hippopus), (T. derasa), (T. gigas), (T. squamosa)*
Solomon Islands	WorldFish Centre	1989	*T. maxima, T. squamosa, T. derasa, H. hippopus, T. gigas*
Thailand	Department of Fisheries	1997	*T. squamosa*
Tonga	Ministry of the Lands, Survey and Natural Resources, JICA, EarthWatch	1989	*T. maxima, T. squamosa, T. derasa, T. tevoroa, (T. gigas), (H. hippopus), (T. crocea)*
Tuvalu	SPC/Tuvalu Fish	1989	*(T. derasa)*
USA (Hawaii)	Not available	1951	*(T. crocea), (T. squamosa), (T. gigas)*
Vanuatu	Vanuatu Fisheries Dept., Japanese International Cooperation Agency, Private company – Reef Life and Reef Solutions. Ringi Te Suh Marine Conservation Reserve, Maskelynes, Malekula.	1998	*T. maxima, T. squamosa, T. crocea, H. hippopus, (T. derasa), (T. gigas)*

Notes: [1] **Also see Eldredge, 1994.**
[2] **There are separate facilities in Yap, Chuuk, Kosrae and Phonpei States.**

lower when clams were held in the intertidal zone (Lucas, 1994), and in Solomon Islands, ***H. hippopus*** was held on the bottom but behind suspended cargo netting, to protect medium sized hatchery reared clams from predation by large rays.

Major difficulties faced

- When placed at sea, survival of juvenile giant clams (<25 mm shell length) is generally low even with protection and husbandry, and therefore clams require ~9 months in land based nurseries. Clams only reach a general escape size at approx 150 mm shell length, and then are still vulnerable to rays, trigger fish and turtles (Heslinga ***et al.***, 1990).
- Producing giant clam spat in hatcheries, and holding them in early juvenile culture is relatively expensive. Estimates for each juvenile ready for transfer to the sea, range from US$ 0.27 - US$ 0.36 (Tidsdell ***et al.***, 1993). These estimates do not fully reflect the full capital cost of hatchery developments.
- Skills needed for spawning giant clams and rearing spat until escape size are varied and not always available or funded for long periods, making operations unsustainable in some cases.
- Poaching of broodstock, from 'clam circles' and hatchery programs, was high in some cases.
- Biological issues: Genetic diversity (gene frequency) of hatchery-reared stock is likely to be lower, or in some cases different to that found in wild populations. Hatcheries also increase the potential for introduction of pathogens (Eldredge, 1994). Although to date there have been no virus, chlamydia, mycoplasma, fungus, or neoplasm mortality events reported, rickettsia-like organisms have been noted in local and translocated giant clams, and mass mortalities of ***T. gigas*** and ***T. derasa*** has been recorded on the Great Barrier Reef without any responsible pathogen recorded in testing.

Major lessons learned

- Managing wild stocks can be more cost efficient than investing in hatcheries to re-stock overfished giant clam populations.
- Site selection and early stock husbandry are critical to survival of giant clams, especially hatchery reared juveniles. Selection of a site with suitable environmental conditions, and where there is social cohesion, assists the growth and general condition of stocks, while minimising losses to predation and/or poachers.
- Restocking of giant clams requires greater effort to be put into stakeholder consultation. Attaining an intellectual concord between researchers, government workers and local villagers requires extended periods of awareness raising and information sharing. Special care should be taken for programs to respond appropriately to traditional reef tenure systems and encourage direct community and fisher participation in re-introduction and re-enforcement programs.
- The original premise of the ICLARM/ACIAR Giant Clam Project started in 1984, that one could spread the economic burden of producing large enough clams for re-stocking by coupling restocking programs with commercial

farming, has been supported. The technology developed for clam production has in some cases been transferred to the private sector and a number of people across the Pacific are employed to produce clams for the marine ornamental trade. A proportion of production is also available for restocking.

Success of project

Highly Successful	Successful	**Partially Successful**	Failure
		√	

Reasons for success/failure:

- Success in simple hatchery and early rearing production saw a good spread in technology and a high adoption rate.
- Small scale industry development offered incentives to support this initiative.
- High mortality of juvenile clams lowered the extent of the success.
- High cost and extended time period required limited the sustainability of many operations.
- Lack of social adhesion in communities participating in these projects caused some failures. In some cases, the projects were not well matched to the communities needs or wants.
- Lack of funding for monitoring and a lack of uniform protocols limited the reporting of results that arose from re-introduction and re-enforcement programs.

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Establishment and re-introduction of the field cricket into Southern UK

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Introduction

The field cricket (***Gryllus camprestris***) is one of the UK's rarest insect species and is increasingly threatened over many parts of its mainland European range. In the UK it has been regionally listed as endangered (Shirt, 1987). As a result of alteration and fragmentation of its highly selective grassland habitat, by the late 1980's, the UK population of ***G. campestris*** was reduced to a single colony of fewer than 100 individuals in West Sussex. In 1991 the species was placed on English Nature's ***Species Recovery Program*** (SRP).

Goals

- Goal 1: The overall objective of the project is the conservation and protection of ***G. campestris*** in the UK.
- Goal 2: Establish an ***ex situ*** breeding program and associated health screening protocol to provide the large number of animals needed for the field establishment and re-introduction elements of the program.
- Goal 3. Identify and manage 10 suitable former range sites in Southern England in readiness for establishing new populations.
- Goal 4: Establishment and, where necessary, re-introduction of ***G. campestris*** into the prepared new sites with follow up monitoring plan in place.

Success Indicators

- Indicator 1: Identification of, and sympathetic management plan for, suitable former UK range area sites.
- Indicator 2: Assurance of ability of surviving UK colony to sustain annual harvesting of three pairs of founder crickets for the ***ex situ*** breeding and release program.
- Indicator 3: Development of health screening protocol to clarify and monitor surviving wild UK ***G. campestris*** population.
- Indicator 4: Confirmation of secure, reproducing populations on 10 UK sites.

Field cricket - female

Release site showing bracken encroachment

Project Summary

Feasibility: Extensive field surveys by the conservation agency English Nature confirmed that by the late 1980's the status of the surviving UK ***G. campestris*** population had reduced to a single colony in West Sussex. The reason for the cricket's decline was confirmed as alteration and fragmentation of its highly selective grassland habitat. In 1990 a ***G. campestris*** Species Recovery Program was developed with an Action Plan specifying the establishment of 10 secure field populations in areas of the species' historic range. Because the surviving wild population was too low to support direct translocation of the large number of animals that would be needed for establishing the intended new colonies it was necessary to develop an ***ex situ*** breeding plan in partnership with the Zoological Society of London. This also involved the development of a health screening protocol to clarify natural health profiles in the surviving wild population and monitor health profiles in the ***ex situ*** populations, especially in the pre-release program phase.

Implementation: In 1992 the breeding and rearing initiative was established at the Zoological Society of London. The ***ex situ*** breeding and rearing plan entailed collecting three pairs of sub-adult crickets from the surviving wild population each spring to be bred at the Zoo to produce large numbers of late-instar F_1 generation nymphs for the new field colony establishments and where necessary re-introduction actions. To help clarify natural health profiles, a fecal screening and post mortem protocol was implemented for all field-collected founder crickets. The crickets were housed in an isolated breeding room to reduce the risk of disease contamination from non-native insect species. The husbandry methods are detailed in Jones ***et al.***, 1999. Separate progeny lines were maintained to ensure maximum genetic diversity in the ***ex situ*** F_1 population prior to combining for field release. Overall breeding and rearing success has been high, with annual mortality rates ranging between 10 - 20% in the F_1 nymphs. Between 1992 and 2007 the breeding program provided in excess of 17,000 late-instar nymphs for the SRP field establishment program.

Post-release monitoring: Four of the seven field colonies established with the ***ex situ*** bred crickets were still extant in 2007, the longest of which was shown to have persisted to the 8^{th} generation. The knowledge derived from monitoring the fluctuation dynamics of the field-released ***G. campestris*** populations has informed optimal site management requirements for the species, and helped clarify the subtle environmental factors influencing colony survival. The breeding program has also helped raise public awareness of the field cricket and its

conservation issues and provides a model for developing similar recovery initiatives for the species in other range countries (Pearce-Kelly ***et al.***, 2007).

Field cricket rearing unit at the Zoological Society of London, UK

Major difficulties faced

- Pre-release health screening in 1996 and 1997 confirmed the presence of gregarine parasites in the captive population, preventing field releases in both those years (Cunningham ***et al.***, 1996).
- Several of the release sites could not be sufficiently managed to enable persistence of the established population. This necessitated either re-introductions or the abandonment of a site in favor of better sites.

Major lessons learned

- The importance of effective post-arrival and pre-release health screening protocols was highlighted by the discovery in 1996 and 1997 of gregarine parasites in the captive population, preventing field releases in both those years (Cunningham ***et al.***, 1996). This underlines the necessity of ensuring that adequate infection barriers are in place for all ***ex situ*** populations destined for re-introduction (Pizzi, 2004).
- It quickly became apparent that the original Action Plan remit of realizing 10 secure populations of ***G. campestris*** in the specie's UK range is reliant on ongoing monitoring and management of the selected sites. As is thought to be the case in natural ***G. campestris*** population/site dynamics, established local populations are prone to decline and even complete die off when site conditions alter to sub-optimal states. This consideration necessitates sensitive monitoring and at times re-introduction or enforcement actions. The longer term objective which is currently being implemented is to realize sufficient connectivity between these sites to enable free movement between sites.
- The public and media response to the ***G. campestris*** Species Recovery Program proved that invertebrate focused conservation efforts are capable of realizing as high a level of interest and support as are vertebrate programs.

Success of project

Highly Successful	Successful	**Partially Successful**	Failure
		√	

Reasons for success/failure:

- The ***G. campestris*** Species Recovery Program is an ongoing conservation effort and as such the target number of secure site populations have yet to be realized.
- The natural propensity for ***G. campestris*** sites to become sub-optimal (as detailed in Major lessons learned section above) without ongoing active management intervention means that some site populations are almost certain to experience declines or even local population extinctions.

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Project partners

- **English Nature (renamed Natural England), Northminster House, Peterborough PE1 1UA, UK.**
- **Mike Edwards, Ecological Consultant.**

Captive management and re-introduction of the Karner blue butterfly to the Oak Openings of Northwest Ohio, USA

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Introduction

The Karner blue butterfly (***Lycaeides melissa samuelis***) is a resident of oak savanna, pine barren and sand barren habitats of the Midwest, mid-Atlantic and New England regions of the United States. Within these arid habitats resides its sole host plant, wild lupine (***Lupinus perennis***). In the last 25 years, the butterfly has suffered a dramatic population decline throughout its range primarily from habitat loss and fragmentation. Originally native to 12 states and one Canadian province, the species is now extant in Indiana, Michigan, Minnesota, New Hampshire, New York and Wisconsin. The Karner blue was re-introduced to Ohio in 1998. The species is listed as a federally (U.S. Fish and Wildlife Service 1992) and state (Ohio Department of Natural Resources 1992) endangered species.

Goals

- Goal 1: To re-establish viable populations of the Karner blue butterfly (***Lycaeides melissa samuelis***) within its historic range in Ohio, and maintain and restore associated species of oak savanna lepidoptera.
- Goal 2: Increase the quantity and quality of oak savanna habitat within the Oak Openings Region of northwest Ohio, USA.
- Goal 3. Increase public awareness of the Karner blue butterfly and associated Lepidoptera, as well as the Oak Openings Region.

Success Indicators

- Indicator 1: The establishment of a self-sustaining population of the Karner blue butterfly with a minimum of three meta-populations within the Oak Openings Region, increasing the populations of associated lepidoptera in the process.
- Indicator 2: The amount of protected and managed oak savanna habitat will increase by several thousand hectares.
- Indicator 3: Discontinuous oak savanna habitat supporting

Karner blue butterfly

Karner blue butterfly habitat in the ASGA, Michigan, USA

recovered Karner blue populations will be connected by habitat corridors to reduce the isolation of these populations.

- Indicator 4: The production and distribution of educational materials for the general public regarding the Karner blue butterfly, associated Lepidoptera, and the importance of the Oak Openings Region.

Project Summary

Feasibility: Since 1992, the Ohio Karner Blue Butterfly Recovery Team has been working on a plan to re-introduce the Karner blue butterfly (KBB) to its historic habitat in the Oak Openings of Lucas County, Ohio. Preliminary studies were conducted to determine the feasibility of a re-introduction. Initial funding by the Ohio Department of Natural Resources (ODNR) Division of Natural Areas and Preserves centered on the construction of a greenhouse on the grounds of The Toledo Zoo and mass propagation of the KBB host plant, wild lupine (***Lupinus perennis***). Over 5,000 lupine plants were successfully grown, using protocols developed by The Toledo Zoo staff. Butterfly rearing and transportation protocols were developed using a model species, the closely related Melissa blue butterfly (***Lycaeides melissa melissa***). Adult Melissa blue butterflies (MBB) were successfully shipped from Denver, Colorado to The Toledo Zoo and their progeny reared through a partial third generation. During 1997 and 1998 the ODNR Division of Wildlife provided funding for an intensive habitat analysis of the founder location, Allegan State Game Area (ASGA), Allegan County, Michigan USA and the re-introduction site, the Kitty Todd Preserve (KTP), Lucas County, Ohio USA. The density and frequency of lupine and preferred nectar sources were measured at both sites. Data collected from the founder site was used to establish a benchmark. This data was then compared against the data collected from the proposed release site. This provided the team with a tool to gauge the habitat's readiness for a re-introduction. Lastly, a study comparing the microhabitat of the KBB at the founder location and the re-introduction site was undertaken.

Implementation: Annually, Toledo Zoo conservation staff captures first generation adult females from sites in Michigan. Individual females are placed in a clear plastic container that is then positioned in a cooler for transport to the Zoo. Each female is sequestered on a potted lupine plant covered with a cylindrical net. Adults are hand fed daily using a honey-water solution. Eggs are typically deposited on the leaves and petioles of the host after one or two days. Once hatched, larvae are closely monitored. To negate cannibalism, second instar larvae are moved to new plants so that no more than 10 were on a single plant. Host plants are replaced regularly. Small pieces of pine bark are added to the soil

surface of the potted plant during the final instar. Larvae usually crawl under the bark to pupate. Adults are transported to the release site in the afternoon following ecolsion. The rearing unit is enclosed in a double barrier and isolated from other invertebrates in the collection. Instruments as well as the floor, benches and other equipment are regularly disinfected.

Post release monitoring: Monitoring of 1st flight Karner blue adults begins approximately the third week in May. Transects are monitored daily, as weather conditions permit, until no adults have been sighted for at least three days. Monitoring is then suspended. Monitoring resumes in the same fashion when 2nd generation adults appear (approximately 28 days after the conclusion of the first flight). Emigration of adults is monitored and recorded daily by walking transect routes through lupine patches outside the initial release zone. The transect routes are always monitored by two spotters. The primary release site is the major transect area. This area has a plot of 120 m x 100 m with path widths of 10 m. Spotters walk 10 m abreast, counting adults that appear 5 m to either side or in front of the observer. Direction is reversed at the border of the plot. Secondary transect sites are smaller but are monitored using the same method. Sightings of adults are plotted on a topographic map. Gender and condition of each observed adult is recorded in addition to weather conditions (e.g. temperature, relative humidity, wind speed and percent cloud cover) and duration of the monitoring event. Since the initial release in 1992, Karner blue adults have migrated and populated lupine sites throughout the preserve.

Major difficulties faced

The introduction of the Karner blue at KTP precluded the continuation of the intensive habitat management regime that was in place prior to the initial release. Provisions under the U.S. Endangered Species Act (ESA) prohibited the use of management practices that could potentially harm individuals. Consequently, habitat that had been restored in preparation for the re-introduction degraded and was no longer suitable for the species. Eventually, amendments to the ESA permit allowed for a rotating schedule of prescribed burns in the KBB habitat to control woody invasives. A late freeze in May of 2005, during the period when 1st generation adults would normally be eclosing, had a great impact on recovery. Up until that time, indices indicated that the population had steadily increased since the initial re-introduction. Numbers have not recovered to pre-2005 levels. Having sufficient quantities of lupine available for the captive breeding efforts has continuously presented challenges. The stresses imposed on the plants by larvae feeding are extensive and plants normally do not recover. Thus, new plants must be grown from seed every year. In addition, certain strains of seed have produced less vigorous plants. In some instances, zoo staff has used cuttings from wild grown lupine to supplement the potted greenhouse plants. The use of cuttings presents a concern because of a possible breakdown of important nutrients and secondary compounds and because of the possibility of introducing disease and bacteria to the captive population.

Major lessons learned

- The importance of having an abundance of vigorous lupine plants for captive

breeding cannot be overemphasized. Sufficient resources of funds, personnel and greenhouse space must be dedicated to this end. Without an adequate supply of host plant, the captive-breeding effort is much more problematic and susceptible to failure.

- Because of stochastic events (e.g. freeze, fire, drought, etc.), it is important to identify new introduction sites and, subsequently, prepare those sites for releases. Additionally, the sites should cover the gambit of habitat types that have been identified to support Karner blue butterflies. For instance, a habitat with a widely spaced oak (***Quercus spp***.) canopy cover provides protection against late freeze events.
- Habitat management that has taken place as a result of the Karner blue introduction has benefited the entire ecological community. Many state endangered plants (e.g. ***Habenaria ciliaris***) and butterfly species occupying habitat with the Karner blue (e.g. ***Incisalia irus*** and ***Erynnis persius*** in particular) have benefited from the effort to recover the species.

Success of project

Highly Successful	Successful	**Partially Successful**	Failure
		√	

Reasons for success/failure:

- Karner blue recovery is an ongoing conservation effort. Stochastic events still threaten the recovery of the species in Ohio. Augmentation of currently establish populations and releases into newly restored habitat will continue. Minimum viable population size has yet to be realized.
- Karner blue habitat will disappear unless ongoing management is continued in perpetuity. Fire suppression and invasive and aggressive non-native plant species precludes a laissez-faire approach to KBB habitat. Funding and personnel cuts will threaten the long-term recovery of the species.

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Project Partners

- The Ohio Department of Natural Resources (ODNR), Division of Wildlife, Columbus, Ohio, USA.
- The ODNR, Division of Natural Areas and Preserves, Columbus, Ohio, USA
- The ODNR, Division of Forestry, Columbus, Ohio, USA.
- The Nature Conservancy, Ohio Field Office, Columbus, Ohio, USA.
- The Ohio Lepidopterist Society, Columbus, Ohio, USA.
- The Metroparks of the Toledo Area, Toledo, Ohio, USA.
- The USFWS, Endangered Species Unit, Reynoldsburg, Ohio, USA.

Re-introduction of allis shad to the River Rhine System: Netherlands, Germany & France

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Introduction

Allis shad ***(Alosa alosa)*** belong to the herring family living most of their life in seawater but migrating to freshwater to spawn (anadromous fish). They grow up to 70 cm in total length and reach a total weight of up to 4 kg. Allis shad were widely distributed in Western Europe at the end of the 19th century. The distribution ranged from Scotland in the North to Morocco in the South and in Germany they were found in all large rivers draining to the North Sea. The fishery on allis shad in the Rhine was very important and hundreds of thousands were caught annually. In the last 100 years the distribution range of the species has decreased dramatically and large shad populations only exist in France today. As a consequence allis shad is listed as priority species in Annex II and V of the Habitats Directive. In Germany allis shad is listed as extinct or suffering from extinction in the national Red List (IUCN Red List: DD). The geographical area of the re-introduction project comprises the Netherlands, Germany and France (The Rhine River is partly the French-German border).

Goals

- Goal 1: The overall objective of the project is the conservation and protection of allis shad in Europe.
- Goal 2: Develop techniques for mass production and mass marking of allis shad.
- Goal 3: Re-introduction of allis shad to the River Rhine System.

Success Indicators

Indicator 1: Increase of return rates to the Rhine River measured by e.g. fishermen catches or monitoring of upstream migration at fish ways (e.g. Buisdorf, River Sieg, Iffezheim, Gambsheim, River Rhine).

Allis Shad (*Alosa alosa*)

First Life Allis Shad Symposium
Aquazoo - 6th June 2007

Indicator 2: Active spawning grounds in the Rhine River or tributaries.
Indicator 3: Detection of allis shad larvae/juveniles originating from natural reproduction in the river/ estuary or maturing shads in the Dutch/German coastal area.

Project Summary

Feasibility: This was conducted for the re-introduction of allis shad in the River Rhine according to the IUCN criteria was conducted during 2003 - 2005. This study included genetic analyses, mapping of potential spawning and stocking sites, transport of adult and juvenile shad, breeding and rearing experiments in France and Germany, and research visits in France and the U.S.A. Due to results of this extensive feasibility study the necessary actions to implement the project objectives could be determined. With the help of techniques developed for the successful re-introduction of the closely related American shad (***Alosa sapidissima***) in many rivers along the U. S. Atlantic Coast it was planned to produce five million allis shad larvae which will be stocked in the Rhine system in the years 2007 - 2010. In 2005 the Ministry of Environment decided to apply for EU LIFE funding. EU Life is one of the most important tools available for the fostering of the EU's joint environmental policies.

The LIFE project proposal was supported by all relevant authorities, including the International Commission for the protection of the River Rhine, nature conservationists and local people. Out of 229 European Life Project proposals the allis shad project was one of 61 projects selected for co-funding through the European Commission and started on 1st January 2007 (duration of the LIFE project: 2007 - 2010). The LIFE project is included in the Migratory Fish Program of North Rhine Westphalia (Key species: Allis shad, eel and salmon). Project management is provided by the State Office for Nature, Environment and Consumer Protection in North-Rhine-Westphalia which works in partnership with French organizations CEMAGREF and MIGADO; funding is also provided by the HIT Umweltstiftung, the Rheinfischereigenossenschaft NRW (Association for Fishing on the Rhine), the environmental department of the German State of Hesse, the Region Aquitaine in France and the Dutch Sports Fishermen. Stiftung Wasserlauf (an environmental foundation dedicated to migrant fish and water ecology) was commissioned to coordinate and handle the scientific aspects of the project. The Aquazoo Löbbecke Museum in Düsseldorf is an important partner for public awareness campaigns and hosts the project office.

Five million shad larvae will be stocked in the Rhine System in the next three years. All fish will be produced in France and marked before stocking to analyze

the success of the project. Stocking of allis shad larvae will be accompanied by an extensive monitoring program. After stocking, the behaviour of allis shad larvae will be analyzed with drift netting and electro-fishing to evaluate the quality of the stocking area and the success of stocking operations. The distribution area and migration routes of young allis shad will be analyzed in cooperation with Dutch fishermen in the Rhine delta in autumn 2008 - 2010. With information campaigns for the professional and recreational fishery, in addition to the described monitoring tools, more information about the development of the stocked animals will be collected. The life cycle of allis shad is app. 3 - 6 years. Thus, the majority of returning adults will arrive after 2010 and monitoring and stocking campaigns have to be continued after the end of the LIFE project. A detailed After-Life Conservation plan is an important component of the ongoing LIFE project. You will find more information about the project at: ***www.alosa-alosa.eu***

Major difficulties faced

- The donor population for the Rhine System in the Rivers Garonne and Dordogne in France is facing some problems at the moment. Return rates were low in 2006 and 2007. The reasons are still unknown. Maybe a combination of increased fishing mortality, extreme hydrologic conditions and global climate change are responsible for the low return rates.

Success of project

Highly Successful	Successful	**Partially Successful**	Failure
		√	

Reasons for success/failure:

- The feasibility study of this project started in 2003. After three years of planning North-Rhine-Westphalia, Germany applied successfully for EU LIFE funding in 2006. The Life project started in 2007. First fish will be released in 2008. Thus, the success of the re-introduction can be determined in 5 - 15 years.

Project Partners

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Re-introduction program of the Spanish toothcarp "Fartet" in the Valencian Region, Spain

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Introduction

The Fartet (Spanish killifish) is a small freshwater fish of the Cyprinodontidae family. In the Valencian Region (Spain), where the Fartet re-introduction program has been carried out, the range of the species currently includes coastal populations as well as some inland populations at the Vinalopó watershed, with unique genetic characteristics that make them different compared to the coastal ones. The most relevant populations among the coastal ones are those at the marshes of Peñíscola, Prat de Cabanes-Torreblanca (Castellón), Marjal dels Moros (Valencia) and the wetlands of El Hondo and Santa Pola (Alicante). These populations have experienced both isolation and reduction of their distribution range due to loss of their characteristic habitat. Inland wild populations are probably extinct, only remaining in captivity and sanctuaries. The Fartet is listed as "critically endangered" in the national endangered species act (Real Decreto 439/1990 de 30 de marzo), and so, in the regional endangered species catalogue (Decreto 32/2004) with the same category. The species is also included in annex II of the Natural Habitats directive and as "endangered" in the IUCN Red List.

Goals

- Goal 1: Guarantee the long-term persistence of the species.
- Goal 2: Expand its distribution range.

Fartet (*Aphanius iberus*)

Success Indicators

- Indicator 1: Population viability has been confirmed by the results of population monitoring.
- Indicator 2: Number of sanctuaries created, meant as expansion of the species distribution area.
- Indicator 3: Individuals produced and maintained in rearing facilities, and number of re-introduced individuals.

Project Summary

Fartet habitat in Spain

Feasibility: The species shows a high adaptability to extreme conditions. Despite it is classified as a freshwater fish, it is capable of surviving in hypersaline environments. This fact has allowed the establishment of stable populations that cannot be colonized by other alien invasive species. Basically it feeds on small aquatic invertebrates: crustaceans, insect larvae (chironomids and other dipterans, etc.) and also molluscs, although it does not reject other kinds of food. The null economic interest of the species has somehow conditioned a social indifference. However it is usually identified with some traditional aspects of Valencian Region. The main difficulty in relation to the management and recovery of the species is, no doubt, the preservation of its habitat i.e. coastal wetlands.

implementation: After the approval in 1992 of the LIFE project "First phase of an action program for the conservation of two wetlands and the creation of a reserve network for ***Valencia hispanica***" co-founded by the E.U. and the Valencian Regional Government, a series of actions addressed to the conservation of Fartet in the Valencian Region were launched, as both species belong to the same order (Cyprinodontiformes) and practically have the same biological requirements, and frequently share the same habitat. Among these actions, the establishment of a program of captive-breeding of the main populations has special relevance, as well as the re-introduction and re-enforcement of the most precarious wild populations.

In order to develop these captive-breeding tasks the facilities of the "El Palmar" fish research centre, run by the Valencian Regional Government, were arranged to meet the species requirements. Since then, more than 125,000 individuals have been raised to-date. These individuals have been employed both for re-introduction programs to re-enforce the most degraded populations, as well as for re-introductions in reserve areas specially restored for them, keeping in mind the genetic criteria of the existence of different conservation units. So, in each reserve individuals re-introduced are those belonging to nearest natural population.

Special relevance has the recovery of the populations at inland Alicante by means of re-introductions that assure the permanence of those populations. There is an agreement between Regional Environmental Authority and the council of Villena in order to develop actions aimed at improving the species situation. Also the High Vinalopó area is included among the areas of recovery of the Fartet in the recently approved action plan for this species (Decreto 9/2007, de 19 de enero).

Post-release monitoring: In relation to the results of the re-introduction and the captive-breeding program, monitoring has confirmed the stabilization of most of the natural populations. The great ability of this species to adapt to salinity changes makes it resistant to the continuous hydrologic fluctuations that the coastal wetlands of the Valencian Region are exposed to, and that cause these considerable variations in salinity. On the other hand, the recently created sanctuaries present populations that can maintain themselves autonomously, so re-introductions are not needed. This is so, mainly due to the biological characteristics of the species with a high reproduction rate, both in the wild and in captivity, thus re-introductions in new reserve areas become stable populations in relatively short periods of time.

Major difficulties faced

- Habitat destruction: Anthropogenic influence is a major factor in habitat loss. This is emphasized in the case of ***A. iberus*** by their particular location at the coastal strip of a territory exposed to an increasing process of alteration due to the high number of human activities in this area.
- Presence of exotic fauna: The presence of alien species such as ***Gambusia affinis***, ***Cyprinus carpio***, etc, both as predators or competitors, has taken its toll and caused a decrease of some well established populations.
- Pollution: Contamination of waters by industrial, agricultural and urban wastes is another type of habitat loss as it represents an alteration of the water quality.
- Aquifer over-exploitation: Leads to a lowering of the water table and consequently leads to direct habitat destruction.

Major lessons learned

- Increased knowledge of the species and complete control on the captive-breeding processes so species extinction can be avoided. Also there is no lack of genetic variability in natural populations.
- We know that protection measures applied in the natural habitat of the species are difficult to implement and that they are not included in the major protection plans of wetlands and natural parks. Only the acquisition and management of lands or the creation of reserve areas have shown to be effective regarding habitat conservation.
- Euryhaline nature of the species allows it to survive in hypersaline environments where competing species cannot survive; therefore the protection and reclamation of these habitats should be considered as a high-priority to ensure the long-term survival of the species.
- The recent approval of the Fartet Action Plan in the Valencian Region means a significant

Searching for Fartet using dip nets

commitment by the Administration to revert the species current situation. Although there is no doubt of the increase in their numbers, effective protection of their natural habitats is essential, as the Action Plan reflects, by promoting the recovery of the wetlands of the Valencian Region.

Success of project

Highly Successful	**Successful**	Partially Successful	Failure
	√		

Reasons for success/failure:

- Increase in the species distribution range.
- A successful captive-breeding program.

One of the invasive species - common carp (*Cyprinus carpio*)

The re-introduction of the burbot to the United Kingdom and Flanders

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Introduction

The burbot (***Lota lota***) has a northern circumpolar distribution, inhabiting fresh and some brackish waters of continental Eurasia and North America, southward to about 40°N. Despite its extensive range, over much of its distribution burbot populations are threatened or face extirpation (Paragamian & Willis, 2000). In the UK and Flanders the species is thought to be extinct with the last confirmed captures in the two countries 1969 and 1957 respectively. In the UK the burbot is listed as a Biodiversity Action Plan (BAP) Species and is given special protection under Schedule 5 of the Wildlife and Countryside Act 1981. Adult burbot are usually 30 - 60 cm in length, but in parts of Siberia and Alaska may reach 120 cm and 32 kg in weight (Maitland & Lyle, 1991). Burbot are the only fully freshwater member of the ***Gadidae*** and are generally classified as opportunist piscivores. Burbot are found in both lentic and lotic environments, with spawning taking place at low water temperatures during the winter period (December to February).

Goals

- Goal 1: Assess the feasibility of re-introducing the burbot to Flanders and the United Kingdom.
- Goal 2: If feasible, create a self sustaining population within the species' former range in Flanders and the UK.
- Goal 3: Develop understanding to improve methodologies and protocols for species re-introductions, especially in relation to fish.

Burbot (*Lota lota*)
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Success Indicators

- Indicator 1: Survival in the wild of released individuals.
- Indicator 2: Breeding in the wild of released individuals.

- Indicator 3: Expansion of species' range from initial release sites.

Project Summary

Feasibility: Despite similar overall aims of re-establishing viable burbot populations in its former range within the UK and Flanders (a part of Belgium), the two projects are currently at different stages. In the UK, the feasibility of re-introduction is still to be determined, whereas implementation and post-release monitoring is underway in Flanders. The overarching aim of the UK feasibility study is to identify the causes of the burbot's extinction, determine whether these causal factors persist, and assess future risks that may threaten any successful implementation. In order to achieve this, the former distribution and abundance of the species within UK Rivers must be estimated, and the time-scale of the species' decline in abundance to the point of extinction described. This will enable identification of factors that led to the extirpation of the burbot from the UK. Potential reasons include over-harvest, pollution, habitat modification and loss, and climate change. A key component of the study is to identify habitat suitability indices and assess the quantity of suitable habitat available in the former range. There is also a need to predict how environmental conditions may change in the future and how this would impact burbot viability within the UK. Identification of temperatures required for spawning appears particularly pertinent as this cold-water adapted species may require low temperatures in January and February to trigger reproduction.

Spawning trials will be conducted to investigate whether viable burbot progeny can be cultured over a range of temperatures that represent best and worse case scenarios under climate change predictions (UKCIP, 2002). To facilitate selection of the potential source populations for any future re-introduction, genetic samples from preserved burbot specimens of known British provenance will be compared with the known phylogenetic distribution of the species'. As an apex predator, burbot have a key role in ecosystem function. The views of key stakeholders, including angling groups and conservation organizations, on a possible re-introduction will be considered. Based on the outcomes of this research, which examines the species' biological and ecological requirements, genetic lineage, critical life history traits as well as the public perception of a possible re-introduction, the feasibility of re-introducing the burbot to the UK will be determined.

Artificially spawned burbot larvae

Implementation: The Flemish burbot re-introduction project was launched in 1999. The feasibility study consisted of a genetic study, a habitat suitability study and a captive breeding program. Genetic

Typical burbot habitat
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research using mitochondrial DNA distinguished two subspecies for burbot: ***Lota lota lota***, found in Eurasia and Alaska, and ***Lota lota maculosa***, found in North America. Within Europe four distinct phylogenetic clades were identified (Baltic and Northern, Central and Western European) (van Houdt ***et al.***, 2003).The research using microsatellite markers showed that French burbot populations (part of the Western European clade) were closest genetically to the original Belgian stock and therefore a good source population for the re-introduction project. By studying populations in a reference biotope (the French river "La Bar") similar to Flemish lowland rivers, the habitat requirements of the burbot were identified for a number of its life stages. Based on this data, habitat suitability models were developed to assess potential re-introduction sites in Belgium. Concurrently a breeding program was developed to spawn and rear burbot in captivity to provide enough individuals of known genetic origin for the re-introduction. The fish culture program started in 1999 and due to improvements in hatchery techniques has become increasingly successful in terms of larval survival with time.

Post-release monitoring: In spring 2005 more than two million cultured burbot larvae of French origin were re-introduced to several tributaries of the River Grote Nete and the River Bosbeek. However, this re-introduction is thought to have failed as no juvenile burbot were recaptured during post-release monitoring. During the autumn of the same year 2,000 and 1,000 larger (0+ age-class) burbot were released at several locations in the River Grote Nete and in the River Bosbeek respectively. After re-introduction, the stocking sites were regularly sampled by electrofishing with recaptured burbot showing good growth and condition in both rivers. The percentage of recaptured burbot ranged between 4% and 12%. During sampling in December 2007 sexually mature males and females in spawning condition, were captured in the River Grote Nete. However it should be noted that further evaluation of survival, growth, maturation and natural recruitment is necessary to see if a self-sustaining population can be established. Due to the positive results of the earlier re-introductions, juvenile burbot have subsequently been released at other suitable locations in the Rivers Maarkebeek, Abeek and in the River Ijse.

Major difficulties faced

- Lack of baseline data on burbot population size prior to extinction.
- Difficult to quantify causes of extinction due to deficits in the time-scale of environmental monitoring.

- Securing adequate funding for all project phases.
- Developing a methodology to import burbot to the UK without compromising the UK's disease status.

Major lessons learned

None

Success of project

Highly Successful	Successful	**Partially Successful**	Failure
		√	

Reasons for success/failure:

1. Two years after re-introduction burbot are still present on the release sites.
2. Recaptured burbot show good growth and are in good condition. In winter of 2007 sexually mature females and males, in spawning condition, were observed
3. Further evaluation is necessary to see if natural recruitment has taken place.

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Saving the sturgeon: re-Introduction of lake sturgeon to the Tennessee River, Tennessee, USA

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Introduction

Lake sturgeon (***Acipenser fulvescens***) were historically distributed in the Mississippi River, Great Lakes, Hudson Bay and St. Lawrence drainages in the United States and Canada, and sparsely inhabited the Mobile Basin in the southeast United States. It is currently listed as a species of Least Concern (LC) by the IUCN and under Appendix II of CITES. While lake sturgeon are not listed under the United States Endangered Species Act, they are protected in 17 of the 19 states where they were historically distributed. Within Tennessee, lake sturgeon are classified as endangered, and their harvest is prohibited. This program aims to restore lake sturgeon to the Tennessee River Basin in order to remove its endangered status within Tennessee. While numbers of lake sturgeon in the Mississippi and lower Missouri river drainages are deemed to be small, but relatively stable, they are not able to recolonize the Tennessee River because of impoundments. Prior to this program, the last commercial harvest of lake sturgeon from Tennessee was from the early 1960s; unverified reports continued through the 1970s. Our re-introduction efforts began in the late 1990s with stock from the Wisconsin and Wolf Rivers, Wisconsin, following the creation of policies leading to better water quality in the region.

Lake sturgeon (*Acipenser fulvescens*)

Goals

- Goal 1: To restore a self-

sustaining population of lake sturgeon to its historic range within the Tennessee River Basin.

- Goal 2: To use the best available science to manage a future recreational fishery and ensure long-term population viability.
- Goal 3: To ensure all significant portions of the management area are occupied by or accessible to the population.
- Goal 4: To educate stakeholders about the project and the need to protect the population of lake sturgeon.

Success Indicators

- Indicator 1: All significant portions of the re-introduction area in the upper Tennessee River Basin are occupied or accessible to the lake sturgeon population.
- Indicator 2: The population contains at least 20 year classes of adults older than 15 years of age.
- Indicator 3: Natural reproduction is evident.
- Indicator 4: Above average natural recruitment at least one out of every five years.
- Indicator 5: Some level of harvest can be supported.

Project Summary

Feasibility: The program to restore lake sturgeon to the upper Tennessee River Basin began with general water quality improvement in the basin following the passage of the Clean Water Act in 1973. Between 1988 and 1993, the Tennessee Valley Authority (TVA), which regulates major dams in the area, began a Reservoir Release Improvement (RRI) program to institute minimum flows and increase dissolved oxygen levels in tailwaters below targeted dams. Douglas Dam, on the French Broad River, was chosen as one of the sites for the RRI. Dramatic improvements in the downstream fish and macroinvertebrate communities over the first 5 years of monitoring following RRI implementation suggested lake sturgeon might once again thrive in the upper Tennessee River Basin. A lake sturgeon recovery team was formed in 1998, including partners from the most important aquatic resources agencies/organizations in the region (U.S. Fish and Wildlife Service, Tennessee Wildlife Resources Agency, TVA, U.S. Geological Survey, Tennessee Aquarium Research Institute, University of Tennessee, Tennessee Technological University, Tennessee Clean Water Network and World Wildlife Fund). In 2000, 41 two-year old lake sturgeon were implanted with radio telemetry devices and released into the French Broad

Releasing lake sturgeon

River over a period of six stockings during three seasons. Because the fish were moving widely and thriving in the river, large-scale rearing of lake sturgeon eggs was initiated at the Tennessee Aquarium Research Institute and three U.S. Fish and Wildlife Service National Fish Hatcheries (Warm Springs, Pvt. John Allen, and Mammoth Spring).

Implementation: The first major release of lake sturgeon occurred 19th July 2000, just below Douglas Dam, with 1,441 fingerling sturgeon entering the French Broad River. Each year, fertilized eggs are gathered from spawning lake sturgeon in the Wolf or Wisconsin rivers, Wisconsin. In order to maximize the number of family groups for each year class of fish, 5 females and 5 males per female are used for fertilizing eggs. These eggs are transported to the Warm Springs National Fish Hatchery, Georgia, and hatched on site. Fry are kept on-site for at least one month, until fingerlings can be distributed to the three other participating hatcheries. Fingerlings are reared until late fall, at which point the majority are released into the French Broad River. Prior to release, a sub-sample of the individuals in captivity are screened by the Warm Springs Fish Health Center for known pathogens, including sturgeon iridovirus. Affected individuals would not be released. All fingerlings are marked by the removal of a particular scute for each year class. During 2000 - 2007, 53,255 lake sturgeon were stocked into the river, with 85% of these individuals stocked as yearlings, 6% as sub-adults (age 1), and 9% as adults (≥age 2). Sub-adults are retained only at the Tennessee Aquarium Research Institute, with the goal of increasing their survival, as well as providing larger individuals for monitoring efforts. All sub-adults have PIT tags implanted prior to release.

Post-release monitoring: The Tennessee River Lake Sturgeon Working Group holds yearly meetings to discuss the ongoing project and conduct monitoring. A variety of methods have been used for monitoring over the past eight years, including routine gill netting, electrofishing, and setting trot lines. Some of the sub-adult fish have been used for radio telemetry and sonic tag studies. Recently, we have begun working with local commercial fishermen, who often capture lake sturgeon as by-catch. We have provided some with PIT tag scanners, and they will photograph, record length, and scan fish before releasing them. We have also distributed cards about lake sturgeon that are distributed with the sale of fishing licenses in east Tennessee. These cards include basic information about lake sturgeon, as well as a number that recreational fishermen can call if they capture a lake sturgeon. Signs about lake sturgeon have also been posted near many fishing ramps in the upper Tennessee River Basin.

An education component was added in 2006. Throughout the preceding years, local schoolchildren were invited to help release young sturgeon. This arrangement was formalized in 2006 with a partnership with nearby Gap Creek Elementary School. The 5th grade students raised a sturgeon in their classroom, learned about sturgeon and watersheds during four visits from a Tennessee Aquarium educator, visited the Tennessee Aquarium, and finally participated in the November 2006 release with Tennessee Aquarium Research Institute staff. This program is set to continue with each new 5th grade class. Additionally, the

Tennessee Aquarium has a lake sturgeon touch tank where visitors can touch a live lake sturgeon, watch videos of releases, and talk to docents about the program.

Major difficulties faced

- Obtaining sufficient eggs to build a genetically diverse population capable of sustaining a healthy, wild population.
- Securing funding for a long-term program with 20 years of captive rearing of lake sturgeon fingerlings.
- Adequately monitoring the highly mobile lake sturgeon to determine if captive rearing, stocking times, and stocking densities are sufficient.

Major lessons learned

- The large partnership of stakeholders in the Tennessee River Lake Sturgeon Working Group has been crucial to our success.
- Re-introduction programs must be adaptable in adopting new technologies and methodologies to meet propagation objectives (e.g. egg hauling protocols) and field assessment (e.g. indirect-fishermen creel information might be better than direct sampling).
- Concern for virulent organisms may supersede fishery management objectives; quarantine protocols must be stringent and inflexible.

Success of project

Highly Successful	**Successful**	Partially Successful	Failure
	√		

Reasons for success/failure:

1. We have reached our target numbers for annual releases and are well-publicized to attract community support.
2. We have incorporated an education component and have been able to work with local fishermen, both commercial and recreational.
3. We are still learning the optimal method of monitoring our sturgeon population, and we need to expand our education program to more schools.
4. Lake sturgeon do not spawn until 12 - 25 years of age; the oldest sturgeon released are currently 10 years old and will not reach maturity for at least two more years.
5. While we are meeting all targets, we cannot consider this project highly successful until there is evidence of natural reproduction in the wild.

Conservation of the endemic Azraq killifish in Jordan

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Introduction

Aphanius sirhani is the only endemic vertebrate species in Jordan. It was described in 1983, after been misidentified since 1960s as an Arabian killifish (***Aphanius dispar*)*.*** The species was named after ***wadi al sirhan*** that includes Azraq Oasis, the only site where ***A. sirhani*** is known to occur, and so ***A. sirhani*** became known as the Azraq killifish. Early when it was collected in the 1960s - 1970s the species was recorded to be the most abundant species with "endless" numbers after Nelson, 1973. However, continuous water extraction from the oasis led the species to be "endangered of extinction" by 1989 due to its habitat loss that resulted mainly because of water extraction. Later, the species was thought to be extinct by the mid-1990s, and no further research was carried out until 2000 when the species was re-discovered, but in very low numbers. At that time, its status was declared as "at the edge of extinction", and added to IUCN Red List with a status of Critically Endangered by 2004. At this time the RSCN started a rescue mission to save the only endemic vertebrate of Jordan, through a long-term habitat and re-introduction (re- enforcement) project which is still running.

Goals

- Goal 1: To have a sustainable, free-range and easily managed population of ***A. sirhani*** in the Azraq wetland reserve.
- Goal 2: To reduce the threats on the endemic species mainly via the introduced alien species.

***Aphanius sirhani* - male**

Success Indicators

- Indicator 1: Population sizes.
- Indicator 2: Distribution.
- Indicator 3: Age structure (focusing on number of juveniles).
- Indicator 4: Alien species population size, structure and distribution.
- Indicator 5: Habitat quality.

Project Summary

Feasibility: In this stage the species was deeply surveyed to identify its ecological and biological

survival needs. When so, habitat assessment was carried out to draw up the species optimum habitats built on the old wetland system. The species profile was enlarged as the only endemic vertebrate in Jordan, and it became well known to local communities as a part of their heritage. It is also integrated into the school curriculum.

***Aphanius sirhani* - female**

Implementation: Implementation includes several stages as follow:

- Baseline survey: To collect the needed data, in 2000, 2001, and 2002.
- First stocking, to secure a group of individuals, and start up the captive-breeding program.
- Low scale captive breeding program includes aquariums and concrete pools.
- Large scale captive-breeding program, include semi natural habitats that are isolated and free of alien species.
- Releasing stage, include three trial releases, and the large scale release.
- Diversify the genetic pools of the species by targeting those who have aquarium specimens collected from Azraq earlier in 1990s.
- Secure the species outside Azraq and Jordan, in case of emergency. Specimens are kept at the Sharjah Wildlife Centre for Arabian Endangered Species in the United Arab Emirates.
- Rehabilitation: After the scientific understanding of the species ecological and biological needs, at the same time the old wetland system was traced back to the 1960s before water extraction, a large scale rehabilitation scheme took place. The habitats were drawn to resemble the exact old ecosystem (in smaller scale according to the available water amount) at the same time to apply the species survival requirements. Large pools were created, and the area of the water bodies in the wetland increased from 0.02 % of the original oasis up to 5.5%. The new habitats apply the needs of the species mainly by being shallow enough, having nesting sties and being free of alien species.

Post-release monitoring stage:
In 2002 the comprehensive baseline survey established the monitoring program parameters that were to be monitored annually.

These parameters were:

- Population size of ***A. sirhani.***
- Population structure of ***A. sirhani***.
- Catchability of alien species.
- Population size of alien species.

Newly restored habitat

- Population structure of alien species.

Major difficulties faced

- Understanding the species biological and ecological needs.
- Funding and resources.
- Gaining public support.
- Understand the old water system of the Azraq Oasis.
- Rehabilitation works needs a lot of experience and effort.
- Maintaining ***A. sirhani*** under artificial conditions reduces its productivity.
- Controlling the alien species mainly cichlids (tilapia).

Major lessons learned

1. Re-introduction is an effective tool, but it is only need to be used when necessary. It is too costly and needs a lot of efforts to be performed.
2. Adopting habitat approach by conserving the habitats and its related biodiversity is more effective than having species outside in captive programs and re-introduce them back to their habitats.
3. When practicing re-introduction, habitats conservation should always be in consideration, and work should focus on both species conservation and habitats.
4. Public awareness is effective tool, and can be more effective when dealing with endangered and endemic species because it helps in building the story of conservation.

Success of project

Highly Successful	Successful	Partially Successful	Failure
√			

Reasons for success/failure:

- Achieving program goal by having a viable population.
- Organizational commitment toward the conservation project.
- The project has gained national and international support on both the public and organizational level.

Re-introduction of trout cod into the Murray-Darling River Basin, Australia

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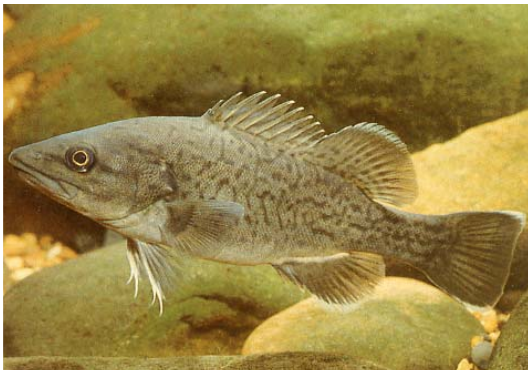
Introduction

The trout cod (***Maccullochella macquariensis*** Cuvier) (Percichthyidae), is a large, predatory, freshwater fish that was formally widespread throughout the more southerly tributaries of the Murray-Darling River basin of inland south east Australia. Currently one natural breeding population in the Murray River between Yarrawonga and Barmah, and two translocated populations (Seven Cks and Cataract Dam), remain. Declines in distribution and abundance have been attributed to a range of factors including habitat degradation (river management works associated with irrigation, flood mitigation and hydro-electricity generation, and pollution), over-fishing and impacts of introduced species. In Australia trout cod is listed nationally as endangered under the ***Environment Protection and Biodiversity Act*** (1999), and endangered by the the Australian and New Zealand Environment and Conservation Council and the Australian Society for Fish Biology. The species is listed as Endangered (C2a) by the IUCN. Since the trout cod was formally described as a species in 1972, and concerns over its conservation status raised, regulations and legislation in NSW, ACT and Victoria, including bans on its capture by anglers, have been introduced to protect the species. Captive breeding and re-introduction programs, which aimed to produce juvenile fish for release into rivers across the species former range, were established by state governments in NSW and Victoria in the mid-1980's. Both programs are on-going.

Goals

- Goal 1: Secure populations of trout cod in captivity for species preservation purposes in the event that wild populations become extinct,
- Goal 2: Develop captive-breeding techniques to allow the production of juvenile fish for re-introduction purposes.
- Goal 3: Increase the distribution and abundance of trout cod within its former natural range.
- Goal 4: Increase the number of



Trout cod (***Maccullochella macquariensis***)

Releasing trout cod fingerlings Into the Bendora Dam 031

self-maintaining populations of trout cod within its former natural range.

- Goal 5: Support objectives and activities of state and national recovery plans for trout cod.

Success Indicators

- Indicator 1: Populations of broodstock maintained in captivity.
- Indicator 2: Large numbers of juvenile trout cod are reliably and routinely produced from captive broodstock.
- Indicator 3: Large numbers of juvenile trout cod are released into rivers in the species' former natural range.
- Indicator 4: Re-introduced trout cod establish viable self-maintaining populations, as indicated by natural recruitment.

Project Summary

Feasibility: In the mid-1980's, in response to concerns over the species' threatened status, two state fisheries agencies (NSW and Victoria) commenced captive breeding and re-introduction programs for trout cod, which preceded the development of recovery plans for the species. The first national funded Recovery Plan, and Victorian Action Statement for the species were prepared in the early 1990s. Both programs would be established at existing government hatcheries where facilities and expertise were available. Wild fish caught from the single remaining natural population (Murray River), would be used as broodstock, and the genetics of these fish and their progeny were considered when developing the breeding and stocking plans. In particular, only wild fish would be used as broodstock and these would be regularly replaced with fresh wild stock. Hatchery-bred stock would not be used as broodstock. The breeding programs were also viewed as an opportunity to undertake additional research on the biology, reproduction and early life history of the species. In addition, a small independent breeding program was also established by Native Fish Australia (NFA) in Victoria.

Implementation: Procurement of broodstock from the wild (Murray River population) commenced in the early 1980s. Fish were held in large earthen ponds (up to 0.3 ha), under semi-wild conditions, at two hatcheries, one in Victoria and one in NSW. There has been some exchange of broodstock between the two programs, but most new broodstock are still derived from the Murray River population. Breeding trials commenced in 1985, and the first successful spawning of captive trout cod occurred in the spring of 1986 when hormone injections were used to induce ovulation. Since then, the captive breeding of trout cod has been refined and become reliable and routine. After hatching fry are usually stocked into fertilized earthen ponds and reared on plankton and other aquatic invertebrates that bloom in the ponds. Stocking sites for re-introduction of trout

cod were selected and prioritized on the basis that they were within the former historic range of the species and consideration of habitat condition (size, type, water supply, water quality, temperature, altitude, etc.), land use, fish species present and angler accessibility. These sites are expected to provide conditions suitable for trout cod to complete its entire life cycle. The first re-introduction of trout cod occurred in January 1987 when 1,000 hatchery-produced juvenile fish were released into the upper Murray River. To date, 984,600 fingerlings (30 - 50 mm in length) have been released, 13,000 - 151,000 fish annually. Trout cod have been re-introduced into 32 sites in eight river catchments (Vic. 10 sites in 5 river catchments, NSW & ACT, 22 sites in 4 river catchments). In addition, 11,700 trout cod yearlings and 2-year olds (>130 mm), which have been intensively on-grown in tanks, have also been released.

Fish and data produced by the breeding programs have assisted other trout cod research activities, including studies on water quality and environmental preferences, genetics, diet and nutrition, movement and dispersal, and population modeling, and have supported captive breeding programs for other ***Maccullochella*** species. Re-introduction is a feature in all recovery plans developed for the species to date. However it is emphasized it is not the sole answer to recovery of trout cod. Other important recovery actions have included legislation and regulations, habitat protection and improvement, monitoring and research on existing populations, both natural and translocated, and community awareness and education about trout cod. These activities have had a positive affect on trout cod. In particular, the one remaining natural population in the Murray has extended its range downstream over the past decade.

Post-release monitoring: Monitoring of stocked populations is on-going by state fisheries and conservation agencies in NSW, the ACT and Victoria. Although it has been recommended that stocked sites be monitored at least annually, due to limited resources this has been variable with some populations being monitored more rigorously than others, and some sites have yet to be surveyed for evidence of recruitment. In addition to these surveys, anecdotal reports by anglers have also provided information on survival. Stocked trout cod are surviving in many of the stocked sites and to date, natural recruitment has been confirmed in four rivers (lower Murrumbidgee R., Ryans Ck., Goulburn R. and Cotter R.) and suspected in another three rivers (upper Murrumbidgee R., Ovens R. and Upper Murray R). At least three stocking sites in Victoria have failed with no reported captures for fish in recent years.

Releasing fingerlings in the Mitta Mitta River

Since the early 1990s hatchery produced fish have been chemically marked (alizarin or

oxytetracyclene) prior to release to assist in distinguishing them from naturally spawned fish. This, combined with length frequencies and otolith aging of captured fish at stocking sites is used to identify natural recruitment.

Major difficulties faced

- During the initial stages of establishing captive-breeding populations, catching suitable stock was difficult due to their rarity in the wild.
- Trout cod is closely related, and similar in appearance, to the more common Murray cod (***Maccullochella peelii peelii***), which occurs sympatrically with trout cod in some areas. Public awareness of the difference between the two species and the endangered status of trout cod was required in areas where trout cod were being stocked.
- On-going stocking of trout cod, and establishment of self-recruiting populations in some areas has increased the catch of trout cod by recreational anglers. As a result, there is increasing community pressure to review conservation status of the species and to allow some take by anglers.
- In recent years fish stocking programs have come under scrutiny due to concerns over potential detrimental impacts on receiving populations and environments. In particular, genetic identity and diversity of stocked fish and transfer of diseases and unwanted species from hatcheries to the wild. Trout cod breeding programs have incorporated genetics guidelines since the outset, and more stringent stocking practices are being introduced (such as imposed by national and state translocation guidelines, and hatchery quality assurance guidelines).

Major lessons learned

- Evidence of natural recruitment in stocked populations was expected to occur shortly after the initial stocked fish reached maturity (five years). However, it has taken a decade for natural recruitment to be observed in several of the stocked populations.
- Yearling and sub-adult, trout cod are highly susceptive to angling, which has been implicated in the failure of one stocking site. This problem, together with the knowledge that some stocked populations are becoming well-established and known to anglers, indicates the need to maintain community awareness about trout cod.
- Small numbers of hatchery-reared yearling and sub-adult trout cod have been re-introduced during the programs. However, recent telemetry studies have indicated that survival of fish that have been on-grown in hatcheries for more than a year is generally poor. It is suggested that these fish lack survival skills due to the nature of their upbringing.

Success of project

Highly Successful	**Successful**	Partially Successful	Failure
	√		

Reasons for success/failure:

- Since commencement of stocking activities, 996,300 trout cod have been re-introduced into 32 sites in 8 river catchments across the Murray-Darling Basin.
- Stocked trout cod are surviving in many of the stocked sites and to date, natural recruitment has been confirmed in four rivers and suspected in another three rivers.
- Due to the success of these stockings, and pressure from angling groups, state fisheries agencies in NSW and Victoria are considering changes to regulations to allow limited take by recreational anglers in some areas.

Restoration of the Formosan landlocked salmon in the Shei-Pa National Park, Taiwan

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Introduction

The Formosan landlocked salmon (***Oncorhynchus masou formosanus***) is an endangered endemic species distributed only in the basin of the Chichiawan Stream of Wuling area (2000 a.s.l., 24°22'46'N, 121°18'26"E) in Shei-Pa National Park, central Taiwan. Their habitats were destroyed due to recreation development and high-mountain agricultural farms, mainly the farms administrated by retired-solder authority in the central government. So far, the population size remains to be <3,000 over the past two decades. The fish is listed as Critically Endangered (CR B1+2d) by the IUCN Red List and Endangered by theTaiwan government. The restoration projects began quite early, but it was not until the establishment of the Salmon Wildlife Refuge that it really took off. The restoration projects are administrated by the personnel of Shei-Pa National Park and closely monitored by a team of scientists sponsored by the park. Major projects included the establishment of a salmon wildlife refuge by the Wildlife Conservation Law, establishment of partnership by including all stakeholders, re-vegetation of riparian habitat, reinforcement of water conservation facilities within agricultural areas, regulation of water resource usage, evaluation of the sites for re-introduction, abolishment of sand check dams in the streams, improvement of aquaculture techniques, continuing research on the biology and ecology of salmon, constructing a new shelter for salmon during the flooding period in the summer, and regulation of recreation activities.

Formosan landlocked salmon (*Oncorhynchus masou formosanus*)

Goals

- Goal 1: ***Short-term*** - To improve current habitats and restore the salmon population into a sustainable level by the following activities:

⇒ Habitat improvement projects
⇒ Re-introduction of salmon.
⇒ Regulation of agriculture and tourist activities.
⇒ Continuing monitoring population.

- Goal 2: ***Mid-term*** – To enlarge the potential habitat and re-introduce the salmon to these habitats.
- Goal 3: ***Long-term*** – To maintain the salmon population for sustainable management.

Success Indicators

- Indicator 1: ***Short-term habitat improvements***
  - ⇒ Re-vegetation of riparian habitat.
  - ⇒ Improved water quality.
  - ⇒ Reduced agricultural areas.
  - ⇒ Regulation of water resource usage.
  - ⇒ Abolishment of sand check dams in the streams.
  - ⇒ Constructing a new shelter for salmon during flooding period in the summer.
  - ⇒ Regulation of recreation activity.
- Indicator 2: ***Mid-term habitat enlargement***
  - ⇒ Evaluation of the potential sites for re-introduction.
  - ⇒ Population size increase.
- Indicator 3: ***Long-term sustainability***
  - ⇒ Population size at sustainable level.
  - ⇒ Increase in salmon habitat.

Project Summary

The history of Formosan landlocked salmon conservation in Taiwan includes five stages: i) the initial period (1917 - 1945), ii) the neglect and restart period (1945 - 1983), iii) the protection by the Council of Agriculture period (1984 - 1992), iv) the protection by the Shei-Pa National Park period (1992 - 1995) and v) the planning for the Wildlife Refuge period (1995 - now). Many of the activities, i.e., the establishment of a salmon wildlife refuge by the Wildlife Conservation Law, establishment of partnership by including all stakeholders, re-vegetation of riparian habitat, reinforcement of water conservation facilities within agricultural areas, regulation of water resource usage, evaluation of the sites for re-introduction, abolishment of sand check dams in the streams, improvement of aquaculture techniques, continuing researches on the biology and ecology of salmon, constructing a new shelter for salmon during flooding period in the summer, and regulation of recreation activity, are implemented after 1995. The population of the salmon reached its lowest level in the period between 1987 and 1995 and agricultural and recreational activities were thought to be the major factors contributing to its decline. Reducing the agricultural and recreational activities became the main strategy for saving the salmon from extinction. The sources of pollution identified by the park officials, scientists, and conservation NGOs as being local farmers and tourists. Their livelihoods and interests would

The Chichiawan Stream

be greatly affected by any reduction of agricultural production and regulation of tourism. As a result, the well-being of the salmon and the livelihoods of local people represented two opposite poles of debate.

During this 5th stage, the planning authorities of the Salmon Wildlife Refuge Council of Agriculture (COA) representing the central government, Taiwan Provincial Government, and Taichung County Government came to adopt a more collaborative planning approach to settling disputes between the Park and the Farms. COA played a key role as a mediator between the 'two adversarial sides': The National Park authority, scientists, and conservation NGOs represented one side that emphasised the well-being of the salmon. The Farm Authority represented the other side that emphasised the livelihoods of local farmers and the interests of tourists. By holding the public meetings and the Working Panel meetings for the proposed Salmon Wildlife Refuge, the planning authorities of the Salmon Wildlife Refuge introduced a more collaborative approach. Unlike the previous stage it sought to mediate between interests of the conservation of the salmon and the interests of local farmers and tourists in the following ways:

First, the planning authorities made an effort to deal with the complex management problems on the ground. It also recognised the importance of local farmers' livelihoods and tourists' interests by incorporating the Farm's ***Transformation Project*** into the ***Conservation Plan of the Salmon Wildlife Refuge***, though the overall emphasis was still placed on the well-being of the Salmon.

Second, the planning authorities adopted a more inclusionary approach to involving more stakeholders than the previous stage into the planning processes, including the planning authorities, the Farm authorities and more scientists and conservation NGOs (as members of COA's Wildlife Conservation Advisory Committee). The planning authorities, especially the COA, played a pivotal role as a mediator in helping to reconcile the conflicts and build up better working relations between the two adversarial groups of stakeholders.

Third, the planning authorities employed a series of public meetings and recruited a planning committee (the Working Panel) as key arenas for mobilising the two adversarial sides of stakeholders to work on consensus building. Together they worked out a ***Conservation Plan for the Salmon Wildlife Refuge*** in which a task-division agenda was drawn up and responsible authorities identified for implementing the associated conservation work. On 1st October 1997, the

Taichung County Government legally designated the Salmon Wildlife Refuge under the Wildlife Conservation Law.

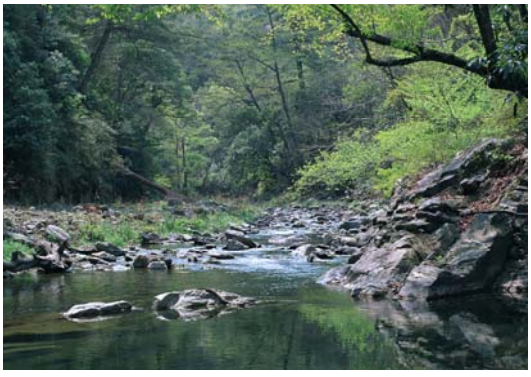
After the designation, the National Park authorities took control of the protection and implemented many activities, such as those described in this articles and greatly improved the habitat conditions in which the salmon lives. So far, the whole project is in its mid-term stage that focuses on the enlargement of the habitats and re-introduction of newly hatched salmon into these habitats.

Major difficulties faced

- Conflicts of interest among various stakeholders that need be addressed.
- Continuous habitat degradation by agricultural and recreational activities, and suitable habitats limited.
- Small population size.
- Constant natural disturbance from typhoons.
- Potential effect of climate change that may increase the stream water temperature to make it less suitable for salmon.

Major lessons learned

- Scientific knowledge dominates the construction of the meanings and values of the salmon, and the identification of negative factors contributing to the decline of the salmon.
- Human factors are regarded as being negative both for scientific reasons and because the institutional values of the nature conservation authorities (notably the park authority) are bedded in a scientific rationale. As a result, the dominant management strategy is to give high priority to the salmon and low priority to livelihoods of local people. This strategy possibly accounted for the failure before the 4th stage.
- Scientific knowledge cannot provide definitive answers to the question of what factors contribute most to the decline of the salmon. Like many cases of environmental change, it is impossible to say that people rather than nature are responsible. Negative factors, both human and natural, are many and uncertain. Traditional rational planning approach ignores this uncertainty by offering partial explanations that often cannot provide a full ecological analysis. As a result, the effectiveness of a conservation strategy based on scientific knowledge alone is likely to be compromised.
- The composition of stakeholders in the traditional rational planning processes is dominated by government institutions and scientists who



Another view of the Chichiawan Stream

form a 'closed community' reinforced by formal and professional working relationships. Together with the 'Salmon first, people last' conservation strategy, this tight official and expert community marginalizes other knowledge communities, especially local people. These official stakeholders and their working practices also contribute to the development of an adversarial relationship and uncoordinated ways of addressing management issues that focus around 'pro-wildlife' institutions and 'pro-people' institutions. As a result, the effectiveness of working relationships based on an official and professional community is likely to be compromised.

- Traditional rational planning approaches are underpinned by a legal, regulatory, and sectoral delivery system structured with 'top-down', 'hierarchical' institutional arrangements. This 'hard infrastructure' largely determines the range of 'stakeholders' consulted and their professional working relationship, the institutional values and norms that guide strategic policy making, and the formal ways of communication adopted in the planning and management processes. Local people are systematically excluded from the traditional planning processes and the absence of any informal, communicative channels for their claims to be given an equal voice means that they feel alienated. Little common basis exists on which to forge solutions other than separating wildlife conservation from local people's livelihoods. As a result, the effectiveness of this legal, regulatory, and sectoral delivery system based on 'top-down' institutional arrangements finds little support in the local community.
- The involvement of local people and conservation NGOs is mandatory.
- Environmental education programs are essential to conservation of the salmon restoration project.

Success of project

Highly Successful	Successful	**Partially Successful**	Failure
		√	

Reasons for success/failure:

1. The population size has steadily increased.
2. The habitat condition has improved e.g. the stream temperature has decreased and this makes it better for the requirements of the salmon. The water quality has also improved.
3. The sand check dams that used to be a barrier for the fish have been removed.

Translocation of Romer's Tree Frog in Hong Kong SAR, China

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Introduction

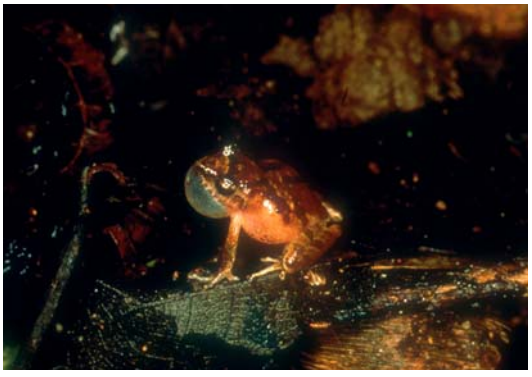
Romer's tree frog used to be called ***Philautus romeri,*** but a recent taxonomic review places it tentatively in the genus ***Chirixalus*** due to its free-swimming larval stage. This species is listed as Endangered by the IUCN and is protected in Hong Kong under the "Wild Animals Protection Ordinance". It is endemic to Hong Kong and is naturally known from four off-shore islands. The species became threatened when Chek Lap Kok, one of the four islands originally inhabited by this species, was chosen as the site for the new airport in 1989. In late 1991, the Royal Hong Kong Jockey Charities Ltd. supported the University of Hong Kong to conserve Romer's tree frog. Rescue operations were carried out from November 1991 to December 1992 and captive-breeding programs were established at the University of Hong Kong (UHK) and at Melbourne Zoo (MZ). Habitat requirements, ecology and genetic relationships among the different populations were also studied. Suitable release sites were identified in the New Territories and Hong Kong Island where natural populations were absent and translocations were carried out from 1993 to 1996.

Goals

- Goal 1: To establish viable populations of the Chek Lap Kok population of Romer's tree frogs in the release sites.
- Goal 2: To increase the number of individuals through captive breeding.
- Goal 3: To gain knowledge on the ecology, breeding biology, genetics and captive care of this species through field study and captive observations.

Success indicators

- Indicator 1: Viable populations established in the release sites and their range expanded.
- Indicator 2: The captive-breeding program is successful, producing the required number of individuals for the releases.
- Indicator 3: Enough knowledge



Romer's tree frog (*Philautus romeri*)

gained on this species to ensure a high degree of success in both the captive breeding and translocation programs.

Project Summary

Feasibility Stage: Funding was secured by the UHK. A literature search was carried out to determine important success factors and concerns in cases of amphibian and reptile re-introductions. Field work was carried out on Chek Lap Kok to assess the species' distribution and a small number of frogs were captured and maintained in captivity before the project started.

Implementation Stage: Rescue operations were carried out from 1991 to 1992 when construction had already started. Field studies were conducted into habitat requirements and ecology. Partners in captive-breeding programs were sought through the IUCN/SSC Captive Breeding Specialist Group. Melbourne Zoo and Frankfurt Zoo agreed to join the program and breeding was successful in the UHK and MZ. Frogs bred at MZ were transferred to UHK for subsequent release. Genetic studies were undertaken to look at the genetic relationships among the different insular populations and it was found that there was some genetic differentiation among them. Hence, release of the Chek Lap Kok frogs to the other three islands was ruled out. Potential release sites were identified in the mainland New Territories and Hong Kong Island. Discussions were carried out with the relevant government departments and Kadoorie Farm & Botanic Garden (KFBG) to select sites where frogs would be protected in the future and to carry out habitat management work to provide suitable breeding habitats. In 1993, trial release of tadpoles was carried out in three sites and they were monitored weekly. Marked adults were only released when tadpoles survived and grew. The released individuals were again monitored regularly. Translocation was expanded to five additional sites in 1994 after tadpoles succeeded in metamorphosing and calling males were located in the three trial sites.

Post-release Monitoring Stage: The released populations were monitored at least once every year during the breeding season to locate individuals (in particular calling males and tadpoles) and to map their distribution. Follow-up work was needed for some sites to maintain the breeding habitats. Even after the project finished, monitoring was carried out initially by the project implementer (Michael Lau at the UHK) and later taken up by the Agriculture, Fisheries & Conservation Department and KFBG.

Breeding tubs for released individuals

Major difficulties faced

- Very little was known about this species when the project started.

- The rescue work had a very limited time frame as construction had already started before the project began.
- The captive-breeding program consumed a lot of time and manpower as this species matures in less than a year and produces several clutches per year.
- Not many well-documented successful amphibian re-introduction examples to draw from.

Major lessons learned

- Adequate understanding of the species' ecology, biology and genetics is essential.
- A project of this nature takes at least five years (even on a species with very short generation time). This might be more than a funding agency is willing to cover and more than the normal time span of a post-graduate project.
- Captive-breeding can be very time-consuming and resource demanding and partnerships should be established with other organizations, especially zoos as they have the expertise and facilities.
- If the project requires captive-breeding, this should involve more than one institution to reduce the impact of potential accidents.
- Captive-breeding and re-introduction programs are good at attracting media and public attention. This should then be used to raise community awareness and promote conservation of the species and its habitats.
- Open exchange of information and experiences very important for project success.
- Continual monitoring is required to prevent habitat degradation and to maintain suitable conditions for the target species.

Success of project

Highly Successful	**Successful**	Partially Successful	Failure
	√		

Reasons for success/failure:

1. Major funding to enable the necessary studies to be undertaken.
2. A committed individual with the necessary skills and expertise to work consistently on the project from the outset.
3. Having consistent institutional support.
4. An external partner organization to provide captive management/breeding support, which was important in the initial stages to spread the risk of captive management failure.

Re-introduction of Puerto Rican crested toads to historic range in Puerto Rico

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Introduction

The Puerto Rican crested toad (*Peltophryne lemur*) is listed as threatened by the United States Fish and Wildlife Service and critically endangered by the IUCN. Two genetically distinct northern and southern populations once existed in Puerto Rico. The northern populations are extirpated in the wild. The only known wild population is found in Guanica National Forest and over 25 years the population has fluctuated between 500 and 2,000 adults. A stable breeding population of northern and southern toads is held in captivity. Addressing threats is important given the small population, single breeding pond and potential for a catastrophic event to cause extinction. The American Zoo Association Species Survival Plan (SSP) for the crested toad was approved in 1984. A USFWS Service Recovery plan was written in 1991. The SSP has merged management goals with those of the recovery plan. Recovery partners: 21 zoos and aquariums (US, Canada, UK and Puerto Rico), USFWS, Puerto Rico Department of Natural and Ecological Resources, University of Puerto Rico, Puerto Rican National Park Company at Juan Rivero Zoo, Iniciativa Herpetologica, Inc. and Citizens of the Karst. Recovery priorities for this species are coordinated through the FWS Puerto Rican Crested Toad Recovery Plan and Population and Habitat Viability Analysis Working Group.

Puerto Rican Crested Toad
(*Peltophryne lemur*)

Goals

- Goal 1: Creation of new ponds to support six self-sustaining meta-populations (three in the north and three in the south).
- Goal 2: Expansion of ecological research.
- Goal 3: Protection and restoration of existing habitat.
- Goal 4: Island-wide education and outreach.
- Goal 5: Re-introduction of tadpoles from captive genetically and demographically managed population.
- Goal 6: In-country training and

capacity building.

Success Indicators

- Indicator 1: To meet demographic and genetic goals of captive management, expansion of captive population to over 400, supplemented by tadpoles collected from wild.
- Indicator 2: Post-release survival to maturity in wild of captive bred tadpoles.
- Indicator 3: Breeding of adult toads released as tadpoles within 10 years; ongoing until six meta-populations breeding for 10 years.
- Indicator 4: No net loss of breeding habitat.
- Indicator 5: Increased profile and awareness of threats to toads.
- Indicator 6: Increase in number of constructed breeding sites (to support meta-population persistence) on protected lands.
- Indicator 7: In-country training and establishment of captive breeding and release in Puerto Rico.

Project Summary

Feasibility: Focus would remain on protection, hydrological research, and addressing threats to the single remaining natural breeding wetland in Guanica forest. Only tadpoles (to maintain a potential founder group of 20) from separate tadpole schools or pond sections would be collected to establish captive populations. Several research projects were initiated on the captive populations (genetic, growth, health screening, and nutritional). Lack of awareness of the existence of the toad and the threats to its survival were identified and stakeholder groups identified. Forging working partnerships with shared goals was initiated through working meetings with USFWS, DNER and AZA SSP with invited stakeholders. Working groups expanded to include all stakeholders and formalized in a PHVA Masterplan. A GIS based survey of potential release sites was subjected to further on site analysis to select best sites to establish satellite populations.

Implementation: Recovery efforts are directed through a Memorandum of Understanding between the USFWS, Department of Natural and Ecological Resources (DNER), Puerto Rican National Park Company and the AZA. Permit requirements are met through annual issue of blanket permit listing participating institutions to facilitate and expedite (within six days of hatching) movement of tadpoles back to Puerto Rico. All tadpoles are released at the earliest age possible to ponds outside the existing migratory range of the single extant

Tamarindo breeding site

Puerto Rican crested toad mascot

population and within ground truthed habitat profiles in the historic range of the toad. All tadpoles are subject to health screening prior to release; random testing for disease; and no tadpoles are released from groups with parents with illness or death and tadpole groups with unexplained deaths prior to release.

Post-release monitoring: Marking techniques for tadpoles and technology to efficiently track toads through a labyrinth of subterranean limestone caverns has yet to be developed. Subsequently, post metamorphic survival and movements have been the subject of graduate projects. All natural and constructed breeding ponds are monitored for breeding activity under guidelines establishing windows for searches. Monitoring of historic and release sites has begun using automated frog call loggers. Health assessment studies of sympatric species and crested toads is ongoing. This also includes chytrid fungus screening.

Major difficulties faced

- Difficulty of monitoring either adults or juvenile toads in natural habitat.
- Lack of protected release sites in the north.
- Loss of protected wild habitat.
- No formal biological research program to understand natural history and severity of identified threats paralleling efforts to maintain assurance populations.
- Funding for inter-disciplinary research.

Major lessons learned

- Large number of early age metamorphs required to mimic natural life stage mortality tables (i.e. ramp up partners to meet numbers before releases attempted).
- Importance of establishing in-country partnerships and agreement on shared goals at earliest stages.
- Need to establish assurance populations early even while protection of natural habitat and addressing threats is being undertaken.
- Need for and value of social marketing skills and trained professionals to deliver these skills.
- Need for leadership to win small short-term victories in the face of overwhelming odds and to show success while formal long-term programming is under development.
- It may take up to 10 years before establishment of a re-introduced population;

highly variable dependant upon number of offspring released.

Success of project

Highly Successful	Successful	**Partially Successful**	Failure
		√	

Reasons for success/failure:

1. Juvenile recruitment has been confirmed at one southern location (the other two release sites are less than two years old); ongoing construction of ponds for increasing protected breeding habitat is underway.
2. Breeding of adult toads themselves released as tadpoles into ponds constructed for release has been confirmed over two breeding seasons.
3. Increased awareness of threats and partnerships for conservation action.
4. We are seeing recruitment at the main release site and the Puerto Ricans are finally taking ownership of this project. This program has also been used as a model for many other release programs). Long-term population persistence has not been documented, so partially successful in that regard.

Re-introduction of the Mallorcan midwife toad, Mallorca, Spain

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Introduction

The Mallorcan midwife toad (***Alytes muletensis***, Sanchíz & Alcover, 1977) or ***ferreret*** was first described in the 1970s as ***Baleaphryne muletensis*** from upper Pleistocene fossils, and was considered extinct. The discovery of live tadpoles in 1980 led to further research which confirmed the species as extant and endemic to Mallorca (Mayol & Alcover, 1981). Subfossils suggest that the species was once widespread across the island, but today it is confined to a few gorges within the Serra de Tramuntana mountains in the north-west part of the island. There are currently about 34 populations within the mountains and adjacent areas (16 original wild populations plus 18 re-introductions). These are largely isolated from each other by physiographic barriers, but there is little evidence of any inbreeding depression. Re-introduction of captive bred toads started in 1989 and it is estimated that about 25% of the wild toads stem from captive bred stock. The successful re-introduction program contributed to the downgrading of the species from 'Critically Endangered' to 'Vulnerable' in the Global Amphibian Assessment of 2004. There is little evidence that wild populations are continuing to decline, but the recent discovery of chytridiomycosis in four populations gives cause for concern.

Mallorcan midwife toad (*Alytes muletensis*)

Goals

- Goal 1: Identification of potential re-introduction sites within the species' historic range.
- Goal 2: Habitat management and creation at potential re-introduction sites.
- Goal 3: Sustainable populations of toads established in all areas where there is suitable habitat, hydrology and absence of introduced predators.
- Goal 4: Annual monitoring of all toad populations (both natural and

re-introduced).

Success Indicators

- Indicator 1: Self-sustaining populations established at re-introduction sites.
- Indicator 2: Overall geographical distribution of the species extended.

Toad tadpoles in a natural pool

Project Summary

A captive breeding program was initiated at Jersey Zoo in 1985 following the collection of 8 animals from the wild. This was supplemented by a further 12 individuals in 1987 and the species was bred for the first time in 1988. Further breeding colonies were subsequently established at other collection-based institutions and Universities in Europe, with the Balearic Island government retaining formal ownership of all animals. Following an assessment of potential re-introduction sites by the Mallorcan conservation authority (Conselleria d'Agricultura i Pesca), 76 tadpoles were returned to Mallorca and released at 2 sites in 1989. Since that time releases of both toadlets and tadpoles occurred on an annual basis up to 1997 (Buley & García, 1997), and then less regularly until 2001.

Meetings of all project partners have occurred at approximately two-yearly intervals to evaluate progress and decide upon future goals. In 1996 an extensive health screening program of captive toads was established (probably the first for any amphibian in a captive-breeding program). Toads underwent parasitological and bacterial screening for three months prior to release, and fecal samples were collected from both captive and wild toads for analysis by the veterinary department at Jersey Zoo. As all toads in captivity were descended from the original 20 founders collected in 1985 - 1987, and three new bloodlines were established in captivity in 1997 with the collection of 25 tadpoles from each of three wild populations (Buley & Gonzalez-Villavicencio, 2000; Roca ***et al.***, 1998, 2000).

With concerns growing towards the end of the 1990s about the global impact of emerging infectious diseases on amphibians, a recommendation was made that no further re-introductions should be carried out until i) the disease implications of further re-introductions became clearer; and ii) genetic analysis of both wild and captive populations was carried out. Microsatellite DNA analysis was completed in 2006, and revealed that although populations in different gorges were largely isolated, wild populations retained relatively high levels of genetic diversity. Equally, there was no evidence that reintroduced or captive toads had suffered any loss of fitness or genetic variability for up to eight generations of captive breeding (Kraaijeveld-Smit ***et al.***, 2005; 2006). Screening for chytridiomycosis

Artificial cistern which is used by *Alytes* (now constructed as a conservation management measure)

(***Batrachochytrium dendrobatidis***) was added to the health screening protocol in 2005, and chytrid-positive animals have subsequently been identified in four populations. The impact of chytrid remains unclear, but successful breeding still appears to be occurring in the populations concerned.

A complete census of all ***Alytes muletensis*** breeding sites is carried out annually. As the adult toads spend most of their lives underground and are very difficult to survey, the censuses consist of counts of tadpoles observed in each pool. Although it is difficult to relate such simple counts to actual population sizes, the presence of abundant tadpoles spread across several size classes provides a useful index of breeding success. Breeding populations of toads have become established at all 18 sites where re-introductions were carried up to 2001, and wild populations appear to be stable, and in some cases, increasing. Since its early days, the conservation program for the Mallorcan midwife toad has embraced a multidisciplinary approach to species recovery. In this respect, the wider components of the project have included conservation education initiatives, publicity, applied ecological research, predator control, conservation genetics, health screening and habitat management and creation. In addition to using natural torrent pools as breeding sites, the toad also breeds successfully in artificial cisterns constructed for the watering of livestock. Construction of such cisterns in suitable areas has proved to be a successful supplementary conservation action.

Major difficulties faced

- Alien predators and competitors – notably the viperine snake (***Natrix maura***) and Spanish marsh frog (***Rana perezi***) – remain a widespread and very significant threat and are very difficult to control.
- A burgeoning human population coupled with climate change means that water is in short supply on Mallorca. Consequently, torrents flow less frequently than they once did and breeding pools may be more prone to desiccation.
- Because of the two points mentioned above it is impossible to completely neutralize the threats to the toads on the island, and re-introductions may therefore need to be accompanied by management measures to minimize the impact of alien predators and desiccation.

Major lessons learned

- A small partnership of co-operative stakeholders that meet regularly enabled decisions to be made quickly and appropriate actions implemented.
- A health screening program was in place before reliable methods for the detection of chytridiomycosis were known. Chytridiomycosis (and possibly other emerging infectious diseases not yet known to science) may therefore have gone undetected for several years.
- Management decisions have been informed by scientific research (more scientific papers have been published on ***Alytes muletensis*** than on any other amphibian species in a captive breeding/re-introduction program).
- The program has been running for nearly 30 years, and during this time has tried to embrace new ideas and protocols in re-introduction practice as they have been developed. Consequently the whole program has 'evolved' rather than been 'planned'.

Success of project

Highly Successful	Successful	Partially Successful	Failure
√			

Reasons for success/failure:

- The Mallorcan midwife toad was the only amphibian species in the Global Amphibian Assessment to be downgraded from 'Critically Endangered' to 'Vulnerable' in 2004.
- All of the 18 re-introductions appear to have been successful. This has resulted in a doubling of the original geographical range of the species.

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Re-introduction of tuatara as part of an ecological restoration project on Wakatere-papanui Island, Marlborough Sounds, New Zealand

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Introduction

Tuatara (***Sphenodon***), medium sized reptiles originating in the Triassic and sole living representatives of the Order Sphenodontia, were formerly widespread throughout New Zealand. Introduced mammalian predators reduced tuatara to small isolated populations on offshore islands. One of the three recognized variants of tuatara, ***S. punctatus*** Cook Strait, is known from four islands between the two main islands of New Zealand. These islands range in area from 1 - 150 ha and are home to approximately 80% of all tuatara (Gaze, 2001). This subspecies is no longer listed on the IUCN Red List. The New Zealand Department of Conservation's Threat Classification System List 2005 lists the subspecies as range-restricted. We report on the re-introduction of tuatara (***S. punctatus*** Cook Strait) to Wakatere-papanui Island, Cook Strait, New Zealand from nearby Stephens Island. Wakatere-papanui Island had no resident tuatara, probably due to the invasion by introduced mammalian predators (rodents ***Rattus norvegicus*** and ***Rattus exulans***) in the last few hundred years.

Tuatara (*Sphenodon punctatus*)

Goals

- Goal 1: Restoration of a self-sustaining population of tuatara to an island within their former range.
- Goal 2: Initiation of ecological restoration of an island by rat removal.
- Goal 3: Using an ecological restoration project to build relationships and potential for skill

transfer among researchers, managers and the community.

Success Indicators

- Indicator 1: Recapture of 30% of founders within three years post-translocation.
- Indicator 2: Increase in length and weight of all founders recaptured within one year post -translocation.
- Indicator 3: Identification of recruitment of young into the population within 10 years.
- Indicator 4: Evidence of a self-sustaining population within 100 years.

Transporting tuatara to Wakatere-papanui Island

Project Summary

Feasibility: Wakatere-papanui is a 61 ha island administered by the New Zealand Department of Conservation. It belongs to a chain known as the Rangitoto Islands, with its nearest neighbour only 210 m away. Wakatere-papanui Island has a history of burning and grazing but still has many elements of the original coastal forest typical of islands in Cook Strait. It has long been recognised as having great potential for the restoration of natural communities characteristic of Cook Strait if rodents were eradicated (***Rattus norvegicus*** & ***Rattus exulans***). If rats are present, revegetation would be slow, and restoration of invertebrates, reptiles and birds would be even slower or non-existent. Wakatere-papanui is also within the swimming distance of rodents from neighbouring islands. In order to prepare Wakatere-papanui Island for a tuatara re-introduction, rodents were eradicated from all three islands in the Rangitoto group in 1999 with funding from the San Diego Zoo and Pacific Development and Conservation Trust. The eradication involved extensive negotiation with owners of other islands in the group, including the local Māori (New Zealand's indigenous people), Ngati Koata no Rangitoto ki te Tonga. Domestic sheep had to be removed from one of the islands until after the eradication poison's withholding period.

Implementation: Translocated tuatara were sourced in two groups from Stephens Island, within the same ecological region as Wakatere-papanui. Tuatara sourced directly from the wild were removed from an area of native frog habitat to relieve predation pressure on endangered frogs. This group, comprising 89 individuals ranging from adults to hatchlings, was translocated within a week of collection directly to Wakatere-papanui in November 2003. The second group was sourced as eggs and newly hatched juveniles (that had not yet left their nests) from nesting rookeries across the eastern face of Stephens Island in 1998/99. Eggs finished incubation at Victoria University of Wellington, and all hatchlings were head-started at Nga Manu Nature Reserve, Waikanae, in semi-

natural conditions where they were protected from predators. In October 2004, 343 juveniles aged approximately five years old, were translocated to Wakatere-papanui. The sex ratio of the founding population was approximately 1 male to 0.75 females; juveniles taken directly from Stephens Island were too young to sex using external characteristics. Tuatara were weighed and measured, and samples for health screening were taken in the week prior to translocation of each group, including cloacal swabs for ***Salmonella***, blood smears for white blood cell counts and investigation of blood parasites, and faecal material for investigation of internal parasites. All tuatara were externally inspected to ensure they appeared healthy. Tuatara were moved in each instance prior to knowledge of results from the health screening, due to lack of knowledge on implications of results for the translocation. Ecto-parasites (ticks and mites) on tuatara moved directly from the wild were left attached due to the uncertainty of negative impacts on tuatara and the threatened status of the tuatara tick (***Amblyomma sphenodonti***: Family Ixodidae). Tuatara were packaged individually in aerated postal tubes, and carried in groups in mesh bags or boxes for transportation by helicopter. They were released on the afternoon of the same day as packaging occurred. Burrows were prepared for adults, comprising holes approximately 50 cm long under vegetation. Thirty-one of the tuatara taken directly from the wild were released in two groups with neighbors from their capture location. The rest were randomly allocated to release burrows. Release habitat for juveniles comprised a rocky area with crevices and vegetation for cover; no burrows were prepared.

Post-release monitoring: A search by five people comprising one day and three nights was conducted for the tuatara released in 2003 during preparation for the 2004 translocation. A second monitoring trip was conducted in November 2006 where 3 - 6 people spent five days searching the 2003 and 2004 release sites and 5 nights searching the 2003 release area. A total of 25% of the 2003 and 6% of the 2004 founding tuatara were relocated. All re-located tuatara had gained weight and length, even those translocated as adults (tuatara have an indeterminate growth pattern). For example, mean percent increase in mass of adult males was 43% and snout-vent length was 9% for those recaptured in 2006, three years after relocation. No evidence of recruitment into the population was observed. These results are similar to findings from other tuatara translocations (Nelson ***et al.***, 2002). Monitoring of this population is expected to continue for decades to evaluate whether a self-sustaining population has established, as tuatara may live for 100 years and females reproduce on average every four years.

Major difficulties faced

- Relocating cryptic and especially small juvenile tuatara in their new habitat.
- Searching for tuatara on a cliff bound island with difficult terrain in an early stage of revegetation.
- Lack of knowledge of tuatara diseases and therefore interpretation of health screening results.
- The logistics of transporting three tonnes of brodifacoum poison to the site and arranging thorough distribution by helicopter over all three islands.

- Obtaining consent from other island owners for the eradication of rodents which included multiple Maori owners of one island.

Major lessons learned

- Adult sized tuatara are easier to recapture, therefore surveys for juveniles are more productive if a big search effort is initiated once they reach sub-adult size (e.g.10 years old).
- Each search uncovers founders that have not been seen since translocation, therefore recapture numbers must be treated as minimum number alive, and are likely to be a result of limitations of surveyor abilities and behavior of juvenile tuatara, not lack of translocation success.
- A major conservation achievement was possible through the joint commitment of university staff and students, the resident community, a government department, zoos and financial sponsorship.
- Evaluating success and lessons is long term.

Success of project

Highly Successful	**Successful**	Partially Successful	Failure
	√		

Reasons for success/failure:

- Founders have survived and are in good health, therefore tuatara can survive in this location.
- More founders are relocated on each search, therefore more are likely to be alive.
- Life history of tuatara (i.e. long-lived, infrequent breeders) means we can only define success in the short term by survival, growth and condition of founders. It is too early to tell if recruitment has occurred and whether this or any tuatara translocation is going to be self-sustaining in the long-term.

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Re-introduction of skink and gecko species to Marotere Islands, Northland, New Zealand

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Introduction

The distribution of the Mokohinau skink (***Cyclodina townsi***) is restricted to the Mokohinau Islands (two very small islands: stack H 0.74 ha, Tarakihi Island 3.0 ha) and the Maretere (Chickens) Islands (three small islands: Muriwhenua/ Wareware islands 8.75 ha and Middle stack 1.35 ha). It's conservation status is: IUCN not listed and Range Restricted (Stable, Human Induced). Re-introduced to Lady Alice Island 155ha, Whatupuke Island 102 ha and Coppermine Island 79.5 ha. McGregor's skink (***Cyclodina macgregori***) is restricted to Motuharakeke Island, Cavalli islands group 6 ha, Mauitaha Island in the Bream Island group 4.5 ha, Sail Rock, Hen & Chickens islands group 2.1 ha and Mana Island near Wellington 217 ha. It's conservation status is IUCN Threatened (VU D2), and Range Restricted (Stable, Human Induced). Re-introduced to Lady Alice and Whatupuke islands. The Pacific gecko (***Hoplodactylus pacificus***) is widespread but uncommon on the North island mainland and islands with predators. Common to abundant on a suite of predator free islands. It's conservation status is IUCN not listed and Gradual Decline (Human Induced). Re-introduced to Lady Alice Island.

Goals

- Goal 1: To achieve the restoration objectives identified in the Action Plan for Taranga Ecological District and the Restoration Plan for the Principal Marotere Islands.
- Goal 2: Increase the number and size of populations of the rare McGregor's skink.
- Goal 3: Increase the number and size of populations of the rare Hen and Chickens Mokohinau skink populations.
- Goal 4: Test the design of gecko release strategies using funds provided by the Green Package.

Mokohinau skink (*Cyclodina townsi*)

Success Indicators

- Indicator 1: Monitor after five

years and provide evidence of survivorship of released lizards.
- Indicator 2: Monitor after 10 years and provide evidence of breeding occurring.
- Indicator 3: Monitor after 15 years and provide evidence of a self-sustaining population by capturing more lizards than were released and a greater proportion of new lizards to released lizards

Pacific gecko (*Hoplodactylus pacificus*)

Project Summary

Feasibility: The habitat on the three islands to receive the lizards had all been modified, firstly by Maori occupation and then by European with mining on Coppermine Island and grazing on Lady Alice Island. Whatupuke Island is considered to be the least modified and Coppermine Island the most modified. All three islands had Pacific rats (***Rattus exulans***) locally known as ***kiore*** present. These were eradicated in 1993 (Whatupuke), 1994 (Lady Alice) and 1997 (Coppermine). The Mokohinau skink survived on three small islands that would have been attached during the last ice age and up to 5,000 years ago. The McGregor's skink survived on Sail Rock, part of the Hen & Chickens group and on Mauitaha Island about 12 km away. Pacific geckos were known from Whatupuke and Coppermine islands in very low numbers but had not been located on Lady Alice Island. The New Zealand Department of Conservation had Translocation Guidelines in place. A proposal was prepared and submitted, and was approved by the Director of Protected Species Policy Division on 31st March 1997.

Implementation: The local Maori tribe (iwi) Ngatiwai were consulted over the restoration of the islands, the eradication of kiore and the re-introductions of species. Initially, Ngatiwai were opposed to the eradication of kiore which they considered to be a taonga (treasure) but agreed for it to occur on the Marotere (Chicken) Islands but not Taranga (Hen) Island providing the department monitor the response of resident species. Studies of plant regeneration, small seabird breeding success, forest bird recovery, lizard and tuatara (***Sphenodon punctatus***) recovery were carried out and still continue. In all studies the response was positive and in some cases dramatic. These results were presented to Ngatiwai in a series of workshops and presentations. Because these islands were all connected in the recent geological past and are situated close to each other, it was considered not necessary to carry out disease/parasite monitoring. The populations of McGregor's skinks on Mauitaha Island and Sail Rock were assessed and Sail Rock was chosen because the numbers captured were much higher. Likewise the Mokohinau skink populations on Muriwhenua/ Wareware islands and Middle stack were assessed. All three islands carried substantial populations. Middle stack is eroding badly and will eventually become

View of Pupuha, Muriwhenua and Wareware islands (left to right) from Lady Alice Island

unsuitable for Mokohinau skinks. Skinks were taken from Muriwhenua Island and Middle stack. Eight small rock stacks within the island group were surveyed and assessed for populations of Pacific geckos. Pupuha Island was chosen as the source population.

A minimum of 30 lizards for each translocation was chosen. Because Ngatiwai opposed toe-clipping as the method of marking the lizards, it was decided to use adults or large juveniles making it easy to determine breeding after 10 years when all lizards would be adult. We also experimented with photo-identification and each lizard released was photographed, described, measured, weighed, sexed and checked for natural toe-loss. We endeavored to capture equal numbers of male and female lizards, and our captures were timed to maximize the likelihood of capturing gravid females, thereby potentially increasing the numbers of lizards released. All lizards were transported either in cloth bags or in large plastic expedition boxes with leaf litter included. All were processed on the day of capture and released that day or next morning.

Post-release monitoring: Skinks were monitored by the installation and running of 4 liter baited pitfall traps twice a year. The geckos were provided with various shelters for them to occupy and these were checked twice a year. The first release of Mokohinau skinks and the only release of Pacific geckos were monitored yearly for the first five years. The Whatupuke release of Mokohinau and McGregor's skinks were monitored after two years because of difficulties monitoring the first release of Mokohinau skinks on Lady Alice (see below). The other translocations have been monitored to the regime described in the Translocation Proposal. As the first releases were carried out in 1997, no translocation has reached phase three of the success criteria and monitoring of all releases continues.

Major difficulties faced

- The first release of Mokohinau skinks was made in forest within a valley on Lady Alice Island. Only three were ever recaptured and these died in a pitfall trap in which the lid had sprung between monitoring periods. These three were in a trap diagonally opposite their release site, some 25 m away. Therefore, it is assumed the lizards migrated out of the forested area and up onto a sunny ridge. Subsequent releases were all into beach sites and survivorship appears to be very successful. A second release was made onto a beach on Lady Alice Island.
- Photographic identification was reasonably successful but difficulties

encountered included lack of definition of some photographs and the influx of juveniles which continually grew in size and pattern.

- While success criteria for phase 1 and 2 has largely been achieved for most releases, the numbers caught have been relatively low. Because lizards are much more difficult to monitor than say birds, proving success criteria 3 may be difficult and will probably require a large amount of effort.

Release of Pacific geckos on Lady Alice Island by David Towns & Tanya Monroe, representative of Ngatiwai Iwi tribe

Major lessons learned

- Following a pest eradication program you need to allow sufficient time to elapse and then carry out intensive and extensive surveys for the species. We surveyed Lady Alice and Whatupuke islands after 8 years and after we had commenced releases (2 years after eradication). So, 6 years after we released Pacific geckos, we discovered 2 sites elsewhere on the island where they occurred. These were not released geckos but geckos that had obviously survived in the presence of kiore. Had we waited we would not have needed to transfer any. Had we brought the geckos from elsewhere, we could have potentially mixed the gene pool.
- Because of difficulties in identifying individual animals in this project and others, research is underway to find an easier method.

Success of project

Highly Successful	**Successful**	Partially Successful	Failure
	√		

Reasons for success/failure:

- Apart from the first release of Mokohinau skinks, all the releases have met success criteria 1 & 2.
- All the released lizards recaptured have increased in size, weight and condition thereby showing the habitat is suitable.
- The project has been useful in proving to Ngatiwai that the eradication of kiore and the subsequent re-introductions of lizards is of benefit to them.

Re-introduction of the Virgin Islands boa to the Puerto Rico Bank

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Introduction

The Virgin Islands boa (***Epicrates monensis granti***), is a small ~1.0 m snout-vent length (SVL) snake endemic to the Puerto Rico Bank, where it inhabits a disjunct constellation of islands from Puerto Rico itself eastward into the British Virgin Islands. It is an attractively blotched brown snake, inconspicuous and rarely seen. Because of its nocturnal habits and retiring nature, this little boa is rarely the victim of human persecution. But a series of events, starting with climatic and eustatic changes on the Puerto Rico Bank in the Late Pleistocene and followed by large scale habitat destruction and the introduction of exotic mammalian predators, such as the black rat (***Rattus rattus***), house cat (***Felis catus***), and the mongoose (***Herpestes auropunctatus***), have put this species in extreme peril over most of its range. Consequently, the Virgin Islands boa was listed as Endangered under the U.S. Endangered Species Act.

Goals

- Goal 1: Collection of data on natural history and habitat use.
- Goal 2: Conservation breeding at multiple zoos.
- Goal 3: Black rat eradication at >3 potential release sites.
- Goal 4: Release of boas at >3 suitable sites.

Virgin Islands boa
(*Epicrates monensis granti*)

Success Indicators

- Indicator 1: Completion of Principal Components Analysis of Virgin Islands boa habitat and basic life history study.
- Indicator 2: Multiple conservation breeding events in AZA zoos.
- Indicator 3: Eradication of black

rats at release sites.

- Indicator 4: Completion of health screening and behavioral testing for release suitability.
- Indicator 5: >50 % one year survival of released individuals.
- Indicator 6: Successful reproduction at release site.
- Indicator 7: >10 year persistence of population at release site with suitable population structure.

Boa crew weighing snakes (left to right) J. Ettling, C. Ellsworth & M. A. García

Project Summary

Epicrates monensis granti was first described by Stull from a specimen captured by a native for Major Chapman Grant on the island of Tortola in 1932. Grant gave no detailed habitat information, remarking only that the boa "inhabits rocky cliffs on Tortola and Guana Island". It was subsequently discovered on several islands and cays throughout the Puerto Rico Bank, but the extremely disjunct distribution of this subspecies provides evidence for a long history of extirpation and decline on the Bank since the Pleistocene. Although we acknowledged that re-introduction of the Virgin Islands boa was problematical because of the almost complete lack of natural history information, we perceived it as a reasonable strategy because of the availability of protected, relatively undisturbed cays on the Bank administered by the Departamento de Recursos Naturales y Ambientales de Puerto Rico (DRNA) or the Division of Wildlife, U.S. Virgin Islands (VIFW).

We commenced a natural history study of the boa in 1984 to collect the information necessary to breed and house this species. This nine year study resulted in >650 captures of >300 marked individuals. Boas were most successful in habitat that had few or no exotic predators and was primarily composed of relatively dense vegetation with an interlocking canopy. Further studies revealed the foraging strategies of these snakes. These data were subsequently incorporated in the U.S. Fish and Wildlife Service (USFWS) Recovery Plan. In 1985 The Toledo Zoo commenced a cooperative breeding program with the USFWS, the DRNA, and VIFW that resulted in the first successful captive-breeding of the species in 1986, publication of the AZA-sanctioned Regional Studbook in 1987, and the Species Survival Plan in 1990. While producing snakes for release, we began to investigate Virgin Islands boa habitat using Principal Components Analysis in order to identify potential release sites on the Bank. We examined prey densities and predator threats as well as vegetation attributes. We selected four potential sites and then began efforts to eradicate black rats (***Rattus rattus***), from the sites by placing 8 - 10 blocks of the anticoagulant poison bromadiolone- currently available as Contrac® and Maki® paraffin blocks- at each interstice of a 10 m^2 grid which covered the entire site. Baits were replenished as they were consumed for a period of three days. This

regimen was repeated on two successive visits spaced six months apart. Pre- and post-poisoning activity by rats at the site was monitored by removal trapping along three 100 m transects. The pre-poisoning rat index of 0.160 rats/trap/h at the site, calculated from trapping on 1st - 3rd September 1991, dropped to an activity level of 0 rats/trap/h on the next two visits after poisoning. To detect low levels of rat activity vegetable oil-soaked chew sticks were placed for one week in each habitat type on the island and were checked for rat chew marks. No rats were detected using this method.

By late 1991 we had more than 100 boas in captivity and began the next phase of the project - preparing the animals for release. We originally fed neonate boas with small ***Anolis carolinensis***, later switching their diet to neonate mice, but as ***E. m. granti*** feeds primarily on ***Anolis cristatellus*** in the wild, we tested each sub-adult and adult boa destined for release for willingness to feed on dead ***A. cristatellus,*** and all fed Immediately. We then tested the snakes for their ability to capture living ***A. cristatellus*** in a 2.0 m x 2.0 m x 1.5 m screened enclosure. Only two snakes of the 31 adults tested failed to capture prey during the first attempt. Snakes underwent a 30-day quarantine period prior to release. None presented with any parasites or medical problems. ***Anolis cristatellus*** densities in June 1993 indicated that the sites had adequate food resources for a re-introduction attempt. After transport to the release sites, snakes were implanted with Trovan transponders and released. During 1993, 28 captive born boas from seven different zoos were released; an additional 13 snakes were released through 1995. Three age classes were used for releases: completely naive neonates, sub-adults from 500 - 600 mm SVL, and reproductively mature adults, >700 mm SVL. In 1996 the VIFW began boa translocations from St. Thomas, USVI to a cay previously cleared of rats. Thirty-one snakes were translocated from 1996 - 2002. These were joined by an additional 11 captive-born snakes from the Toledo Zoo in 2002.

We evaluated success of the re-introductions by repeated visits to the research sites. Boas were monitored quarterly the first year and bi-annually for the first five years. A 10 year evaluation at the Puerto Rico site revealed that the population had increased from the original 41 snakes to nearly 500 snakes (Schnable estimate of 482.7) In the U.S. Virgin Islands the population had increased from the original 42 snakes to nearly 170 snakes (Schnable estimate of 168) in 2004.

Subtropical dry forest in the U.S. Virgin Islands - typical inland boa habitat

Major difficulties faced

- Finding a sufficiently numerous population of boas to conduct the

life history study.
- Attaining permits from the Puerto Rico Environmental Quality Board to conduct rat poisoning.
- Finding the snakes in dense vegetation.
- Limiting visitation to the protected sites by campers and fishermen.
- Preventing habitat destruction by campers and fishermen.
- Convincing management authorities of the necessity of the environmental tradeoffs required for the project.

Littoral forest habitat at Punta Puerca, Puerto Rico - typical boa coastal habitat

Major lessons learned

- Allowing sufficient time for project tasks.
- Importance of adequate human resources and funding.
- Boid snakes are excellent candidates for re-introduction.
- Long-term adequate monitoring is necessary for demonstrating success.

Success of project

Highly Successful	Successful	Partially Successful	Failure
√			

Reasons for success/failure:

- High initial survival of released animals.
- Multiple reproductive events the first and subsequent years.
- Importance of pre-evaluation of release site conditions.

Re-introduction and conservation introductions of the western swamp tortoise in south-western Western Australia

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Introduction

The western swamp tortoise (***Pseudemydura umbrina***) meets 'Critically Endangered' (CR) under Criteria A2c; D under IUCN (2001) Red List Categories. It is listed as CR in the ***2007 IUCN Red List of threatened species*** and as 'critically endangered' under the Australian Commonwealth ***Environment Protection and Biodiversity Conservation Act***. It has been declared as fauna 'likely to become extinct or is rare' under the Western Australian ***Wildlife Conservation Act*** and is listed on CITES Appendix I**.** Specimens have been recorded only from scattered localities in a narrow strip of the Swan Coastal Plain with alluvial clay soils. Almost all this land is now cleared and either urbanized, used for intensive agriculture and viticulture, or mined for clay for brick and tile manufacture. From the 1960s until 2000 there were two known and monitored wild populations in Ellen Brook (EBNR) and Twin Swamps (TSNR) Nature Reserves, which were created to protect the tortoise's habitat in 1962. Populations were estimated at 30 (EBNR) and 200 (TSNR) turtles during the mid-1960s, but by the late 1980s the TSNR population had nearly disappeared. Since 1988 successful captive breeding takes place at Perth Zoo and since 1994 captive-bred juveniles are used for re-introduction and conservation introductions.

Released western swamp tortoise with vehicle traffic visible on nearby highway

Goals

"to decrease the chance of extinction of the western swamp tortoise by creating at least three wild populations and increasing the total number of mature individuals to >50". (One wild population persists at EBNR, thus two additional populations have to be created through re-introduction and conservation introduction).

Success Indicators

- Indicator 1: Persistence of a population of more than 40 adult sub-adult and juvenile (>2 years old) tortoises at Twin Swamps Nature Reserve and reproduction (egg laying) of re-introduced tortoises demonstrated by 2007.
- Indicator 2: The creation of a population from captive-bred animals at Mogumber Nature Reserve of more than 35 adult, sub-adult and juvenile (>2 years old) tortoises by 2007.
- Indicator 3: The total number of adult wild western swamp tortoise being >50.
- Indicator 4: The maintenance of a captive population of at least 12 breeding adults producing at least 20 two-year-old animals each year.
- Indicator 5: The selection by the Recovery Team and endorsement by relevant authorities of a third suitable translocation site.

Project Summary

Twin Swamps Nature Reserve (TSNR):

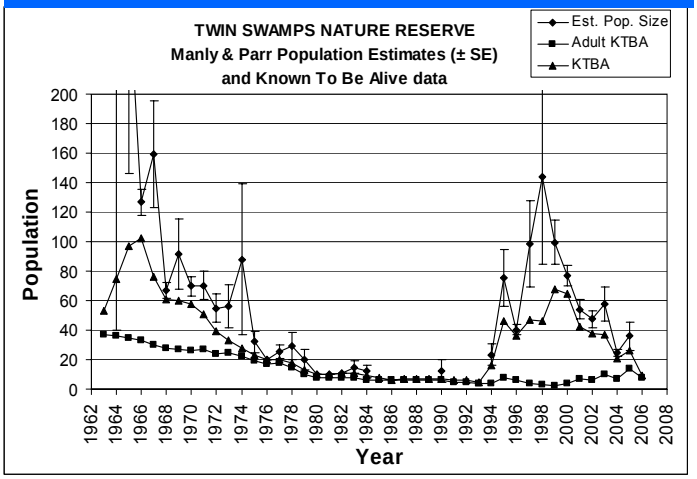
Feasibility: the feasibility of re-introduction of western swamp tortoise to TSNR was based on the following rationale:

- TSNR provided a very good habitat during the mid-1960s. Recruitment was then successful and the population was considered to be expanding.
- The main factors responsible for the decline of the TSNR population during the 1970s and early 1980s were identified as:
    - ⇒ predation by the introduced European red fox;
    - ⇒ a drying climate, leading to a shorter duration of swamp life in the seasonally-wet swamps and
    - ⇒ susceptibility of tortoises aestivating under leaf litter, shrubs or logs to summer wildfire.
    - ⇒ Since 1989 the implementation of a successful captive breeding program at Perth Zoo provided captive-bred juveniles for re-introduction.

Implementation: The main factors responsible for the near-disappearance of the species at TSNR were addressed through:

- The construction of a fox-proof fence around TSNR and fox eradication with 1080 poison baits (continues about twice a year in case of fox intrusions).
- The provision of a groundwater bore and pipelines for water supplementation into two swamps during dry winters and springs.
- Maintaining a system of strategic low fuel internal buffers by winter/spring prescribed burning to ensure the total area burnt in any one wildfire is minimized.
- Since 1994, a total of 162 captive-bred juveniles >95 g have been re-

Figure 1



introduced at TSNR.

Post-release Monitoring:

- All individuals are permanently individually marked by filing notches into marginal scutes.
- Some of the released individuals are radio-tracked to monitor movements and survival.
- Ultrasound scanning demonstrated that several released females produced eggs in every year since 2002.
- Mark-recapture is used to estimate population trends with the following results as shown in figure 1.

TSNR: Known to be alive (KTBA) data, adult KTBA and estimated population size using Manly & Parr (1968) with standard error bars.

Notes: 1) KTBA is significantly lower than actual for at least the most recent five (or so) years because of low sample size. The figures for recent years are not a reliable estimate of actual population size; 2) Animals with carapace length >110 mm are assumed to be adults; 3) Juveniles are one or more years old, but <110 mm carapace length & 4) Manly & Parr estimates are not possible in the first and last year of sampling and in some other years due to small number of animals captured. Accuracy of these estimates depends on the proportion of a population captured each year - the larger the better.

Mogumber Nature Reserve:

Feasibility: the feasibility of conservation introduction of western swamp tortoise to Mogumber was based on the following rational:

- Anecdotal reports in the 1960s suggested that western swamp tortoise once occurred in seasonal swamps near Mogumber.
- 180 ha of privately owned natural bush land which includes three clay swamps with vegetation cover appropriate for western swamp tortoise was acquired for conservation by the Western Australian Government in 2000.
- Since no wild specimens of western swamp tortoise were ever reliably recorded in the area, the translocation was classified as conservation introduction.

Implementation:

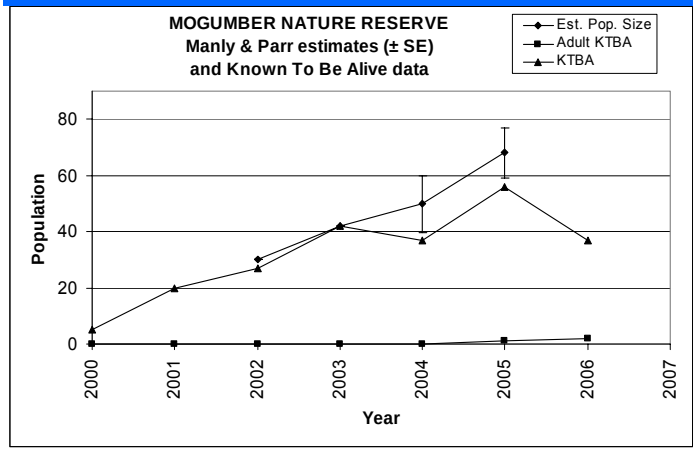
- Since 2000 fox control through monthly 1080 baiting at Mogumber Nature Reserve and some adjacent properties.
- A total of 151 juvenile tortoises have been released at Mogumber Nature

Reserve since 2000.

Post-release Monitoring:

- All individuals are permanently individually marked by filing notches into marginal scutes.
- Some of the released individuals are radio-tracked to monitor movements and survival.
- Mark-recapture is used to estimate population trends with the following results as shown in figure 2.

Figure 2



Notes: Mogumber Nature Reserve: KTBA, adult KTBA and estimated population size using Manly & Parr (1968) with standard error bars. See notes above under 'TSNR'.

Moore River Nature Reserve:

Feasibility:

- A GIS study to identify potential western swamp tortoise habitat in 2002 suggested that the south-eastern part of Moore River Nature Reserve could offer good habitat for the species.
- Investigations in 2004 and 2005 have shown that, while the area is largely suitable, it does not hold water for long enough to support western swamp tortoise. Artificial bunding could deepen some swamps and limited mechanical deepening may also be necessary to make the area suitable.
- A main proportion of suitable habitat is a Threatened Ecological Community and listed as "Vulnerable" in Western Australia. This complicates the approval process for earth work.

Implementation:

- A trial release (conservation introduction) of 10 captive-bred, juvenile, radio-tracked western swamp tortoise started in August 2007.
- Trial bunding of one swamp outside of the Threatened Ecological Community successfully extended the swamp life in this area.
- Approval has been obtained from the WA Conservation Commission for further modification to improve habitat in 2008.

Post-release Monitoring:

- After 10 weeks of monitoring the tortoises showed similar growth rates to those in the other wild populations. The trial was completed and seven of the tortoises were returned to Perth Zoo. The three others had lost their radio-transmitter (because they shed their scutes) and remained at Moore River

"Friends of the Western Swamp Tortoise" group releasing tortoises under supervision of staff

Nature Reserve.

Major difficulties faced

- Following the exclusion of foxes from EBNR and TSNR predation of tortoises by native ravens and introduced black rats.
- Several farm dams adjacent to TSNR attract tortoises to the fence when swamps inside the reserve do not contain much water or are dry. In this way dams adjacent to the fences are potential death traps for western swamp tortoise which are prone to perish at fences through over-heating.
- Due to the drying climate since the mid-1970s the swamp life at TSNR is now too short to allow successful natural recruitment despite the availability of a ground water bore to supplement one of the swamps. Although some of the released, captive-bred females produce eggs since 2002, no juveniles have been recruited into the population.
- A hot summer wildfire at Mogumber Nature Reserve in December 2002 immediately killed half of the radio-tracked tortoises. The survivors were rehabilitated at Perth Zoo. Post-fire mortality of non-radio-tracked tortoises may have been close to 100%, since none of those tortoises has yet been recaptured.
- Due to changes in aestivation management at Perth Zoo (new pens did not provide holes for aestivation, only leaf litter) released tortoises from 2003 - 2005 preferred to aestivate under leaf litter rather than in natural holes or in artificial aestivation tunnels. This makes them much more prone to die in wildfires.

Major lessons learned

- In addition to fox control, raven and black rat control is also necessary in EBNR and TSNR which are surrounded by agricultural developments.
- During early 1997 and since small 'dams' were constructed inside the nature reserve opposite major farm dams with the aim of minimizing undesirable tortoise movements to the fence.
- In 2006, the Department of Environment and Conservation contracted hydrological consultants to investigate the hydrology of TSNR and report on options for improving swamp depth and swamp longevity. An upgrade of the bore and pump system to sustain key swamps if dry climatic conditions continue, will be undertaken in 2008.
- During the wildfire at Mogumber Nature Reserve in 2002 all three radio-tracked tortoises that aestivated in trial artificial aestivation tunnels (then 16 in total) survived the fire. For that reason an additional 160 artificial aestivation

tunnels were since installed at Mogumber Nature Reserve to fire-proof the reserve. About the same number of artificial aestivation tunnels were also installed at TSNR.

- Since late 2003 Perth Zoo changed the aestivation management of juveniles to "train" them again to use holes for aestivation. Since 2007 released juveniles now again preferentially choose holes including artificial aestivation tunnels for aestivation. This increases their chance of survival in a wildfire.

Success of project

Highly Successful	**Successful**	Partially Successful	Failure
	√		

Reasons for success/failure:

- Indicator 1 most probably reached (persistence of a population of more than 40 adult sub-adult and juvenile (>2 years old) tortoises at Twin Swamps Nature Reserve and reproduction (egg laying) of re-introduced tortoises demonstrated by 2007): although KTBA for 2007 is lower than 40, it is likely that a number > 40 will be demonstrated once future recapture data allow a better population estimate. Egg production was recorded by ultrasound scanning in every year since 2002. However, successful recruitment of juveniles into the population still has not been demonstrated.
- Indicator 2 reached and fulfilled (the creation of a population from captive-bred animals at Mogumber Nature Reserve of more than 35 adult, sub-adult and juvenile (>2 years old) tortoises by 2007): The KTBA number at Mogumber in 2007 was 45 individuals including three adults.
- Indicator 3 (the total number of adult wild western swamp tortoise being >50) cannot yet be demonstrated to be fulfilled, but will most likely be reached once future recapture data allow better population estimates.
- Indicator 4 reached and fulfilled (the maintenance of a captive population of at least 12 breeding adults producing at least 20 two-year-old animals each year): in 2007 Perth Zoo held 25 breeding adults and 35 captive-bred juveniles were released.
- Indicator 5 reached and fulfilled (the selection by the Recovery Team and endorsement by relevant authorities of a third suitable translocation site): a trial release at Moore River Nature Reserve has been authorized and was successfully completed in 2007.

Re-introduction of Chinese alligators into the Gaojingmiao forestry farm, Anhui province, China

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Introduction

The Chinese alligator (***Alligator sinensis***) is an endemic species in China and is listed in the first class national protected animals of China. It is classified as a CR species in the IUCN Red List of threatened species and listed in appendix I in CITES. The release site chosen for re-introduction of the Chinese alligator is Gaojingmiao forestry farm (119°12.132`E, 31°00.978`N), which is located in Langxi County, Anhui Province, China. The mean temperature there is 15.9° C and the annual rainfall is 1,294.4 mm. The forestry farm has an area of 10.37 km^2 and consists of forest, grassland, water bodies and marshes. Dominant shrubbery in the area is ***Pteioblastus amarus-Rosa laevigata*** and the vegetation community type there is ***Pinus massoniana-Pteioblastus amarus-Pteridium aquilinum***. Before carrying out the project, some aquatic organism, such as fish and snail, has been put into the ponds for several times in order to establish the food chain for the Chinese alligator.

Goals

- Goal 1: Establish a small stable population which could develop themselves.
- Goal 2: To gain the first-hand information on behavioral ecology, physiology and conservation biology of the released Chinese alligators.
- Goal 3: Develop strategies for the re-introduction project in the future.

Chinese alligator (*Alligator sinensis*)

Success Indicators

- Indicator 1: Survive the winter successfully.
- Indicator 2: Breeding of released individuals.
- Indicator 3: Establishment of a small stable population.

Project Summary

The Chinese alligator is one of the world's most endangered crocodilians. In recent years, because of habitat fragmentation and additionally the effect of increased industrialization, the

Chinese alligator release site

distribution area of the Chinese alligator has decreased rapidly. The population of wild Chinese alligators has already been on the verge of extinction. It is estimated that there is only a population of less than approximately 120 individuals occurring in Anhui Province of China. In contrast to the wild population, the captive population currently exceeds 10,000 individuals in Anhui Research Center for Chinese Alligator Reproduction. It is high time that the captive Chinese alligators be re-introduced into the wild to save this precious species. With the financial support from the State Forestry Administration of Chinese Government, the Project of re-introduction of the Chinese alligator was launched in early 2006. The Gaojingmiao forestry farm is chosen for carrying out the project. The project is also highly supported by the local government.

All of the 25 candidate Chinese alligators to be released were donated by Anhui Research Center for Chinese Alligator Reproduction, which has the largest captive breeding population of the Chinese alligator. Physical examination was carried out before release in order to choose six healthy adult Chinese alligators (2 males and 4 females). All of the 25 Chinese alligators were marked by removing the specific tail scutes in an individual numbering pattern. According to the physical examination results, six healthy adult Chinese alligators were chosen at last. In order to tracking the released alligators efficiently in the field, each of them was attached with a transmitter weighing between 127 g - 129.5 g (HLPM-3140, Frequency 150 MHz, Wildlife Materials Inc.) on the foreside of the coronary tail. All of the transmitters were less than 4% of the released alligators' weight and each transmitter had been set a different frequency beforehand. All of the Chinese alligators were transported to Gaojingmiao forestry farm by vehicle on 28th April 2006. Before release, all of them were secured by binding their snout and put into gunny bags. At the release site, they were unbound and released directly into the pond.

After release, all the six Chinese alligators were monitored daily. Three main methods have been used to monitor their movement pattern and activity area. The preliminary results of each method are showed below:

Radio-telemetry: The results showed that each of the crocodiles gradually lived in a relatively stable region around the release site for about four weeks. All the crocodiles did not have their own territory as their region overlapped. As time went on, all the alligators started to explore the new environment a little further from the release site to broaden their range. In mid June, the individual M906 has

the largest ranging pattern in an area of about 9.9 ha.
Spotlight survey: The results showed that the frequency of crocodiles observed was relatively stable between months. Months of high counts (May to July) have mostly likely been the result of frequent movements in the breeding season.

Direct observation: A female crocodile was found to make a cavity during the month of June but high water in July forced it to abandon the cavity. When the water level fell, the cavity was used by another individual. During the breeding season, courtship display and mating were observed but no reproduction was observed.

Major difficulties faced

- Difficulties in observing the Chinese alligator directly due to the varied topography and dense vegetation.
- Limitation of funding.

Major lessons learned

- Good choice of release site where the original source of decline/extinction has been eliminated or reduced to a manageable level is critically important.
- The Chinese alligator should be exercised before release.
- The Chinese alligator may be released earlier before the breeding season to adjust to the environment for successful reproduction.
- Scientific research should be carried out synchronously to direct the practice of re-introduction.

Success of project

Highly Successful	Successful	**Partially Successful**	Failure
		√	

Reasons for success/failure:

- All individuals survived the winter successfully.
- No individuals died after release.
- Courtship display and mating were observed but no reproduction was found in the first breeding season.

Philippine crocodile hatchling head-start and re-enforcement program in San Mariano, Isabela Province, Luzon, the Philippines

Merlijn van Weerd & Jan van der Ploeg

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Introduction

The endemic freshwater Philippine crocodile (***Crocodylus mindorensis***) is probably the most severely threatened crocodilian in the world with an estimated population of less than 100 mature individuals in the wild. The species is listed as critically endangered by IUCN and is on CITES Appendix I. Nationally, the Philippine crocodile and its habitat are protected by the Philippine Wildlife Act since 2004. A number of earlier laws partially protected crocodiles and wetlands. Following an alarming report about the status of the Philippine crocodile in the 1980's, the Philippine government responded with a captive breeding program, which has been successful in propagating crocodiles. However, no crocodiles have been re-introduced to the wild and the species and its habitat continued to disappear. In 1999, a small Philippine crocodile population was discovered in the municipality of San Mariano in Isabela Province. A conservation project here has been successful in generating local government and community support for crocodile conservation through communication campaigns leading to effective participative conservation of crocodiles and wetlands and a growing population which currently (December 2007) stands at ~23 non-hatchling individuals. To aid the recovery of the population, a participative nest protection, hatchling head-start and re-enforcement program is in place since 2005.

Goals

- Goal 1: Local participation in crocodile population monitoring, protection and crocodile nest identification in San Mariano.
- Goal 2: Effective protection of crocodile nests in San Mariano.
- Goal 3: Establishment of an effective, professional but inexpensive and sustainable crocodile hatchling head-start facility in San Mariano.
- Goal 4: Survival of the majority

Philippine crocodile (*Crocodylus mindorensis*)

of crocodile hatchlings born in the wild in San Mariano, naturally in safe areas and through head-starting in high-risk areas.
- Goal 5: Re-enforcement of the wild Philippine crocodile population with captive reared (head-started) juvenile crocodiles in San Mariano.

Success Indicators

- Indicator 1: Local crocodile monitoring and protection group trained, established and participating in crocodile monitoring surveys, environmental law enforcement and identification of crocodile nests with at least two local protection group members per crocodile locality.
- Indicator 2: 100% of crocodile nests in San Mariano found in an early stage of construction or breeding.
- Indicator 3: 100% of found crocodile nests in San Mariano protected by the local protection group leading to survival of at least 75% of nests and minimized losses of nests and eggs to predators, including people, and to natural disasters such as flooding.
- Indicator 4: Annual successful breeding of Philippine crocodiles in San Mariano with at least one successfully hatching clutch.
- Indicator 5: Local head-start facility established with individual holding pens for at least 20 hatchlings.
- Indicator 6: Head start facility well-equipped with clean water system, electricity, trained/salaried caretaker and reliable and varied crocodile hatchling food supply with establishment costs of less than US$ 10,000 and overhead costs of less than US$ 250/month.
- Indicator 7: Annual (partial) collection of at least 20 hatchlings in San Mariano.
- Indicator 8: Survival of at least 50% of hatchlings in head-start facility to juvenile release age of 18 months.
- Indicator 9: Survival of at least 50% of released juveniles into wild conditions in the 12 months following reinforcement.
- Indicator 10: Annual growth of Philippine crocodile population in San Mariano with a total non-hatchling population in the wild of more than 100 individuals in 2010.

Project Summary

Feasibility: San Mariano has three Philippine crocodile localities with reproducing sub-populations: Dunoy Lake/Catalangan River, Disulap River and Dinang Creek/ Ilaguen River. The three sub-populations are theoretically linked as the rivers confluence near San Mariano town. However, 40,000 people live along these rivers. Radio telemetry studies show that crocodiles use limited largely uninhabited stretches of river of about 6 km during the dry season. During the wet season when river currents are very strong, crocodiles retreat to lakes and creeks. Crocodiles have survived in these remote areas because of the traditional practices and belief systems of indigenous peoples (Agta and Kalinga), who have taboos on killing crocodiles. However, continued immigration of land-seeking farmers into San Mariano threatens crocodiles. Wetlands are converted into rice-fields, watersheds are logged, destructive fishing methods such as dynamite and electricity fishing are used and crocodiles are killed for skins, meat or to eradicate

a perceived dangerous pest. Government has little control in the poor uplands of San Mariano.

Releasing Philippine crocodiles

The Mabuwaya Foundation (***Mabuhay*** = long live, ***Buwaya*** = crocodile) implements a crocodile research and conservation project in San Mariano. A variety of communication and empowerment tools are used to involve communities in crocodile and wetland conservation. This has led to a broad local acceptance of and pride in having the rare Philippine crocodile. A trained protection group of 12 farmers and fishermen is officially deputized and paid by the municipal government to enforce environmental laws. The project works with various levels of local government (village, municipal and provincial councils) to institutionalize crocodile and wetland conservation. The three core localities have been declared crocodile sanctuaries and are protected by the local protection group members who control human activities and participate in crocodile surveys. Breeding occurred in all three localities in 2005 but one nest was accidentally plowed under by a farmer and one nest was raided by army ants killing ten hatchlings. The surviving nine hatchlings were collected. Monitoring of earlier hatchling survival rates showed that these differ greatly between localities. The majority of hatchlings in stagnant Dunoy Lake survive whereas all hatchlings in fast-flowing Disulap River disappear within weeks. These observations, and earlier experiences with successfully raising two crocodiles that were retrieved from fishermen in 2002, led to the design of a nest protection and head-start program.

Implementation: A make-shift head-start facility was set up in 2005 with two large tanks. Due to inter-specific fighting five hatchlings of the nine collected in 2005 were lost. In 2006, two nests (Disulap River and Dinang Creek) were guarded by the local protection group and hatched. One undiscovered nest (Dunoy Lake) hatched as well. This yielded a total of 54 hatchlings of which 35 were collected for head-starting. In 2006, hatchlings were kept in smaller groups in large tanks until inter-specific fighting started after three months as well; four hatchlings were injured but survived. Since then all hatchlings are kept in individual tanks in a new facility. Mabuwaya Foundation staff received training in crocodile husbandry at the government crocodile breeding farm; a daily care taker was trained by Mabuwaya staff. Two earlier raised crocodiles were released in 2006 and 2007 in the Dunoy and Disulap localities and adapted well to the wild without interventions needed. In February 2007, four juveniles (of 2005) were released in a constructed pond next to Disulap River. The pond provides excellent conditions for small crocodiles, with an adequate food supply and the juveniles adapted well to the wild. All 35 hatchlings collected in 2006 survive to date; a

genetic/gender mix of the 31 uninjured crocodiles will be released in February 2008 in three constructed ponds that provide safe habitat and one natural marsh area within the Dunoy and Disulap localities.

Post-release monitoring: The two sub-adult crocodiles released in 2006 and 2007 are monitored using radio telemetry. They survive to date and move short distances within their release site. The four smaller crocodiles released in 2006 have been visually monitored daily for four months from a hide by Philippine and Dutch students. Survival, movements, territoriality, prey choice, hunting behavior and activity budgets were studied. Without any interventions they all survive to date (December 2007) and have moved out of the release pond into a nearby creek. The juveniles to be released in 2008 will be monitored using small radio transmitters, and observation hides.

Major difficulties faced

- Nest protection: 24 hr crocodile nest protection is relatively expensive (~10 US$/day for 65 days = US$ 650/nest) and does not guarantee nests will survive as it is nearly impossible to protect nests from small natural predators such as rats, ants or monitor lizards. Egg collection and incubation is not a viable alternative as electricity supply (incubator) is unreliable in the project region and eggs would need to be transported over dozens of kilometers to a site with electricity over rough trails and roads presenting high risks to egg/ embryo survival.
- Husbandry: Philippine crocodiles are extremely aggressive towards each other; mortalities and injuries do even result from fighting between three month old hatchlings. All crocodiles therefore have to be kept in separate pens or tanks which raises the costs of a head-start facility. It is furthermore unknown what the impact of solitary raising of Philippine crocodiles will be on social behavior after release into the wild.
- Permit: it was difficult to obtain a permit from government for the head-start program, principally because the chief advising scientist long resisted the idea of releasing crocodiles into the wild on the ground that there was not enough information to assess whether captive raised crocodiles would be able to adapt to wild conditions (there is no precedent of Philippine crocodile re-introductions). The permit was eventually granted after several adjustments to the proposal, and a number of support letters from international crocodile specialists.

Major lessons learned

- Captive rearing of crocodiles that are collected as hatchlings from wild nests is relatively easy and cost-effective as opposed to captive breeding of crocodiles for which much larger, more expensive, more sophisticated facilities and more technical knowledge are needed.
- When entering as hatchlings, 18 months seems to be a valid time period to keep Philippine crocodiles in a head start program before releasing them into the wild. Philippine crocodiles grow three times their birth length during this period and this size protects them against most predators that prey on

hatchlings (herons, raptors, monitor lizards, snakes). A 12-month growing period seems too short.

- Releasing captive reared juvenile crocodiles in optimal, if necessary, human-altered habitat with sufficient and varied prey (shrimps, fingerlings and small fish, frogs, snails, dragonflies and other insects) seems to facilitate adaptation and enhance survival. We released juvenile crocodiles in a constructed shallow pond in which we introduced an abundance of prey species. Our released crocodiles adapted very well and all survived the re-introduction without any need for interventions. After six months crocodiles started to explore a wider area around the pond and settled in a nearby natural creek.
- Even (Philippine) crocodiles that have lived in captivity for many years adapt to wild conditions, without interventions, when re-introduced to the wild. We released two sub-adult crocodiles which had been raised in captivity for five years since juvenile stage. Both survived the release and adapted without problems to wild conditions. They did not approach humans, which were present near the release sites, and there have not been any crocodile-human or crocodile-livestock incidents in the 16 and six months respectively following re-introduction.
- The Philippine crocodile head-start program was only started when a successful ***in situ*** conservation program was already running for six years and firmly in place. Head-start reinforcement programs must be seen as an added strategy to attain a recovery of small populations in the wild, and as such could play an important role. They are certainly not the panacea to the conservation challenges species with extremely small populations, such as the Philippine crocodile, are facing; effective conservation of surviving wild individuals of such a species, and protection of remaining habitat, should be the first priority.

Success of project

Highly Successful	Successful	**Partially Successful**	Failure
		√	

Reasons for success/failure:

- The project has successfully trained and established a local crocodile protection group which participates in crocodile surveys and searches and guards crocodile nests. 24 hr nest protection is however not a guarantee for nest survival as a guarded nest was lost in 2007.
- The project has successfully established a low cost Philippine crocodile head–start facility. Initial problems with infighting have caused mortality and injury among crocodile hatchlings; after construction of individual holding tanks survival rates have dramatically increased and are well above the target of 50%.
- The project has successfully released a first batch of four head-started Philippine crocodile juveniles in human-altered optimal habitat and two sub-adult captive-raised Philippine crocodiles in natural habitat.

Conservation Plan and re-introduction program of Orinoco crocodile in Venezuela

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Introduction

The Orinoco crocodile (***Crocodylus intermedius***) is the biggest crocodile in South America and it is present in the Orinoco river basins of Colombia and Venezuela. The area in Venezuela is around 240,000 Km^2. This species is listed by IUCN as "Critically Endangered" (CR – A1c, C2a). In CITES it is listed in App. I and in Venezuela in the Banned List (Ministerial Resolution No 95 dated 28/11/1979) and in the Red Book as endangered. The area where the conservation plan for this species is implemented is in the Venezuela plains (llanos), which is characterized by lots of rivers and lagoons. The vegetation of this region is mainly herbaceous with forests behind the rivers.

Goals

- Goal 1: The recovery of the Orinoco crocodile populations throughout its range.
- Goal 2: The creation of new populations through re-introduction programs.
- Goal 3: The development of captive-breeding and ranching programs. Also the operations of farms is encouraged.
- Goal 4: Involving ranch owners in crocodile conservation programs.
- Goal 5. Increasing the budget allocated by the government for conservation programs.
- Goal 6: Involving more institutions within the recovery program.
- Goal 7: Creating protected areas for the species.

Orinoco crocodile (*Crocodylus intermedius*)
© César Barrio

Success Indicators before implementation of the project

- Indicator 1: Population reduction.
- Indicator 2: Lack of knowledge amongst the local population on species conservation issues.

- Indicator 3: Absence of protected areas for the species.

Two Orinoco crocodiles on a sandbank

Project Summary

The first stage was species status knowledge, information on the habitat and creating a conservation management plan. In the beginning, two institutions began to build the facilities for maintaining crocodiles in captivity and another one to collect hatchlings from the wild with the knowledge of the government. Also at the same surveys of the main populations were conducted and to try and identify possible areas for re-introduction in its historical habitat.

After the first re-introduction, the Ministry of Environment began monitoring the areas where the species was re-introduced and created the Caño Guaritico Wildlife Refuge for this species. After this re-introduction attempt a new breeding population has been established. This program also involves other National Parks into the conservation program, where the species is re-introduced. A monitoring program has been established with some NGO's and universities which monitor these areas and evaluate program success. On farms a complete sanitary program has also been established to ensure proper waste disposal.

Major difficulties faced

- Financial support.
- Studies in wildlife of reproduction success.
- Continued monitoring programs with re-enforced population.
- Number of facilities involved in the program.

Major lessons learned

- It is possible recover the species.
- It is possible involve more institutions.
- The local population understands the project.

Success of project

Highly Successful	**Successful**	Partially Successful	Failure
	√		

Reasons for success/failure:

- The creation a new population in Caño Guaritico Wildlife Refuge in Apure State.

Orinoco crocodile hatchlings
© Rafael Antelo

- Created a functional protocol of breeding program in the farms.
- Increasing the numbers of institutions that are involved with the program.
- Increasing the budget by the government.
- Increasing the number of farms.
- Increasing the biologists that work with this species.
- Creation of the Crocodile Specialist Group of Venezuela.

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Supplementation of Indian Gharial in protected areas of Madhya Pradesh, India

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Introduction

The Ganges river system in North India includes in its fauna two species of crocodiles - the Indian Gharial (***Gavialis gangeticus***) and the marsh crocodile (***Crocodylus palustris***). The Gharial, a fish-eating crocodile with a long snout, is now reported only from India and Nepal. The populations of Gharial in India were driven to very low levels relative to their earlier abundance. The Gharial has been illegally hunted throughout its range for hides, meat and medicine. In addition the loss of habitat from alteration and human settlement, and the use of nylon nets for fishing may have been significant in regulating some local populations. By the end of 1960s the Gharial population was dwindled to less than 150 animals. Efforts to conserve crocodiles in India effectively began in 1972 with the declaration of the Indian Wildlife Protection Act under which all three species of Indian crocodiles were declared totally protected fauna. The Gharial is considered as endangered in IUCN Red Data Book and is listed on Appendix I of CITES. The decline in the population of adult Gharial has raised international alarm. It has prompted the IUCN to classify them as critically endangered on its Red List of species. A Nation -wide crocodile conservation project was initiated in the Country by the Govt. of India during 1975 in technical collaboration with FAO/UNDP. Under the Crocodile Project many crocodile habitats were identified and protected by declaring 13 of them as crocodile sanctuaries. Among them seven (54%) sanctuaries with an area of 2,986 km^2 are specially created for the protection of Gharial including three sanctuaries in Madhya Pradesh named National Chambal Sanctuary on the Chambal River, Ken Gharial Sanctuary on the Ken River and Son Gharial Sanctuary on Son River in Ganges River System in North India.

Goals

- Goal 1: Provide a suitable and protected habitat for the endangered Gharial in its distributional range.
- Goal 2: Supplement the dwindling population with captive raised Gharial under the "***Go and Release Program***".

Gharial (*Gavialis gangeticus*)

Gharial habitat on the Chambal River, India

- Goal 3: Develop a trained human resource for the conservation and management of the Gharial and other aquatic animals.

Success Indicators

- Indicator 1: Increase in the population of Gharial.
- Indicator 2: Survival of the released Gharial.
- Indicator 3: Breeding of the released Gharial in the wild.

Project Summary

Feasibility: The Chambal River is perennial, having its origin in Vindhyan Range near Mhow district of Madhya Pradesh (M.P.). It flows in a North-eastern direction, passing through Rajasthan (RAJ) up to the point where its major tributary, Parbati joins it near Pali. Thereafter, it flows in an eastern direction, forming the boundary of M.P. and Rajasthan and M.P. and Uttar Pradesh. It joins the Yamuna River near Bareeh of Etawah district of U.P. The Yamuna, in turn, flows south-east direction till it meets the Ganges at Allahabad. Kali Sindh, Parbati, Banas and Kuno are the important tributaries of the Chambal River. A series of multipurpose dams at Gandhi Sagar (M.P.), Rana Pratap Sagar (RAJ), Jawahar Sagar (RAJ) and Kota Barrage (RAJ) have been erected in the upper reaches of the Chambal River. The deep and fast flowing Chambal River varies considerably. At places the river is shallow and fast and there are many shallow riffle areas. The substrate ranges from mud and silt to sand and rock. At low water periods (April - June) the river is 150 - 250 m wide and has a maximum depth of 20 m. During the wet season (July - September) the river floods naturally and high extents of erosion and deposition of soil take place. During this period the maximum depth of the river is around 50 m. The Chambal River is a good habitat for large number of aquatic animals including a variety of fishes, crocodiles, turtles, migratory birds, aquatic mammals like dolphin and otter.

The National Chambal Sanctuary is managed by the Forest Departments (Wildlife wing) of Rajasthan, Madhya Pradesh and Uttar Pradesh. The Sanctuary head-quarters of M.P., U.P. and Rajasthan are at Deori, Dist. Morena; Agra and Kota, respectively. Stopping of fishing activity, maintaining full protection from poaching, extending protection to the habitat and rehabilitation of gharial under `grow and release' scheme are the management strategies adopted in the National Chambal Sanctuary. Rehabilitation of gharial has been taken up in the sanctuary from 1978. Gharial eggs are being collected from the Chambal River for artificial hatching at Deori Gharial Rearing Centre (DGRC). Rehabilitation of Gharial has been taken up in the National Chambal Sanctuary from 1978. Around 2,000

captive reared Gharial have been released in the Chambal River by Madhya Pradesh and Uttar Pradesh Forest Departments. To avoid any possible migration of Gharial to outside the Sanctuary area, most of the releases were done in the up-stream of the Chambal River near Pali, Baroli and Rameswar ghat where river Banas joins Chambal River. Captive reared muggers were also released in the Chambal River. In addition to release of crocodiles in the Chambal River captive reared Gharial have also been released in Ken and Son Gharial Sanctuaries of Madhya Pradesh. The conservation and management of Indian Gharial received International recognition. In addition to crocodiles, turtles, dolphins, otters and migratory birds also received protection in the Sanctuary. Although due to financial crisis and ignorance, the re-introduction of gharial was ceased for a period of 10 years from 1993 - 2003, Gharial captive rearing program was again started at the Gharial rearing centre, Morena, Madhya Pradesh from 2003.

Implementation: The State Governments of Madhya Pradesh, Rajasthan and Uttar Pradesh are taking conservation management programs including re-introduction of Gharial in the Chambal Sanctuary. The Forest Departments monitor the populations of endangered species in the Sanctuary regularly. As borders between States are political and not ecological, habitats in the Sanctuary are subject to different, or even conflicting, management and land use practices. Senior forest officers of all three States are in-charge of their respective projects. Range officers, research assistants, field assistants, forest guards and boat-men are looking after the protection in the field. Every year the Forest Department of Madhya Pradesh conducts surveys to monitor the populations of endangered species including migratory birds.

Post-release monitoring: Monitoring of the released Gharial is the responsibility of the concerned Forest Department. However, due to lack of scientific intervention the monitoring is not up to the expectation. Although annual surveys were conducted initially for a period of 10 years, monitoring of post-release of Gharial was not carried out regularly. After cessation of monitoring for many years, recently surveys have been carried out to assess the Gharial population in the Chambal and other rivers. If the specific goals of a conservation-oriented re-introduction and the criteria by which success is evaluated depend both on the species' status in the wild and in captivity and the political and social conditions in the region surrounding the release site, then the Gharial re-introduction in the Chambal region is partially successful.

Villagers crossing the Chambal River

Overview of the Chambal River

Major difficulties faced

- Lack of scientific input for project implementation.
- Lack of coordination by different agencies in implementing the project.
- Lack of facilities for regular monitoring of the project.
- Lack of motivation and awareness for scientific research.

Major lessons learned

- There is a need for scientific monitoring of the project.
- Human activities in the project area should be totally eliminated.
- Care should be taken for socio-economic conditions of the people living in the project area.

Success of project

Highly Successful	Successful	**Partially Successful**	Failure
		√	

Reasons for success/failure:

- Re-introductions were done unscientifically.
- No post-release monitoring.
- Species is still declining in its population.

Conservation status of re-introduced red-necked ostrich in Mahazat as-Sayd, Saudi Arabia

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Introduction

The Arabian ostrich (***Struthio camelus camelus***) has been completely lost from the Arabian avifauna. The ostrich had remained in counterpoint with its human predators for probably thousands of years as it could compete on equal terms against hunters armed only with lances and mounted on horses. The ostrich became extinct in the late 1930s, after only a short period when it's hunters gained advantage through modern firearms and becoming vehicle-mounted (Jennings, 1986). The sad story of the ostrich's fate in Arabia is a sobering pointer to the destructive potential of man, especially when enthused by the chance of reward or the excitement of the chase. The ostrich (***Struthio camelus***), was historically distributed across Africa, Arabia, and parts the Middle East. The form that occurred in Arabia, generally accepted as a distinct subspecies (***S. c. syriacus***) and known as the Arabian ostrich (Jennings, 1986), became extinct in the wild during the mid-20th century, due to over-hunting and commercial exploitation (Jennings, 1986). Arabian ostriches became extinct in captivity at about the same time. Most of these ostrich populations have been listed in Appendix I of CITES and are protected by law throughout their range. Ostriches were often captured whilst young and raised in captivity, there are records of imported captive birds at Taif as early as 1917 and an escaped chick was caught near Jeddah in 1978. Since the 1970s, ostrich farms and private collections containing ostrich of various subspecies have been reported from all corners of Arabia and escapes have occurred, there is even a report of a road kill in Kuwait in 2005. Since 1997 there have been attempts to re-introduce the ostrich, of the nominate subspecies, back into the wild in Arabia. In the Mahazat as Sayd reserve in central Saudi Arabia ostrich have been released into a semi wild environment in a large fenced enclosure.

Arabian ostrich (*Struthio camelus camelus*) in Saudi Arabia © O. Couppey

Restoration of the ostrich is one of the aims of the Kingdom of Saudi Arabia's (KSA) National Commission for Wildlife Conservation and Development (NCWCD), which has initiated a conservation program to captive breed and re-introduce ostriches into Mahazat as-Sayd Protected Area and proposed to re-introduce in Al-Khunfah Protected Area. The extant ***S. c. camelus***, a red-necked form that occurs in northeastern Africa and is considered the most closely related, and possibly the same subspecies as the extinct Arabian form, has been chosen for the re-introduction, in accordance with existing international guidelines on re-introductions. The re-introduction program was started in 1988 - 1989 by obtaining red-necked ostrich from Sudan from a private collection and in 1990 couple of birds were translocated to Mahazat as-Sayd protected area in 200 ha fenced enclosure, and in 1994, seven ostriches were released into the wild Mahazat as-Sayd protected area. Mahazat as-Sayd protected area in Makkah province of about 2,200 km^2 of area with fairly level, sandy plain. The substrate at Mahazat may be sand, gravel, or alluvial clays, and is usually loose, but not shifting, forming an even surface. Mahazat as-Sayd is one of the world's largest fenced protected areas. The entire 220 km perimeter is fenced with 2 m high chain-link fencing, topped with three strands of barbed wire, with 0.9 m of chicken mesh buried in the ground, and lying behind a large earth embankment. Lying in central Saudi Arabia Mahazat as-Sayd is a vast undulating plain. Protection from livestock grazing has allowed a spectacular recovery of native vegetation - the grasslands of the reserve are a reminder of what much of central Saudi Arabia must have once looked like. The vegetation recovery allowed the re-introduction of Arabian oryx, sand gazelles, houbara bustard and red-necked ostrich. The reserve holds large natural populations of red and Ruppell's fox and significant numbers of sand cat, wild cat and ratel, and the spiny-tailed lizard (***Uromastyx*** spp.) It is a major breeding area for the threatened lappet-faced vulture (***Torgos tracheliotus***) and an important stopover site for migrating birds.

Goals

The objectives of this initial, experimental re-introduction in Mahazat are:

- Goal 1: Restoration of the ostrich in the KSA.
- Goal 2: Captive-breeding of ***S.c. camelus***.
- Goal 3: To determine whether captive-born ostriches can survive and successfully reproduce in the area without supplemental food and water.
- Goal 4: If so, to begin establishing a free-ranging, self-sustaining population.
- Goal 5: Monitoring patterns of daily movement, and home-range of released ostriches.
- Goal 6: Determining when released birds become independent of provisioned food and water.
- Goal 7: Understanding how to handle and release this species into the wild.
- Goal 8: Determine the major components of the diet.

Success Indicators

- Indicator 1: Current population at Mahazat as-Sayd Protected Area - although the current number of ostriches in Mahazat as-Sayd is not known it is estimated to be between 90 and 100 birds. It is essential that some of these

birds are captured and marked, as this will facilitate both the monitoring of the birds and the estimation of the population size.

- Indicator 2: Only protected area in the region where red-necked ostrich has significant population.

Project Summary

The introduction of ostriches into Mahazat as-Sayd Protected Area was started in June 1994, when seven birds were released, four and a half years after having been translocated from the NWRC to the pre-release enclosure in Mahazat as-Sayd. Three of these birds died within one year. Two ostriches translocated to Mahazat as-Sayd in May 1995 were released two months later and died during the following year. Of the four birds translocated in July 1995 and released in December 1996, two died in the summer 1997. Three of the four ostriches which were translocated in June 1996 and released in December 1996 died during the 1997 dry season. Over half (58.8%) of captive bred adults released since 1994 have died after being released, irrespective of the duration of the pre-release period. Between 1997 and 2001 more birds were translocated from NWRC to Mahazat as-Sayd, compensating for deaths related to an outbreak of Newcastle disease in the flock, and bringing the total flock size to 20 (12 males : 8 females) birds. From 1994 to 2001, a total of 96 red-necked ostrich have been release in Mahazat as-Sayd. Because of the inability of ostriches to survive during summer at Mahazat as-Sayd, the release project was stopped until better forage conditions occur. Survivors were re-captured and kept in the pre-release enclosure.

Breeding success: The first eggs hatched in 1997 in Mahazat as-Sayd, and only two of the twelve chicks had died by the end of the summer. The eight surviving chicks joined the other four and their parents, forming a single group soon after hatching. Two more chicks hatched, but they died soon after hatching. Seven eggs were fertile and one was infertile (Haque, 1997). The hatching of wild chicks in Mahazat as-Sayd is an undeniable success. The survival of most of the chicks (only two of the 12 chicks died), compared with that of adults, appears to support the hypothesis that wild-hatched chicks are better adapted to natural conditions than captive bred adults, especially concerning their foraging ability. In 2001, five nests within the 25 ha pre-release enclosure. Between November 2000 and February 2001 progress of the incubation and hatching events were recorded. From first nest 10 eggs incubated with 40% of crude hatchability and 25% survival rate at one month old, from second nest 12 eggs incubated with 75% crude hatchability with 0% survival rate, third nest had 15 eggs with 100% hatchability and 100% survival rate, fourth nest had 17 eggs with 59% hatchability and 89% survival rate and fifth nest had 19 eggs with 68% hatchability and 92% survival rate. In 2002, seven nests were recorded with 6, 13, 14, 15, 8, 10 and 11 eggs with crude hatchability ranged between 61.5% and 84.6% and 92% on average survival rate. In 2003, a total of 47 chicks were produced out of four nests. Although the absolute ostrich productivity was lower than in 2002 (i.e. 62 chicks) the average productivity per nest was higher in 2003; 11.7 chicks/nest vs. 8.8 chicks/nest in 2002.

Between November 2004 and December 20005, seven ostrich nests were recorded in Mahazat as-Sayd Protected Area. Subsequently all the nests were periodically visited to record the progress of the incubation and hatching events. A total of 197 eggs hatched out of seven nests and 93 chicks were hatched with more than 60% survival rate. In January 2006, nine nests were recorded in Mahazat as-Sayd. Two nests failed to hatch and been abundant by the parents and the remaining eggs were removed and sent to the NWRC to determine whether they were fertilized.

Mortalities: Until 2001, introductions were carried out to determine whether ostriches could survive in the reserve without supplementary food and water. Results indicate that captive bred adult ostriches have difficulty surviving during the summer, even with food provided, because of the absence of the water (six of the 13 adults died in 1997). In 2005 more than 50 individuals were died during drought period and also in 2006, most of the ostrich flocks with chicks gathered in the vicinity of the Mammal Camp from 29th June water was provided till 15th July, around 25 ostriches managed to drink and others did not drink especially chicks as they were afraid from researchers presence and the presence of oryx that comes to drink from ostrich's water container. Mahazat as-Sayd is fenced, which prevents the migration of ostriches to more favorable sites. Some release methods therefore need to be changed to reduce this high adult mortality.

Management: The main question that should be addressed is: "***should introduced ostriches be provided with food and water, and if so, what should the provisioning strategy be?***" Released ostriches should be supported during the dry season because of the limitations on their movements imposed by the fence, and also because there are too few red-necked ostriches available for introduction to permit large losses of these birds. In July 2005 and 2006 water was provided to the ostriches at the pre-release enclosures in the Mahazat as-Sayd Protected Area. Despite this management regime 53 ostrich carcasses were recorded during the year, with 96% of the dead birds being chicks that hatched at the beginning of the year. The 51 dead chicks represent 55% of all the chicks that were found at the time of hatching. However, it is believed that a significantly higher proportion of the chicks might have died during the reporting period. It is essential that an attempt is made to effectively monitor the ostrich population in the Mahazat As-Sayd Protected Area. This could best be done by fitting radio-transmitters to 15 - 20 birds and marking additional 10 - 20 birds with numbered leg rings.

Some of the key questions to be answered include:

- What proportion of females breed, and what is the hatching success?
- What are the seasonal range sizes used by the ostriches and which habitats are seasonally important to the birds?
- What proportion of birds makes use of the supplementary food and water provisions, and what happens to those birds that do not use it?

Answering these questions would help elucidate whether it is hatching success and/or chick survival or adult survival that is limiting the ostrich population in the

Mahazat As-Sayd Protected Area. Furthermore it would help to put an efficient management regime for ostriches into place.

Major difficulties faced

- High mortality rate of adult as well as young birds during summer is a serious issue to be taken and evidence that wild hatched ostriches are also in poor condition during drought period.
- Ecology and biology of ostriches are not properly studied.
- No researcher appointed for this project.
- No species management prepared.

Major lessons learned

- The period of stay at the pre-release enclosure should be extended to at least a 10 - 12 month period so that birds can adapt to local environmental conditions.
- The time of the release should be at the onset of the winter, which should be a time of least environmental stress for the birds.
- Handling of the birds should be done as little as possible to avoid accumulating stresses.
- One or two birds should not be released, as ostriches are very social birds and learn a lot by mimicking and stimulating each other. Thus during the initial stage of re-introduction a large group of birds should be released. It is likely that large groups will demonstrate more adaptive initiatives than small ones.

Success of project

Highly Successful	**Successful**	**Partially Successful**	Failure
	√		

Reasons for success/failure:

- There were no ostriches in the wild and now at least a significant population found in Saudi Arabia.

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Re-introduction of the nēnē, a remote island goose, Hawai`i, USA

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Introduction

The nēne or Hawaiian goose (***Branta sandvicensis***) is endemic to Hawai`i and listed as endangered by the Federal government and the State of Hawai`i. It is classified vulnerable on the IUCN Red List 2002 and listed in Appendix I of CITES (UNEP-WCMC database 2002). Nēnē are the sole surviving species of a diverse assemblage of mostly flightless geese that evolved from a single resident population of Canada geese (Banko ***et al***.,1999 & Paxinos ***et al***., 2002). Subfossil remains of nēnē have been found on most of the main Hawaiian islands, although historically, nēnē were documented only on Hawai`i Island (Olson and James, 1991 & USFWS, 2004). Nēnē were reduced to a single known wild population of some 30 individuals by 1995. To date, nēnē re-introductions have occurred on Hawai`i (1960 to present), Maui (1962 to present), Kaua`i (1985 and 1991 - 2000), and Moloka`i (2001 - 2004). The first re-introductions of nēnē in Hawai`i were the result of breeding efforts of Sir Peter Scott at the Severn Wildlife Trust, Slimbridge, England (now the Wildfowl and Wetlands Trust), the Territory of Hawai`i, and Mr. Herbert C. Shipman, Kea`au, Hawai`i (Banko ***et al.,*** 1999). Smaller scale captive -breeding efforts are currently maintained by the Zoological Society of San Diego.

Nēnē or Hawai`ian goose (*Branta sandvicensis*) © National Park Service

Goals

- Goal 1: Re-establish and manage a meta-population consisting of island and district populations.
- Goal 2: Promote natural movements to connect populations.
- Goal 3: Re-introduce nēnē to

lowland breeding habitat.

Success Indicators

- Indicator 1: Stable or increasing populations on more than one island.
- Indicator 2: Seasonal movement and natural genetic exchange between at least some populations.
- Indicator 3: Breeding in lowland habitats.

Project Summary

Feasibility: Nēnē inhabit wetlands and coastal areas but they are the most terrestrial of geese and are strongly associated with open-country shrub-lands and grasslands and sparsely-vegetated lava fields. There is little information on habitat conditions before human contact (1,000 years ago), although lowland areas were quickly transformed by humans and introduced rats, whereas sub-alpine and alpine areas were least affected. Pollen analyses indicate the loss of many native shrubs and trees from lowland areas. Historically (since 1778), introduced ungulates altered habitats to varying degrees on all islands, and lowland habitats were heavily invaded by alien plants. Early naturalists noted that nēnē nested mainly in remote lowland areas during fall and winter then moved to upland shrub-grasslands with fledglings. Nēnē are generalists in feeding habits and habitat use; thus, they are attracted to highly modified habitats, such as golf courses, pastures, and roadsides. Grasses, fruits, and other plant foods comprise the diets of goslings and adults. The reproductive strategy of the nēnē is typical of arctic-nesting geese, but nēnē nest mainly in fall and winter when day lengths are short. Females fatten significantly before laying and fast during incubation, although they feed more often than other species and lose less weight. Nevertheless, access to lush grass and other vegetation critically affects nesting success. Eggs are relatively large, clutches are smaller than congeners, and incubation is long (30 days). Goslings develop slowly, and nēnē are most vulnerable to mongooses and other introduced predators during the nesting season. Although parents defend against predators, females often nap during incubation, increasing their vulnerability to surprise attack.

Once hunted, nēnē now are fully protected under the ESA and state laws. As the Hawai`i State Bird, nēnē are widely appreciated by the public, although some poaching occurs. On Kaua`i, although it is not a major problem at this point, some farmers do consider them a pest as they eat their corn and sometimes their lettuce plants. Despite sometimes raiding gardens, nēnē are not considered agricultural pests on Hawai`i or Maui Islands. They do, however, present strike hazards near

Fitting a leg band © National Park Service

airports. Private landowners sometimes agree to Safe Harbor agreements with state and federal authorities that allow certain levels of take in exchange for rights to pursue economically value land use practices that will also show a net benefit to nēnē.

Implementation: Nēnē are relatively docile and easy to transport and maintain in captivity. Survival of captive-reared and released individuals is influenced by climatic conditions (particularly in drought years), age at release, and method of release. To date, releases of captive-bred birds have not lead to a self-sustaining wild population (Black ***et al.,*** 1997). Prolonged droughts cause nēnē to disperse widely in search of food and appears to lead to an increase in adult mortality. A small scale translocation project was recently initiated on Hawai`i Island to encourage strategic movements away from drought-affected areas to wetter or specially managed areas. Preliminary results suggest that birds can be moved to new locations in order to establish new movement patterns. Inter-island translocations are problematic because nēnē may carry different strains of malarial parasites (***Plasmodium relictum***) from one island to another. Risks of transporting diseases can be minimized by monitoring blood parasites during a short quarantine period.

Post-Release Monitoring: Monitoring remote or scattered populations is difficult, but the social nature of nēnē generally makes it possible to count birds in accessible flocking areas. Finding people who can regularly survey populations is a serious challenge to monitoring programs. A statewide network of volunteers has not been established for this purpose; however, some agencies routinely monitor numbers and reproductive activity. Annual summaries of nēnē surveys have been informally undertaken by the Nēnē Action Working Group, which is planning to regularly publish results. Banding has been a priority in some areas to aid in annual surveys, and there are plans to increase banding efforts in all areas. In addition, the Nēnē Action Working Group hopes to increase consistency in monitoring between islands. A new study will investigate movement patterns and habitat use of nēnē on Hawai`i Island using satellite radio telemetry, which will improve survey protocols.

Major difficulties faced

- Losses of eggs, goslings, and adults to introduced predators.
- Human-caused losses of birds such as traffic collisions, wind towers, and golf balls.
- Attraction of birds to grassy areas near airports, roadsides, and other areas of high human activity.
- Loss of birds due to deterioration of habitat and climactic extremes, such as drought and excessive rain.
- Complacency in managing habitat, controlling predators, and monitoring populations due to the expediency of releasing supplemental birds through captive propagation.
- Lack of a genetic management strategy for re-introduction and translocation and possible effects of inbreeding depression.

- Inconsistent monitoring efforts and data collection methods makes the compilation and interpretation of information from different sources difficult.

Major lessons learned

- Reducing losses to predators is expensive but critical; preventing mongoose establishment on Kaua`i is extremely important.
- Nēnē are difficult to exclude from hazardous areas (e.g., roadsides) and not always easy to attract to managed areas.
- A variety of areas must be available for populations to use, and birds must become acquainted with alternative sites when conditions in their primary range deteriorate.
- Alternative strategies (e.g., irrigation, supplemental feed, stringent predator control) are necessary in some areas to minimize egg loss and gosling mortality during the breeding period and adult mortality during droughts.

Success of project

Highly Successful	**Successful**	Partially Successful	Failure
	√		

Reasons for success/failure:

- Nēnē have expanded their range and are found on islands where they were rare or absent historically; however, they are absent from or not nesting in many lowland areas where they were once found.
- Some populations are increasing even without stringent predator control; however, most populations would decline without occasional releases of birds.
- Sufficient information about nēnē ecology is known to recover the species; however, nēnē management is given low priority due to competition with many other compelling conservation problems in Hawai`i .

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Wild-to-wild transfer of great spotted kiwi to the Rotoiti Nature Recovery Project, Nelson Lakes National Park, New Zealand

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Introduction

The great spotted kiwi (***Apteryx haastii***) is one of six species of flightless ratite in the New Zealand family Apterygidae. Young kiwi weighing <1 kg are extremely vulnerable to predation by introduced carnivores, particularly stoats (***Mustela erminna***). Kiwi of all sizes are susceptible to predation by dogs. Great spotted kiwi persist in three populations in the South Island, and collectively number about 17,000. Monogamous pairs breed annually and lay one large egg which is incubated for 75 - 80 days. The Department of Conservation (DOC) threat category assigned to this species is "5, gradual decline". The IUCN ranking is 'vulnerable' (A2be + 3be). Nine adult great spotted kiwi were transferred to a 5,000 hectare site within the Rotoiti Nature Recovery Project (RNRP) during May 2004, and seven birds were transferred during May 2006. The RNRP is a DOC "mainland island": a site-based natural heritage management project with a primary focus on learning how to carry out ecological restoration. Pest control is a key activity. The release site consists of montane southern beech (***Nothofagus***) forests, alpine scrub, rock and tussock lands. It is unfenced, and is contiguous with thousands of hectares of similar habitat in Nelson Lakes National Park and beyond. All of the transferred kiwi were sourced from the wild in Kahurangi National Park (northwest South Island).

Kiwi captured at Corkscrew Creek

Goals

- Goal 1: To learn whether a wild-to-wild transfer of adult great spotted kiwi can be used to establish a new population.
- Goal 2: An objective of the Rotoiti Nature Recovery Project is to re-introduce recently depleted species, including kiwi.

Success Indicators

- Indicator 1: All of the critical performance standards (management and monitoring actions specified in the

translocation operational plan) were met.

- Indicator 2: Also 50% or more of the male kiwi and 50% or more of the female kiwi have settled into defined territories within the RNRP recovery area 10 months after their release.
- Indicator 3: No goals relating to breeding, recruitment or long-term persistence of the population were identified, because the wild-to-wild transfer method had not been adequately trialed or monitored before, and it was not possible to identify suitable goals beyond the initial phase of establishing the founder population.

1 week old hatchling from the Rotoiti Nature Recovery Project - January 2007

Project Summary

Feasibility: The feasibility of the transfer was assessed in terms of the Department of Conservation's Standard Operating Procedure for the Translocation of New Zealand's Indigenous Terrestrial Flora and Fauna. The southern beech forest and alpine habitat in the Rotoiti Nature Recovery Project area is further inland, cooler and drier than the majority of the habitat within the current range of great spotted kiwi; however it is broadly similar to habitat in the south-east of great spotted kiwi's current range, the eastern flanks of the Southern Alps in Canterbury. Experience with transferring other species of kiwi (e.g. Okarito Brown Kiwi/Rowi from central Westland to Motuara Island in the Marlborough Sounds) has shown that kiwi can adapt to different climates, geologies and vegetation types. The first transfer in 2004 was preceded by two years of planning and consultation. Amongst some stakeholders there was a perception that the proposal was high risk: wild-to-wild kiwi transfers had not been adequately tested and monitored, and great spotted kiwi was the least well studied of kiwi species. It was considered possible that the adult kiwi could disperse from the release area. During the planning phase a contingency plan was made to monitor and manage kiwi dispersal from the RNRP mainland island.

Implementation: The transfers involved the collection of adult kiwi over approximately a week in winter 2004 and a week in winter 2006. There was a preference for collecting established pairs. Kiwi were captured at night using a variety of methods including (most successfully) a trained and certified kiwi catching dog. Kiwi were held in plywood crates until being transferred by helicopter to the release area, usually on the day after capture. Quarantining was not undertaken because there were no suitable quarantine facilities available for holding wild great spotted kiwi. Pre-transfer disease screening was considered impractical because - due to their flightiness - great spotted kiwi were expected to be difficult to capture a second time (for transfer) after having been caught for

Kiwi capture site, Corkscrew Creek, Kahurangin National Park

disease screening. Great spotted kiwi in the source population were surveyed for several common avian diseases at a study site 6 km from the source area two months prior to the transfer, with no positive results obtained. The transferred kiwi were sampled for diseases at the time of transfer, but disease status was not known at the time of release. In 2004 one kiwi's bill was injured by the lid of a transfer crate, and the kiwi was not able to be released. The transfer crates were modified to prevent the same problem from recurring in 2006. All other kiwi were transferred and released within 48 hours of being collected, often sooner. Five males and four females were released in 2004; and three males and four females were released in 2006. Maori representing the donor and receiving ***rohe*** (traditional tribal areas) celebrated the 2004 and 2006 transfers with ***powhiri*** (welcoming ceremonies) at the public entrance to the release area. With one exception kiwi were placed into specially prepared pre-release burrows (in 2006 a single female was released directly into the territory of a single male). Members of established pairs were placed in adjacent burrows, and attempts were made to artificially pair some individuals in this manner. Different pairs were spaced 600 - 800 m apart within the release area. The spacing was considered to be approximately similar to territorial spacing in the source area. Burrow entrances were blocked to contain kiwi during the remainder of the day on which they were transferred, and were unblocked at sunset allowing the kiwi to emerge at will.

Post-release monitoring: The dispersal and survival of each of the transferred kiwi was monitored by radio telemetry. The transmitters were programmed to detect and report mortality. Monitoring frequency was initially daily, but was later reduced to weekly when it was determined that dispersal was low. Each adult kiwi has been recaptured yearly in order to replace its transmitter and monitor its physical condition. None of the 16 released adult kiwi are known to have dispersed from the 5,000 hectare release area, although one adult kiwi is unaccounted for. Within the release area kiwi use forest at all altitudes, and in 2007 a chick hatched successfully at the tree line, 1,440 m above sea level. One of the transferred kiwi died 21 months after release as a result of misadventure (drowning during a flood event). Previously paired kiwi stayed together following the 2004 transfer, and these pairs dispersed shorter distances than artificially paired birds. Artificially paired birds did not form lasting pair bonds. The average weight of females introduced in 2004 declined by 3% in the first year after transfer, but the average weight of males increased by 8%. The average weight of females introduced in 2006 declined by 8% in the first year, but the average weight of males introduced in 2006 stayed the same. Breeding and incubation

activity was inferred from continuous series of observations of kiwi using a single daytime shelter. Five breeding attempts were detected in the first three years of monitoring, and three juvenile kiwi were found and radio-tagged. Stoat trapping in the RNRP Mainland Island is succeeding in protecting kiwi chicks from predation: all of the three juveniles have lived to exceed 1 kg. Kiwi exceeding this weight are unlikely to fall prey to stoats.

Major difficulties faced

- Pre-transfer disease screening and quarantining was considered too difficult to undertake, as great spotted kiwi were known to be difficult to recapture soon after an initial capture, and quarantine facilities suitable for holding wild great spotted kiwi were unavailable.
- Damage was sustained to one kiwi bill inside a transfer box (2004 transfer).
- Failure to meet collection target (2006 transfer): the project was aiming for 10 kiwi to be collected from Kahurangi National Park during a collecting trip in 2006, but only seven were caught. This reflects the difficulties of catching wild great spotted kiwi, rather than the population status in Kahurangi National Park.

Major lessons learned

- Groups of 7 - 9 adult great spotted kiwi can be successfully transferred from the wild into large unfenced areas of similar habitat, and there is a low risk of dispersal. Established pairs are likely to remain intact. Selecting established pairs may reduce the level of dispersal.
- Methods for transporting kiwi need to take particular care of the long bill. Elevated creatinine kinase (CK) levels may result from restraining legs during handling and transport in the field.
- Great spotted kiwi chicks can reach the “safe weight” threshold of 1 kg under a predator control regime that controls stoats to below 5% tracking tunnel monitoring. Great spotted kiwi chicks may live with their parents for a year or more, and parents may not attempt to nest during this time.

Success of project

Highly Successful	Successful	**Partially Successful**	Failure
		√	

Reasons for success/failure:

- None of the released kiwi are known to have dispersed from the release site.
- Survival and health of transferred kiwi has been good: there has been only one known death, attributable to misadventure rather than poor health or predation.
- Transferred kiwi bred successfully in the release area, and all known chicks have survived the stage of vulnerability to predation by stoats.
- The injury of one kiwi during the first transfer prevented the translocation from being “highly successful”.

Ten years on: a re-introduction of southern ground hornbill on Mabula Private Game Reserve in the Limpopo Province of South Africa

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Introduction

The southern ground hornbill (***Bucorvus leadbeateri***) is the largest co-operatively breeding species in the world and is currently listed as vulnerable in the Eskom Red Data book of South Africa. The species has disappeared from much of its former range (up to 50%) with an associated population decline of at least 10% recorded in South Africa, which is mostly due to burgeoning human populations and associated habitat destruction (Kemp, 2000). A re-introduction project was initiated on Mabula Private Game Reserve (MPGR) in the Limpopo Province of South Africa, within the species historical range in 1999, with three birds hand-reared at Pretoria Zoo. This release set in motion the development of a conservation project and an experiment in re-introduction with ground hornbills in various parts of South Africa, with MPGR the centre of the release effort.

Goals

- Goal 1: The establishment of a group on MPGR that is self sustaining and ultimately breeding.
- Goal 2: The utilization of the Mabula group as a means to prepare hand-reared juveniles for future release efforts primarily into suitable habitat outside of the protected areas, and eventually other parts of South Africa.

Ground hornbill with puff-adder snake
© Nicholas Theron - Ground Hornbill Project

Success Indicators

- Indicator 1: The establishment of a territory and a nesting site.
- Indicator 2: Ability of individuals in the group to maintain their own energy requirements, and integrate into the social structure of the group.
- Indicator 3: Breeding of alpha pair.

Project Summary

Southern ground hornbills are long

lived, occur at low densities and have a slow reproductive rate (Kemp, 2000). Juveniles are also dependent on adults for at least a year and may be fed by adults when at least two years old (Kemp, 1995). These traits render the species vulnerable to threats as well as having implications for any release effort. The mabula group can be seen as a free roaming and independent release but the group, more specifically the alpha male, provides an opportunity to play a second important role in a greater release effort. It was learnt with the release of the rehabilitated alpha male that he would adopt, teach and protect unrelated juveniles released into the group. This level of acceptance does vary and juvenile females do not integrate into the group as easily as juvenile males, although they are usually tolerated for at least a year. This apparently unselfish behavior was again observed when a second wild, rehabilitated male was donated to the project. This male was originally ousted and established a territory on a reserve adjoining MPGR, but returned when the original male was not on the property, taking over the leadership of the group. The original male subsequently returned and ousted the second male. During this time there was no adult female and the competition seemed to be for the group and not a female or prime territory. Juveniles that are hand-reared by the project can therefore be introduced into the mabula group, ultimately preparing them for future release efforts.

Feasibility: The species inhabits a broad range of grassland, woodland and savanna habitat (Kemp, 2005). MPGR occurs in an area of bushveld, which is a savannah habitat unique to South Africa. There are also historical records of groups from the surrounding areas of Nylsvlei and Northam (Kemp, 2000). An evaluation of the habitat on MPGR by Dr. A. Kemp deemed it suitable for a re-introduction attempt. Due to a lack of large trees with cavities for nesting an artificial nest log was provided. MPGR is approximately 10,000ha in extent and is a reserve whose primary focus is eco-tourism. Initially MPGR was the only reserve in the area where a re-introduction was feasible but this has changed and allowed the re-introduction project to focus on the surrounding areas as well. The surrounding reserves up until approximately five years ago were mainly cattle farms. Due to changes in the environment the area is now largely unsuitable for cattle farming, this in conjunction with escalations in the land price, has meant many cattle farmers have either sold or converted to game ranching. With the result that eco-tourism and hunting ranches are prevalent in the area. These reserves are more receptive to re-introduction initiatives with ground hornbills interestingly being a sought after species because they are a large, charismatic bird of high eco-tourism value.

Implementation: Initially a human shepherd was employed to be with the birds almost 24 hours a day until the rehabilitated wild male was donated to the project. This bird transformed the release and took over the role of leading the group, negating the need for human contact after fledging. Core members of the group are a wild, rehabilitated alpha male; a seven year old, hand reared alpha female and a two year old hand reared male. Other juveniles are hand reared and re-introduced into the group to learn important foraging skills, predator avoidance and the intricate social structure before being considered for further release efforts in South Africa. Due to the fact that more than one juvenile is introduced

Artificial nest at release site
© Dee de Waal - Ground Hornbill Project

into the group and up to three juveniles can be present in a group at a time the group is supplementary fed. The adults in the group are unable or unwilling to maintain more than one juvenile and the alpha male will focus on feeding one individual although he does expend energy searching for, calling and keeping together all members of the group. Supplementary feeding is undertaken during times when prey is scarce and juveniles are unable to meet their own energy requirements.

Post-release monitoring: All the birds released on MPGR are fitted with backpack transmitters (Holohil and Sirtrack) and are monitored on a daily basis. A program has also been put in place where the foraging behavior of members of the group is carefully observed and recorded. In this way foraging behavior and the acquirement of foraging skills can be measured as a means to interpret interactions within the group and the group's environment, which will help to make decisions with regards to the supplementary feeding regime as well as future release efforts.

Major Difficulties Faced

- The low reproductive rate of the species. The average age of breeding for females and males is estimated at 11 and 13 years, while the age at first breeding is estimated at six and eight years respectively (Morrison ***et al.***, 2005). All these factors have implications for the release effort with regards to funding, time and infrastructure.
- Lack of suitable habitat and large territory sizes of groups. Suitable habitat refers to areas that are large enough to support SGH, have large trees for roosting and nesting (artificial nests can be provided) and a low human density. The species has a territory of approximately 100 km² (Kemp, 1980).
- Hand-reared birds are easily habituated. On a reserve such as MPGR where there are many guests on a daily basis the birds do come into contact with humans and this can create problems.

Major lessons learned

- An alpha or adult wild bird will adopt, teach, protect and lead juveniles in a group. This may be an essential component to making any release work especially because released stock mostly consists of hand-reared juveniles.
- Release sites should ideally have a very low density of humans and large natural areas are needed.
- Chicks for hand-rearing are wild second hatched chicks, that always die in the

nest of dehydration, or from the captive breeding program initiated in 2003.

Success of Project:

Highly Successful	Successful	**Partially Successful**	Failure
		√	

Reasons for success/failure:

- Breeding has not taken place. The alpha male and female have been observed copulating and during the breeding season the female sits in the nest while the male delivers nesting material and food. Interestingly though the female will sometimes leave the territory after the first rains and has moved up to 40 km from MPGR.
- The success of the release is difficult to gauge due to the slow production rate of the species and the time taken for birds to reach adulthood and sexual maturity.
- In addition to re-introduction the Mabula Project has initiated a Population count to prove the decline in South Africa and thus a possible change of Red Data status, which is available on our GIS Map as a link into our website (***www.mabulagroundhornbillconservationproject.org.za***).
- A captive breeding program has been set up and the first chicks hatched in 2003.
- A program of collection of genetic samples is in progress world wide for micro-satellite testing to discover if there is a sub-species within the nine African countries where southern ground hornbill reside.
- A Global Single Species Studbook has been set up with CIRCC to encompass captive birds worldwide and those released back into the wild.

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The re-introduction of the red-billed curassow at Reserva Ecológica de Guapiaçu, Rio de Janeiro state, Brazil

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Introduction

The red-billed curassow (***Crax blumenbachii***) is a Cracidae endemic to the Brazilian Atlantic Rain Forest. It is considered to be globally endangered by IUCN and BirdLife International (2008). It is estimated that none of its sub-populations number more than 250 adult birds. Originally, this species occurred in a restricted geographical range in eastern Brazil, in lowland areas up to 500 m above sea level. Nowadays it can be found only in four areas in Bahia state and in two areas in Espírito Santo state. Hunting and the dramatic reduction of the Atlantic forest, mainly over the last 100 years, are important factors affecting survival of the red-billed curassows. This bird was extinct in Minas Gerais state in the early 20th century, and successful re-introductions have occurred since 1991 in three areas. In Rio de Janeiro state, the curassows vanished from the forests presumably in the 1960's. In August 2006 the re-introduction program of this species started in the Atlantic forest of a property located in one of the largest remnants in the state of Rio de Janeiro (Reserva Ecológica de Guapiaçu). All the re-introduced individuals are monitored post-release, with a backpack transmitter with a life span of 2.5 years.

Red-billed curassow (*Crax blumenbachii*)
© Edson Valgas Paiva

Goals

- Goal 1: The re-establishment of a viable population of a Cracidae species, which is considered globally endangered, in an area where it previously occurred.
- Goal 2: The return of a potential seed-eater and seed disperser, as well as an important prey for medium/ large carnivores of the Atlantic Rain Forest.
- Goal 3: To accumulate basic biological information about the species with relevance to future re-introductions (patterns of

movement, home range size, association of the birds, survival rates, commencement of breeding etc).

Success Indicators

- Indicator 1: The birth of second generation chicks in the re-introduction area.
- Indicator 2: A viable population of red-billed curassows.
- Indicator 3: Good local awareness about the red-billed curassow re-introduction program.

Project Summary

Feasibility: Need for species conservation actions - the red-billed curassow is an endemic and an endangered species of a very restricted part of the Atlantic Rain Forest, which is one of the most threatened ecosystems in the world. Habitat loss and hunting removed this species from its distributional range, mainly during the 20th century. On 27th May 2003, the species was officially considered threatened by extinction in Brazil. In 2004, the Action Plan for the red-billed curassow listed the most important actions to recover the species from its endangered conservation status, including re-introduction programs and long-term monitoring of the released birds. During the 1990's, three re-introduction programs occurred in Minas Gerais state, Brasil, but post-release monitoring was done only by eventual direct observations of the released individuals. Large number of birds available for re-introduction purposes:- the techniques for captive-breeding have dominated the work of the Crax Brasil breeding center, and a large number of birds have been bred since the 1980's.

Availability of potential sites for re-introduction: the Reserva Ecológica de Guapiaçu (REGUA) was suggested in the Action Plan as a potential site for re-introduction in Rio de Janeiro state as the forest is protected and hunting no longer occurs. There are eight park rangers patrolling REGUA; in addition, the environmental education programs, developed since 2000, make local children and teenagers aware of the consequences of hunting in the fauna and flora of their region. REGUA has roughly 5,500 ha of Atlantic Rain Forest, located within the Três Picos State Park (46,000 ha). Rivers are abundant in the region, which is another important factor in the re-introduction of a Cracidae which requires water resources. Financial support for the re-introduction program at REGUA, including the post-release monitoring of individuals through telemetry techniques, was provided by the Brazilian Atlantic Rain Forest Trust (UK). Country official authorization- the national environmental agency (IBAMA), as well as the state environmental agency (Instituto Estadual de Florestas - IEF) licensed the re-introduction program at REGUA.

Implementation: Infra-structure/ facility-building- the selected site for re-introduction must have easy access such as a trail system in the area to facilitate the research after the dispersal of the released birds. A release pen must be constructed in the forest, near water bodies and fruiting trees (where the birds are enclosed for roughly 40 days to acclimatize), but with vehicular access to facilitate the transportation of the birds to the release pen. Park rangers are required to accompany the researchers and assist in the monitoring etc. Selection,

preparation, transportation and adaptation of the birds - Crax Brasil breeding center has developed a protocol, described in the action Plan of the red-billed curassow. Choose the appropriate radio tag design - before fitting the bird with a radio-transmitter, a trial should be conducted to verify which tag design may be more appropriate for the target species. Communication with local communities and lectures to communities near REGUA are given, aiming not only to inform and increase awareness of local people, but also to help change their environmental attitudes through conservation activities.

Post-release monitoring: All the released birds at REGUA have backpack radio-transmitters, that weigh 46 g and have a life span of 2.5 years. The use of radio telemetry equipment (SIKA model receiver in conjunction with Yagi 3 elements antennae supplied by Biotrack, Dorset, UK) attempts to reveal key missing information about the biology of all the re-introduced red billed curassows at REGUA. This information will assist with the planning of future re-introductions, such as the patterns of movement of the released individuals, the use of home range by males and females (as well as its temporal variation), spatial and temporal patterns of pair bonding, survival rates etc. The triangulation protocol method is used to locate the animals in the region. They are quickly located in a standardized order, starting with a different bird each day. This schedule avoids repeated locations of birds at the same time of day and allows to monitor all the birds that are interacting/ avoiding each other.

Major difficulties faced

- Semi-wild dogs, which belong to inhabitants that live in communities near REGUA, were recorded near the release pen. They were responsible for four curassow's deaths in a period of 17 months.
- It is difficult to obtain licenses from the national/ state environmental agencies to transport live or dead birds.
- Two females became very tame when they reached one of the communities nearby REGUA.

Overview of release site
© Thor Ostbye

Major lessons learned

- Always talk to people who live near the areas where the red-billed curassows are to be released. Showing them the picture of male and female increases the reliability of future records by them.
- Always have back-up telemetry equipment to replace faulty or damaged equipment.
- At Crax Brasil breeding center (May 2006), Brian Creswell (Biotrack®, Dorset, UK) supervised us on testing three different radio-transmitter models in some captive

male red-billed curassows: necklace, tail mount and backpack design. The backpack (46 g or roughly 1% of the curassow body mass) was chosen mainly because it is quickly fixed in the bird, it has long-durability harnesses and it is more difficult to the birds detach it due to its position in relation to their bodies. We also verified that after three months, the harnesses did not hurt the bird or limited their movements to fly and/or roost.

- Two females presented tame behavior when reached one of the communities nearby REGUA.

Success of project

Highly Successful	Successful	Partially Successful	Failure
-	-	-	-

Success not listed - see reason below

Reasons for success/failure:
This project began in August 2006, and all the re-introduced individuals are still young. They will be able to reproduce in the next breeding season (August 2008 - April 2009). Although it is too soon to answer this question, the survival rates of the re-introduced birds show that there is a high chance of success (38 re-introduced birds and 17 alive after 18 months).

Release of captive-reared Hawaii creeper and Hawai`i Akepa into Kipuka 21 on the Big Island of Hawai`i, USA

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Introduction

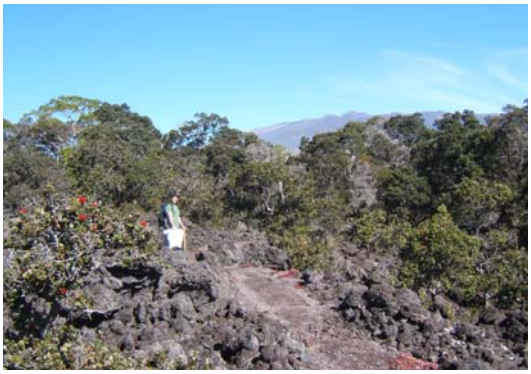
Hawaii Akepa (***Loxops coccineus coccineus***) and Hawai`i creeper (***Oreomystis mana***) are endemic Hawaiian honeycreepers restricted to high elevation Ohia and Koa forests on the island of Hawai`i. Both species are Red Listed by the IUCN and are listed as endangered at the federal and state level. The entire Akepa population was recently estimated at 14,000 individuals and Hawaii creepers between 2,500 and 10,000 individuals. Both species historically occupied wider ranges but habitat destruction and degradation caused by logging and introduced feral ungulates reduced the amount of available suitable habitat. Severe population declines were further attributed to predation from introduced black rats (***Rattus rattus***) and mongoose (***Herpestes auropunctatus***), and the spread of mosquito-borne avian diseases, such as pox and malaria. As a result, bottleneck populations of these birds reside at higher elevations where these diseases have not advanced. Kipuka is the Hawaiian term for an island of mature forest surrounded by younger lava flows resulting in isolation from proximal forest patches. The Kipuka 21 release site is located at mile 21 along Saddle Road between the Mauna Loa and Mauna Kea volcanoes, which rise to 4,267 m on either side. The region is characterized by these scattered kipukas, which have remained relatively isolated since the lava receded and cooled providing vital late successional vegetation for nesting sites.

Hawai`i Creeper (*Oreomystis mana*)

Goals

- Goal 1: Successfully release 12 Hawai`i Akepas and six Hawai`i creepers in habitat protected by fencing to exclude feral ungulates and a grid system of bait boxes to control mammalian predators with the objective of establishing a resident population in an area with high public outreach.
- Goal 2: Successfully monitor the survival of released birds and

provide supplemental food to birds post-release through the 2008 breeding season.
- Goal 3: Reduce time and space allocated to these species at the Keauhou Bird Conservation Center (KBCC) in order to concentrate programmatic resources on higher priority target species.



Kikupa 21 - release site

Success Indicators

- Indicator 1: All birds are successfully transported and released without incident.
- Indicator 2: Birds continue to be re-sighted in the region and are present near the hack tower post-release.
- Indicator 3: Breeding is confirmed by one or both species at the Kipuka 21 site.

Project Summary

Hawai`i Akepa and Hawai`i creeper inhabit wet mesic forest consisting primarily of Ohia and Koa on the island of Hawai`i. Hawai`i Akepas are insectivorous and forage high in the canopy, using their unusual crossbill to pry open leaf and flower buds in search of arthropods. Akepa are obligate cavity-nesters dependent on areas with mature trees to provide adequate nesting cavities. The sexes are dimorphic; males are bright orange-red with black wings and have short, yellow bills and long, notched black tails while females are dull green-yellow with dark wings and tails and a yellow breast band. Fully grown, Akepa weigh only 10 g while newly hatched chicks can weigh <1 g. At the KBCC, Akepa were offered several cavity-nesting constructions in their aviaries including a box nest constructed from wood and large diameter PVC pipe cut to simulate a cavity nest. Ten of these constructed cavities were placed high in the canopy near the release aviary in order to provide the birds nesting options they might recognize.

Hawai`i Creepers are bark-pickers typically seen foraging on thick trunks and branches of trees probing for insects. The sexes are monomorphic with olive-grey upperparts and paler underparts with pale chins and throats, black masks that extend from the base of the bill to behind the eyes, and straight bills. Adults generally weigh 12 - 14 g. Both sexes exhibit territoriality which had to be accommodated by hard releases to reduce the amount of time individuals occupied the aviary together. In September and October of 2007, twelve Hawai`i Akepas and six Hawai`i creepers were released into Kipuka 21 with the objective of establishing resident breeding populations. A release aviary was erected on a raised platform with predator-proof flashing to soften the transition from a captive life. A 150 m x 150 m rat grid with bait boxes containing diaphacinone were placed every 25 m to protect the core habitat. Five release events were staggered over the course of a month. Birds were secured in special carriers and transported from KBCC to the release site in a KBCC vehicle following

Release aviary at Kikupa 21

established protocol. A researcher from KBCC remained in the Kipuka full time to monitor the birds in the aviary and provide food and care until the release. Three “soft release” events were accomplished, in which the birds were allowed to acclimate in the release aviary for 10 days. Two “hard release” events were accomplished, in which birds were provided food in the release aviary and held for an hour to monitor behavior. Post-release, supplemental food was provided outside the aviary to further soften the transition. Supplemental food was offered in several locations on platforms affixed to the outside of the aviary to reduce resource competition among released birds. Monitoring of released birds indicated that birds possessed the skills necessary for survival. Although the birds had been in captivity since hatch, individuals began foraging for insects immediately post-release, successfully finding and consuming invertebrates within minutes of release.

Released birds continue to return to the hack tower for supplemental food. No transmitters were used due to the birds’ small size, but re-sights were effective using binoculars and observing birds as they fed. Additionally, periodic hikes through the 15 acre fenced area confirmed the presence of released birds. The Kipuka 21 will continue to be monitored as supplemental feeding is reduced over time. Not all of the released birds have been seen since the release but many have been documented at the hack tower and on two occasions, release birds were observed outside the boundaries of the Kipuka. Plans for Kipuka 21 include a parking lot, bathrooms, viewing areas, trail access, and interpretive signs. The isolated forested area contains many native birds including: ‘Oma’o, ‘Elepaio, ‘Amakihi, ‘Apapane, and ‘I’iwi. High native species diversity coupled with the natural beauty and ease of access will no doubt draw many visitors. Kipuka 21 will remain a valuable public outreach opportunity as well as good publicity for native Hawaiian species conservation.

Major difficulties faced

- The logistics of packing all supplies down into the area was demanding and the food was perishable and needed to be replaced periodically. Supplies were hiked in and the release tower constructed on site.
- Our staff was relatively small, so staffing on site was minimal.
- No transmitters were used. The birds’ habits of foraging high in the canopy combined with frequent inclement weather made re-sighting difficult.

Major lessons learned

- The key to success was cooperation and close coordination with government agencies.
- It was important to keep a plan that was easily adaptable. As situations arose and certain aspects of the project took more or less time than planned, it was important to adjust to accommodate and take advantage of this time, especially with a limited staff.
- Often, coordination and communication as a staff and with other agencies required the most time, but it remains vital. As an example, through talking with a trail construction coordinator who works in the Kipuka, trail work volunteers have commenced searching for released birds, which will lead to valuable survival data.

Success of project

Highly Successful	Successful	Partially Successful	Failure
√			

Reasons for success/failure:

- All birds were successfully transported to the release site and released from the cage without incident.
- The majority of the released birds returned to the hack tower for supplemental food post-release.
- The release event will remain useful as public outreach for endangered Hawaiian birds, for the Keauhou Bird Conservation Center, and for the eventual opening of Kipuka 21 to the general public.

Using translocation of North Island robins to counter effects of forest fragmentation in the central North Island of New Zealand

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Introduction

The purpose of most translocation projects is to preserve endangered species or restore the ecosystem of an area. In comparison this translocation is being used as a research tool, though it is hoped that the knowledge gained will help future conservation efforts. It is part of a wider set of research projects being undertaken by staff and post-graduate students at Massey University. The main pre-requisite for re-introduction is usually to reverse the habitat factors causing the initial loss of the species. However, in fragmented habitats, it is possible that species' distribution may be reduced by failure to re-colonize following chance extinctions, i.e., due to meta-population dynamics. In such cases, it may be possible to increase the distribution of the species through translocation alone. The main purpose of the translocations described in this case study was to develop methods for assessing whether translocation can be used to counter the effect of fragmentation. North Island (***Petroica longipes***) robins were used to trial this idea because; they are relatively easy to monitor and handle, they are found in a suitable study area (fragmented forest habitat in the central North Island of New Zealand), they are not currently considered to be endangered (although they have disappeared from most of their original range), and source robins for translocation were available in nearby commercial pine plantations which were due to be felled. The North Island robin is a small (26 - 32 g) forest dwelling, insectivorous bird. They are strongly territorial and sedentary, rarely leaving the territory once it is established, and form monogamous pairs that often last for life. The study area consists of native forest fragments (4 - 50 ha) on rolling hill country pasture near the township of Benneydale. The fragments have varying degrees of isolation from each other and with

North Island robin (*Petroica longipes*)

respect to a large conservation area and pine plantation to the east of the study area, and about 40% of fragments in the area contained robins at the start of the study. There are exotic predators present in the study area, mainly ship rats and stoats, which have reduced survival rates of robins to levels where their persistence is marginal.

Goals

- Overall Goal: To use re-introductions of North Island robins to assess whether translocation can be used to counter the effects of fragmentation.
- 2005 Objectives: Translocate robins to six unoccupied fragments, and obtain dispersal data for re-introduced birds.
- 2005 - 2006 Season Objectives: Obtain first year of reproduction data for fragments monitored (eight previously-occupied fragments, plus the six previously-unoccupied fragments that now have robins). Translocate robins to an additional six unoccupied fragments, and obtain dispersal data for second set of re-introduced birds.
- 2006 - 2007 Season Objectives: Obtain second year of reproduction data for all fragments (total of nine naturally occupied fragments, plus all 12 previously unoccupied fragments with robins from either set of re-introductions). Modeling of results being done by Yvan Richard as part of his postdoctoral fellowship.

Success Indicators

- Indicator 1: Survival and reproductive rates of re-introduced populations should be similar to those in previously occupied patches (accounting for density dependence), meaning absences were due to chance extinction and isolation rather than inferior habitat quality.
- Indicator 2: Immigration and emigration rates for animals re-introduced to isolated patches should be lower than those for less isolated patches.
- Indicator 3: Model based on the data collected should show that an increase in connectivity would increase the proportion of populations occupied in the long term.

Release site of North Island robins showing fragmented forest patches

Project Summary

Feasibility: North Island robins were selected as a suitable species for the study as they are easy to monitor and handle and they are not currently an endangered species. They have also been translocated several times in the past with very few problems. The area around Benneydale was selected as a suitable study area as it had a good sample of forest fragments, some of which already had robin populations and some which were unoccupied. There had been three years of previous research on robins in occupied fragments in the system by PhD students Yvan Richard and Rebecca Boulton. Their work provided good base data and comparative breeding data, and results showed that it was feasible that the distribution of robins was limited by isolation among forest fragments. Robins were available for translocation from the nearby pine plantation that was due to be felled within two years, meaning there would be no conservation "cost" even if the forest fragments they were translocated to turned out to be completely unsuitable. The study area was on private property, which was owned and managed by a local Maori trust. The trust has a strong interest in biodiversity conservation on their land, and was therefore supportive of the project, allowing easy access to the study area. Permission was necessary from the Department of Conservation, which administers the Wildlife Act, to carry out research, capture, handle and translocate an absolutely protected species. Because the translocations were over short distances (within 20 km), with natural movement of species between them, there were no issues to consider with respect to genetic provenance or inadvertent introduction of parasites or pathogens to new areas. Previous blood and fecal tests showed very low levels of disease.

Implementation: Robins were translocated over a three month period after the breeding season in both 2005 and 2006, with some additional birds translocated in 2007 to increase numbers in some patches. We initially searched the source areas to find robins, and then trained them to take meal worms. We later caught the birds by using meal worms to lure them individually under spring-loaded clap traps (a net springs from a vertical position to flat on the group when triggered). The time to capture an individual bird varied from about half an hour to several hours. On capture, birds were colour banded and fitted with Holohil BD-2 transmitters attached with an elastic Rappole harness around the pelvis (these transmitters have a battery life of about six weeks). Birds were then held in individual cardboard cat-carrying boxes (modified by fitting a perch and increasing ventilation) for a few hours or overnight, with mealworms and water provided in the boxes. Birds were translocated to release sites by 4WD vehicle, and always released early enough that they had a few hours to find food and a suitable roost before it got dark. Up to five pairs were translocated into each patch. We could determine sexes of some birds at the time of capture (e.g. because males >1 year old are darker than females or young males), and otherwise made a preliminary assessment based on measurements and found the true sex later using DNA from feather samples. We used this information to attempt to balance the sex ratio at each release site. This is one of the reasons that translocations were done in small numbers over a period of time, rather than a few mass translocations (as is more usual). Also we were learning as we went, locating and training birds, and the strategy spread the telemetry monitoring load.

Post-release monitoring: We tracked the translocated birds using telemetry until the transmitter batteries failed. Each bird was initially checked the day after release, then subsequently at least once per week (more often if they were dispersing from the release site). The birds were fed with meal worms where possible to re-establish their confidence, making it possible to re-capture them to remove the transmitters and easier to monitor them in the future. There were some difficulties with the radio tracking due to the limited range and strength of the signal, combined with the hilly landscape. If a bird was behind a small hill or in a gully, out of line-of-sight then there was no signal. It was often necessary to try from a number of different sites to locate a bird. This was particularly a problem when individuals left the release area, and several were never relocated. We searched the release sites and surrounding areas at the start of the next breeding season (September) to locate birds that had survived and remained in (or near) the release patches. We monitored all birds throughout the breeding season to obtain data on survival and reproduction (number of young raised to independence per female), and obtained similar data for robins in patches where they occurred naturally.

Summary of results: We translocated a total of 34 robins to six previously-unoccupied forest fragments in 2005, and 72 robins to seven previously-unoccupied forest fragments in 2006. This showed that it was possible to re-establish this species in small (<20 ha) habitat patches through short-distance (<10 km) translocations. The degree of dispersal from patches was highly correlated with patch isolation. The overall proportion of birds remaining in the target patches at the start of the next breeding season was relatively low (29%), but the numbers have been supplemented by natural colonists that appear to have been attracted by the translocated birds. We obtained data from 49 breeding robins in 10 previously unoccupied fragments over the last two years, and obtained similar data for 77 robins in naturally occupied fragments. So far, the previously unoccupied fragments have had a slightly higher reproductive rate than the naturally occupied fragments, but have had a lower adult survival rate and have been estimated to have a slightly lower finite rate of increase. This suggests that differences in habitat quality could have played some role in the distribution of robins among forest fragments in this landscape, but sample sizes are low at this stage and data collection still in progress. Previous analysis by Yvan Richard and Pierre-Yves Regnier has shown that dispersal of both juveniles and translocated birds is strongly correlated with connectivity of the forest fragments, and therefore that the rate at which robins naturally re-colonize fragments is also correlated with connectivity. Yvan Richard has constructed a simulation model for the system, and this model can be used to predict the long-term effects of translocation or landscape modification.

Major difficulties faced

- Although short-distance translocations to forest fragments are convenient in terms of logistics as well as genetic and disease considerations, they are problematic in that birds may easily leave those fragments and even return to their home territories. We therefore needed to translocate a large number of birds in order to establish a small number in the previously-unoccupied

fragments.

Major lessons learned

- Translocation lessons - where short-distance translocations are being carried out a large number need to be moved in order to establish a small population as birds may easily leave those fragments and even return to their home territories.
- Research lessons - analysis still being carried out.

Success of project

Highly Successful	Successful	**Partially Successful**	Failure
		√	

Reasons for success/failure:

- Study is not concluded, though initial results are looking promising.
- Robins have established and successful bred in most of the previously unoccupied fragments.

Conservation introductions of the Seychelles white-eye on predator-free rehabilitated islands of the Seychelles archipelago, Indian Ocean

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Introduction

The Seychelles white-eye (***Zosterops modestus***) is one of the most threatened endemic birds in Seychelles. Originally known only from Mahé, it was classified as Critically Endangered due to its tiny and declining population and range. Intensive surveys and public appeals in 1996 - 1997 lead to the discovery of an unknown healthy population on Conception Island (69 ha). Research on population size, biology and ecology was mainly conducted under Phase 1 of the Seychelles White-eye Recovery Program (SWERP), started by the Seychelles Ministry of Environment in 1998. This elucidated the species' requirements and the main problems responsible for the species decline (mainly nest predation and habitat degradation due to introduced invasive species). A Species Action Plan was adopted and a transferred population established on Frégate Island (221 ha) between 2001 and 2003. The species was consequently downlisted to Endangered in 2005, and in 2007 there were about 400 birds on three different islands (245 on Conception, 60 on Mahé, and 100 on Frégate). The Island Conservation Society, now leading SWERP conservation activities under the FFEM funded project 'Rehabilitation of Island Ecosystems', was responsible for undertaking in July 2007 additional transfers to North Island (201 ha), and to Cousine Island (26 ha) where post-release monitoring results are being analyzed and will be reported after all planned transfers are completed.

Seychelles white-eye (*Zosterops modestus*)
© J. Hendwood / Cousine

Goals

Goal 1: Ensure the survival of the Seychelles white-eye on at least three islands in viable, self-maintaining populations, and bring the species conservation status from Critically endangered to Vulnerable (as a first step to remove this bird from the Globally

Conception Island source site
© M. Meyers / North Island

Threatened Species list). This corresponds to the overall aim of the SWERP, and of the Species Action Plan.
Sub-goal 1: Establish a new viable population on another island in order to ensure the long-term survival of the species.
Sub-goal 2: Establish a second new viable island population of, mixing individuals from both Conception and Mahé origins, to restore the species genetic diversity and ensure the long-term survival of the species.

Success Indicators

- Indicators for sub-goal 1 (Frégate Island introduction):
  - ⇒ 1.1: First breeding attempt of transferred birds by October/November 2001.
  - ⇒ 1.2: First successful nest of transferred birds by November/December 2001.
  - ⇒ 1.3: Number of transferred birds that bred successfully; number of breeding territorial groups formed; number of successful nests, and number of fledglings produced during the first breeding season (April 2002).
  - ⇒ 1.4: Establishment of a breeding population of minimum 100 individuals by 2004.
  - ⇒ 1.5: Presence of a viable/self-sustaining population of minimum 225 birds by 2006.
- Indicators for sub-goal 2 (North Island introduction):
  - ⇒ 2.1: First breeding attempt of transferred birds by September/October 2007.
  - ⇒ 2.2: First successful nest of transferred birds by October/November 2007.
  - ⇒ 2.3: Number of transferred birds that bred successfully; number of breeding territorial groups formed; number of successful nests, and number of fledglings produced during the first breeding season (April 2008).
  - ⇒ 2.4: Presence of a breeding population of more than 60 individuals by 2009.
  - ⇒ 2.5: Presence of a breeding population of more than 100 individuals by 2012.
  - ⇒ 2.6: Presence of a viable/self-sustaining population of minimum 250 birds by 2016.

Project Summary

Feasibility: The conservation introduction proposals to Frégate and North Island strictly followed the IUCN guidelines, providing information on each required section. In both cases, a detailed assessment to ascertain availability and quality of suitable habitat (through measurements of vegetation composition and structure, and abundance of invertebrates and fruits) was produced and included a carrying capacity estimate for each island using a model built with Conception parameters. Basic parasite screening for internal parasites and general body condition was conducted for the source populations (Conception, and later, Mahé) and for other bird species present on destination islands, and existing information, compiled and assessed. The white-eye is a species that inhabits mixed woodland dominated by broad-leaved trees (both introduced and native). On Mahé (and Frégate), it is found in residential areas with orchards and gardens adjacent to mixed forest. The species principally eats insects, but also berries. Flowers and nectar are occasionally taken. Large preys are mainly caterpillars, crickets and grasshoppers, spiders, smaller ones including aphids, mosquitoes, flies, etc. captured from leaves, branches and trunks. Vegetal items for source populations comprise mainly berries from native plants such as 'Bois siro' (***Premna serratifolia***), 'Bois cuillère' (***Tabernaemontana coffeoides***), 'Bois dur' (***Canthium bibracteatum***), and introduced species like Cinnamon (***Cinnamomum verum***) or 'Vieille fille' (***Lantana camara***). Hence, abundance in the above mentioned features was considered as an indicator of habitat suitability. Absence of the introduced ship rat (***Rattus rattus***), a nest-predator identified as the main cause of decline for the species, and feral cat (***Felis catus***) was the first basic requirement. Rats had been eradicated in 2000 on Frégate (under a DTF program run by the Ministry of Environment), and in 2005 on North (under the same FFEM project), whilst Cousine has always been rat free. Candidate islands also needed to have a proven record for the necessary abatement protocols in place to prevent re-infestation (rat fence, rat proof room , bait stations, etc).

Implementation: All transfer protocols (capture, transportation, captivity and release) were first tested on Conception. White-eyes were captured early in the morning by the use of mist-nets and tape-luring. Two birds maximum per territory were selected to maximize genetic diversity, taking into consideration whenever possible sex ratio and age ratio. They were then placed in individual bird bags after all morphological measurements, ringing, blood-sampling for health screening and external parasite checks had been done. During the 2007 transfers, a

'Helibird box' with cooling fans
© M. Meyers / North Island

Translocation team with helicopter
© G. Rocamora / ICS

probably benign blood parasite microfilaria, was found in about 51% of the birds from Conception. A special box, called 'Hélibird box' was designed and built to safely transport the birds by Helicopter. It was equipped with pocket fans to ventilate and keep the birds cool, and 'insonorised' to a noise level of less than 60 decibels. Upon arrival, birds were placed into a release aviary for them to recover, feed and get accustomed to their new environment. The aviary was built at a suitable release site surrounded by vegetation with favorite berries, and filled with foliage and fruit-bearing branches. Plain and sugared water was sprayed onto the foliage, and birds were regularly provided with insects captured with hand vacuum cleaners and stuck to branches with honey. In 2001 transfers, birds were kept for 3 - 4 hours in captivity before being released into the wild but during the 2007 transfers they were most often kept overnight. The 2001 transfer to Frégate Island consisted of six individual transfers of two to seven birds per trip totaling 31 white-eyes. Due to a skewed sex ratio (10 females for 21 males), an additional transfer of six females had to be undertaken in 2003. In July 2007, 25 birds (including nine females) and 20 birds (including nine females) from Conception Island were transferred to North and Cousine respectively, with an additional 3 Mahé birds transferred to Cousine in October 2007.

Post-release monitoring: Based on color-ring individual identification, initial post -release monitoring aimed at detecting all transferred birds and their initial nesting attempts, provide adequate protection to nests whenever required, and ring and blood-sample the young. Initially performed several days every 1 - 2 weeks, this was progressively reduced after six months (visits of 1 - 2 weeks several times per quarter or even per year) to determine population size, number of breeding territories, ecological measurements, plus breeding success and productivity when possible. Immediate post-release mortality was limited to 8.1% (three out of 37) and to 0% for Frégate and North transfers respectively. There were six breeding territories (3.2 birds per territory on average) established on both Frégate and North. The percentage of transferred birds participating to breeding activities on Frégate in 2001 - 2002 was 72% (21 birds including 9 females), and 80% on North in 2007 - 2008 (20 birds including eight females). Despite the limited number of females, first year productivity in fledglings was very high on Frégate and the population size increased by 60%. Similarly, nine to 12 fledglings have already been produced during the first eight months on North, bringing numbers from 25 to 34 - 37 birds. Growth rates decreased on Frégate during following years, and the population reached 70 birds by 2004, ~100 in 2007 and probably ~120 birds in 2008. A Masters study was conducted to investigate

various aspects of the Frégate population (dynamics, biology, ecology and territoriality), followed by a PhD comparing the different islands and integrating colonization patterns and species-habitat interactions. The species shows a great ecological plasticity for both its foraging and nesting habitats on the new islands, frequently using tree species for nesting (e.g. ***Pterocarpus indicus*** on Frégate) or vegetal food items absent (e.g. fruits from ***Phyllantus pervilleanus*** & ***Trema orientalis*** on North) or rare (***Ficus reflexa***) from Conception. Ongoing habitat rehabilitation with native trees producing berries or rich in invertebrates has been conducted by the three private islands.

Major difficulties faced

- Difficulty to capture birds of known sex and (minimal) age for transfers: This applies to birds ringed in previous years expected to be adults with some breeding experience to be transferred. In 2001, only 10 known sexed adults out of 31 (32%) were transferred to Frégate. With 48% of such known sexed adults in the Conception population in 2007, these were 51% of the 45 birds transferred, but only 9 known sexed adults out of 25 (36%) could be sent to North Island (compared to 70 % for Cousine).
- Unbalanced sex ratio of transferred founder populations: This is mainly due to an already skewed sex ratio in the source population (58% of males), aggravated by the regular use of tape-luring during capture.
- Initial founder populations had 68% of males on both Frégate (31 individuals) and North (25 individuals): An additional six females were therefore transferred from Conception to Frégate in August 2003. A balanced sex-ratio was however obtained for the 20 birds that were transferred from Conception to Cousine.
- Health screening for white-eyes transferred to Frégate in 2001 had to be done abroad: Without previous experience of keeping white-eyes in captivity for more than two days, birds had to be released before the results could be obtained.
- Health screening for white-eyes transferred to Frégate in 2001 had to be done abroad: Due to custom problems, samples took three weeks to reach the New Zealand Center for Conservation Medicine (NZCCM) and their quality was affected. Lack of training in preparation of the blood and fecal smears was also a difficulty. A trained veterinarian was present on the source islands during the 2007 transfers.
- Difficulty to re-sight birds during the first few weeks after post-release: On Frégate & North Island, most of the transferred birds appeared to be prospecting the island, high in the canopy, before establishing territories and becoming more vocal. Despite intensive searches including use of tape-luring, very few birds could be spotted on Frégate immediately after the 2001 transfers. A similar pattern was observed, although less pronounced, after the North Island transfers. This was not observed on Cousine, probably due to its much smaller size (26 ha).
- Unexpected early start of the breeding season in 2001: Whereas the start of the breeding season had never been recorded earlier than September, white-eyes had already started singing by mid-August this year. Precautions had to

North island release site
© G. Rocamora / ICS

be taken to ensure that transferred birds were not involved in nesting activities, resulting in considerable extra time and energy spent during the 2001 transfers, and two dependant juveniles (one to two months old) left with only one adult in two territories. Future transfers were then planned earlier (July/ August).

- Logistical limitations in terms of transport and accommodation to the transfer islands to conduct post-release monitoring: This has been a serious limiting factor for several months on North Island during the crucial stage of the establishment of the transferred population, when many nesting attempts could not be monitored and fledglings could not be ringed. Similar problems also occur during certain periods on Frégate. This does not apply to Cousine, which has its own team and could conduct almost daily post-release monitoring. It is important for the islands to have the necessary human and financial resources for post-release monitoring.

Major lessons learned

- Despite the problems encountered, the protocol designed and the equipment used for the first white-eye transfer worked out in general very well. In total, 31 birds were transported successfully from Conception and released in perfect condition on Frégate, making it a very successful transfer operation. Experience gained during this first island introduction was used to improve future island transfers and captive management for the same species, but also for transfer of other related passerines like bridled white-eye (***Zosterops conspicillatus saypani***) from Saipan to Sarigan (Mariana Islands).
- Improvement in captive management techniques: feeding techniques, length of captivity & release cage size. Feeding techniques tested during 2001 & 2003 transfers included water (plain and sugared) sprayed on foliage, honey smeared on sticks and sprinkled with live termites and other insects, termites provided on young coconut leaves, and seed-bearing branches or young trees in fruit placed into the aviary. During the 2007 transfers papayas and other fruits were cut in halves and placed in the aviary to attract invertebrates. On Cousine, termites were also successfully provided in small pots attached to perches; and 'Avesnectar' provided in drip feeders and sprayed onto the vegetation. The release cage was made larger (3 m x 4 m x 2.5 m instead of 2 m x 2 m x 2 m on other islands) to improve the conditions of captivity and to reduce the level of stress. Other improvements included a proper door for keeper access, a better hatch for introducing the birds and a clear plastic sheet rolled over the top to provide shelter during rains. Keeping white-eyes overnight in captivity in 2007 deemed beneficial as it allowed them with more

time to settle in and become familiar with their new environment. On both islands, some birds came back to the release site to roost after they have been released. Proper hides were also built to allow more discreet observation of the birds hence reducing their level of stress.

- In spite of the practical difficulty to conduct transfers after the breeding season had began in 2001, the timing of the transfers (October - November) allowed a successful introduction in 2001 with a quick establishment of several territorial groups, the first successful breeding within two months (December), and a high productivity (14 fledglings) during the first eight months after the release.
- Due to the early start of the breeding season in certain years (late July in 2007) future transfers should be planned early July, as done for the 2007 transfers. By early July, the chicks fledged at the end of the breeding season (late April/early May) are no longer dependant. Compared to Frégate transfers, birds transferred in July 2007 to North Island (and Cousine) had to wait longer for favorable breeding conditions, with first breeding attempts in October and first successful nesting in December, although still within three and six months respectively after the transfers.
- To maximize the number of adult birds (with supposed previous breeding experience) of known sex, it is necessary to capture and ring the largest possible number of birds in the source population one year before the transfer.
- However additional transfers of females may prove necessary to re-equilibrate sex-ratios and maximize the number of breeding groups the following year, as done on Frégate in 2003.
- Health screening needs to be organized locally so that results can be immediately available (within 1 - 2 days) and the birds released afterwards
- ICS Veterinarian was especially sent to New Zealand for training at NZCCM in June 2007, and consequently performed all required analysis in July during the transfers and also trained other participating staff in sample collection and preparation.
- Close monitoring of established territorial groups and nesting attempts allows surveillance and protection measures that can be crucial for an early breeding success. Surveillance and protection against disturbance, predators or adverse weather conditions maximizes chances of success for the very first nests, hence helping the population to kick off rapidly.
- The white-eye is a species with major adaptability and ecological plasticity. Close monitoring of the transferred birds have provided (and are still providing) very valuable and novel information regarding the extreme adaptability of these birds to plants, habitats or conditions that are new to them.
- Post release breeding success and productivity immediately after the transfers were exceptionally high on Frégate, and to a lesser extent on North Island. On Frégate, 66% of breeding attempts were successful with 0.71 fledglings / breeding adult after eight months. A prolonged breeding season was observed on Frégate compared to Conception and Mahé (as it happened on Aride with the transferred Seychelles warbler compared to Cousin). Nesting attempts could not be properly monitored on North, however nest failures appear more frequent than on Frégate and productivity was still high with 0.45 to 0.60 fledglings/ breeding adult after eight months. Initial productivity in fledglings

appears much lower on Cousine and reasons are being currently investigated (e.g. the Seychelles magpie robin has been seen attacking and killing young fledglings which occupy the same territory).

- The dynamic of a transferred population cannot be extrapolated from previous transfers with other species in different islands. The same applies to source populations. Very high population growth did not last for several years with the white-eye introduction on Frégate, contrarily to what had been observed with introduced Seychelles warblers on Aride (1988) or Cousine (1992). Replacement of transferred adults by island-born juveniles appear as a delicate phase, as this coincided with a slight decrease in the Frégate white-eye population in 2005. More Seychelles white-eyes island introductions are required before we can make reasonable predictions based on modeling. Similarly, rapid recovery of the Conception source population after the 2001 transfers could not be established, unlike with the Seychelles Warbler source population on Cousin island.
- The white-eye appears like a powerful propagator for seeds of several native plants and trees. Some trees producing berries preferentially eaten by the species have shown a spectacular spread on Frégate. This was particularly the case for ***Tabernaemontana caffeoides*** (introduced to Frégate during the preparatory stages) or ***Premna serratifolia*** seedlings. Similar observations are now being done on Cousine Island

Success of project

Highly Successful	**Successful**	Partially Successful	Failure
	√		

Reasons for success/failure:

- Our main initial goal to create two new viable populations (in addition to the existing mother population of Conception) has been partially achieved but has not yet been reached.
- Following the establishment of a new breeding population of almost 100 birds on Frégate Island, the species has been downlisted in the IUCN Red Data List from Critically endangered to Endangered.
- This is one step to having the species further downlisted to Vulnerable category, when two of the new populations are considered viable, alike Conception (~250 birds).
- Six years after the first transfers, one new middle size population (>100 birds) has been successfully established on Frégate Island. Indicators 1.1 to 1.4 have been met, although 1.4 was only achieved by 2008.
- Despite absence of introduced predators, and suitable habitat not being a limiting factor, this population has grown slower than originally envisaged. Indicators of population growth were derived from previous transfers of Seychelles warbler, and it now clearly appears that these cannot be transposed to the white-eyes case. Based on the Frégate experience, more realistic indicators were set up for the North Island introduction.

- With regards to the North Island transfers, conducted in 2007, indicators 2.1 to 2.3 have already been met satisfactorily. In addition, successful breeding has also been recorded on Cousine Island.

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Re-introduction and population re-enforcement of Asian houbara bustard in Asia

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Introduction

The National Avian Research Center (NARC) is a department of The Environment Agency - Abu Dhabi (EAD), in the Abu Dhabi Emirate of the United Arab Emirates. The object of its study is the Asian houbara bustard (***Chlamydotis macqueenii***, hereafter houbara) and the reason for its existence is Arabian falconry, for which the houbara is primary quarry species. NARC aims to promote houbara conservation and reconcile the tradition of Arabian falconry with sustainable use of houbara throughout their range, which for the Asian houbara stretches from Yemen to Mongolia. A broad international scope of operations is necessitated by the migratory nature of both the houbara, which are chiefly winter visitors to the Arabian Peninsula breeding in the Central Asian steppes, and the falconers, who travel widely in search of quarry. Since 1979 the houbara has been listed in Appendix I of the CITES convention. In 2004 its IUCN Red List status was elevated from 'Low risk/near threatened' to 'Vulnerable'. NARC studies indicate that houbara numbers are declining and that excessive hunting and poaching is the primary cause. The Asian migratory meta-population is declining at an average of 5 - 8% per year since consistent counting started in 1998. Isolated remnant resident populations in the Arabian Peninsula are so depleted as to be facing extinction.

Release of Houbara by H.E. Mohammed Al Bowardi, Managing Director EAD

Goals

- Goal 1: Help to ensure the cultural preservation of Arabian falconry by contributing to the continued survival of viable wild populations of the houbara.
- Goal 2: Establish a reproducing and self-sustaining wild population of houbara in the Abu Dhabi emirate.
- Goal 3: Re-enforce migrant as well as resident houbara populations throughout their range

in Asia, with special attention to highly endangered populations in the Arabian Peninsula and Pakistan.
- Goal 4: Contribute to the establishment of a sustainable hunting management system for the re-introduced and re-enforced populations.

First successful breeding in the wild recorded in Abu Dhabi - 2007

Success Indicators

- Indicator 1: A captive-breeding production of 2,000 Asian houbara per year at NARC in Abu Dhabi, chiefly of resident bloodlines from the Arabian Peninsula and the south of the houbara distribution range in Asia. For release to the wild according to region of origin.
- Indicator 2: Through collaboration with the Emirates Center for Wildlife Propagation (ECWP) in Morocco, production of 10,000 Asian houbara per year at ECWP, chiefly of migrant bloodlines. For release to the wild according to region of origin.
- Indicator 3: Houbara population trends measured by means of long-term and large-scale surveys in concerned countries.
- Indicator 4: Growth of re-introduced populations of 5% per annum.

Project Summary

Feasibility Stage: The prominent position of falconry hunting in Emirati culture means that the houbara, as quarry, can act as a flagship species to stimulate conservation actions. NARC has proposed the implementation of a series of conservation measures aimed at preserving the integrity of remaining wild houbara populations in their ecological, migratory, physiological, and genetic diversity. The strategy targets a substantial and global reduction in the hunting and poaching pressure on wild birds through management of breeding and hunting grounds, management of the wild houbara populations and production of houbara in captivity for establishment or re-establishment of self-sustained populations, to release birds for hunting, and to provide birds for falcon training purposes. Due to hunting pressure over many decades, the distribution of resident breeding houbara in Arabia had contracted markedly, and the original extent of distribution is not clear. Anecdotal evidence indicates that in the past houbara have bred in Abu Dhabi, although it was probably not a major breeding area. The establishment of a managed (for hunting) houbara population in a falconers' home state may ease hunting pressure on wild houbara elsewhere in the range and facilitate efforts to control or manage that hunting.

Implementation Stage: Fieldwork studies and collection of wild eggs, for establishment of captive-breeding blood lines, have been undertaken through agreements with government agencies of Kazakhstan, Iran and Yemen. These agreements include clauses for the future release of offspring from the collected birds, in the country of origin. Fieldwork studies alone have been undertaken in China, Mongolia and Oman. Projects focusing on release of captive-bred birds have started in Abu Dhabi and, more recently the Baluchistan region of Pakistan. The remnant resident populations of houbara elsewhere in the Arabian Peninsula would provide the most suitable source for a houbara release in Abu Dhabi. However, the low numbers and low density of houbara remaining, together with their geographically and politically challenging locations, means these populations cannot be a practical source of birds. Therefore, the birds used have genetic origin in the resident non-migratory population of Baluchistan, in south-western Pakistan, with founder stock having been collected from there by the National Wildlife Research Centre in Taif, Saudi Arabia, in 1987 - 1988. Since the founder stock was collected from Balochistan the resident population appears to have declined severely, with more recent searches finding very little or no evidence of breeding activity. So, it is also intended to channel some of the captive-breeding production for re-introduction in Baluchistan (see table 1).

Table 1. Production of houbara at NARC is shown in the table below, which includes birds of all genetic origins held in the collection. Birds released in Abu Dhabi and Pakistan are of the Baluchistan bloodline

Year	Chicks hatched in NARC captive breeding	Houbara released in Abu Dhabi (from previous year's chick production)	Houbara released in Balochistan (from previous year's chick production)
2001	22	-	-
2002	49	-	-
2003	121	-	-
2004	223	5	-
2005	463	15	-
2006	642	59	-
2007	805	86	18

Experimentation is ongoing to assess any benefit of "soft release", where the birds are maintained in cages at the release site for some weeks before release to settle them on the area, compared to "hard release" where birds are transported to the release site and set free at once.

Post-release monitoring: To date all birds released have been harnessed with either a satellite transmitter (26 birds) or a radio transmitter (157 birds).

Mortality rate post release as follows (for all releases combined):

To 1 month post release:	***26.8%***
To 3 months post release:	***33.3%***
To 6 months post release:	***38.8%***
To 1 year post release:	***48.1%***

Predation accounts for at least 70% of mortality and 76% of this predation is attributable to red foxes (***Vulpes vulpes***). The mortality rate listed above is for confirmed mortality. In addition to this there is a floating number of "missing" birds, which can include live birds that have moved and not yet been relocated, birds that have died in a place where their transmitter signal has not yet been found, and birds that are alive or dead with a transmitter that is no longer working. At one year post release, missing birds account for 16.3% of the total. The first successful wild breeding occurred in spring 2007, by females released in 2005 (being, at two years of age, the oldest surviving females). Of five potentially breeding females known to be alive from 2005, three produced clutches, all of which were fertile, indicating successful mating. Two clutches hatched in the wild (giving 4 chicks) and one clutch was abandoned but the eggs were retrieved and subsequently hatched in captivity (2 chicks) to be included in the 2008 release.

Major difficulties faced

- Inter-annual variations of environmental conditions make it difficult to analyze and clearly understand the factors affecting post-release survival. Adjustments of release process are more dependent on empiric choices rather than results of scientific experiments.
- It is an on-going process to steer the response to predation pressure on released birds away from a historical, generalized persecution of predators and towards a limited, targeted control taking concern of wider conservation objectives.
- For the future, updated hunting legislation pertinent to handling the existence of large numbers of free-ranging houbara in UAE remains undefined, but should be in process soon.

Major lessons learned

- Post-release survival is increased by releasing houbara when food availability is at its best, soon after rainfall events.
- Post-release survival decreases with age at release: houbara released in their first year have a higher survival rate than older ones.
- Predator control does not seem to be effective on post-release survival to one year. Intuitively there should be some benefit to

Typical houbara bustard habitat in the UAE

controlling predators in the release area; to reduce the targeting of disorientated and naïve newly released birds and discourage individual foxes from specializing in houbara. In practice the main effect seems to just spread predation events over time but without improving the overall long-term survival (i.e. birds live longer, but still get predated in the end). Our predator control strategy needs refinement, and we should think in terms of containing predation within manageable limits, rather than eliminating it.

Success of project

Highly Successful	Successful	**Partially Successful**	Failure
		√	

Reasons for success/failure:

- The project is still in relatively early days and it is not yet clear how successful it will be, or what form such success will take.
- In Abu Dhabi, released birds may demonstrate a preference for semi-natural habitat (e.g. areas enhanced by irrigation) rather than natural habitat, which may increase their survival but could be considered as only partial success in re-introduction terms.

Re-introduction of the white-headed duck to Kiskunság, Hungary

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Introduction

The white-headed duck (***Oxiura leucocephala***) is listed on the IUCN Red List as endangered, and on the Appendix II of CITES. The species became extinct in Hungary in the 1960s and is now listed as strictly protected by the countries legislation. The re-introduction sites of Lake Kondor and Lake Péteri are situated on the Great Hungarian Plain, the region between the rivers Danube and Tisza. They are part of the Kiskunság National Park.

Goals

- Goal 1: To establish a breeding population of the white-headed duck in Hungary

Success Indicators

- Indicator 1: No success indicator was determined before initiation of project.

Project Summary

Feasibility stage: Hungary was on the periphery of the white-headed duck's former breeding range with only a small and fluctuating population, which probably never exceeded 100 birds. The last breeding record was in 1961 at Lake Kondor. The fate of the white-headed duck in Hungary was probably dependent upon the population dynamics of the species in the eastern breeding areas in the (former) USSR. Decline of the eastern population, habitat loss due to climate change and drainage, hunting and egg collection were probably the factors driving the species to local extinction. The white-headed duck breeding and re-introduction program began in 1982, when Hungarian aviculturalists were trained by the Wildfowl and Wetlands Trust at Slimbridge, England. Between 1983 and 1986, a breeding centre was established at Fülöpháza. The site is situated next to Lake Kondor, where the last breeding of the species was

White-headed duck (*Oxiura leucocephala*) - female (left) & male (right)

Pond & wintering house

recorded. No detailed feasibility study was carried out prior to the project. The project was carried out by the Hungarian Ornithological Society, with the support of many volunteers, the Wildfowl & Wetlands Trust, and the companies Taurus and British Airways.

Implementation Stage: Fülöpháza breeding program - the centre consisted of seven ponds with a total surface area of 1,300m^2. The ponds were lined with rubber sheets and covered with netting. Winter facilities were also built with a direct link to the outside ponds. However, the birds did not use the heated buildings, and preferred to stay outside despite the low temperatures, where it was difficult to maintain an ice-free water surface, even when water was constantly circulated. Between 1984 and 1988, 162 eggs were transported from England to Fülöpháza and then artificially incubated. The hatched birds started to breed in 1985 although no eggs hatched in that year. During the first two years, when all the birds were kept together on the same pond, aggression was a significant problem and the hatching success remained low. From 1987, birds were therefore separated into trios of one male and two females for the courtship and nesting seasons. Aggression subsequently decreased and breeding success improved. Hatching success peaked at 52% in 1988, but the 60% hatching success normally recorded at Slimbridge was not reached during the Hungarian program. Hatching success started to decline in 1989, and no eggs were subsequently hatched. No data are available for 1991, because some birds were transferred to Budapest Zoo. In 1992, the remaining birds were transferred to Budapest, representing the end of the Hungarian white-headed duck breeding program. The birds did not breed at Budapest Zoo and none survive today.

The hatching success during the last two years decreased mainly because the proportion of damaged and abandoned eggs increased. This increase had three causes: i) Abnormal behavior: nest-desertion, nest-parasitism and early abandonment of ducklings; ii) Higher aggression, because birds were not segregated for the 1990 breeding season & iii) Egg predation by rats. The proportion of infertile/addled eggs was high throughout the breeding program. Several factors may have caused the behavioral aberrations and the high proportion of infertile eggs such as i) Inadequate food. According to the experience at Slimbridge, the menu at Fülöpháza was diverse enough to avoid this problem; ii) Disease - negative results of several veterinary visits and toxicological analyses suggests disease was not the cause of the low breeding success; iii) Inbreeding depression - the captive white-headed duck populations are descendants of only three founder pairs captured in 1968, so they could be

threatened by inbreeding depression; iv) the birds at Fülöpháza were not marked individually, so it was impossible to apply methods to preserve genetic variability. At Slimbridge, inbreeding depression was not apparent even though the Slimbridge population has the same origin. The reasons for the low breeding success therefore remain unknown.

Re-introduction: A total of 52 birds were released between 1986 and 1988. No information is available on the fourth and last release in 1991. On 7th June 1986 10 (5:5) and 22nd May 1987 13 (7:6) white-headed ducks were released on Lake Péteri, Pálmonostora. On 16th April 1988 29 (17:12) were released on Lake Kondor, Fülöpháza.

Post-release monitoring: The releases were not successful. Seven birds from the third release were recaptured after three months when the lake dried out. Three or four birds dispersed to a neighboring hunting area, from where they disappeared at the beginning of the hunting season. Perhaps they had been shot illegally. Most of the released birds disappeared within a period of two months. No information is available on their subsequent fate.

Major difficulties faced

- Low hatching success during the breeding program, difficulties with supplying birds for re-introduction.
- The Lake Kondor dried out, so the released birds had to be recaptured.

Major lessons learned

- The release sites were not suitable. Lake Péteri was not a past breeding site for white-headed duck and, moreover, it is a fishing area with human disturbance. Lake Kondor had been largely dry for several years before the re-introduction, and there may not have been enough food for a species preferring eutrophic, productive habitats. This highlights the importance of detailed studies on release sites and environmental evaluation before the start of costly re-introduction programs.
- Factors which caused the initial extinction need to be identified and rectified.
- Experience from Mallorca suggests that acclimatization in a fenced area at the release site improves the success of white-headed duck re-introduction. In Hungary, this method was not used due to shortage of funds.
- This was the first project of this kind with this species and no previous experience was available.

Success of project

Highly Successful	Successful	Partially Successful	**Failure**
			√

Reasons for success/failure:

- The project failed to establish a population.

Attempted re-introduction of cheer pheasant to the Margalla Hills National Park, Pakistan

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Introduction

The cheer pheasant (***Catreus wallichi***) was classified as Endangered in the first Red Data Book lists of threatened species, but data collected since combined with development of the IUCN Red List Criteria has resulted in a more robust Vulnerable listing. It is on Appendix I of CITES, and was abundant in captivity in Europe during 1980 - 1995; it is now rare in these collections. This species is native of open grasslands and scrub at 1,000 - 3,000 m along the Himalayan chain from NE Pakistan to the Kali-Gandaki valley in west-central Nepal. The re-introduction project undertaken by the World Pheasant Association (WPA) from 1978 to around 1990 was centered on the Margalla Hills National Park at the extreme NW limit of the native distribution. The last wild cheer pheasants in this area were believed to have been hunted in 1976. For a full review and references, see Garson ***et al.***, 1992. Biological Conservation 59: 25 - 35.

Goals

- Goal 1: The establishment of self-sustaining population of cheer pheasant in the Margalla Hills National Park, Pakistan.
- Goal 2: A capability in the Capital Development Authority of Islamabad to manage this population and its habitat for conservation.

Cheer Pheasant (*Catreus wallichi*) male © Jean Howman

Success Indicators

- Indicator 1: The existence of a wild population of cheer pheasant producing sufficient offspring to survive in the long term in the Margalla Hills National Park, Pakistan.
- Indicator 2: Capacity within the Capital Development Authority of Islamabad to manage this population and its habitat in the Margalla Hills National Park, Pakistan.

Project Summary

Feasibility: The feasibility of this re-introduction project was assessed in 1977 by Sheldon Severinghaus for WPA. An accessible site for a soft-release pen (Dhok Jiwan) was

selected at only 700 m, below the known altitude range for the species, and the site was on the very edge of the geographical range. The habitat (and altitude), given what was then known about the species' biology, seemed suitable: a mix of grass, scrub and scattered tree cover. The Margalla Hills were given greater conservation status in 1978, when the area was upgraded from a Game Sanctuary to a National Park. This resulted in a marked reduction in grass cutting, grazing and browsing by domestic stock, which in the course of time allowed a dense scrub to develop close to the original release pen and more generally. A new release site (Jabri) on the main ridge at >1,000 m was established in 1983, and another (Gagra) at a higher and more remote location was used from 1988.

Typical cheer pheasant habitat

Implementation: This involved the transport of fertile eggs laid by birds in the aviaries of European WPA members to Islamabad, and thence the few kilometers to the incubation facilities and adjacent release pens. In each year some hundreds of eggs were sent to Pakistan, but avicultural problems such as excessive heat, incubator failure and disease outbreaks amongst the confined poults, resulted in few surviving to the point of release. This required the birds to fly out of their single large release pen, although they could return there via 'pop-holes' which only opened inwards in the fence. Evidence of a lack of anti-predator behavior in the released birds led to rearing procedures that minimized human contact and increased parent-rearing, at the expense of incubators and broodies, from 1986 onwards. In 1987, the entire population of several hundred chicks died a few weeks after hatching as a result of bacterial and parasitic infections. An attempt was made to soft release smaller groups of poults, simulating the covey (family group) in nature, from multiple pens at Gagra in 1988 - 1989.

Post-release monitoring: The first serious attempt at post-release monitoring in 1981 involved radiotagging ten poults (all of which were predated by foxes, jackals or civets). In 1984 - 1985 up to six birds survived (from 38) for over six months, with a similar result in 1985. Following the change in rearing conditions in 1986 there was evidence of better survival following release, and birds attempted to breed in both 1987 and 1989. There is no good evidence that any wild-bred chicks survived beyond three months. By this time, in the light of research on wild cheer pheasant in India and successional changes from grassland to dense scrub in the Margalla Hills, the amount of suitable habitat available amounted to no more that three territories at Gagra and none anywhere else in the National Park.

Major difficulties faced

- A lack of knowledge of the natural history of the species when the project was initiated.
- Severe logistic, climatic and veterinary difficulties in the chick rearing phase.
- A lack of equipment and expertise in most years for post-release monitoring.
- A progressive deterioration of the habitat from a managed seral grass and scrub to an impenetrable scrub forest. By the end of the project there was too little suitable habitat left for a re-introduction project to have any prospect of success.

Major lessons learned

- Research your species where it still occurs in the wild if details of its basic natural history are unknown.
- Simulate natural social organization in captive rearing conditions: minimize human contact and maximize the use of real parents to rear chicks in pens in the habitat into which they will be released.
- Provide sufficient training and equipment to allow all aspects of the project, including producing eggs from breeding stock and post-release monitoring, to proceed under local stewardship as soon as possible.
- Be aware of wider conservation and protected area management issues that may affect the viability of the project.

Success of project

Highly Successful	Successful	Partially Successful	**Failure**
			√

Reasons for success/failure/failure:

- Habitat became progressively less suitable to the point at which a successful project was impossible.
- Little evidence of prolonged survival of released birds.
- No reliable evidence of wild-bred chicks surviving to independence.

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Re-introduction of the bearded vulture into the European Alps

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Introduction

The bearded vulture (***Gypaetus barbatus***) - formerly known as Lämmergeier - was distributed throughout mountainous regions of Africa, Southern Europe and Asia originally. According to the IUCN Red List the species is evaluated as Least Concern. The Bearded vulture is listed in CITES (Annex II) and in the European Bird Directive (Annex I). Especially in Europe the species has dramatically declined in numbers. In the Alps human persecution reached its peak in the end of the 19th century and the species vanished in the Alps completely soon after. In south-eastern Europe some pairs remained until the end of the 20th century. Actually, original populations can be found only in the Pyrenees (Spain & France with approx. 135 pairs), 4 - 5 pairs in Crete (Greece) and less than 10 pairs in Corsica (France).

In the Alps the first re-introduction attempts failed in the early 1970s using captured wild birds from Afghanistan. A new re-introduction project based on a captive-breeding stock was started (built up of breeding stock in 1978, which was included to the EEPs in 1985). The first release took place in 1986 in the Hohe Tauern National Park (Austria); other releases followed in the succeeding years in four different release areas covering also France, Italy and Switzerland.

Goals

- Goal 1: Use of captive-breeding and naturally reared (no hand rearing) birds exclusively.
- Goal 2: Re-establishment of a self sustaining population in the Alps.
- Goal 3: Linkages with the neighboring populations to fuse them into a meta-population.

Success Indicators

- Indicator 1: Survival of released birds until they become mature.
- Indicator 2: Reproduction in the

Bearded vulture (*Gypaetus barbatus*)

Bearded vulture habitat in the Alps

wild.

- Indicator 3: Natural reproduction which exceeds average number of released birds.
- Indicator 4: Natural exchange of individuals between the Alps and neighboring populations.

Project Summary

Feasibility: To test whether the Alps meet the habitat criteria for re-introduction first analyses have been done by Schenker 1979. The geomorphology of the Alps was expected to offer huge potential and high quality habitats and the rough landscape was expected to provide enough food based on natural mortality of domestic and wild ungulates. The disturbance rate could be expected to be rather low and this approach was further developed. A detailed analysis about historical breeding sites, the potential basis of food, the acceptance of the species by people, the potential of sufficient breeding sites etc. was provided by Müller & Buchli (1982 & 1989). On that basis four release areas have been finally chosen and to a considerable degree public relations, environmental education and legal aspects had to be communicated.

Implementation: According to the guidelines of the IUCN Re-introduction Specialist Group it was decided to avoid translocation of birds from other sites due to general population decrease. Lots of efforts were focused to establish a breeding network and to improve knowledge about keeping and reproducing the species. An EEP (European Endangered species breeding Program) was found to coordinate as many as 35 different zoos up until now. Special attention was directed to rearing conditions - hand rearing as avoided to produce birds with intact behavior. For the re-introduction a modified hacking-back method was chosen. This method favors natural adaptation in the wild and increases local fixation due to philopatric imprinting. Birds were transferred to well prepared caves (similar to natural breeding sites) and fed without sight or contact of the keepers until fledging. Food was provided in the surroundings until birds did not use it any more (usually six weeks after fledging). Continuous monitoring of behavior was carried out during nestling and fledging phase at the release site.

Post-release monitoring: Until becoming mature bearded vultures explored areas of several ten thousands of square kilometres and even territorial breeding pairs use up to 7,500 km² (Brown, 1983). Monitoring them is only successful at an international level with the following problems in Europe: Harmonization of data is often not possible, different languages hamper communication, monitoring approaches differ between countries and following animals with a huge home range is often extremely difficult. Our aim was to develop a monitoring system based on common data standards avoiding problems caused by different

languages.

Within the framework of the European Bearded Vulture Re-introduction Program (e.g. Frey 1992, Zink 2002 & 2003) we were assigned by the Foundation for the Conservation of the Bearded Vulture (FCBV) to collect and maintain all relevant information and create an online database on a WEB-2 application. The database (a web-application compatible with all common browsers) can only be accessed by authorized users. No user-side installation is required. The program aims at high usability and intuitive handling and supports fast access to complex and large amounts of data by using up to date techniques like AJAX. For data retrieval this application is embedded in a publicly available homepage (see: ***www.gyp-monitoring.com***).

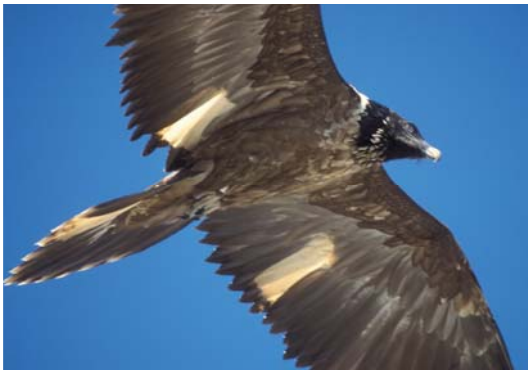
Currently five dialogs (various cross linked tables) for recording observations, individuals, nesting sites, reproduction, and frequency of information are available. For the management of identified individuals 200 fields of input can be used optionally. Up to now the database consists of nearly 40,000 records mostly based on direct observation, telemetry, or genetic analyses and also stud book data. Different services are offered (from read-only to specific download access) depending on user privileges. Besides offering a user friendly interface, visitors are also provided with simple query options and geographical data visualization. The system is multilingual by design and currently available in English, French, German, and Italian. The open architecture of the system allows to extend it to other species as well.

Major difficulties faced

- Enormous mobility of birds circumvents effectiveness of local protection measures.
- Natural return of large predators (especially the wolf) increases illegal use of poison baits.
- Intensive hunting on wild ungulates and the remains after shooting entails considerable risk of lead poisoning.
- Arial cables such as electric lines, ski-lifts, etc. form a certain risk of collision with lethal consequences.

Major lessons learned

- Natural rearing conditions are essential to produce individuals for re-introduction purpose
- A tool for transnational and multilingual communication has proven value to exchange information and to store data in a common pool. This could be



Bearded vulture in flight
© M. Knollseisen

achieved by the implementation of an online application
- (see: ***www.gyp-monitoring.com***).
- Public relation was the best tool for the improvement of species acceptance.
- Huge protected areas without hunting still seem to offer the best breeding opportunities for the species. This is due both to the risk of illegal shooting but probably even more to the fact that the lead remains of hunting in meat caused considerable damage of poisoning.

Success of project

Highly Successful	Successful	Partially Successful	Failure
√			

Reasons for success/failure:
- The species started to reproduce in the wild soon after the first individuals reached maturity. Actually a dozen of pairs breed again in the Alps. Since 1997 a total of 43 chicks fledged successfully. Reproduction in 2nd generation in the wild confirmed.
- The drop out rate of birds remained fairly low
- Meanwhile reproductive population output exceeds the quota of releases and the population increases.

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Re-introduction of the Aplomado falcon into Texas and New Mexico, USA

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Introduction

At the beginning of the 20th century the northern Aplomado falcon (***Falco femoralis septentrionalis***) was a common resident of the grasslands of southwestern North America, but by 1930 the falcon was mostly absent from all areas north of Mexico - causes unknown. Between 1978 and 1988 a total of 25 Aplomado falcons were collected from nests in southern Mexico to establish a captive breeding program. The Aplomado falcon was placed on the United States endangered species list on 27th March 1986. A species restoration pilot project was accomplished between 1985 and 1989 and restoration on a larger scale began in 1993. Hacking procedures developed for Peregrine falcon re-introduction were modified and utilized for the release of Aplomado falcons. Although the captive propagation of this species has been challenging, a total of 1,506 Aplomado falcons have been produced and 1,393 released into South and West Texas and Southern New Mexico by the "hacking method." During the spring of 2006, 45 wild pairs of Aplomado falcons were located in South Texas, 56 young fledged from 33 nests.

Goals

- Goal 1: Re-establish viable wild populations of the northern Aplomado falcon in the southwestern United States and northern Mexico through the release of captive-bred young and to see the species officially de-listed.
- Goal 2: Monitor released falcons, documenting the pairs that result, and their productivity.
- Goal 3: Monitor the levels of environmental contaminants observed in released Aplomado falcons and their progeny.
- Goal 4: As possible gain new information and insight about the species through scientific investigation and publish results.

Northern Aplomado falcon
(*Falco femoralis septentrionalis*)

Success Indicators

- Indicator 1: Captive production of over 50 young Aplomado falcons per year.
- Indicator 2: Develop successful release techniques.
- Indicator 3: Develop monitoring techniques with the use of banding and radio telemetry.

Project Summary

Feasibility: The Peregrine Fund chose South Texas for the focus of its initial re-introduction effort for the Aplomado falcon because: 1) some of the last known United States breeding attempts of the species occurred in this area, 2) the highest known nesting density historically occurred in this area, 3) wild Aplomado falcons were still being seen in and along the South Texas coast, and, especially, 4) there appeared to be extensive suitable but unoccupied habitat for re-establishing a wild population. Habitat along the Gulf Coast was surveyed by light aircraft from Sergeant's Beach, Texas, south to San Fernando in the Mexican state of Tamaulipas. In addition, the Aransas National Wildlife Refuge, Attwater Prairie Chicken Refuge, Laguna Atascosa National Wildlife Refuge, Welder Wildlife Foundation, and three divisions of the King Ranch were visited and their comparative merits for potential release sites analyzed. Primary consideration for release site selection includes habitat structure, prey availability, nesting structures, potential threats from predators, logistics to work the site, and extent and proximity to other suitable habitat

Implementation: The Implementation phase began in 1993 with the first releases at Laguna Atascosa National Wildlife Refuge. Restoration has continued on other refuges and on neighboring, privately owned cattle ranches. Releases have occurred along the Laguna Madre as far north as Matagorda Island and Sea Drift, Texas, and inland as far west as the Welder Wildlife Foundation near Sinton, Texas. We have been able to utilize artificial nest structures, that the falcons quickly adapted to, in areas where natural nest sites were lacking. We now have 54 of these structures are in place in South Texas. Beginning in 2005, we concentrated all of our releases in trans - Pecos region of West Texas as a result of the reproductive success observed in the falcon population now established in South Texas.

***Safe Harbor - A significant component of this re-introduction program was the development of a program under section 10(a)(1)(B) of the Endangered Species Act (Act) that encourages the release of Aplomado falcons on private lands in return for land owner protection-- a "Safe Harbor" - from any additional future liabilities under the Act. The Peregrine Fund is the formal permittee under the requested Section 10(a)(1)(B) permit.**

In 2002, The Peregrine Fund was able to expand its **Safe Harbor*** permit to enable the development of release sites in West Texas. To date over 2,176,367 acres of private land are involved in the Safe Harbor in both South and West Texas.

For a number of years The Peregrine Fund has been working with a variety of private, state, and

Northern Aplomado falcon habitat

federal entities in New Mexico in an effort to utilize the 10(j) rule of the Endangered Species act to begin to establish a “non essential experimental population” of Aplomado falcons in New Mexico. The rule was approved by the USFWS in 2006 and releases have been occurring for the past two seasons. These xeric grasslands, once home to breeding Aplomado falcons, provide extensive habitat for their re-introduction and will make it possible to establish a second, disjunct wild population from South Texas. In summary 1,393 Aplomado falcons have been released. A self sustaining population of approximately 50 pairs has been established in South Texas. Last years survey efforts in West Texas produced a total of six pairs, and an additional pair was found in New Mexico.

The post-release wild population in Texas will continue to be monitored, and additional barred nest structures will be placed in both areas with existing falcons and in areas located between the nesting pairs on Matagorda Island and those to the south around Laguna Atascosa National Wildlife Refuge and Brownsville. During the 2008 field season we will identify, by plane G.I.S. habitat maps, as much suitable habitat in South Texas for an expanded falcon survey outside the current survey area. We will document territory occupancy and productivity from established pairs, band and collect blood and/or feather samples from nestlings in artificial nest structures, collect addled eggs and egg shell fragments for environmental contaminant analysis, collect prey remains, and identify as many individual falcons as needed to determine stability of this population using a refined model. We also will inspect and maintain existing nest structures in South Texas. We are working closely with the USFWS to update current recovery goals.

Major difficulties faced

- Learning how to propagate Aplomado falcons on a large scale.
- Identifying the best habitat for releases to occur where there would be a minimum amount of mortality with the young falcons being released.
- Developing partners who would sign on to the Safe Harbor in Texas.
- Establishing the 10(j) rule of the Endangered Species Act in New Mexico, which would allow for the release of captive produced Aplomado falcons.

Major lessons learned

- We learned how to raise large numbers of falcons in captivity.
- We learned how to safely release Aplomado falcons into their native habitat.

- Incorporated the Safe Harbor and 10(j) rule of the Endangered Species act to allow for the release of falcons on both private and government lands.
- We have successfully worked with both the government and private sector throughout the entire re-introduction effort.
- We designed and implemented the use of artificial nest structures in areas that were lacking in suitable nesting sites.

Success of project

Highly Successful	Successful	Partially Successful	Failure
√			

Reasons for success/failure:

- Produced and released 1,393 Aplomado falcons into their native habitat.
- Established a self sustaining population of approximately 50 breeding pairs of Aplomado falcons in South Texas.
- Successfully used the Safe Harbor and 10(j) rule of the Endangered Species Act to work with both private and government land managers.
- We have provided artificial nest structures in over 50 locations with an 85% occupancy rate.

The re-introduction of the golden eagle to Glenveagh National Park, County Donegal, Republic of Ireland.

Lorcán O Toole

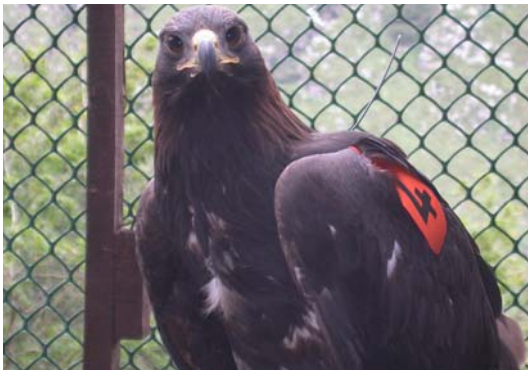
Project Manager, Irish Golden Eagle Re-introduction Project, Golden Eagle Trust Limited, Carrowtrasna, Churchill, Letterkenny, County Donegal, Republic of Ireland (lorcanotoole@goldeneagle.ie)

Introduction

The golden eagle (***Aquila chrysaetos***) is listed as extinct in the Irish Red Data Book 2: Vertebrates and an Annex I species in Europe. Ireland has the lowest range of bird of prey species in the European Union due to the extinction of up to seven species historically- primarily the bigger raptors. Golden eagles were known to have bred in the majority of Ireland's Mountains up to the 19th century. The project was based in Glenveagh National Park, County Donegal - in the extreme North west of Ireland, where the National Parks and Wildlife Service had explored the idea in the early 1990s. The Irish Raptor Study Group and the Curlew Trust Ltd. developed the proposal since 1995 and established a single entity, the Golden Eagle Trust Ltd., in order to implement the project proposals. The Golden Eagle Trust Ltd. staff had experience of re-introductions and golden eagles, gained in Scotland. We also sought outside expert opinion and advice from leading raptor and re-introduction experts; in Scotland, England and Norway. As a newly established charity we were entirely dependent on project funding from the Heritage Council, the National Millennium Committee, the EU LIFE Nature fund and the Department of Environment, Heritage and Local Government.

Goals

Goal 1: Our primary goal was to establish a viable golden eagle breeding population in Ireland.
Goal 2: Our secondary goal was to use this proactive conservation project to help change public attitudes toward conservation in Ireland.
Goal 3: We also aimed to raise awareness of Ireland's other existing and extinct raptors.



Female Golden Eagle (*Aquila chrysaetos*) captive stage - 2005 © Lorcan o'Toole

First golden eagle chick to hatch in almost 100 years © Lorcan o'Toole

Success Indicators

- Indicator 1: Establish 6 - 10 territorial pairs of golden eagles in Ireland by 2010.
- Indicator 2: We did not set a target here, but are satisfied that the level of national media attention has shown this conservation project in a positive light. It is noticeable that elected representatives have repeatedly endorsed this project since its inception.
- Indicator 3: Again no targets were set, but the re-introduction of the white-tailed eagle and red kite into Ireland has been a consequence of the golden eagle project and there is more public awareness now of other extinct Irish raptors such as marsh harrier and osprey.

Project Summary

The golden eagle re-introduction proposal was produced and developed between 1995 and 2000. The National Parks and Wildlife Service (NPWS) had already carried out live prey and carrion transects in Donegal in the early 1990s. We had a clear understanding of the species ecological requirements from nearby Scotland. There were detailed historical records of former breeding places prior to their extinction in 1912. Fieldwork by the Irish Raptor Study Group identified at least 23 potential golden eagle home ranges in the North west of the Island of Ireland. The Northwest of Ireland was chosen, above other potential release areas, because of the presence of buzzards in Donegal - a key indicator species of the absence/presence of poison meat baits. We were confident that the ecological conditions were suitable. However, the Irish mountains are relatively low and usually range from 300 to 500 m above sea level and therefore Irish mountains are more accessible than other European mountain ranges. From the outset, we had fully appreciated the IUCN RSG advice that, “re-introduction lies squarely at the junction of biology and sociology”. We felt that the public attitude to the eagles, especially among farmers, would determine the success of the project. We invited representatives of the farming, tourism and Gaeltacht (Irish language - speaking communities) to join the project steering group. The tourism sector accepted that the eagles would help promote Donegal. The Donegal farming representative body were reassured, by Scottish farmers, that there was only a minimal risk of lamb predation among lambs lambed indoors. We emphasized that the project would have economic, cultural, aesthetic and educational benefits alongside its conservation enhancement.

The project is managed by the Golden Eagle Trust Limited (GET) in partnership with the NPWS. The project began in March 2000 and the first birds were released in August 2001. The captive stage was similar to the recent Scottish

white-tailed eagle and red kite release programs, rearing the captive stock in wooden release cages for 5 - 6 weeks and feeding them through a cloth sleeve to minimize human contact. Scottish Natural Heritage granted permission to collect 60 - 75 Scottish golden eagle chicks from eyries containing two chicks at 5 - 7 weeks of age. The logistical support available in Glenveagh National Park (including a variety of skilled staff, walk in freezers, visitor centre, machinery etc.) greatly added to the project management. The collection of donor stock has been totally reliant on the voluntary support and goodwill of up to 100 individuals in Scotland, including raptor enthusiasts, wildlife bodies and landowners and estate staff. Unfortunately, due to a recent decrease in the productivity of the Scottish eagles our original aim to release 60 - 75 birds, over five years, has not been met. We have released 50 birds over seven years to date (2001 - 2007) though we still aim to release up to 75 birds by extending the release period. All birds between 2001 - 2006 were fitted with patagial PVC wing tags and fitted with radio backpacks or satellite tags (just two birds).

During the latter stages of the project it has become more difficult to effectively monitor the released birds as they wander and settle further away from the core release area. We are seeking assistance from other larger conservation bodies to monitor these immature vagrants and outlying sub-adults. In 2007, the released birds were only fitted with wing tags, as we believed we could no longer justify attaching radio backpacks to the released birds. The first pair of released golden eagles to breed laid one egg in 2005. Two pairs laid two clutches of two eggs in 2006 - including one three-year-old pair. However, none of these clutches hatched. In 2007, there were five occupied territories including two pairs that laid two eggs each. One of these pairs laid two eggs, hatched two chicks and fledged a single chick in Glenveagh National Park. This was the first successful golden eagle pair to breed in the Republic of Ireland in approx 100 years. The remaining priorities are to release a further15 - 25 birds, maximize the productivity of Irish breeding pairs and try to extend the effective monitoring and awareness of golden eagles in areas outside of Donegal. We hope to satellite tag more released golden eagles in future years and also try to establish a CCTV viewing system based on the breeding pair in Glenveagh National Park. We have shown that golden eagles can breed successfully in Ireland, but it may be another decade or more before we can say we have established a viable population. This would constitute a 20 - year pre- and post- project conservation effort. To date the project has cost the GET ~€473,000 (March 2000 - December 2007). The considerable effort involved seems justified in light of establishing golden eagles in a country devoid of large raptors and in light of the enormous amount of public goodwill the project has generated toward conservation in Ireland.

Major difficulties faced

- Overcoming the concerns of Irish conservationists regarding the feasibility of the project proposal and thereby getting the import license issued.
- As it was not a recognized conservation priority, it was difficult raising project funding initially.
- Allaying the traditional fears of such a predator among the hill sheep farmers in Donegal.

- Convincing the public that the golden eagles and the project itself would make a beneficial contribution to Donegal's natural and cultural heritage.

Major lessons learned

- Extremely useful to have to have cross community (i.e. non - conservationists) support and input for the project.
- We incorrectly assumed that Scottish golden eagle donor stock would be more readily available. This view was based on expert opinions - but was not thoroughly investigated.
- We were surprised at the level of reticence and in some cases opposition to the project amongst wildlife enthusiasts. We may have slightly overlooked this sector whilst focusing on the farming sector in particular. The level of PR generated by re-introduction projects can be perceived as unwarranted by other committed conservation projects working with equally important but possibly lower profile species.
- It was beneficial that our energy was focused on raising the species profile and not diluted by mixed messages about the lead organization, membership and other worthwhile conservation causes.

Success of project

Highly Successful	Successful	**Partially Successful**	Failure
		√	

Reasons for success/failure:

- Too soon to say that we have established a viable breeding population.
- The project is now recognized as an important Irish conservation project.
- This project has lead to the re-introduction of other extinct Irish raptors elsewhere in the country.

Re-introduction of the white-tailed sea eagle to County Kerry, Republic of Ireland

Dr. Allan Mee

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Introduction

White-tailed sea eagle (***Haliaeetus albicilla***) IUCN previously Near Threatened, recently downlisted to Least Concern. EU Birds Directive Annex 1. CITES Appendix 1. Status in Europe Rare SPEC 3. Species distributed across Northern Palearctic from E Asia (Siberia, Japan) to W Europe and Iceland. A distinct subspecies ***H. a. groenlandicus*** occurs in Greenland. Previously extinct in the UK (1916) and Ireland (last bred 1898, extinct c. 1910). Previously widespread breeder especially along the west coast of Ireland. Listed as extinct in Irish Red Data Book 2: Vertebrates. Re-introduced to Republic of Ireland beginning in 2007. Project is collaboration between the Golden Eagle Trust Ltd. (GET), National Parks & Wildlife Service (NPWS) of the Department of Environment, Heritage and Local Government, and Prosject Havørn, Norway. Fifteen birds collected under license from nests in west central Norway in June 2007. Released in August 2007 in Killarney National Park, Co. Kerry, SW Ireland. Release area is Ireland's largest National Park (10,289 ha), including extensive freshwater lakes, open mountain, and native deciduous forest. The site is designated as a Special Protection Area (4038) under the EU Birds Directive. The release site was a historical breeding area probably holding at least one pair of sea eagles.

Goals

- Goal 1: Establish a viable white-tailed sea eagle breeding population in Ireland.
- Goal 2: Use sea eagles as a flagship species for conservation of the wider terrestrial and aquatic ecosystems through research and education.
- Goal 3: Raise awareness of Ireland's other existing and extinct raptors.

Success Indicators

- Indicator 1: Adequate survivorship to re-establish a population (33+ birds surviving from 95 released over a 5-year period. 2007 - 2011).

Capture of eagles from source population © Allan Mee

Released eagle © Valerie O'Sullivan

- Indicator 2: First breeding attempts by 2012 - 2013.
- Indicator 3: First successful breeding by 2015.
- Indicator 4: 5 - 10 pairs breeding by 2020.

Project Summary

Groundwork for the Irish White-tailed Sea Eagle Project began in 2005. Priorities included: assessing feasibility and conservation importance of the re-introduction, identification and availability of a donor population, identification of the optimum release site within the species former range, habitat assessment including prey availability and threats, populations modeling to determine number of birds required to re-establish a viable population and likely survivorship, impacts on existing species of release, and public consultation especially with farming interests within the species likely future range. Resulting from this were: i) project proposal based on IUCN criteria, ii) release area evaluation document, iii) population viability modeling, iv) environmental assessment of release. Based on this background research we believe re-introduction is a high conservation priority nationally and that likelihood of success is very good. Further, data from 30 years of the successful re-introduction of the species to the west of Scotland has provided both an excellent model and targets for assessment of project success.

Primary concern prior to and during project implementation has been consultation with the farming community regarding re-introduction of the species. Extensive evidence from Norway provided very strong evidence of no risk to livestock, primarily lambs, from sea eagles (no case of predation in last 30 years in pop. of 2,500 pairs). Sea eagles were previously killed as 'vermin' in Norway until protection in 1968 but are now regarded as benign by farmers. However, evidence of lamb 'predation' on Mull, Scotland, was the primary concern for hill sheep farmers in SW Ireland. Data suggests that most of this 'predation' is in fact scavenging, and of primary concern during nesting. Secondary concerns were risk of EU designations for eagles and disease concerns. Despite initial opposition in some farming sectors progress has been made on direct farming community involvement. Since arrival and release, public interest and opinion has been largely positive. Based of evidence from west Scotland socio-economic benefits to rural communities of the sea eagles are likely to be important, especially to the coastal communities of west Kerry and Cork.

During June 2007, 15 birds were collected from nests in west central Norway by Norwegian counterparts in Prosject Havørn and under license from the Norwegian Directorate of Nature Management. Birds were transported by air to Kerry and housed for two months in isolated cages in Killarney National Park.

Veterinarians assessed the health of birds prior to transport from Norway and pre-release in Ireland. Food was provided on a daily basis using techniques modeled on the Scottish re-introduction. Post-release monitoring (August 2007 - present) has been carried out by the project manager (GET) with logistical support from NPWS. We attached radio-transmitters and patagial wing-tags to all 15 birds prior to release to allow for individual identification and location in the wild. Since release birds have dispersed up to 70 km from the release site but most remain within 10 km. Survival to date has been promising. One bird died in November 2007 from as yet unknown causes. Observation has revealed diet is almost wholly carrion. A further 20 birds are due to be released annually between 2008 - 2011 after which the project will be reviewed.

Major difficulties faced

- Overcoming the concerns of farmers regarding the threat to livestock from eagles.
- Raising sufficient funds for the project.
- Raising public awareness of threats to eagles (e.g. poisoning).

Major lessons learned

- Greater cross community support and input to the project from an early stage prior to initiation would have increased 'local ownership' of the project without detracting from the conservation goals.
- Greater input from government biologists at an early stage would have helped ally fears of impacts on other species.
- Other lessons likely to be learn but too early in the project to determine.

Success of project

Highly Successful	Successful	**Partially Successful**	Failure
		√	

Reasons for success/failure:

- Too early to determine long-term outcome as in 1st year of project but prospects believed to be good.
- Good survivorship to date.
- Project has focused attention on relationship between man and a previously extinct species, esp. attitude to predators/scavengers in the wider environment.
- Potential for future socio-economic benefits related to sea eagle eco-tourism likely to be positive for conservation of the environment as a whole.

Re-introduction of the red kite into Co. Wicklow, Ireland

Damian Clarke

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Introduction

Red Kite (***Milvus milvus***) EU Birds Directive - listed in Annex I, CITES Convention listed in Appendix II, EU Annex A. Bonn Convention listed in Appendix II. Berne Convention listed in Appendix II. IUCN Red List: Near threatened. Species of European Conservation Concern (SPEC) category 2 - declining. There is good evidence that red kites formerly occurred in many parts of Ireland. Red kite bones have been found during archaeological excavations in Wood Quay, Dublin, Lough Gur, Limerick and Roscrea Castle, Tipperary dating from the 11th, 14th and 17th centuries, respectively. There are several old Irish names for red kites from numerous sources, including Cúr (used in the modern standard Irish-English and English-Irish dictionaries), Préachan Ceirteach or Préachan na gCearc and variations of these dating from documentary sources from 507 AD to the 19th century. The Irish red kite project is based in Co. Wicklow, on the East Coast of Ireland. The Irish Raptor Study Group and the Golden Eagle Trust started development of the proposal in January 2006. The project plans on releasing Welsh red kites in Co. Wicklow over a five-year period, with a minimum of 100 kites released over the five years. The Golden Eagle Trust Ltd. Staff have extensive experience of re-introductions and red kites gained in Scotland. Expert opinion was also sought from re-introduction and red kite experts in Scotland, Wales and England. Funding for the project is primarily from two sources the Department of Environment, Heritage and Local Government and the Heritage Council.

First red kite (*Milvus milvus*) being released in Ireland © John Griffin

Goals

- Goal 1: Our primary goal is to establish a viable red kite breeding population in Ireland.
- Goal 2: Our secondary goal is to promote conservation awareness.
- Goal 3: We also aim to raise awareness of Irelands other existing and extinct raptors.

Success Indicators

- Indicator 1: Release a minimum of 20 red kites per year over the five-year period.

- Indicator 2: Establish breeding red kites by 2010.

Project Summary

The Wicklow Red Kite project is managed by the Golden Eagle Trust (GET) Ltd. in partnership with the Irish National Parks and Wildlife Service and the Welsh Kite Trust. The project was initially proposed by the Irish Raptor Study Group (IRSG) in January 2006. Early on in the planning phase contact was made with the Welsh Kite Trust to discuss sourcing donor stock from Wales. The IRSG and the GET felt that as Wales contained the last remnant of the native British stock and given Wales' closeness to Ireland, Welsh red kites would be the most suitable stock for re-introduction to Ireland. The GET conducted a detailed assessment of potential release areas. From the outset it was felt the East Coast of Ireland was best suited given its lower rainfall and higher average summer temperatures. Co. Wicklow was selected primarily on the basis of the mixed habitat types present, high percentage of forestry and an increasing, productive population of common buzzards. The specific release areas were visited and endorsed by kite experts Tony Cross and John Roberts of The Welsh Kite Trust and Professor Ian Newton.

The GET engaged in consultation with Wicklow's farming community, forestry sector and Gun clubs. The GET organized for representatives of the National farming association and Coillte (Irelands largest forestry company) to visit Wales to meet with their Welsh counterparts. The open and frank discussions between these groups went a great way to allaying any fears that the respective groups may have had about red kites. The Wicklow Red Kite Project will use donor stock solely from Wales. The collection of the donor stock is carried out by the Welsh Kite Trust. The GET funds the expense of the collection and extra nest monitoring that is necessary. We are currently entering year two of the project. In year one thirty kites were collected for the project. The chicks are aged between 4 - 6 weeks when taken. In year two, 50 Welsh kites will be imported into Ireland. Half the donor stock will be released at a second release program to be established in County Down, on the East Coast of Northern Ireland, by the Royal Society for the Protection of Birds in 2008. With the Welsh Kite Trust being partners in the project and our funding the collection, we feel we have secured a steady source of donor stock. The captive stage is similar to that done in the Scottish red kite re-introductions. The donor stock are reared in wooden release cages for 5 - 6 weeks. Feeding is done through a cloth sleeve to minimize human contact. All foodstuffs are lead free, having been either trapped or shot with steel shot. During their

Welsh farmer donating a red kite to the project team © Damian Clarke

stay in captivity all the birds were fitted with PVC wing tags and tail mounted radios. Blood samples were taken for health screening and sexing of the kites. Post release of the red kites, supplementary feeding sites were established. These were monitored on a daily basis to monitor which and how many birds attended. When the birds ceased attending these feeding sites, the feeding was ceased. Since release regular radio tracking of the kites is conducted. The current number of kites in the general release area is assessed once a week as a minimum, although it is generally done more frequently. Contact is made with owners of lands where the kites frequent. Through the post release monitoring we have built up a good rapport with the community in the general release area. This local support from the farmers, gun club members and shooting estates has already proven vital in the project. The shooting of a red kite in Wicklow led to condemnation of the act from all sectors. The landowner, a local farmer, in a show of support subsequently banned all shooting over his lands. The Wicklow Kite Project is still at a very early stage, we are only now entering year two. In year two and year three monitoring of nesting attempts of the released red kites will become an important part of the project. This will be done concurrently with the import of donor stock from Wales. During all stages of the project liaising with local communities in Wicklow and the Welsh farmers and landowners who allow us to take “their” red kites will be high priorities.

Major difficulties faced

- Overcoming the concerns of the local farming community regarding the impact red kites may have on their farming activities, particularly in relation to designation of SPA’s for red kites.
- As it was not a conservation priority funding was initially difficult to secure.

Major lessons learned

- The partnership with the Welsh Kite Trust (WKT) has been invaluable in securing the donor stock. While we have only conducted one season of donor stock collection we are of the belief that the WKT will be able to supply all the donor stock required throughout the five years of the project.
- Liaison with the local farming community and gun clubs is vital. Arranging for Wicklow farmers to meet and freely discuss red kites with their Welsh counterparts was key in securing the support of the Wicklow farming community.
- High quality images have been key in getting excellent media coverage. The Wicklow Red Kite project has gotten front-page coverage in the National newspapers on a number of occasions. Quality images have been key to this.

Success of project

Reasons for success/failure:

Highly Successful	Successful	**Partially Successful**	Failure
		√	

- Too early to say at this point, but the project has so far gone as planned.

Captive breeding and re-introduction of red kites to Hampshire, England

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Introduction

The red kite (***Milvus milvus***) in the United Kingdom is a species of national conservation concern. It is listed as Lower Risk (Near Threatened) by the IUCN (2005). Once numerous and widespread, during the late 19th century the red kite was exterminated in England and Scotland, primarily due to human persecution (Lovegrove, 1990). A relict population survived in Wales. Following an improved public perception of the species and a major reduction in persecution, a red kite re-introduction program began in the United Kingdom in 1989. Kites translocated from nests in continental Europe and reared in aviaries were released to sites in northern Scotland and southern England (Carter, 2001). Additional release sites were established in other locations between 1995 - 2003. Despite the success of the national reintroduction program, red kites remained rare in northwest Hampshire in southern England, where the species is listed as 'regionally important'. Between July 2003 and 2005, we released 12 red kites into the wild. The initial release birds were captive bred. Subsequent releases consisted of captive stock birds and one rehabilitated wild bird.

Goals

- Goal 1: Captive breeding of red kites.
- Goal 2: Release of at least 10 individuals.
- Goal 3: Establishment of a local red kite population.

Success Indicators

- Indicator 1: Successful captive breeding.
- Indicator 2: Survival of release birds.
- Indicator 3: Breeding of released individuals.

Project Summary

Feasibility: Obtaining suitable stock for breeding was time consuming and took place between 1996 and 2001. Planning and preparation for the release stages included close work with

Young red kites (*Milvus milvus*) post-release

local farmers and landowners to outline the project, develop links and ensure community involvement and support. Significant efforts were made to assess the risks of secondary poisoning exposure and the likelihood of persecution. The habitat requirement often cited for red kites is a mixture of forest patches to breed and open areas to search for food (Seoane ***et al.***, 2003). This corresponded with our release site, which comprised woodlands and open habitats mixed with large hedges surrounding arable or grass fields.

Implementation: Breeding kites were kept in large semi-seclusion aviaries with nest site choices of basket, platform and open box. Fertile eggs were incubated by broody hens and transferred to incubators for hatching. The chicks were reared by surrogate parents (European buzzards ***Buteo buteo***) until their removal prior to release. Following health checks and screening for disease and parasites, four young captive-bred kites were transferred to artificial nest sites ('hack sites') in pairs at a pre-fledging age of 41 to 45 days. The kites were fitted with leg rings and radio tags attached by backpack. Food was supplied to the nest site remotely and consisted of local carrion types. The kites were monitored during all daylight hours for eight months. Food provision to the hack site gradually decreased as the kites had access to a nearby (~200 m) feeding station. During the second release, eight mature kites were released including one wild rehabilitated kite. The rehabilitated kite had suffered from a blood disorder, and upon recovery exhibited leucism (partial loss of pigment in plumage and pigmented eyes). Pre-release preparations were the same as for the young kites, except radio tags were tail-mounted. For three weeks before release, the mature kites lived in a large aviary with a view across the surrounding area and a nearby feeding station. At release a section of the aviary was removed and the mature kites were tracked daily for five months. Food was provided at the feeding station.

Post-release monitoring: The young kites had all left their hack site after eight days. Initial movements were short (~50 m). The hack site trees were part of large hedgerows, which enabled the kites to make short gliding flights and land a short distance away. Roosting positions were in or within 10 m of the hack site. In this early fledging period the limited flight skills of the young kites often forced them to land on almost any available perch, and after 18 and 17 days post - fledging two of the young kites died from electrocution on a powerline. After 141 days a third young kite was found near the release site. A veterinary examination revealed severe head trauma, possibly due to an encounter with another raptor. The final young kite encountered no obvious difficulties and apart from excursions of up to 27 km during the first year of release, remains local to the release area and has made a breeding attempt with a wild kite in 2008. Conversely, within a week of release, all the mature kites were accomplished fliers and they possessed superior skill and coordination. Two had left the release area after only two days. The remaining mature kites had dispersed by day 56 and during monitoring gradually increased the distances they moved away from the release site (up to 12.5 km). There were no observed fatalities of mature kites resulting from the use of pylons.

Despite careful post-release monitoring and supplementary feeding, the rehabilitated leucistic kite died ten days post-release. This may have been due to leucistic birds being rare and possibly at a disadvantage to conspecifics resulting from their conspicuous plumage and presumed optic deficiencies. All kites avoided the centre of woodlands and utilized woodland edges or large hedgerows. There were no other observed fatalities during the period of post-release monitoring, indicating a confirmed mortality rate during the observation period of 12.5% for the group of mature kites, 75% for the young kites and 33% for the combined release.

Results so far indicate a successful release. Recorded sightings include regular feeding in the wild and courtship behavior of four release birds during 2006. This program has assisted the establishment of a small population of red kites in the target area. Additional (wild) birds have been attracted to the region and red kites are seen virtually every day in 2008. Early in the 2008 breeding season there are three known nest sites within 5 km of the release site. There are no plans to continue the release program. With established kites in the area, and a species that is increasing nationally, the prospects for red kites in northwest Hampshire remain positive.

Major difficulties faced

- Increased risk of mortality during post-release fledging period.
- Inter-specific aggression.
- Mortality from electrical distribution lines.

Major lessons learned

- Release of fully-fledged birds likely to be more successful than releasing juveniles in artificial nests.
- Behavioral variation between individuals (and how this might lead to different responses to the post-release environment) must be taken into account when dealing with small release populations.
- Continuing post-release support (feeding) after the period of post-release dependence can be important for attracting con-specifics to a release area.

Success of project

Highly Successful	**Successful**	Partially Successful	Failure
	√		

Reasons for success/failure:

- Successful captive breeding.
- Observed pair formation between release birds and wild birds.
- First breeding attempt by release birds (2008).
- Increased occurrence of target species in release area.
- Confirmation of optimum release technique for the species.

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Re-introduction of the red squirrel into Newborough forest on the island of Anglesey, UK

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Introduction

The red squirrel (***Sciurus vulgaris***) is an arboreal rodent found in temperate forests throughout much of the Palaearctic. It is vulnerable to habitat fragmentation and woodland loss, and in Eurasia faces competition and pathological viral disease carried by the introduced North American eastern grey squirrel (***Sciurus carolinensis***), which is spreading from introduction sites in the United Kingdom and Italy. The species is included in the IUCN Red List where it is described as 'near threatened' and is also listed under Article III of the Berne Convention. It is protected under Schedules 5 and 6 of The UK Wildlife & Countryside Act 1981, legislation which was amended by the Countryside & Rights of Way Act 2000 for England and Wales. There is a UK Species Action Plan to facilitate the conservation and recovery of populations. Anglesey is a 720 km^2 island lying on the north coast of Wales, UK. The coastal commercial pine plantation of Newborough forest is located on the south east tip of the island and contained red squirrels until their extinction in the mid-1990s.

Goals

- Goal 1: The eradication and then exclusion of grey squirrels from Newborough forest.
- Goal 2: The establishment of a captive red squirrel colony ***in situ*** to produce juveniles for release.
- Goal 3: The re-introduction of red squirrels to establish a self sustaining population.

Success Indicators

- Grey squirrel completely eradicated from the forest prior to the release of red squirrels.
- No evidence of red squirrels being infected with squirrel-pox

Red squirrel (*Sciurus vulgaris*)

Newborough forest release site

virus, a disease carried by grey squirrels and which is fatal to indigenous red squirrel populations.

- Reproduction within the captive red squirrel population, and the successful weaning, and survival to release, of young animals.
- Evidence of reproduction in the released population and favorable rates of survival relative to established wild populations.
- Progressive expansion of both red squirrel abundance and geographical distribution.
- The development of a self sustaining wild red squirrel population in the forest.

Project Summary

Feasibility: Newborough forest is a 770 ha coastal commercial coniferous conifer plantation dominated by stands of mature Corsican pine (***Pinus nigra***). The red squirrel had become extinct in the forest during the mid-1990s as a direct result of grey squirrel colonization. In 1998, it was recognized that, as an island, Anglesey offered a unique opportunity to eradicate the grey squirrel and reinstate the red squirrel. The removal of grey squirrels from a second conifer plantation on the island, Mynydd Llwydiarth forest, had already facilitated the recovery of the remnant red squirrel population there, and had demonstrated that woodland habitat could be maintained free from grey squirrels. The red squirrel is an iconic and popular native mammal, and remnant populations are important in a socio-economic context as they are a major natural attraction for tourists. UK red squirrel conservation strategies recommend systematic grey squirrel control and have stressed the need for studies to investigate the relative efficacy of captive-bred and translocated animal releases. The re-introduction of the red squirrel into Newborough forest therefore offered both conservation and local economic benefits.

Implementation: Five large woodland enclosures were constructed in the spring of 2003, and subsequently captive bred red squirrels were obtained via the Zoological Society of Wales. Genetic sequencing on hair samples collected from a proportion of these individuals ensured suitable genetic diversity was present within the founding population. A trial release was carried out in May 2004 using three adults in order to assess behavior and settlement patterns prior to the main release. The remaining animals were held separately in mixed sex pairs or trios, and were used as breeding stock. Captive animals were regularly screened for endo-parasites, particularly coccidia, and any carcasses were sent for appropriate histology and viral screening by a veterinary pathologist. In the three years from 2004 to 2006, twenty red squirrels were released into the surrounding forest using soft-release protocols. Whilst housed in captivity the animals were provided with

suitably designed nest boxes and both natural and supplemental foods. On release the squirrels were able to use additional nest boxes and feeding stations in the adjacent stands. A systematic grey squirrel eradication program began in 2002. This was continued throughout the captive breeding and subsequent release of red squirrels. Captured grey squirrels were euthanized and a blood sample screened for squirrel-pox anti-bodies.

Post-release monitoring: Three adults released in 2004 were fitted with radio-tags and data collected on ranging behavior and nest site selection. Nest boxes and live-trapping provided data on reproduction and revealed that the single female produced two litters of young within six months of release. Two of the three animals survived at least 18 months after release. The captive red squirrels were productive and females typically produced at least one litter, and occasionally two. Adult survival was also favorable at 67 - 78% except in 2005, when three adult pairs and several young captive squirrels were lost from a suspected viral infection. In 2007 the deaths of three juveniles were associated with adenovirus infection. As a new threat for red squirrels, this virus is now the subject of government veterinary investigation; the Anglesey deaths are an important research case.

Live trapping of released animals revealed steady geographical expansion of red squirrel distribution and regular breeding in the wild. In May 2007, three years after the first release, 13 breeding females were trapped in the forest. During the intervening three years a total of five wild born litters were discovered in nest boxes. Nest box inspection also first revealed the presence of a red squirrel possibly infected with squirrel-pox. Subsequent trapping suggested that although additional animals may have been lost, a significant number of adults and young lived through this period. Live trapping demonstrated that although the grey squirrel population had been almost eliminated, up to 10 individuals, were present in the forest each year. Achieving permanent eradication had been underestimated, so the project reassessed the trapping strategy. Continuing island-wide grey squirrel eradication is scheduled to be complete in 2010.

Major difficulties faced

- Preventing grey squirrel ingress into the study site, which was an optimal coniferous habitat for the species, proved to be more of a challenge than was anticipated and subsequently led to a review of trapping protocols.
- Grey squirrels carry a ‘squirrel-pox’ virus as a latent or sub-clinical infection, and this causes pathological disease in indigenous red squirrel populations. Unfortunately the mechanism of inter-specific infection has not been precisely identified and this means that protocols aimed at halting any outbreak can only be general in nature.
- The discovery of an adenovirus which was associated with the deaths of several captive red squirrels was unexpected. The disease had previously only been recorded in two localities and viral research is still at an early stage; there are consequently currently no recommendations for managing the infection.

Major lessons learned

- If introduced competitors mediate competition through disease, it is imperative that they are permanently removed from a release area. This study demonstrated that the persistence of only a few grey squirrels was an unacceptable disease risk.
- Discovery of adenovirus in wild and captive red squirrels was unexpected but contingency plans proved generally robust. The project has given data which will be useful to future release projects and highlighted the need for a better understanding of the role of pathological disease in red squirrel population dynamics.
- Captive bred red squirrels have an important role in the conservation of the species in the UK and their use removes the need to source stock from wild populations.

Success of project

Highly Successful	**Successful**	Partially Successful	Failure
	√		

Reasons for success/failure:

- It was demonstrated that, through the use of soft release protocols, captive bred animals can be released into the wild where they establish home ranges and reproduce.
- A productive and widespread wild red squirrel population was successfully established in the forest.
- Previous re-introductions and population supplementation projects have proved to be challenging and often unsuccessful. The reason for this has been identified as the continued presence of grey squirrels within the habitat. In this project we were unable to prevent small numbers of grey squirrels from living within the forest.

Re-introduction of the gray wolf into Yellowstone National Park and central Idaho, USA

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Introduction

Gray wolves (***Canis lupus***) were historically common in the western United States but were deliberately exterminated by 1930. Several subspecies of gray wolves were listed as 'Endangered' under the U.S. Endangered Species Act (ESA) in 1974, but in 1978 all gray wolves became listed in the contiguous U.S. In 1986, naturally dispersing wolves from Canada denned in Glacier National Park in northwestern Montana. In early 1995 and 1996 we re-introduced wolves in remote areas of extensive federal national forests in central Idaho (hard release) and into Yellowstone National Park in northwestern Wyoming (soft release) to accelerate recovery. Those areas were designated as experimental populations under section 10(j), a special category of the ESA that allows extra management flexibility, to foster political and local public tolerance. The gray wolf in North America is listed as a species of least concern in the IUCN Red List.

Goals

- Goal 1: Develop enough public tolerance and political support so that wolf re-introductions could be conducted into suitable habitat.
- Goal 2: Conduct wolf re-introductions in a manner that would ensure development of a viable wolf population.
- Goal 3: Develop an interagency program to manage wolf population growth and distribution to minimize chronic conflicts with local people and their livestock.
- Goal 4: Provide accurate and science-based information about the project to maintain credibility and tolerance of wolves and the wolf management program.
- Goal 5: Transfer management of the recovered wolf

Gray wolf (*Canis lupus*) pack chasing elk @ Douglas W. Smith

population into the traditional State-led wildlife conservation model that includes regulated public hunting.

Success Indicators

- Indicator 1: Re-introduction planning and federal government rule-making was authorized and funded by the U.S. Congress from 1988 - 1994. The management program remains funded.
- Indicator 2: Sixty-six wolves from two different areas of Canada were re-introduced to suitable habitat in central Idaho and Yellowstone National Park in 1995 and 1996.
- Indicator 3: By 2007, the population reached 1,500 wolves and had grown at 24% annually. Wolf packs are largely confined to suitable habitat within a 160,000 km^2 area (Oakleaf ***et al.***, 2006). Over 700 problem wolves had been killed and confirmed livestock conflicts are below predicted levels.
- Indicator 4: From 1992 - 2007, the Federal, State, and Tribal interagency wolf management team conducted thousands of media interviews, hundreds of public and scientific presentations and publications, and produced weekly and annual reports. The program is widely perceived as highly successful.
- Indicator 5: In 2007, the northern Rocky Mountain wolf population was proposed to be removed from federal protection and transferred to State and Tribal wolf management programs.

Project Summary

Feasibility: Wolves were listed under the ESA in 1974 and recovery plans were approved in 1980 and 1987. Wolves began to naturally recolonize northwestern Montana in the early 1980's and they attacked livestock in 1987. In 1988, Congress authorized the "Wolves for Yellowstone" studies. In 1991 Congress created a Wolf Management Committee in a failed attempt to develop a political solution to wolf restoration. In 1992, Congress mandated planning and massive public involvement about wolf re-introduction into central Idaho and Yellowstone National Park (USFWS, 1994). Re-introduction techniques were also analyzed (Fritts ***et al.***, 1997 & Bangs and Fritts, 1996). The remoteness and huge size of central Idaho made a hard release of young adult wolves most feasible. In Yellowstone Park, road access made release of packs from large pens possible. In 1994, federal regulations were promulgated that allowed more management flexibility for re-introduced wolves. We developed regulations and management agreements with other natural resource agencies. As one example U.S. Dept of Agriculture Wildlife Services specialists investigate reports of livestock

Cattle near Yellowstone during winter

damage and implement the appropriate control measures. Federal regulations were widely publicized so that the local public knew what they legally could do and who to call if they had questions or problems. Research on wolves in Glacier National Park began by the University of Montana in the early 1980s. Additionally, a federal, state, and tribal wolf working group had been involved in wolf management in northwestern Montana since 1988, so each agency's role and responsibilities were already well defined (Bangs ***et al.***, 1998). Because of this history, a fairly large, dispersed, and experienced field staff was already in place by the time the first wolves were to be captured in Canada and released in the U.S.

Cattle in Madison Valley - wolf release area

Implementation: In 1994, we hired additional staff, purchased equipment, and developed contracts for logistic support (e.g. aircraft, facilities, trucks). We also enlisted cooperators to assist us including biologists, wolf capture specialists, law enforcement agents, and veterinarians from Alaska, Canada, and the contiguous U.S. We built pens in Yellowstone Park and identified release sites in central Idaho. We contacted Canadian officials to identify source populations and to address their biological, legal, and political concerns. We selected two sites to facilitate genetic diversity, minimize impact to one area, and to provide a back-up. Wolves were radio-collared to aid future capture efforts and to evaluate the affects of wolf removal. In western Alberta we bought, collared, and released wolves caught by local fur trappers. Wolf packs were then captured by helicopter darting. Wolves had health examinations for injuries, diseases, and parasites and then flown to the U.S. in individual shipping crates. In January 1995, 15 wolves were directly released in remote areas of central Idaho. After eight weeks, 14 wolves in three family groups were released from three one acre pens in Yellowstone Park. In 1996, this procedure was repeated in central British Columbia. Twenty wolves were released into central Idaho and 17 wolves in four family groups were released from pens in Yellowstone.

Post-release monitoring: Every re-introduced wolf was radio-collared and monitored 2 - 4 times a month. We continued to monitor wolves and from 1995 - 2007 about 30% of the wolf population has been radio-collared. Wolves have been confirmed to have killed over 830 cattle, 1,760 sheep, 101 dogs, and 14 goats, 12 llamas, 7 horses, and a mule. A privately-run compensation program has paid over US$ 900,000 for confirmed and probable losses, which is a fraction of all wolf damage. We used a wide variety of lethal and non-lethal wolf control techniques to minimize and resolve conflicts with livestock. During the early phases of the program we relocated 117 problem wolves to resolved conflicts.

However, eventually problem wolves were just killed. We have killed over 700 wolves (averaging about 9% of the wolf population annually) because of conflicts with livestock (Service ***et al.***, 2008). We increasingly liberalized our regulations to allow private citizens more opportunity to protect their property. In 1994 a landowner could shoot a wolf biting his cow; by 2005 a federal grazing permittee could shoot a wolf chasing his cow; and in 2008 anyone could legally shoot any wolf attacking their dog. These regulations helped build local tolerance of wolves and only 60 wolves were killed by private individuals.

We established a large Federal, State and Tribal working group to monitor and manage the wolf population and conflicts. We initiated and funded a large number of research projects to provide accurate science-based information about wolves. As the wolf population expanded we transferred management to the States and Tribes, emphasizing more local involvement. In 2007 we proposed to remove wolves from federal protection and transfer management authority solely to State management.

Major difficulties faced

- Wolves are highly symbolic, especially in livestock productions areas where they were deliberately eliminated by the local rancher's ancestors. Obtaining public tolerance and political support was very difficult and took 20 years of debate.
- Wolf re-introduction and management is very simple biologically. But it is very complex politically, so it becomes much more expensive, controversial, and time consuming than is realistically warranted.
- Local tolerance is needed for re-introductions to be successful. Rural people tend to generally oppose wolf restoration while urban residents tend to support it. Rural people support killing problem wolves and urban people often do not. Maintaining a program that addresses both viewpoints is difficult.
- Wolves and wolf management have nothing to do with reality or wolves - it is all about human values and perceptions. Biologists may not have strong people/political skills.

Major lessons learned

- Wolves are an extremely adaptable carnivore but are highly symbolic to people. Success is nearly impossible without public and political support.
- Without core refugia like National Parks or large areas of suitable habitat (e.g. lots of native prey and few/seasonal, and only large, livestock) wolf restoration results in chronic problems that many people will not tolerate.
- Wolf populations require management and sometimes wolves must be killed to maintain local public tolerance. Real and perceived problems must be addressed to reduce illegal killing to a level the wolf population can sustain biologically.
- Clearly separate out scientific biological issues/facts (e.g. how many wolves can die and still maintain a viable wolf population or at what rate do wolves kill livestock) from human social values and perspectives (e.g. should people kill wolves or what rate of livestock loss is tolerable).

- Work hard, trust and respect other's skills and abilities, be honest, empathize with other's perspectives, be a professional honest broker within your political and administrative system.
- Our wolf re-introduction program was far too expensive and manipulative to be widely applied to other species or areas. Public controversy forced us to depend too much on radio telemetry and invasive technology. We ended up creating unrealistic public expectations about the level of human intervention needed to manage wolves. Continuing that level of management is unnecessary, reinforces human stereotypes of wolves being different from other animals, and is too unrealistic, intensive, and expensive to maintain, but the public continues to expect it.

Success of project

Highly Successful	Successful	Partially Successful	Failure
√			

Reasons for success/failure:

- We established a population of over 1,500 wolves in 160,000 km^2 of historic and still suitable habitat within 20 years.
- We have maintained livestock losses and other conflicts with people at low levels and the agency management program is widely respected and used. The general public and media consider the program highly successful.
- The federal wolf management program is being transferred to the traditional State and Tribal model for resident wildlife that will ensure that a viable wolf population, funding, and management will continue for perpetuity.

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Re-introduction of sand gazelle into the Uruq Bani Ma'arid Protected Area, Saudi Arabia

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Introduction

The sand gazelle was first described as a full species ***Gazella marica*** (Thomas, 1897) and later subsumed within ***Gazella leptoceros*** (Ellerman & Morrison-Scott, 1951), before being restored to ***G. subgutturosa*** on the basis of morphometric studies (Groves & Harrison, 1967). Taxonomic distinctiveness of ***G. s. marica*** from nominate ***G. s. subgutturosa*** (and other Asian subspecies) from the steppe habitats eastward from Iran, has been intensely debated (Groves, 1967, 1996, 1997). Genetic evidence (mtDNA) has supported alliance with ***G. leptoceros*** (Hammond ***et al.***, 2001), but this has yet to be demonstrated with nuclear markers. Until 1950 the sand gazelle was widely distributed in Iraq and most of Saudi Arabia with smaller populations in Jordan, Syria and Turkey. (Mallon & Kingswood, 2001). Anecdotal evidence suggests that the occurrence of sand gazelles on islands in the Arabian Gulf today is primarily the result of a long history of human translocations, but there is no published documentation to confirm this. Wild populations in Saudi Arabia were reduced to three sites by the 1980s, when Saudi National Commission for Wildlife Conservation and Development (NCWCD) was formed. The IUCN Red List status of ***G. s. marica*** has been assessed independently in 2003 as Vulnerable under criteria C2a(i).

Reem or sand gazelle (*Gazella subgutturosa marica*)

Goals

- Goal 1: Re-introduce a self-supporting population of sand gazelles into the unfenced Uruq Bani M'arid protected area at the western margin of the empty quarter, where no gazelles had been reported for more than 30 years,
- Goal 2: Contribute to reconstruction of a large herbivore community project re-introducing mountain gazelles (***G. gazella***) and Arabian oryx (***Oryx leucoryx***) at the same time in the same place.
- Goal 3: Maintain long-term monitoring to determine progress and success of the project on a time scale appropriate to the habitat and

support to ranger teams charged with implementing protection and acceptance of re-introduced wildlife.

- Goal 4: Use relatively large founder group size (210 animals), released in quick succession in small social units at three different release sites to maximize chances of success.
- Goal 5: Use captive-breeding management to enlarge effective founder group size by releasing females pregnant by males not used in re-introduction, and compare performance of pregnant and non-pregnant female cohorts in post-release monitoring.
- Goal 6: Base the re-introduction on IUCN guidelines.

Success Indicators

- Indicator 1: That following release of 210 individuals over two years there will be a population of at least 300 within the core protected area by the end of the third year.
- Indicator 2: That gazelles from the 15 different social units were observed by detailed monitoring (individuals recognizable by unique collars or tags and 20% carrying radio collars) to disperse, explore and mix in the post-release period.
- Indicator 3: That first generation calves born in the wild are not all offspring of the males released in the same population.

Project Summary

Feasibility and Implementation: Feasibility was based on the work of the NCWCD beginning in 1986, which with IUCN advice prioritized a nation-wide list of protected areas to be established with the aim of preserving a representative sample of natural habitats. The Uruq Bani Ma'arid site emerged from this process as a large wilderness area with no permanent habitation, representative of spectacular parallel dune formations of the western Empty Quarter and associated gravel plains, where vegetation communities were in relatively good health compared to overgrazed habitats in many other areas, but where the large mammal community (oryx, sand gazelle, mountain gazelle and ibex) had all been extirpated, primarily by excessive hunting, within living memory. In addressing local socio-economic issues the feasibility assessments recommended that a 12,000 km^2 protected area should be defined, within which a 2,000 km^2 core protection zone would be surrounded by a large buffer zone where hunting would also be forbidden, but access for seasonal livestock grazing (camels) would be permitted. Implementation of the protected area proclamation, provision of rangers and ranger camps, and establishment of a liaison group with the local community in the area was handled by NCWCD, while gazelle re-introduction was implemented by the NCWCD's captive breeding centre at the King Khalid Wildlife Research Centre (KKWRC) managed under contract by the Zoological Society of London.

KKWRC developed a release plan based on the goals outlined above. Captive stocks were derived from an intensively managed captive herd of 400 - 600 sand gazelles that had been subject to routine health screening and planned breeding

11 years after release - sand gazelles in Uruq Bani Ma'arid in 2006

management over the previous seven years. Ten release groups were established in separate pens in late 1994 for release in two sessions a month apart in spring 1995, using a system of five pens distributed through three selected sites in the protected area. Ten more groups were formed in late 1995 for release in 1996. Sex ratio was set at 50:50 overall. Social groups were set up with one older male and several yearling males and a combination of two year old and one year old females. One release group of older males only was released in the first year to maintain the sex ratio. Prior to placement in the pre-release groups, half the females in the 1995 release had the opportunity to become pregnant by males not to be released. In 1996 all the females had this opportunity. All gazelles at KKWRC experienced a regime of annual Tb testing (ELISA) and routine vaccination against FMD, PPR and Clostridial infection, with additional temporary coverage against rabies, brucellosis and pastuerellosis for those animals going for release.

Post-release monitoring: This was facilitated by marking all release animals with light-weight uniquely numbered collars, including 20% radio collars on a selection of adult males and females. Monitoring was maintained intensively over the first four years (monthly visits with radio-tracking from ground and aerial tracking several times a year), followed by reduced level monitoring for four years (survey visits one or twice a year with no radio-tracking). Key results were that in the first year 80% of the released individuals were still present in the protected area one year after re-introduction, with 12.5% confirmed mortality. The remaining 7.5% were unaccounted for and predominantly involved animals released at a large public release ceremony held to initiate, publicize and celebrate the re-introduction. In the second year post-release confirmed mortality was 10% but the unaccounted faction, a combination of emigration, collar loss and undetected mortality, rose to 25%. Reports from surrounding communities that groups of tagged sand gazelles had been seen 200 - 500 km from the release site confirmed that long-range dispersion was certainly one factor in explaining the 'unaccounted' fraction in the first years of this re-introduction. Marked to unmarked ratio comparisons provided good evidence that the primary target of a population within the core area greater than 300 animals was reached, and nearly 100% of groups observed in year three comprised released individuals from more than one release pen or cohort and associated wild born young. Radio-tracking also confirmed high rates of change in social group composition for individuals.

A high proportion of the 1995 pregnant cohort of females successfully produced

calves in the months following release (80% observable conception rate with up to 80% twinning rate). Many went on to produce an unexpected second calving, 5 - 6 months later, some producing three calves, and some producing two sets of twins in the year of release. Survivorship among the pregnant release females equaled that among the non-pregnant cohort and most of the non-pregnant cohort also conceived for the first time within a few weeks of release, contributing to the unexpected generation of calves born in late 1995. This breeding success reflected the exceptional rains and associated vegetation that developed over the entire protected area in 1995 and to a lesser extent in 1996. Long-term monitoring established that with ensuing drought, breeding rate among females diminished, with observable conception rates to 50% or less moderated by reduction of twinning rate (in some periods to 0) and reduction or disappearance of double calving within one year. Comparison of social organization after release with social organization imposed during captive-breeding and re-introduction showed differences. Mean group sizes were much smaller, bachelor groups were very seldom observed and older males were frequently encountered alone post-release.

Major difficulties faced

- Identification of taxonomically appropriate stock for release, caused by an absence of record keeping and basic captive stock management prior to commencement of project.
- Establishing Tb free founder groups for same reasons as listed above.
- Maintaining interest in long-term monitoring in an environment where it is particularly necessary because rainfall is unpredictable and expected to vary on a 10 year, rather than annual, cycle.
- Transferring standard monitoring skills and interests to ranger force.

Major lessons learned

- In a desert re-introduction, environmental conditions at the time of release are critically important and major determinants of release feasibility. Monitoring data indicated that patterns of post-release dispersal and individual reproductive success are affected by conditions at time of release.
- Animals involved in a three week soft release acclimatization period show significantly greater likelihood of being with associates in the three months following re-introduction and are significantly less often encountered alone than individuals from groups of matching age, weight and composition, released simultaneously in a hard release protocol.
- A basic soft-release protocol (minimum 2 - 3 week acclimatization on site for animals born in country) is strongly recommended for enabling recovery from stress of transport (significantly increased loss of body weight in overnight crates), with indications of marginal benefits for social coherence and reproductive success post release.

Success of project

Highly Successful	Successful	Partially Successful	Failure
√			

Reasons for success/failure:

- Project highly successful because the soft release protocol based on IUCN re-introduction guidelines did promote welfare and social stability. Indicators were all met by year three and substantially exceeded during years 5 - 10 of this re-introduction.
- The use of a large founder group that included pregnant females, dispersed over three release points, promoted a favourable social environment and rapid initial population growth. These controlled elements were fortuitously reinforced by unusually heavy rains and widespread plant growth.
- The population withstood the 1999 – 2001 drought without further re-introduction support.
- Although no population estimate was available, local concentrations of 50 - 70 animals were seen in 2006, eleven years after start of the project, in separate green areas in the core area with evidence of sand gazelle at lower densities throughout the core area and beyond, providing strong circumstantial evidence that the wild born descendents were at least as numerous as the total founder group.

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Re-introduction of Arabian oryx into Um Al Zomoul, Abu Dhabi Emirate, United Arab Emirates

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Intoduction

Historically the Arabian oryx (***Oryx leucoryx***) inhabited the northern-southern parts of the Arabian Peninsula. In the United Arab Emirates (UAE) the Arabian oryx inhabited the Eastern and Western regions of Abu Dhabi Emirate reaching the Empty Quarter Desert. The Arabian oryx is listed on CITES Appendix I. More than 4,000 captive Arabian oryx are found within the UAE as the result of a governmental and private conservation initiative on saving the Arabian oryx from the edge of extinction. Today, the UAE hosts more than 50% of the total global Arabian oryx population. This huge success in captive breeding was the result of the efforts of the Late President Sheikh Zayed bin Sultan Al Nahyan whose dream was to see these animals roam freely in the deserts of Abu Dhabi. Today this dream has became a reality when H. H. Sheikh Khalifa Bin Zayed Al Nahyan, the President of UAE ordered to establish a release program for the Arabian oryx which resulted in 98 individuals being released to the Um Al Zomoul area as a part of a five-year program under the patronage of H. H. Sheikh Mohammed Bin Zayed Al Nahyan, Crown Prince of Abu Dhabi emirate.

Goals

- Goal 1: Establish a viable population of Arabian oryx in the Um Al Zomoul area in the south-east corner of Abu Dhabi emirate.

Success Indicators

- Indicator 1: An increase in the oryx population.
- Indicator 2: A minimal mortality rate of released oryx.
- Indicator 3: An expanding home range of released oryx.
- Indicator 4: Efforts to continue with habitat restoration.

Arabian oryx (*Oryx leucoryx*)

Project Summary

Following the successful establishment of an Arabian oryx (***Oryx leucoryx***) captive-breeding programs within the Abu Dhabi emirate and with more than 4,000

Arabian oryx on sand dune
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animals (the largest population in the world) are found within these programs. The Environment Agency - Abu Dhabi (EAD) in coordination with other relevant parties took the initiative in preparing a 5-year project proposal to establish a free-living population of Arabian oryx in the deserts of Abu Dhabi emirate. The 5-year project represents the preparatory phase for oryx releases in the Abu Dhabi emirate. Upon its completion the follow-up project (running for another 5 years) will build on the achievements of the initial 5-year phase and consolidate the secure establishment of effective and self-sustaining Arabian oryx sub-populations in UAE.

Site Selection and Habitat Suitability - Site selection and Habitat is one of the most important challenges that were addressed early phases of this project. Certain criteria were agreed and adopted by the re-introduction team members to select release sites that would be suit the animals and these were:

- Availability of food and shelter.
- Availability of water sources.
- Habitat quality and quantity.
- Human use.
- Accessibility.

According to these criteria three potential sites have been identified as release sites in the in the south-eastern corner of Abu Dhabi Emirate which borders Saudi Arabia in the south and Oman to the east. The project release area covers approximately 8,950 km^2 of semi fenced sand-dunes and gravel plains with access control gates. Three pre-release facilities were selected and pre-release enclosures have been constructed at these selected sites. As part of the site preparations, artificial shelters, shades and water drinking sites were constructed in order to encourage the survival of the animals especially during the early stages of the release. Parallel to that, plantations of animal feed such as grasses, shrubs and trees were planted at the release site to provide animals with food and shelter taking into accounts the harsh climatic conditions in the area.

Selection and translocation of animals - Animals were selected from three different sources: i) Al Ain Zoo, ii) Sir Bani Yas Island Collection and iii) private collections. The primary reason for this is to maximize different blood lines and increase the genetic diversity of the released animals. Animal fitness and health, age and sex ratio are the main criteria that used to select animals. Healthy and fit animals have been selected to form herds in the pre-release enclosures and

Umm Al Zamoul oryx release site

grouped into various herds. Each pre-release site has three sub groups, each sub group consists of three males (dominant male, two sub-adult males) and 7 - 8 females (adult and sub adult females). Blood samples of randomly selected animals were first checked for infectious diseases before the actual capture and translocation of the animals was attempted. Translocation procedures started with darting the selecting oryx according to their sex, age, and health conditions. Selected animals were vaccinated against common infectious diseases such as PPR and FMD and Clostridia and 98 oryx were identified using ear tags and microchips. Animals were translocated into the pre-release facilities in single crates to minimize the stress and pressure and kept there 6 - 10 weeks before the official release.

Monitoring and Evaluation - In February 2007, a total of 98 oryx were released in to the wild for the first time after 40 years of extinction in the wild. Released animals were monitored using: 1) satellite tracking and 2) radio tracking. Satellite transmitters send 4 - 6 GPS readings per day which are directly downloaded and displayed visually on a map of Abu Dhabi emirate. Eleven satellite and 26 VHF collars were fitted on various animals with different age structures. In addition to monitoring devices, wildlife rangers follow the animals on daily basis counting them and report for any abnormal observations.

Site Management - Addition to the release program activities, hunting is banned not only in the released area, but all over the UAE as well. Grazing is still a challenging issue within and outside the release area where grazing activities take place. However, the management vision for the release site is primarily aiming to restore the natural vegetation cover and habitats of the area, while at the same time minimize human interference through adopting sustainable strategies and long term objectives, including:

- Establishing the site as a protected area.
- Develop and implement regulations for grazing and other practices.
- Develop a conservation oriented zoning plan for the area.
- Enhance the natural vegetation cover through sustainable agricultural techniques.
- Enforce wildlife legislation through well trained rangers.

Major difficulties faced

- Extreme desert conditions (very hot and dry weather).

Major lessons learned

- It is highly recommended that translocation takes place in the winter months so that heat does not cause additional stress on the animals.
- Animals should be given enough time to form herds and socialize before the actual release takes place.
- Genetic and blood tests are crucially important in the translocation and release phase.
- It is important to get the animals adapted to the release environment through adopting a diet program based on the food quantity and quality that animals might require daily.
- Documentation and proper management of the data are highly important tools to mange the herds and overall release program effectively. Newborns, mortalities, ear tag numbers and all other data should be documented in well designed data collection sheets.
- Daily close observations on the behavior and health conditions of the animals are vitally important to improve the management of animals and ultimately increase the chances of survival and success in the wild.
- Successful re-introduction programs require long term financial commitment and support.

Success of project

Highly Successful	**Successful**	Partially Successful	Failure
	√		

Reasons for success/failure:

- Low mortality rates.
- Good calving season with 17 births.
- Widening distribution range of the released Arabian oryx.

Re-introduction of Arabian oryx into Wadi Rum Protected Area, Jordan

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Introduction

The Arabian Oryx (***Oryx leucoryx***), also known as "***Al Maha***" in Arabic, is the Arabian peninsula's largest antelope and one of the most important species in the Wadi Rum Protected Area. The species has been listed as Endangered on the IUCN Red List and on CITES Appendix I since 1975. The beauty of this animal has always inspired poets and has been associated with the culture and the history of the Rum area. This fact is as stable as the Thamudic era oryx rock drawings dating back 6,000 years and which have been found in many locations within and outside of the Wadi Rum protected area. Located in the southern part of the Hashemite kingdom of Jordan, about 370 km south of Amman and about 60 km north east of Aqaba, Wadi Rum protected area is the largest protected area in Jordan. A total of 720 km^2 of sand dunes wadis delimited with enormous erect sandstone mountain terrains is included within this area.

Goals

- Goal 1: To establish a free-ranging Arabian oryx population in the Wadi Rum protected area in the Hashemite kingdom of Jordan.
- Goal 2: To insure the public support and collaboration for the conservation of Arabian oryx in the Wadi Rum protected area.

Success Indicators

- Indicator 1:
  - ⇒ The Aqaba Special Economic Zone Authority (ASEZA) proposed the idea of having a free-ranging Arabian oryx population.
  - ⇒ Approving the Arabian oryx release strategy.
  - ⇒ Cooperation with the Environment Agency - Abu Dhabi, UAE to implement the Arabian oryx re-introduction

Arabian oryx (*Oryx leucoryx*)

project (H.H. Sheikh Mohammad bin Zayed al Nahyan, Arabian oryx re -introduction project in Wadi Rum protected area, Jordan.

- Indicator 2:
  - ⇒ The local people helped in the experimental Arabian oryx release conducted in 2005.
  - ⇒ No hunting threats were observed since the start of the project in 2007 until now.
  - ⇒ Most of the local people are convinced and motivated by the Arabian oryx release.

Project Summary

Feasibility: Wadi Rum Protected Area is present in the Sudanian vegetation region. As for the vegetation types, there are three types present in the protected area (Eisawi, 1996). 1) Sand dune vegetation type - this vegetation type is only found in the Sudanian vegetation region. Wadi Rum area is one of the best representatives for this and is made up of shrubs and bushes (sand dunes fixatives). The main species that characterize this type include ***Haloxylon persicum***, ***Retama raetam***, ***Calligonum comosum***, ***Neurada procumbens*** and ***Hammada scopiara***. 2) Acacia and rocky Sudanian vegetation type - this vegetation is limited to the rocky areas in the protected area and sometimes it is associated with the sand dune vegetation type. The main species of this type that are present in the protected area include ***Acacia raddiana***, ***Anabasis articulata***, ***Carallum***a spp., ***Fagonia*** spp., ***Gymnocarpos decndrum*** and ***Helianthemum lippii***. 3) Hammada vegetation type - this vegetation type covers more than 70% of Jordan's surface area. In the protected area, this vegetation type is not dominant but nevertheless some of its components are present. The main species of this type that are present in the protected area include ***Anabasis articulata***, ***Retama raetam***, ***Tamarix*** spp., ***Achillea fragrantissima***, ***Artemisia herba-alba*** and ***Zilla spinosa***.

At the habitat level, diversity in the protected area is relatively high, compared to other known areas in Jordan with Sudanian vegetation types. As well as the more ubiquitous gravel and silt wadis, it has large areas of sand dunes and high mountains and many deep, shaded canyons. These factors made the idea of the re-introduction of the Arabian oryx more attainable. On the other hand, the special cultural popularity of the Arabian oryx between the local communities in and around the protected area, and their ambition to see the oryx back home after decades of extinction. This will also boost the eco-tourism potential by having the oryx back in this protected area.

Implementation: The re-introduction program in Wadi Rum which started in 2002, was managed by the Royal Society for Conservation of Nature (RSCN) through a contract signed between ASEZA and RSCN. The re-introduction project is currently being implemented in cooperation between ASEZA and RSCN and 10 oryx individuals (7:3) were initially transferred from Shaumari reserve (north of Jordan) to a 4 km^2 enclosure to investigate their adaptability and behavior. In 2005, Wadi Rum protected area formulated a strategy for the re-introduction

project and the strategy concentrated on the idea of having free-ranging oryx managed and monitored effectively to secure the sustainability of these populations. The strategy also focused on developing the enclosures for better survival condition for the oryx during the adaptation phase. The strategy was finally approved and adopted by both ASEZA and RSCN.

Wildlife ranger in the Wadi Rum Protected Area, Jordan

In 2005, an experimental oryx release was done in the Wadi Rum protected area and which lasted for 25 days and aimed to investigate the behavior of the oryx according to their interaction with human activities (mainly tourism) and livestock; grazing habits and their dispersal rates. The results of the experimental release demonstrated that there is a good likelihood for the success of the free release if financial support is secured. Also the trans-boundary arrangements between Jordan and Saudi Arabia should be insured before starting any final release for the oryx in the Wadi Rum protected area. The experimental release also showed a good indicator on how much this idea is adored by the local people of the area, who are mainly local Bedouins who were very supportive to the team. Six more animals have been added since then and all have been moved to a new enclosure of 18 km^2 in the wilderness zone of the protected area in order to provide better conditions for the oryx which faced a lot of difficulties in the old enclosure which led to the death of more than nine individuals due to falling from cliffs. Recently, the first oryx birth was recorded on 20th February 2006. In April 2007 the third meeting of Coordination Committee for the Conservation of the Arabian Oryx (CCCAO) was held in the Wadi Rum protected Area over three days and reached an agreement on encourage projects aiming to restore the oryx as a free-ranging species. Depending on that, the Wadi Rum protected area submitted to H.H. Sheikh Mohammad bin Zayed al Nahyan of the UAE a proposal for the Arabian oryx re-introduction project in the Wadi rum protected area, Jordan.

Post-release monitoring: As confirmed in the proposal, (H.H. Sheikh Mohammad bin Zayed al Nahyan, Arabian oryx re-introduction project in Wadi Rum protected area, Jordan), the release of the Arabian oryx will be monitored by satellite tracking. The post-release monitoring team will obtain capacity building training from the Environment Agency - Abu Dhabi, UAE especially in tracking techniques and handling of oryx.

Major difficulties faced

- Difficulty in adaptation as the original herd came from Shaumari reserve which is completely different than Wadi Rum especially in regard to climate, vegetation and topography.
- The poor physical and genetic condition of the oryx.
- The small area of the old enclosure and shortage of suitable habitat.
- Financial constrains to improve the project.

Major lessons learned

- A genetic studbook for the oryx is a necessity.
- The carrying capacity and botanic studies should be conducted before transferring oryx to any new site.
- Concentrating on the ***in situ*** conservation program might be more effective than captive breeding.
- The focused planning of the re-introduction program is the key to the success of the re-introduction.
- Working hand in hand with the local people will reduce threats facing any released oryx.

Success of project

Highly Successful	Successful	**Partially Successful**	Failure
		√	

Reasons for success/failure:

- During the first phase planning a more suitable location for the first enclosure was needed.
- There was a shortage on genetic information regarding the first herd.
- Less attention was paid to the habitat of the re-introduction site.

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Re-introduction of Arabian oryx into the Negev Desert, Israel

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Introduction

The Arabian oryx (***Oryx leucoryx***) is an ungulate inhabiting hyper-arid environments living in open and sandy plateaus. The species can travel long distances (40 - 90 km) and is adjusted to extreme dry conditions existing without drinking water for long periods of time. The Arabian oryx is a browser/grazer preferring grainy grasses and other annuals. In the dry season the oryx feeds on shrubs and trees, especially pods and leaves of Acacia trees. The social structure of the Arabian oryx is mixed groups of both sexes and all ages. The geographical range of the species included the Arabian peninsula, Jordan, Syria, Sinai and Israel. Intensive hunting has driven the Arabian oryx to extinction in the wild in 1972. It is currently listed as endangered. The re-introduction of the Arabian oryx in Israel is based on a permanent breeding core (Hai-Bar Yotvata) founded from four pairs received from the Phoenix Zoo, Arizona, USA. Three different areas in the Negev desert were selected for re-introduction: one site in the Saharo-Arabian biogeographic zone in the Negev plateau, one site in the Sudanese biogeographic zone in the Arava valley, and one site in the transition area between these two zones.

Goals

- Goal 1: Establish a viable self sustaining population of Arabian oryx in the Negev desert, thus contributing to the conservation of the species.
- Goal 2: Return a large ruminating ungulate to the ecosystem in order to restore possible functions which were lost, such as plant genetic flow by endozoochory.

Success Indicators

- Indicator 1: Over 100 individuals in the wild.
- Indicator 2: A positive growth rate.

Project Summary

A feasibility study was carried out in 1989. The feasibility study pointed out that habitat conditions in Israel that resembles those found in regions of the Arabian

Arabian oryx in the Negev Desert
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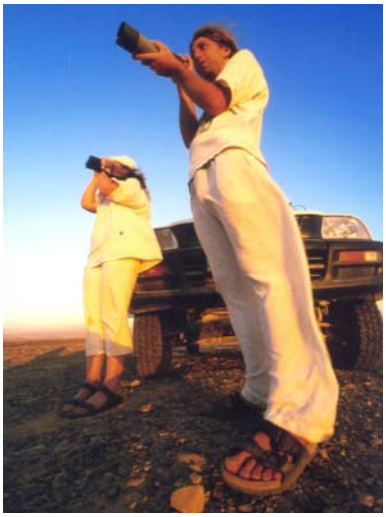

Post-release monitoring of released Arabian oryx

peninsula where oryx were documented to exist in the southern Negev around the Paran riverbed and in the Arava valley. The greatest concern was the narrowness of the Negev in these areas ~20 - 50 km in terms of proximity to international borders. The implementation was based on long range approach using a multiple release strategy focusing on thee different release sites and withdrawing animals from the permanent breeding core at Hai-Bar Yotvata using a sustained yield approach. Sites of release were chosen based on whether they were within a Nature Reserve and the availability of water for the animals while in the habituation enclosure. The three sites selected were the upper Arava valley by the Shachak spring (Sudanese biogeographic zone), the Paran dry riverbed in the center of the Negev (Saharo-Arabian biogeographic zone), and Ketzev riverbed in an area of the transition zone between the Sudanese and Saharo-Arabian biogeographic zones. Based on a demographic model for the captive herd, ~15 females can be withdrawn once every three years from the breeding core without degrading it.

Releases began in 1997 with two releases near the Shachak spring (1997 and 1998) totaling 31 animals (20 females and 11 males), three releases in Paran riverbed (2000,2001,2002) with a total of 21 females and 19 males, and three releases in the Ketzev riverbed (2003, 2005, and 2007) with a total of 22 females and 18 males. All females and most males were radio collared. Animals were darted and radio collared at the breeding core and transferred by truck or in individuals carrying crates to a habituation enclosure at the release site. Habituation enclosures were 1 - 2 ha in size with a 2 m high mesh fence. In the initial releases animal remained in the enclosure for six months, but in later releases this was reduced to 2 - 3 months. Releases were carried out by removing sections of the fence and allowing the animals to exit at their own accord.

Monitoring was carried out on a weekly basis, mostly relying on graduate students. Studies focused on dynamics, space use patterns, the impact of multiple releases, and nutrition. Findings indicate that while the population released in the northern Arava has exhibited a strong positive growth rate, the other two populations have a negative growth rate mostly due to low reproductive success. A nutritional study using fecal analysis relying on near infra red spectroscopy showed significant difference in the nutrition between the three areas, but that all three population were consuming a sufficient amount of protein. We hypothesize that some specific element in the diet (such as lack of tannins that help control parasites) may be responsible for the poor performance of the

Paran and Ketzev population. Socially, the repeated releases at the same location have on the one hand helped animals from later releases to establish and learn the landscape, on the other temporarily destabilized the groups. The herds exhibited fission-fusion dynamics, with smaller groups in winter and larger groups in summer, when food is concentrated in few large riverbeds and acacia stands.

Major difficulties faced

- Low reproduction in two of the three areas.
- Mortality due to small white parachutes used for military flares which the oryx seem to be attracted to and get entangled in.

Major lessons learned

Although large desert ungulates are expected to be bulk feeders and thus less selective in the food choice, it appears that there may be certain elements that are important to them and are found in specific habitats that do not exist outside certain biogeographic zones. This may have played a role the historic range limitation of the species.

Success of project

Highly Successful	Successful	**Partially Successful**	Failure
		√	

Reasons for success/failure:

- Good performance in only one of the three released populations.

Re-introduction of Arabian Oryx into the Dubai Desert Conservation Reserve, Dubai, UAE

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Introduction

Arabian oryx is one of four oryx species, all of which are adapted to arid and semi-arid environments, locally known in Arabic as ***Al Maha***. The Arabian oryx was first described as ***Oryx leucoryx*** (Pallas, 1777). Endemic to the Arabian Peninsula, the Arabian oryx's historically range was across Oman, Saudi Arabia, Jordan, United Arab Emirates, Yemen, Kuwait and Iraq. They are the largest of the antelopes in the region and are extremely well adapted to the extremely arid environment. The Arabian oryx is culturally significant and is revered for its beauty, common in poetry and as a woman's name, ***Maha***. Arabian oryx has been classified as Endangered on the IUCN Red List since 1986 but was already "Very rare and believed to be decreasing in numbers" (Scott) in 1965 and since 1975 it has been listed on Appendix I of CITES. The Dubai Desert Conservation Reserve (DDCR) is an area of 225 km² situated in the South eastern corner of the emirate of Dubai in the UAE (24° 49.5'N; 55° 40.5'E). The area is characterized by sand dunes interspersed with gravel plains. The area has been protected in two phases; the Al Maha Reserve (AMR) of 27 km² was protected in 1999 and subsequently in 2003 the DDCR was protected bring the total area to 225 km². The AMR has had no grazing from domestic stock since 1999 and a vegetation survey showed a significant increase in both diversity and abundance of plant species, suggesting a level of overgrazing is present in the area.

Goals

- Goal 1: Re-introduce a viable, breeding population of Arabian oryx in the DDCR.
- Goal 2: Improve the biodiversity of the DDCR through effective 'eco-system management'. Re introductions of Arabian oryx and gazelle may not negatively impact other species of plant or animal.
- Goal 3: Provide an opportunity for visitors to the Dubai Desert Conservation Reserve to observe Arabian oryx in their natural, desert habitat and to do so in a sustainable manner.

Arabian oryx (*Oryx leucoryx*) on sand dune

Success Indicators

- Indicator 1: A healthy breeding population in the Al Maha Reserve within the first three years.
- Indicator 2: A viable population of Arabian oryx, not reliant on supplementary feeding, within the DDCR.
- Indicator 3: An environmentally and economically sustainable tourism operation within the DDCR which provides regular sightings of Arabian oryx for all visitors.

Dune driving with tourists at the DDCR

Project Summary

The re-introduction of Arabian oryx into the DDCR had two distinct phases. Firstly the re-introduction of oryx into the Al Maha Reserve (1999 - 2003). And secondly the re-introduction into the Dubai Desert Conservation Reserve (2003 - present). In 1999 a protected area (27 km²) was established in conjunction with a small luxury hotel (Al Maha Desert Resort), the re-introduction of Arabian oryx and Arabian gazelle into the protected area was part of the strategy to provide guests of the hotel with an experience of the desert and all its indigenous plant and animal species. In February 1999 the first group of 38 individuals, donated from a private, royal collection was released into the Al Maha Reserve (AMR) from the pre-release boma. A further 79 individuals, from the USA were released directly into the reserve in November 1999. In order to encourage the stated aims of having a breeding population and of increasing the biodiversity of the reserve, supplementary feed, artificial shelter and water was provided.

Supplementary feed was provided at five feed stations on different locations to encourage natural herd size (+/- 20). These feed stations were moved on average every six weeks to prevent isolated areas of overgrazing and a build up of parasites that is inevitable in areas of animal concentration. A vegetation survey conducted soon after the proclamation of the DDCR in 2003 showed that both the diversity and the abundance of plant species had increased within the AMR, at the same time the Arabian oryx herd had bred successfully increased to 194. The Al Maha Resort was running as a successful hotel and won the Conde' Nast award as best resort in Africa and the Middle East in 2001, while fully supporting the conservation work financially.

The second phase of the re-introduction started in 2003 with the establishment of the DDCR (225 km²). Procedures were put in place to reduce the impact on the environment through reducing the grazing pressure of domestic stock and reduce the occurrences of off-road driving. At the time of establishment 17 different tour operators did unregulated dune driving in the area, through a selection process

this was reduced to only four who now operate within the rules and regulations of the reserve and only drive on specific routes. This has ensured that the environment is able to recover and that wildlife now have 'safe areas' in which to move away from vehicles. At the end of 2003 and in March 2004 established herds of 17 and 24 respectively were translocated into separate locations in the northern area of the reserve. The first release was largely unsuccessful as the herd made it way back to the AMR, situated in the center of the DDCR. The second translocation was more successful with a herd of approximately 10 individuals staying in the north, some returning to the AMR and some moving into the southern area of the reserve. A further release in April 2005 was done by moving one of the feeding stations from the AMR into the DDCR. The separation of the AMR and the DDCR is now more permeable allowing oryx to move freely between the two areas and this has lead to the natural formation of free ranging herds of oryx. As of May 2008 approximately 270 Arabian oryx occur within the DDCR of which approximately 50 are independent of supplementary feed or artificial shelters. Monitoring of the Arabian oryx occurs through observation and more recently GPS collars, data is still be collected and analysis to be done on home range, movement between feed stations and time spent away from feed stations.

Major difficulties faced

- Genetic composition of original founder (donated) stock was unknown due to the lack of records of the captive stock.
- Re-introduction into a degraded environment meant that extended management and support through supplementary feeding needed to be in place to ensure the long term success of the re-introduction.
- The education of local farmers and tour operators on environmentally sustainable practices.

Major lessons learned

- The condition of the environment, in particular vegetation, into which Arabian oryx are released directly affects their behavior and dispersion patterns. This has been shown both seasonally, more individuals at feed stations in the summer months and overall, as the environment has improved through protection and better practices dispersion has increased.
- The system of an 'extended soft release' where oryx have the opportunity of supplementary food has worked well in the DDCR as it was already an overgrazed environment. This has allowed the vegetation to improve with Oryx present leading to sustainable self sufficient herds.
- As it is a fenced reserve management of the re-introduction of Arabian oryx will be continuous, in particular through the establishment of carrying capacities for the DDCR.

Success of project

Highly Successful	**Successful**	Partially Successful	Failure
	√		

Reasons for success/failure:

- Arabian oryx are well established within the DDCR, breeding continues to be successful and self sustaining herds although small do now occur within the reserve.
- The re-introduction has not impacted of the biodiversity of the DDCR. In fact there has been and continues to be an improvement in flora and fauna within the reserve.
- Over 200,000 people visited the DDCR in 2007 through good practice and education of tour operators this is being done in a sustainable manner.

Release of greater slow lorises, confiscated from the pet trade, to Batutegi Protected Forest, Sumatra, Indonesia

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Introduction

Although habitat destruction is the main threat to wild slow lorises (***Nycticebus*** spp.) (Daoying, 1999), their popularity in the illegal pet trade and for use as traditional 'medicine' further reduces natural populations (Shepherd ***et al.***, 2004). In response to this threat, in 2007 CITES transferred all slow lorises (***Nycticebus*** spp.) to Appendix 1, banning international commercial trade. Despite legal protection, lack of enforcement in range countries means that trade persists (Nekaris & Jaffe, 2007). Amongst the countries most notorious for trade is Indonesia, where three species of slow loris are traded openly (Shepherd ***et al.***, 2004). One of these species, the greater slow loris (***N. coucang*** - ENA2cd) occurs in Sumatra, where ports in Lampung and Medan facilitate illegal exchange. Pusat Penyelamatan Satwa (PPS), Lampung has basic rescue centre facilities where confiscated animals are held. Due to limited holding facilities, in 2006, they conducted their first release project, releasing pig-tailed macaques into Batutegi Reserve, an 11,000 ha primary lowland rainforest. In April 2007, PPS officials confiscated 26 slow lorises. Batutegi was designated as an appropriate site to release surviving individuals. As to further our understanding of loris re-introduction, we volunteered to aid them in the release process.

Released slow loris (*Nycticebus coucang*) in Batutegi, Southern Sumatra

Goals

- Goal 1: Observe captive behavior of confiscated lorises, ensuring wild survival skills are intact, to determine their suitability for release.
- Goal 2: Determine the ability of wild adult females to care for more than one offspring successfully.
- Goal 3: Release wild-born animals before they spent too long a period in captivity.

- Goal 4: Release the animals to a suitable wild habitat from which they are less likely to be recaptured for trade.

Success Indicators

- Indicator 1: Animals exhibit natural nesting and social behavior, as well as foraging and hunting skills.
- Indicator 2: Adult females successfully rear and bond with more than two juvenile lorises, who themselves show a degree of independence from the mother, in particular as regards foraging skills.
- Indicator 3: Maintain limited human contact with the lorises, and keep them in as natural captive conditions as possible, releasing them only when the first two indicators have been met.
- Indicator 4: The forest area where the animals are released has a high level of protection by the forest department, human impact is limited, and animals are released far into the reserve, where recapture is less likely.

Project Summary

Feasibility: In Sumatra, greater slow lorises prefer secondary tree fall zones in primary rainforest, but can also be found in areas disturbed by humans. Forays into home gardens, slow locomotion and a habit of parking their young mean that lorises are easily caught; both adults and juveniles are common in Indonesian markets, despite being protected by Indonesian law. With a GDP of US$ 880 per capita in Indonesia, prices of up to US$ 100 per animal make lorises a valuable commodity, particularly when coupled with insufficient enforcement of trade laws, and low levels of punishment when violators are prosecuted. PPS Lampung, however, is active in pursuing illegal traders and regularly confiscates animal shipments. In April 2007, they confiscated 19 lorises, including five adults and 14 juveniles. Being susceptible to stress in captivity, 12 of these animals died, leaving two lactating adult females and five juveniles. As lorises can give birth to twins, and occasionally quintuplets, it was deemed feasible to pair one mother with a pair of young, and the older mother with a trio. PPS' facilities are surrounded by natural woodlands, providing natural insects and wild fruits and suitable materials for furnishing enclosures. Surveys in 2006 in Batutegi Reserve revealed that lorises were present, but at low abundance; thus it was chosen as an appropriate site to release the surviving lorises.

Implementation: In order to assess suitability of the animals for release, behavioral observations were conducted from 23rd April to 17th June 2007 for 10 hours per night using systematic animal sampling. Recorded behaviors included those thought to be vital for release including locomotion, social behavior, and substrate use, as well as sequences of play fighting, scent marking and wood gouging (Fitch-Snyder & Ehrlich, 2003). At the onset of behavioral observations, only two adult females survived - one primparous female, and one older multi-parous female, who was clearly an experienced mother. All lorises arrived at the centre malnourished, and thus hand-feeding juveniles and monitoring foraging behavior of independent lorises was a priority. Some juveniles still suckled from the females, and over time, some died due to malnutrition, being neglected by the

mothers or displaced by stronger juveniles. Two large male juveniles were relatively independent, catching insects within the first week of observations. Preparations for release began 7th to 14th June 2007, after behavioral observations showed individuals to be healthy and stable. The release occurred from 14th to 17th June 2007. Health examinations took place on 11th June, during which final weights were recorded, and TB tests and parasite medication given. Each individual was rechecked by Dr. Sanchez on 14th June to determine that the medications caused no complications and that the TB results were negative.

The lorises were transported to the release site in two thick plastic crates (14.0 cm high x 18.5 cm deep x 14.0 cm wide) with side walls consisting of breathing squares 2.0 cm. in diameter. Horizontal branches of bamboo were fitted in the crates, providing lorises with a secure substrate on which to cling. The crates were loaded into a truck and were accompanied by PPS staff members, who monitored them during transport. Equipment and animals were transferred by boat in the Batutegi dam to the forest edge. The lorises were then carried 3.5 km to a rehabilitation cage. The rehabilitation cage (1.3 m x 1.6 m x 1.0 m) consisted of bamboo and nylon net (1.5 cm in diameter, with 2.0 mm thick thread). Two 10 m long bamboo branches connected the net to the canopy to provide two pathways to the trees for the day of release. The group was monitored in this temporary enclosure for two days.

Post-release monitoring: The release took place after 21:00 hrs on 16th June 2007. Team members cut the net around the bamboo pathways, allowing individuals to choose when they left the security of the habituation cage. Once all seven lorises had emerged from the net and were climbing in the canopy, they were observed with red light. Post-release monitoring occurred for one night only. The habituation cage was left in place overnight, acting as a “home base” to provide shelter, in case any of the released animals felt the need to return, (Waples & Stagoll, 1997). Interactions between conspecifics did not change at their new location from what had been observed at PPS. Juveniles actively play-fought with each other, and all seven individuals allogroomed and foraged. The juveniles independently explored their environment and did not cling to either mother. The three juveniles that followed the older mother stayed in close proximity of each other, with the mother returning now and then to check on them. The younger mother, however, did not interact with the two juveniles nearest to her. Both of these juveniles independently explored and were observed to unite to allogroom. Neither the mothers nor juveniles returned to the habituation enclosure.

Major difficulties faced

- We were not able to determine the geographic origins of the animals genetically; two subspecies of loris occur in Sumatra and juveniles are difficult to distinguish.
- Miscommunication regarding husbandry post-confiscation between researchers and local workers meant that enclosures were altered often, creating stress, and perhaps resulting in the premature death of some of the lorises.

- Local customs regarding entering the forest at night impeded the amount of time available for the habituation and post-monitoring periods.
- Misconceptions on ecological issues on the part of local workers meant that length of habituation time and post-release monitoring periods were not a priority.
- The importance of allowing infants to obtain a state of independence from their mothers before release was a difficult concept to relate to local authorities.

Slow lorises in a temporary habituation enclosure at release site

Major lessons learned

- During the pre-release observation period, animals should be kept in stable social groups; lorises are often kept solitarily, but this should be avoided where possible.
- Pre-release enclosures both in captivity and in the forest must be furnished so that animals can move in a semi-natural arboreal setting; lorises become ill when they are forced to sit on the ground.
- Pre-release enclosures should provide hiding places from the sun and from predators, in the form of nest boxes or dense branch tangles kept at a distance from the net/cage, and the enclosures should be placed at a distance from anthropogenic disturbance; hiding places reduce stress.
- Encouraging natural feeding behaviors through a varied diet, including providing live animals for hunting and wood (not timber) for gouging, are essential; in Indonesia, lorises are normally kept only on bananas and die due to malnutrition.
- Team members (preferably a small team) need to have an a prior agreement regarding procedures concerning the release that is carried out throughout the proceeding, with a single well-trained team leader who makes final decisions.
- The release itself should be conducted only by a small committed team to reduce stress to the animals.

Success of project

Highly Successful	Successful	**Partially Successful**	Failure
		√	

Reasons for success/failure:

- The animals were exhibiting natural behaviors, including adoption of infants by the mothers, and were in good health.
- The animals were only recently caught from the wild, most likely in a nearby forest, and had a high chance of survival.
- Local customs and beliefs meant that long-term post-release monitoring was not possible, and thus judgment of the success of this project was severely hindered.
- Facilities are not yet available in Indonesia to maintain lorises in captivity long-term, meaning that the only other option for these Endangered animals was euthanasia. Considering the hindrances this project faced, we felt that the animals had a good chance of survival, even if all IUCN protocols could not be followed.

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Supplementation of the black and white ruffed lemur population with captive-bred individuals in the Betampona Reserve, eastern Madagascar

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Introduction

The black and white ruffed lemur (***Varecia variegata***) is the largest member of the family Lemuridae, weighing 2.5 - 4 kg, and also the most frugivorous. It is characterized by its thick black and white fur, especially around the neck, hence the common name ruffed lemur. According to the latest IUCN Red List assessment the black and white ruffed lemur is classified as Endangered. As with all lemur species it is listed in Appendix I of CITES, Class A of the African Convention and is protected by Malagasy law, although this legislation is impossible to enforce. It is threatened mainly by loss of habitat, but also locally by hunting. The loud and raucous "roar/shriek" chorus of this species is one of the characteristic and most dramatic sounds of the Malagasy rain forest. The supplementation project described here was undertaken by the Madagascar Fauna Group (MFG) in the Betampona Reserve, a 2,228 ha fragment of low altitude rain forest some 40 km north west of Toamasina in eastern Madagascar. The reserve is a completely isolated "island" and prior to the project the resident population of black and white ruffed lemurs was estimated at 35 - 40 individuals (Welch & Katz, 1992).

Black & white ruffed lemur
© David Haring/DULC

Goals

- Goal 1: To assess the ability of captive-bred black and white ruffed lemurs to adapt to a wild existence.
- Goal 2: To attempt to re-enforce the small, isolated resident wild population at Betampona of approximately 35 - 40 individuals (Welch & Katz, 1992) and reduce the risk of inbreeding depression.

Students with native & clove tree seedlings grown in the MFG tree nursery

- Goal 3: To contribute to the protection and conservation management of this lowland rainforest reserve.
- Goal 4: To serve as a model for future lemur re-introductions.

Success Indicators

- Indicator 1: Successful adaptation to the natural habitat: Survival for one year or more without supplementary feeding and/or successful reproduction.
- Indicator 2: Successful contribution to the wild population: Integration into wild groups and successful reproduction with wild individuals.

Project Summary

Prior to the project a population simulation modeling exercise was undertaken indicating that the small population of ***Varecia*** at Betampona would benefit from the addition of a small number of individuals from the captive population (Seal, 1997). Candidates for release were carefully selected on the basis of a number of criteria to ensure that only behaviorally fit individuals took part in the release program, and also that these individuals were genetically surplus to the captive population (Britt ***et al.***, 2004). All individuals were subjected to rigorous veterinary screening prior to selection. Release sites at Betampona were selected on the basis of detailed botanical survey work. Surveys in areas already occupied by the resident ***Varecia*** were used to determine if the necessary abundance of key food plant species was available in proposed release areas (Britt ***et al.***, 2004). The project worked closely with the Ministère des Eaux et Forêts, Madagascar's CITES management authority, to arrange the import and re-introduction of the animals to be released. The Association Nationale pour la Gestion des Aires Protégées (ANGAP) provided technical support concerning research proposals and reserve management. Three releases were carried out - one in November 1997 (3 males, 2 females), the next in November 1998 (1 male, 3 females) and the final release in January 2001 (3 males, 1 female). Intensive post-release monitoring was undertaken until January 2002, this involved the collection of behavioral and habitat use data during all-day follows. Additionally, data were collected from the resident population to allow assessment of the adaptation of the released animals. A number of scientific publications resulted from this research. After January 2002 the data collection ceased, but monitoring of the released animals continues to the present by trained MFG personnel.

Table 1 below summarizes the pre- and post-release histories of the animals released at Betampona. Three of the released lemurs (23%) are still surviving in the reserve and five (38.5%) successfully integrated with the resident wild

Table 1. Summary of pre- and post-release histories of captive-bred *Varecia variegata* released at Betampona

I.D.	Date of Birth	Institution	Release Date	Post-Release survival (months)	Observations
M1	04/24/85	DULC	10/11/97	35	Bred with F1 producing single infant in 1998 and triplets in 1999, one surviving. Victim of Fossa predation.
M2	03/31/93	DULC	10/11/97	Surviving	Integrated with wild group. Bred with wild female, producing one offspring in 2002 and one in 2006.
M3	04/14/96	DULC	10/11/97	8	Died of malnutrition.
M4	04/29/91	LA Zoo	25/11/98	23	Victim of Fossa predation.
M5	05/07/99	DULC	18/01/01	62	Disappeared in 2004.
M6	05/13/00	DULC	18/01/01	Surviving	Integrated with wild female (possible father of one offspring in 2006)*
M7	05/13/00	DULC	18/01/01	Surviving	Integrated with wild female (possible father of one offspring in 2006)*
F1	04/08/86	DULC	10/11/97	32	Bred with M1 producing single infant in 1998 (did not survive) and triplets in 1999, one surviving. Victim of Fossa predation.
F2	04/03/91	DULC	10/11/97	3	Victim of Fossa predation.
F3	05/01/93	WCS	20/11/98	3	Disappeared in 1999.
F4	05/01/91	Hogle Zoo	25/11/98	23	Transferred to captivity due to poor adaptation in 2001.
F5	05/01/91	Hogle Zoo	25/11/98	19	Victim of Fossa predation.
F6	05/02/93	Santa Ana Zoo	18/01/01	32	Bred with wild male in 2002, producing twins. Possible victim of Fossa predation.

DULC = Duke University Lemur Center, North Carolina; WCS = Wildlife Conservation Society, St. Catherine's Island, Georgia. * Either male could have fathered infant born in 2006.

population without requiring supplementary feeding. Five of the released lemurs (38.5%) have successfully reproduced post-release and three (23%) are believed to have bred successfully with the resident wild population (yet to be confirmed genetically, but behavioral data are compelling), thus contributing to the wild ***Varecia*** gene pool at Betampona.

Despite a mortality rate of 69%, the releases have been a success. The abilities to survive beyond one year without provisioning, to reproduce successfully, and to integrate with the wild population have been demonstrated by some of the

released lemurs. Most significantly successful breeding with the resident population has been achieved, making a contribution to the wild ***Varecia*** gene pool at Betampona. In conclusion, it has been demonstrated that captive bred black and white ruffed lemurs can adapt to a wild existence, although losses will be high, and integration with the wild population will be a lengthy process. However, once integration is achieved successful breeding with the wild population can occur. The next stage of this project is to verify the genetic contribution presumed to have been made to the resident population by the released lemurs through the collection of blood samples. There are no plans for any further releases but the fate of the surviving released lemurs will continue to be monitored by the MFG.

Major difficulties faced

- Predation by fossa (***Cryptoprocta ferox***) - five (possibly six) of the 13 animals released were killed by fossa.
- Loss of weight and condition during the austral winter - this lead to the death of one released animal and the adoption of a program of supplementary feeding with commercial primate diet during the winter months. In addition a non-invasive system of monitoring body weight was employed for the third release group. This involved suspending a wire basket from a Pesola® scale and encouraging the lemurs to enter the basket with bananas.
- Failure of radio-collars - this lead to the total loss of two animals and the loss of a third for over a year - male 2 was subsequently discovered by chance integrated into a wild group.
- Migration from the release sites and primary forest into degraded habitats - in the initial stages of the first two releases several individuals had to be located and recaptured outside the reserve limits and returned to their release site.
- Poor adaptation by the second release group - these animals were reliant on supplementary feeding throughout. Their apparent reluctance to range far meant that they did not encounter sufficient natural food sources. We attempted to remedy this by gradually moving feeding sites away from the release site but with little success. The decision was finally made to remove the last remaining female to captivity after the loss of other group members to fossa predation.

Major lessons learned

- Integration and reproduction with the resident population does not occur quickly with the release method employed. This may compromise the survival of released individuals by limiting their opportunities to learn adaptive behaviors (e.g. predator avoidance, coping with seasonal fluctuations in climate and food availability) from their wild conspecifics.
- It appears that males of this species emigrate from their natal group (White ***et al.***, 1993). Given the successful integration and presumed reproduction with wild females by males 2, 6 and 7, it is suggested that a more effective strategy for reinforcing small, isolated populations of this species would be the release of young males in locations peripheral to wild groups. The general lesson here

is that the social system of the species being released needs to be taken into account when developing a release strategy.
- Captive bred black and white ruffed lemurs are particularly vulnerable to predation by fossa (***Cryptoprocta ferox***). In the course of the intensive monitoring phase of the release program (4.5 years) none of the wild study group (n = 10) was lost to predation. No realistic method of training captive bred ***Varecia*** to avoid predation has yet been devised. The best option would be to encourage rapid integration of released animals into wild groups (see first bullet above), where they could learn predator avoidance strategies directly from their wild conspecifics.
- Free-ranging experience during early development appears to increase the likelihood of successful adaptation post-release.
- Free-ranging experience does not necessarily increase the likelihood of survival until integration with wild groups occurs (due to third bullet point above).
- During the austral winter, supplementary feeding is necessary for the released ***Varecia*** due to loss of weight and condition at this time. However, this no longer becomes necessary once released animals are fully integrated into wild groups.

Success of project

Highly Successful	**Successful**	Partially Successful	Failure
	√		

Reasons for success/failure:
- Five individuals survived beyond one year without supplementary feeding.
- A number of individuals have interbred with wild population (2 males and a female), thus contributing to the wild gene pool.
- Overall protection of the reserve improved as a result of the permanent presence of project personnel, improving the chances of persistence of other lemur species, e.g. indri and diademed sifaka and the entire low altitude rain forest ecosystem through public awareness training in bordering villages and an active reforestation scheme.

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The Kalaweit Gibbon Re-habilitation Project: rescue, re-introduction, protection and conservation of Indonesia's gibbons

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Introduction

Gibbons are the smallest of the apes and are widely distributed from Assam and Bangladesh in the north-west, Southern China, Vietnam, across the Malay Peninsula, Thailand, Sumatra (including the Mentawai Islands), Java and Borneo. The long arms and legs of the gibbons make them excellent climbers and they can swing through the upper canopy at great speed. Gibbons can be described by five characteristics: (socially) monogamous, territorial, duetting, suspensory and frugivorous. Gibbons are threatened throughout their range, all species are listed on CITES Appendix I and have various listings on the IUCN Red List.

Kalaweit works to protect:

Common name	Scientific name	IUCN listing	CITES listing	Location of project
Bornean agile gibbon	***Hylobates albibarbis***	Low risk/nationally threatened	App. II	Kalimantan
Müeller's gibbon	***Hylobates muelleri***	Low risk/nationally threatened	App. II	Kalimantan
Sumatran agile gibbon	***Hylobates agilis***	Low risk/nationally threatened	App. II	Sumatra
Lar or white-handed gibbon	***Hylobates lar***	Low risk/nationally threatened	App. II	Sumatra
Siamang	***Symphalangus syndactylus***	Low risk/nationally threatened	App. II	Sumatra
Javan or silvery gibbon	***Hylobates moloch***	Critically endangered	App. II	Java
Kloss gibbon	***Hylobates klossi***	Vulnerable	App. II	Mentawi Islands

Goals

Gibbon with young © Chanee

- Goal 1: To combat the illegal pet trade in gibbons.
- Goal 2: To carry out effective and assessable rehabilitation and re-introduction of rescued gibbons into areas of forest where they are no longer present (but within their historical range).
- Goal 3: To facilitate the involvement of local people in the conservation and protection of gibbons and their habitat.
- Goal 4: To carry out education both in Indonesia and abroad on the impacts of the illegal pet trade on gibbons.
- Goal 5: To provide adequate welfare and care for all gibbons and to ensure that gibbons which cannot be released have the best possible care in captivity.
- Goal 6: To work with researchers to learn more about gibbon behavior.
- Goal 7: To provide employment and training for local people.

Success Indicators

- Indicator 1: To follow all IUCN guidelines and medical tests and follow a behavioral check-list for assessing the suitability of a pair of gibbons for release.
- Indicator 2: That released gibbons demonstrate levels of behavior similar to wild gibbons.
- Indicator 3: The released gibbons will establish territories and successfully raise offspring.
- Indicator 4: That through the efforts of Kalaweit the illegal pet trade will decrease as awareness grows, both in Indonesia and aboard.

Project Summary

Feasibility: Gibbons have been in decline over the past 30 - 40 years, primarily due to habitat destruction and fragmentation through timber felling, charcoal burning, encroachment cultivation, general bush burning for hunting, rubber plantations and tea and pine plantations. Other factors contributing to their demise include the illegal wildlife trade (which involves capturing infant gibbons by shooting the mother), the use of their body parts in the manufacture of traditional medicines, and poaching for sale as pets or to bar owners for the purpose of being tourist attractions. The forest fires of 1997 - 1998 also devastated a large part of the gibbons' natural home range in Sumatra and Borneo: it is estimated that 4,000,000 ha of land comprising various different vegetation types, were destroyed by these fires. Conservation of the gibbons requires two approaches: i) management and protection of wild populations and ii) rehabilitation and management of the wild-born, captive-raised population. Due

Field staff at the release site

to gibbons' decline, several gibbon conservation projects have been established in South-east Asia, all with the aim of rescuing and rehabilitating gibbons. Gibbons are brought to centers when their owners become aware that the gibbon can become too aggressive, or when the owners become aware of the disease risks or when the gibbon is confiscated by local police/forestry officials. These centers also provide a sanctuary for abandoned gibbons that may never be rehabilitated, but can no longer be kept with humans.

Implementation: When the literature on rehabilitation and re-introduction is reviewed, it is clear that many projects have not achieved successful rehabilitation and/or re-introduction of gibbons. Critics of rehabilitation suggested 20 years ago that there is little justification for the continuation of these projects because they are expensive, have limited (documented) success and that conservation efforts should focus on preserving the remaining habitat and populations of wild primates and that the bulk of the available funding should be redirected to these causes. Much of the failure of rehabilitation and re-introduction stems from the lack of knowledge about the specific requirements of the focal species i.e. social, behavioral and nutritional needs. A lack of information about basic husbandry is also a problem. Gibbons can contract humans diseases e.g. hepatitis B and tuberculosis, thus they can act as reservoirs and transmit the diseases to other gibbons, humans and wildlife. To ensure that human diseases are not being released into the wild, all gibbons must undergo extensive medical testing as soon as they arrive at a centre.

We recognize that medical testing can be expensive, but six tests that should be mandatory are:

- Haematology for malaria (Supriatna ***et al.***, 1994).
- Tuberculin test for TB.
- Serology for HepBsAb and HepBsAg (though this needs further study), there is now some evidence that the gibbon Hepadnavirus may have come initially from humans. The risk of zoonosis from Hepatitis is still unclear, but this is one of the biggest problem diseases facing re-introduction of gibbons.
- Fecal examination: Direct analysis, Baerman analysis and a flotation analysis to look for gastro-intestinal parasites. An amoeba culture and sensitivity for pathogenic bacteria e.g. Salmonella, Shigella, etc.. This should also be carried out after the gibbons have been released.
- Herpes simplex: Test for anti-HSV1 and anti-HSV2 antibodies. Gibbons can be infected with HSV: without showing clinical symptoms. Once the symptoms do

manifest, often triggered by an intense period of stress, the onset of cortical neuronal necrosis and degeneration is rapid and irreversible. Gibbons infected with HSV should never be released.
- Worms: De-worming should be carried out every three months.

Post-release monitoring: Gibbons can be relocated by learning their ranging patterns and following them out to where they were seen to bed down for the night. Duetting can also be used to estimate where the gibbon groups are, but many pairs do not sing every day, so there are limits to this method. Since the gibbons will be semi-habituated, it is hoped that after a short space of time, the released gibbons' home ranges and daily travel routes will be known, thus making the following and observing easier than if the gibbons were fully wild. Without adequate post-release monitoring, rehabilitation projects have no way of determining scientifically if the rehabilitation process is adequately preparing the gibbons for a life in the wild. Post-release monitoring requires the collection of data on the gibbons' behavior, ranging, ecology, socialization and on the gibbons' interactions with other animals in the release area e.g. macaques and birds. The importance of daily post-release monitoring, involving observations of the gibbons for the full active period, cannot be overemphasized.

Major difficulties faced

- Lack of detailed information on gibbon rehabilitation and re-introduction, thus Kalaweit has had to tread carefully to ensure welfare of the gibbons at all times.
- Identification of sub-species has proved difficult.
- Lack of suitable habitat into which re-introduced gibbons can be released.
- Lack of knowledge regarding wild gibbon diseases, thus when gibbons test positive for diseases Kalaweit must assume that these animals cannot be released. More research is needed on disease to help Kalaweit make the most informed choice for sick gibbons.

Major lessons learned

- The gibbons need at least 24 hrs to recover from the stress of transport and should be released together from a single cage.
- Gibbons are most vulnerable immediately after release and are likely to flee the release area. Thus the gibbons should be released in an area where they can be easily located.
- Clearly defined procedures and well-trained staff are essential. Staff who are involved in the pre-release, rehabilitation phase should be different from those who carry out post-release monitoring.
- Only one pair should be released at a time and there must be adequate staff to conduct post-release monitoring.
- Only mature (sub-adult or adult) gibbons should be considered for release and single gibbons should not be released: pairs only. Pairs with infants should only be released when the infants are independent of the mother and can travel alone.

- Intensive monitoring is recommended in the initial months post-release, this can be reduced as the gibbons are seen to adapt to the forest.

Success of project

Highly Successful	**Successful**	Partially Successful	Failure
	√		

Reasons for success/failure:

- Kalaweit is at the forefront of gibbon rehabilitation and reintroduction and we are still learning, thus mistakes were made. These have been corrected and Kalaweit is always seeking to improve the release management.
- Ensuring gibbons are ready for release is a long process, thus relatively few pairs have been released. This will change now that Kalaweit has established dedicated release areas
- Finding suitable habitat for release is very difficult, especially in more populated islands e.g. Sumatra and Java.

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Re-introduction of mona monkeys to supplement a depleted population in community forest in southeast Nigeria

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Introduction

The project site (5º40′ 12″ N 8º13′ 12″ E) occurs in Iko Esai community rainforest (forest that is traditionally owned and outside any state or nationally protected area) in southeast Nigeria. It lies within the Cross-Sanaga bioregion: between the Cross River in Nigeria and Sanaga River in Cameroon. Nigeria has lost >90% of its lowland rainforest, and >60% of Nigeria's endangered plant and animal species occur in the forests of the southeast. This region's forests and wildlife are threatened by deforestation due to logging and shifting agriculture, exploitation of non-timber forest products, hunting, and lack of effective protection. Mona monkeys (***Cercopithecus mona***, Schreber 1774) are smaller-bodied (3.5 - 6.5 kg), primarily frugivorous, and diurnal primates; the species' extent of occurrence ranges from Ghana to southern Cameroon. Monas are considered quite adaptable and occur in a variety of forest types, including tropical wet rainforest, tropical dry forest, and mangroves. Although monas are classified as Lower Risk by the IUCN, Ukizintambara and Thebaud (2002) report that they may be under serious threat in the future as they occur mainly in regions with high human population density. Mona monkeys have been legally protected by federal decree in Nigeria since 1985, although this law is not well known and rarely enforced.

Mona monkey (*Cercopithecus mona*)
CERCOPAN/Sherrard

Goals

- Goal 1: Restore species diversity of diurnal primates in community forest in southeast Nigeria by re-introducing two nearly extirpated species: first ***C. mona*** and later ***Cercocebus torquatus***.
- Goal 2: Contribute to the

understanding of re-introduction science and practice by assessing and monitoring the ability of rehabilitated wild-born and captive-reared primates to adapt to a natural environment after release.

- Goal 3: Increase protection of southeast Nigeria's fragile rainforests by developing and implementing forest-protection measures for previously unprotected forest in conjunction with local communities.
- Goal 4: Gain long-term support for and appreciation of the re-introduction project from the host community by integrating community members in planning and decision-making and providing educational, skills-training, and job opportunities.
- Goal 5: Contribute to tropical rainforest discovery and capacity building by offering and promoting educational and research opportunities for Nigerian and international students and researchers.

Success Indicators

- Indicator 1: Reproduction of released individuals and growth of mona population in community forest and adjacent forest.
- Indicator 2: Percent survival and general health and wellbeing of released individuals.
- Indicator 3: Number of violations of established local protection laws (such as number of incidents of primate hunting); number of violators tried by the governing council of chiefs, according to local tradition.
- Indicator 4: Number of complaints from or disagreements with the local community.
- Indicator 5: Number of students and researchers who conduct research at field site; number of successfully completed research projects; number of academic training events conducted.

Project Summary

Feasibility: We (CERCOPAN) had four major requirements for the re-introduction site: It must i) have lost or been depleted of one or more diurnal primate species held in captivity by CERCOPAN; ii) provide suitable habitat for monkeys; iii) have no official protection (so protection of the site would result in increased regional forest protection); and iv) involve a receptive host community with strong leadership. In addition, we wanted to ensure the site was relatively accessible so it could function as a permanent research and education centre.

Requirement 1: In Cross River State (CRS), intensive hunting over many years has depleted the primate community in number and species. Iko Esai alone has >60 hunters. A 2004 study of exploitation in Iko Esai forest showed that primates comprised 11% of species taken. During an 8-month intensive survey of a 400 ha forest zone (to become the immediate release site), density estimate of resident primates (***Cercopithecus nictitans*** and ***C. erythrotis*** in association) was 4.6 individuals/km^2. Only three sightings of solitary ***C. mona*** individuals were made. Reliable reports from hunters indicate both ***C. mona*** and ***C. torquatus*** were formerly abundant in this forest. Reconnaissance surveys over a larger area in adjacent forest indicated similar trends.

Requirement 2: The selected site met the following criteria: was relatively intact forest in close proximity to a large river, provided adequate primate habitat, and was reasonably accessible. We conducted vegetation surveys, including a botanical inventory, plant phenology, and description of forest structure, to confirm availability of resources for primates. There are few data on specific food items of monas: About 40 species have been recorded (based on a search of the literature), and nearly one-half of these occur at the release site. We have also confirmed the presence of many other food species palatable to monas.

Requirement 3: We narrowed our search to forest near or adjacent to Cross River National Park (CRNP), so as to ensure dispersal potential, increase the number of protected forests in the region, and bolster protection of the perimeter around CRNP. We also sought forest with a medium to high degree of threat from outside commercial interests so that protection would be particularly beneficial. The final site selected, Iko Esai, is approximately 10 km west of CRNP and 90 km from the urban centre of Calabar.

Requirement 4: The rural poor in CRS are economically dependent on forest resources. Iko Esai youths were concerned about their forest disappearing and damage to their only access road, both due to logging. They wanted to reduce this threat and needed assistance. Women in the community also supported this appeal. They were keen to invite a conservation organization to help them and pleased that employment and other opportunities would accompany the project. In addition, Iko Esai people have traditionally never used snares for hunting; this is beneficial for long-term protection of terrestrial wildlife.

Implementation:
Threat mitigation: To address the main threat to primates (hunting), in 2000 we established a 400 ha protected area, which is patrolled 24 hours by former hunters employed by CERCOPAN. It is adjacent to a larger forest block of 3,000 ha that is co-managed with the community and has less stringent protection. This is described in a 99-year memorandum of understanding (MOU), negotiated over 18 months with Iko Esai. We further worked with the community to implement a community-wide ban on primate hunting in 2006. We have also used a community-based participatory process to implement a land-use management plan for all community forest. This plan sets aside >12,000 ha for conservation, protected from logging and farming.

Community support: Direct and indirect economic benefits to the community are considered critically important to long-term success of the project. In a survey of hunters, employment was considered the most important benefit (91%). CERCOPAN employs >90% of its field-based staff from the community. There are also indirect economic benefits (e.g. local food purchases). More than one-half of hunters interviewed said their families gained economically from CERCOPAN's presence, even though they were not directly employed. Other project support for the community includes quarterly payments to a community account to support development, alternative-livelihood training, apprenticeships for youth and women, and facilitation of civil works such as road improvements and water

Celebrations marking release of monkeys © CERCOPAN/Snell

provision.

Post-release monitoring: One group of three individuals was released on 1st November 2007: an adult male, adult female, and sub-adult female. All were micro-chipped, and the two adults were fitted with radio transmitters. Research assistants conduct dawn-to-dusk follows and collect data on ranging, feeding, and behavior. The monkeys were initially supplemented daily with high-energy foods, but this was reduced due to their success at foraging on wild foods. At the time of writing, the group is cohesive; forages on a variety of fruits, insects, and leaves; and seems to have a daily routine similar to other wild ***Cercopithecus*** species. To date, they have established a core home range of approximately 2 ha.

Major difficulties faced

- Delay in releasing monkeys was caused by inadequate funding and the length of time required obtaining permission from relevant authorities. This resulted in husbandry (mainly space) issues for release candidates.
- Mistrust among some community members, based on rumors about what was termed the organization's "hidden agenda," was present in the early stages of the project and required additional community-relations work. Such mistrust was likely due to the region's long history of outsiders receiving the lion's share of economic benefit from forest exploitation and local communities receiving very little.
- Local support for special primate protection required extensive work with the community, particularly hunters, including education and trust-building. This required additional investments (financial and human resources).
- Insufficient funding and lack of personnel with livelihood-training experience caused delays in offering alternative-livelihood programs for the community. Also, extra time was needed to build a reputation with donors, develop partnerships with other non-governmental organizations, and source training expertise.
- Additional time and effort were needed to identify and evaluate the cause of a condition that affected the health of primarily juveniles and nursing females in the captive population. This condition caused muscular weakness and was fatal in only a few severe cases. After thorough documentation, analysis of 10 years of diet and husbandry data, and consultation with veterinary experts, it was concluded the condition was caused by a nutritional deficiency, which was most likely caused by a recent change in management and husbandry. This

issue was resolved prior to release, and any individuals who had previously suffered from this condition were no longer considered release candidates. No new cases have been observed since we implemented the dietary changes.

Major lessons learned

- This re-introduction project required a large investment in time (in this case, seven years) to establish a strong relationship with the local community. In general, communities in developing nations may see international projects as having extensive funds and thus expect immediate and large rewards. Managers should be prepared for such situations and plan accordingly.
- Re-introductions of this nature may struggle to succeed without accompanying education and alternative-livelihood programs. CERCOPAN invested heavily in both programs, and even with this investment, more people in the community wanted and expected jobs and training. The education program targeted not only children and schools, but also adults, and it was instrumental in helping change widespread utilitarian-based views of nature; this facilitated the promotion of conservation and land-use changes.
- Experienced veterinarians, including project employees and external advisors, should be part of nearly all stages of a re-introduction project. CERCOPAN was faced with a major challenge when the above-described condition affected some release candidates. Only with the help of the project's long-time experienced veterinary advisor was the condition correctly diagnosed and resolved. The entire re-introduction might have been at risk if not for the careful evaluation and actions of the veterinary team.
- Due to unforeseen circumstances, funding limitations, etc., plans for housing and husbandry of release candidates were prone to change and required a flexible management staff. Re-introduction managers need to have such flexibility and the ability to adapt to unexpected situations.
- Obtaining official permissions may take longer than expected. Managers should start early to obtain official approval and involve relevant authorities early in program development.
- Funding should be a foremost concern of re-introduction project managers. Without adequate financial support, delays will be inevitable, and managers will struggle to complete activities needed to achieve desired goals. Although difficult, funding should be secured in advance whenever possible.

Success of project

Highly Successful	Successful	**Partially Successful**	Failure
		√	

Reasons for success/failure:

- It is too early to evaluate success in terms of percent survival of released individuals or restoration of primate diversity via re-establishment of a ***C. mona*** population. However, some aspects of the overall re-introduction project can be considered successful or highly successful (see bullets below).

- There have been few complaints from the community; community support is now strong and continues to improve over time. CERCOPAN has also been approached by two neighboring communities seeking community development and conservation support.
- Long-term protection of the Iko Esai community forest is assured via the 99-year MOU, and there have been few violations of traditional laws.
- A community ban on primate hunting was established by unanimous vote by the Council of Chiefs and Hunters' Association in 2006 (at this time, there are no data which we can evaluate the success of this ban, though anecdotal information indicates the ban is being respected by nearly all hunters).
- Twelve local residents have been employed as research assistants and trained in the following skills: wildlife monitoring, radio-telemetry, and data collection (survey) methods.
- CERCOPAN has trained nearly 50 local people in alternative-livelihood programs (beekeeping, snail farming, bread making, tailoring, driving, and afang cultivation). These programs were implemented in 2006, and we do not yet have data on the number of people who earn an income from this training.

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Introduction of chimpanzees onto Rubondo Island National Park, Tanzania

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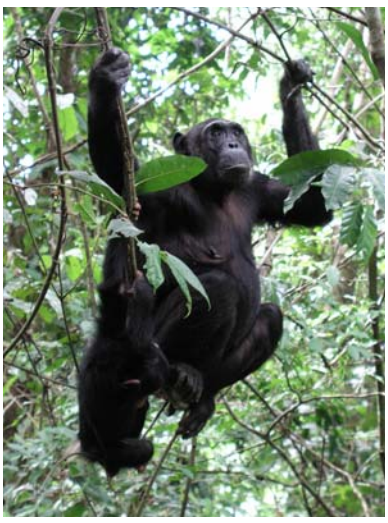
Introduction

The chimpanzee (***Pan troglodytes***), consists of four sub-species, all listed as endangered in the 2007 IUCN Red List of Threatened Species. The Rubondo Island chimpanzees are unique because the species has never inhabited this island prior to introduction and the individuals introduced spent most or all of their lives prior to release in captivity in European Zoos. Rubondo is 240 km^2 in size and is located in the southwestern corner of Lake Victoria, Tanzania (2°18' S, 31°50' E). It was gazetted as a National Park in 1977. The island is 1134 m above sea level. Approximately 70% of the habitat consists of mixed evergreen and semi-deciduous forest characterized by high densities of lianas. The mean total annual rainfall is 1,200 mm and the annual mean high temperature ranges from 19 - 26°C. The only indigenous primate species is the vervet monkey. Other mammals introduced on to the island between 1964 and 1974 and still surviving today are the giraffe, sunni antelope, elephant and the black & white colobus. There are no large predators on the island. Human presence is minimal (park employees, researchers, tourists, support staff) and habitation is limited to a few areas on the lakeshore.



Chimpanzee (*Pan troglodytes schweinfurthii*) © M. A. Huffman

Goals

- Goal 1: To assess how the chimpanzees adapted ecologically to the environment.
- Goal 2: To assess how the chimpanzees integrated themselves socially on the island.
- Goal 3: To assess the relationship between chimpanzees and other species on the island; predator-prey, competition for food resources.
- Goal 4: To determine reproductive status and gender distribution of the population 40 years post release through genetic analysis.
- Goal 5: To determine the number of individuals in the population and their sub-species based on microsatellite and mitochondrial DNA analysis.
- Goal 6: To make paternity charts to define familial relationships at the genetic level, and search for hybridization between sub-species.
- Goal 7: To determine genetic robustness and population viability over the long-term, based on the available genetic pool.
- Goal 8: To establish a non-invasive long-term health monitoring program.

Success Indicators

- Indicator 1: Chimpanzees have survived without long-term provisioning and are behaving similarly to their wild born counterparts elsewhere in the species' natural habitat (diet selection, nest making, tool use, hunting, etc.).
- Indicator 2: Chimpanzees are reproducing and living in stable social groups.
- Indicator 3: Chimpanzees are successful competitors for mutually favored food resources with other frugivorous species on the island (vervets, colobus, birds, elephants, bats).
- Indicator 4: Females are reproducing and successfully rearing young and reproductively active males are sufficient in numbers.
- Indicator 5: Adequate male : female ratios for population growth, and numbers of males generating offspring.
- Indicator 6: A sufficient number of breeding males exist in the population; if sub-species hybridization has occurred and progeny is reproductively viable.
- Indicator 7: Sufficient genetic variability exists in the population for long term population viability.
- Indicator 8: Baseline health status is documented to monitor changes in chimpanzee disease status over time.

Project Summary

Four introductions of chimpanzees onto the island were made from 1966 to 1969 by the Frankfurt Zoological Society (FZS). Of the 17 individuals released, there were nine females and eight males, wild born in several West African countries including Sierra Leone and Guinea. The ratio of males to females in each release was 4:7, 1:0, 1:0 and 2:2, respectively. These individuals had spent between 3.5 months and 9 years in captivity in European Zoos. At the time of release they were aged between four to 12 years (juvenile to sub-adult). In captivity they had lived in varying conditions, ranging from social to solitary housing under good to poor housing conditions. There were no attempts made to integrate all of these individuals into a single social group before release. In fact only a few of the

Researchers on Rubondo © Simon Yohana

released chimpanzees were familiar with each other prior to release. Some had not seen another chimpanzee for some time and/or performed abnormal behavior or attacked human caregivers prior to their release. Others were circus chimpanzees that were quite accustomed to humans. The health conditions and physical preparation of the chimpanzees before the release varied greatly with some receiving anti-malaria treatment and probably also de-worming. After release, four German forester volunteers, who lived on Rubondo between 1966 and 1974 recorded chimpanzee sightings. There was no post-release support apart from a small amount of initial provisioning, which was stopped after only two months, because chimpanzees were observed to feed for themselves on banana sprouts, leaves, wild fruit and seeds. Chimpanzees initially slept in tree forks, but started to make nests after the first year. The first two Rubondo-born chimpanzees were seen in 1968. From 1978 until 1984 Dr. Marcus Borner and his wife Monica of FZS monitored the condition of the Rubondo chimpanzees post release. They found that despite the unfavorable conditions and lack of planning for the release, chimpanzees managed to survive and adapt to this entirely novel environment. They estimated the population at that time to be around 20 individuals. In the early years after the release, some of the introduced chimpanzees were reported to molest people and invade houses and one or two chimpanzee males had to be shot because they attacked people. However subsequent generations of chimpanzees born on Rubondo were reportedly very shy and did not exhibit any of the aggressive behaviors seen in some of the chimpanzees from the founder population. In 1994 a Swiss student, Guido Muller, from Zurich University conducted a preliminary systematic survey of Rubondo chimpanzees. In 1996 the FZS and Tanzanian National Parks (TANAPA) started to habituate the chimpanzees primarily for the purpose of ecotourism. This was discontinued due to slow progress. In 2000, Huffman and co-authors initiated a systematic long-term research project to monitor the chimpanzees once more and to collect ecological, behavioral and health data.

As of 2008, the population is now estimated at around 35+ individuals and they are in a stage of semi-habituation. When located, some groups can be followed for as much as an hour at a time. Chimpanzees have become totally reliant upon the island's natural vegetation for their subsistence. An important factor for sustaining the introduced chimpanzees is the accessibility to abundant and high-quality foods year round, including liana fruits with aseasonal fruiting patterns. The population and individual home range of these chimpanzees are larger than estimated for any other forest dwelling chimpanzee study site. Seasonal range

size increases in relation to increases in the amount of preferred or overall tree fruit availability. These ranging patterns may reflect a strategy of high foraging selectivity, in which chimpanzees seek out preferred tree fruit distributed at low densities in clumped or uniform distributions across the island. The parasite spectrum of chimpanzees is comparable to other chimpanzee sites, but prevalence rates are different. In addition three nematode species new for chimpanzees were found. This is the first study of its kind to document the long-term outcome of chimpanzee introduction into the wild.

Major difficulties faced

- Chimpanzees attacked people or broke into houses in the early phase of post-release, resulting in insufficient human monitoring of chimpanzees due to safety concerns.
- Access for research to remote areas where chimpanzees live on the island is poor.
- Chimpanzees are difficult to locate as they range over a wide area.
- The level of habituation is low, making it difficult to collect adequate data on health and behavior of known individuals and to determine social structure.

Major lessons learned

- Chimpanzees were able to survive post-release with minimal human intervention because the island is predator free, potential high-quality food resources are abundant and available year-round, and con-specific competition for these resources is low.
- Greater effort should be taken prior to introduction to select and socialize group members into a larger group before release.
- Plans for further release of females onto the island is needed to avoid excessive inbreeding, because there is no wild population in the area.
- More intensive and consistent effort is needed to habituate the chimpanzees to further investigate their social adaptation to the release site.
- Planning should take into account male:female ratio and genetic analysis should be performed to ensure sufficient genetic variability exists in released chimpanzees to establish a robust population.
- Biobank genetic material from males and females should be released.
- It is important to collect baseline physiological and health data and biobank samples prior to release and habituation efforts.

Success of project

Highly Successful	**Successful**	Partially Successful	Failure
	√		

Reasons for success/failure:

- Chimpanzees are now totally independent of human assistance.
- Reproduction, infant rearing and population growth is evident.
- The environment is highly suitable for sustaining this species.
- Provisioning was minimal and contact with humans was minimal.

For further information: Moscovice, L. R. ***et al.***, 2007, American Journal of Primatology 69(5) & Petrzelkova, K. J. ***et al.***, (2006) International Journal of Primatology 27(3)

Western gorilla re-introduction to the Batéké Plateau region of Congo and Gabon

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Introduction

The western gorilla (***Gorilla gorilla gorilla***) is classified by IUCN (2007) as Critically Endangered due to past and current rapid population decline, and is listed on CITES Appendix I. The UK-based charity The Aspinall Foundation is coordinating the re-introduction of the species to the Batéké Plateau region of the neighboring Republics of Congo and Gabon, from where it has been extirpated during the past few decades. This is being undertaken within the framework of the Projet Protection des Gorilles (PPG), initiated in co-operation with the respective governments in Congo in 1987, and in Gabon in 1998. The overall mission of PPG is "to work with local partners for the conservation of indigenous endangered species in general, and of gorillas in particular". Gorilla re-introduction is one of the activities of PPG to realise this mission. The current re-introduction sites are the south-west Lefini Reserve in Congo, and the Batéké Plateau National Park (PNPB) in Gabon. The two protected areas are approximately 200 km apart, and are subject to collaborative management projects as a result of the re-introduction program.

Goals

- Goal 1: To re-introduce viable, self-sustaining populations of western gorillas within their former range.
- Goal 2: To ensure effective long-term management of the release sites within legally protected areas.

Success Indicators

- Indicator 1: High post-release survival of released individuals.
- Indicator 2: Successful adaptation of released individuals to release site.
- Indicator 3: Exhibition of social and other behaviors similar to those observed in wild populations.
- Indicator 4: Reproduction within the re-introduced populations.
- Indicator 5: Long-term

Western gorilla (*Gorilla gorilla gorilla*)

A male Western gorilla (*Gorilla gorilla gorilla*)

persistence of the re-introduced populations.

- Indicator 6: Improved legal status of the release sites.
- Indicator 7: Effective management of the release sites leading to ecosystem recovery.

Project Summary

Planning for the program commenced in Congo in the late 1980s, with a cautious approach taken. Various risks involved were recognized and plans were developed accordingly. Risks to released individuals were minimized through soft-release strategies and intensive post-release monitoring. Risks to wild populations were virtually eliminated by selecting release sites where great apes had been locally extirpated, and other primates were at low densities, and by long-term medical assessments of release stock. The sites selected represented relatively degraded ecosystems, for which the re-introduction of gorillas was considered beneficial, both in terms of the significant ecological role that the species has been shown to fulfill in central African forests, and through the associated site management activities. The Batéké Plateau supports a fragile ecosystem, with large expanses of nutrient-poor savanna soils and a growing human population heavily reliant on natural resources. The maintenance of ecosystem functioning is therefore of great importance within the socio-economic situation of the region. Long-term political, technical and financial support were considered crucial to the success of such an ambitious program, so both projects benefit from co-operative partnerships between the respective governments and The Aspinall Foundation.

The Aspinall Foundation manages the largest and most successful breeding colony of gorillas in captivity, at the Howletts and Port Lympne Wild Animal Parks in UK, and is fully committed to supporting the re-introduction program in the long-term. The release stock consists primarily of wild-born gorillas orphaned by the illegal bush-meat trade and confiscated by the national governments. Usually less than three years-old at arrival, the gorillas undergo a lengthy period of rehabilitation and preparation prior to full release. The Gabon release stock has been supplemented by hand-reared captive-born individuals transferred from UK, who also require lengthy pre-release preparation. Rehabilitation and preparation is a complex process that includes aspects such as psychological support, social integration, forest adaptation, behavioral and health assessments, and occasional medical interventions.

The gorillas are released in groups established during the preparation phase. Group composition has generally been influenced by the availability of suitable release stock during the pre-release preparation, and group size at release has

Aerial view of release site

ranged from three to 17 individuals. The first releases took place in 1996, followed by further releases in 1998 and 2001, in the Lesio-Louna Reserve in Congo. Despite high post-release survival and successful adaptation to the site, this first attempt was finally abandoned due to the lack of major ecological barriers between the released gorillas and human activity. Large rivers appear to be the most suitable barriers, and are now used in both Congo and Gabon to separate released gorillas from villages, project camps and local-use zones, although intervention strategies are kept available if necessary. All the surviving gorillas released in the Lesio-Louna were gradually recaptured, and most were re-released in the new site in the neighboring south-west Lefini Reserve in 2003 and 2004. A further three sub-adult females were added to this population in 2006. In the PNPB in Gabon, two groups have been released, in 2001 and 2004. Further releases are planned at both sites.

Post-release monitoring is undertaken by trained national staff using direct and indirect tracking techniques. Initially highly intensive, monitoring is gradually reduced for each group over time to decrease the impact of human presence on gorilla behavior, until it consists simply of a daily or weekly assessment of group ranging, composition and general health. Medical intervention is rarely necessary or even possible, but has been undertaken in some cases. Initial results are encouraging. A total of 51 gorillas have been released between 1996 and 2006, 25 in Congo and 26 in Gabon, consisting of 43 wild-born orphans, plus one ***in situ*** and seven ***ex situ*** hand-reared captive-born individuals. Overall post-release survival rates are high, at 84% in Congo and 84.6% in Gabon, and have been similar for males and females and for wild-borns and captive-borns. Other indications of program success include the observed feeding patterns of the released gorillas which include over 100 species of natural food plants, the ranging behavior of the released groups which is similar to that of wild western gorillas, and the exhibition of natural social behaviors such as female transfer and male dispersal. However, probably the highlight of the program so far has been the birth of six babies to re-introduced groups in the past four years. The baby born to the youngest of the six mothers, at 8.5 years-old, disappeared after six weeks, but the first to be born, to a 16.5 year-old, is now over 3.5 years and in good health. Given the slow life-histories of gorillas and the ongoing release stage, it is still too early to judge long-term population persistence. At the site level, two protected areas have been created through the program, and both, plus another formerly neglected protected area, are now subject to collaborative long-term management projects.

Major difficulties faced

- Lack of major ecological barriers between released gorillas and human activity at the first release site in the Lesio-Louna Reserve.
- Fairly low numbers of available release stock in-country.
- Small number of released groups leading to rapid and long-distance dispersal by solitary adult males.
- Incompatibility of gorillas with radio-tracking equipment.
- Civil unrest.

Major lessons learned

- Gorilla re-introduction is a feasible and realistic conservation strategy, given sufficient long-term technical, financial and political commitment.
- While the general area for a gorilla re-introduction may be identified through consideration of several ecological, sociological and political criteria, the presence of effective ecological barriers between habituated released gorillas and all human activity should define the specific site for release.
- Intervention strategies should be kept available in case of actual or potential human-gorilla conflict.
- Significant pre-release preparation, soft-release strategies and initial intensive post-release monitoring can ensure high post-release survival rates for both orphaned wild-born and hand-reared captive-born gorillas.
- Re-introduction is a media-friendly process that can be used to raise awareness of conservation issues at national and international levels.

Success of project

Highly Successful	**Successful**	Partially Successful	Failure
	√		

Reasons for success/failure:

- Highly successful in terms of survival, adaptation and reproduction of released gorillas, and facilitation of protected area management projects.
- It is too early to conclude that the goal of “re-establishing viable, self-sustaining populations” has been realized.

Re-introduction of small cow-wheat into the Scottish Highlands, UK

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Introduction

Small cow-wheat (***Melampyrum sylvaticum***), is an annual plant of upland woodland undergoing a significant decline in the UK and restricted to 19 isolated sites in the Scottish Highlands. Six sites support less than 200 plants and only three have populations greater than 1,000 individuals. The smaller populations show little genetic diversity and the populations are genetically divergent. The species is classified as nationally scarce within the UK Red Data lists and is included in the UK Biodiversity Action Plan under Agenda 21 of the Convention on Biological Diversity. The Species Action Plan forms the rationale behind this introduction project. Although the species is abundant in parts of Europe, its boreal-montane distribution will contract under current climate change predictions. As the Scottish populations are thought to be particularly vulnerable to increased warming and drought, the genetic diversity contained within these peripheral populations is deemed important enough to protect using experimental introductions. Small cow-wheat has been introduced to five sites within the Highland Perthshire Core Forest Area. Although the species has never been formally recorded at these sites, Perthshire is thought to be within the historic range of the species and supports two of the largest UK populations.

Goals

- Goal 1: Establish, by 2010, small cow-wheat at five suitable sites in order to increase the number of individuals and populations of small cow-wheat in the UK.
- Goal 2: Ensure the new populations of small cow-wheat have greater genetic diversity than the donor populations.

Small cow wheat (*Melampyrum sylvaticum*)

Kynachan - one of the re-introduction sites

Success Indicators

- Indicator 1: Continued survival of small cow-wheat at five introduction sites
- Indicator 2: Increased genetic diversity of individuals within introduced populations as compared with that of the donor populations from which seeds were translocated.

Project Summary

Feasibility: The feasibility of a successful re-introduction of small cow-wheat was assessed using detailed autecological and demographic studies and method trials by Dalrymple (2006, PhD Thesis, University of Aberdeen). Preliminary genetics work was performed by Sharp (2003, MSc Thesis, University of Edinburgh and Royal Botanic Gardens, Edinburgh). Small cow-wheat grows in mixed-canopy woodland dominated by native deciduous species. The species prefers cool, humid areas as evidenced by the close proximity to watercourses and reliance upon canopy shading to protect from drought at lowland sites with drier climates. Although an annual, small cow-wheat populations are generally stable. This is partly a result of density dependent mortality caused by poor dispersal resulting in seeds falling below the parent and germinating ***in situ***. Poor dispersal also means that successive range contractions during periods of drier weather cannot be countered by colonization into suitable habitat once conditions ameliorate. Populations are therefore isolated and genetic divergence between populations is evident. This re-introduction was undertaken to inform large-scale re-introductions in the future. We hope to determine the optimum size of a translocation and whether the combination of seeds from different source populations can bestow benefits through increased genetic diversity or whether the natural populations are now so divergent that outbreeding depression occurs when gene pools mix. For this reason the methods are scientifically rigorous but the re-introduction is relatively small-scale.

Implementation: Thirteen sites were identified that met the criteria for the broad habitat types and proximity to watercourses. The final five sites were selected based on visits to ascertain a closer habitat match and check that site accessibility was adequate. The sites are Upper Deil's Cauldron, Lower Deil's Cauldron, Carie, Kynachan and Rumbling Bridge. Three donor populations from which seed would be sourced were selected based on size as larger populations were shown to be able to tolerate seed removal without adverse demographic effects and were genetically more diverse. The donor populations represent three site types (lowland woodland, upland woodland and montane woodland fragment) within the habitat occupied by small cow-wheat in Scotland. Seeds were collected from 100 plants at each donor population in August 2005. Leaf tissue was also

collected to enable genetic monitoring of the re-introduction. Seeds were stored for a maximum of four days between collection and sowing. Three exclosures with outside measurements of 30 x 30 x 30 cm were used at each site to prevent seed removal. Seeds from 20 plants from each of populations A, B and C, were randomly selected by from each population and sown within each exclosure. The position and number of seeds in each grid square was recorded along with the population identifier and plant number.

Aberfeldy canopy - showing canopy conditions at one of the donor populations

Post-release monitoring: The monitoring program incorporates population counts at the life cycle stages needed to assess demographic trends (seed, seedling and reproducing adult populations) and assessment of genetic diversity. The combination of molecular and ecological techniques will determine if apparent reductions in fitness can be attributed to habitat conditions or genetic factors, further work could be undertaken to identify which aspect might be the cause. In 2006, 94 plants germinated and 29 survived to maturity across the five introduction sites. These totals mask differences between sites, Rumbling Bridge had particularly low germination at only 8% with Lower Deil's Cauldron next with 16% germination. None of these seedlings went on to survive to reproduction. The other sites had germination rates of 21 - 28% matching some natural populations. When viewed by donor population it suggests that population B (germination success only 13%) may be less fit or less well adapted to Perthshire conditions (population B is most distant from the re-introduction sites). Donor populations A and C have germination rates of 29% and 23% respectively suggesting they are more suitable donors.

However, in 2007 the germination patterns were reversed; germination at Rumbling Bridge and Lower Deil's Cauldron were higher than other sites. Most seedlings appeared to be from dormant seed sown in 2005 as plants emerged in locations where no plants had survived to maturity in 2006. Additionally, the theory that donor population B was less fit had to be reassessed when the cumulative germination of 2005 seed classified according to donor rose to 36%, 29% and 30% for populations A, B and C respectively. Therefore, after the effects of dormancy have been taken into account there are no discernable differences in site suitability or donor population fitness. Unfortunately, survival of plants into maturity is unexpectedly low. In 2007 adult plants numbered the following: Upper Deil's Cauldron - 3, Lower Deil's Cauldron - 2, Carie - 2, Kynachan - 1 and Rumbling Bridge - 0. According to estimates from natural populations we might expect survival rates of the order of 10 or more individuals based on seed numbers. The reasons for this decline are unknown but hopefully will be

determined in future years after supplementary re-introductions have occurred.

Major difficulties faced

Landowner cooperation was sometimes problematic. The landowners at certain sites were worried that the introduction of a rare plant and subsequent dispersal might affect how they would be able to manage their land in the future.

Major lessons learned

- Although germination rates were slightly lower then expected, it was the mortality post-germination which was surprisingly high. In future, re-introductions of small cow-wheat will have to translocate many more seeds to account for the unexpected mortality.
- Seed remained viable for longer than expected with many seeds germinating the second spring after sowing, this suggest that small cow-wheat could regenerate from a seed bank in the short term.

Success of project

Highly Successful	Successful	**Partially Successful**	Failure
		√	

Reasons for success/failure:

- It is too early to determine whether the introduced populations will survive.
- The methods have been shown to yield useful information for future introductions regardless of whether the introduced populations survive.

Re-introduction of the endangered Bancroft's Symonanthus in Western Australia

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Introduction

Symonathus bancroftii (Solanaceae) was declared as Rare Flora (ref. Western Australian Wildlife Conservation Act 1950) in October 1996 and later ranked as Critically Endangered (CR) in November 1997; also met IUCN 2000 Red List Criteria A1c and D (based on suspected 90% population reduction over the last three generations due to: decline in area and quality of habitat - with an estimated population size of less than 50 mature individuals). The species is also listed as Endangered under the Commonwealth Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act). Considered extinct (prior to 1997) a male plant was found in 1997, followed by a female plant in 1998. The female plant died in 1999, however material of both plants was preserved via ***in vitro*** culture (both plants were micropropagated at Kings Park & Botanic Garden). Project location: field sites in Shire of Merredin near Ardath townsite and at Nangeen Hill Nature Reserve in south-west Western Australia. This region is extensively farmed (mainly wheat and sheep), with >90% of indigenous vegetation cleared by the 1960s. The landscape is flat with occasional outcrops of granite rocks, soils generally sand/clay, native vegetation mainly open mallee (eucalypt) woodland with perennial shrub (and seasonal herbaceous) understory.

Goals

- Goal 1: "abate identified threats and maintain or enhance the ***in situ*** populations to ensure the long-term preservation of the species in the wild. (see box) - **NOTE: CALM now known as Dept of Environment and Conservation (DEC).**

NB: Text in quotations thus ("...") is quoted directly from: Department of Conservation and Land Management (2006). Bailey's Symonanthus (*Symonanthus bancroftii*) Interim Recovery Plan 2006-2011. Interim Recovery Plan No. 225. Department of Conservation and Land Management (CALM), Western Australia.

Success Indicators

- Indicator 1: "The number of individuals within populations and/or the number of populations have stabilized and/or increased and translocated populations have produced a viable soil seed bank large enough to create a self-sustaining population. **NOTE: Failure of seeds to germinate *in situ* may be due to environmental conditions (e.g. lack of stimuli such as fire, smoke and/or weathering - scarification of seed) and such issues as seed viability must be addressed satisfactorily before an accurate criterion for success can be achieved."**
- Indicator 2: "There is an increase in the knowledge of the biology and ecology

Field site for *Symonanthus bancroftii* at Ardath, WA © I. R. Dixon

of ***Symonanthus bancroftii*** that improves the probability of survival and aids in future management of the species."

- Indicator 3: "Sufficient genetic material for the long-term survival of the species is stored at BGPA or TFSC."
- Indicator 4: "All populations are protected from threatening processes (e.g. human activity), as defined in this document."

Project Summary

Feasibility:

- Habitat - Flat, open mallee (eucalypt) woodland (***Eucalyptus erythronema*** subsp. ***erythronema***, ***E. salmonophloia***, ***E. sheathiana, E. salubris***) with perennial shrubs (e.g. ***Acacia orbifolia***) and seasonal herb understorey. Soil type shallow granitic soil (prone to hard setting) in the vicinity of the sole remaining wild (male) plant.
- Species - "***Symonanthus bancroftii*** is a low, many-stemmed herbaceous undershrub to 25 cm. Its stalkless, egg-shaped to narrow, more or less spreading leaves are 5 - 17 mm long and up to 3 mm wide. They are hairy, somewhat warty and rolled over at the margins. Plants are dioecious. Flowers are white in colour, small, hairy and streaked with violet inside. The fruit is a nearly globular capsule, 3 - 4 mm long, 2.5 - 4 mm wide, with 3 - 5 seeds. Seeds are 2 mm long and 1 mm wide. An aroma of tobacco emanates from Charles Gardner's 75-year-old collection; however this has not been evident from freshly collected material."
- Socio-political & economic - "The implementation of this recovery plan is unlikely to cause significant adverse social and economic impacts as all known populations occur on crown land and Shire reserves."

Implementation:

- Translocation - Field sites were chosen based on availability of suitable land and similarity to existing habitat of remaining wild plants. Trial plantings were undertaken in May - June in 2002 - 2007. Each plant was numbered, irrigated and monitored. Watering of translocated plants occurred 1 - 2 times/week depending on site and prevailing conditions over the summer period. Plants receive 2 - 4 liters/hr via a gravity fed watering system over a 2 - 4 hour period. In June 2004 the Ardath site was ripped two weeks prior to the planting session to attempt to increase plant survival. The Yilgarn District Threatened Flora and Ecological Communities Recovery Team (YDTFECRT) is now overseeing the implementation of this IRP and will include information on progress in their annual report to CALM's Corporate Executive and funding bodies. Information on the translocation of threatened species in the wild is

provided in CALM Policy Statement No. 29 Translocation of Threatened Flora and Fauna.

- Cultural/tribal - "Indigenous communities interested or involved in the region affected by this plan have not yet been identified. The Aboriginal Sites Register maintained by the Department of Indigenous Affairs does not list any significant sites in the vicinity of these populations. However, not all significant sites are listed on the Register. Implementation of recovery actions under this plan will include consideration of the role and interests of indigenous communities in the region."
- Trans-border - Not applicable.
- Veterinary/phytosanitary - Re-introduced plants were micropropagated via sterile (***in vitro***) culture and grown on in an accredited nursery (Kings Park and Botanic Garden Nursery) prior to planting in re-introduction sites, thereby posing no inherent phytosanitary risks.

BGPA, DEC staff & volunteers out-planting into a field site © I. R. Dixon

Post-release monitoring: Regular monitoring of all plants is being undertaken by DEC regional staff and staff from BGPA. The current results indicate just over 250* plants are surviving over the two sites (211 at the Ardath site and 44 at the Nangeen site as at Oct 2007). Survival of plants has varied with early plantings victims of severe drought years (2002 - 2003, zero survival). Post 2003 has seen good survival of plantings from 2004 (>90 plants, Ardath site only), 2005 (10 plants at Nangeen site and 22 at Ardath site), 2006 (nine plants at both sites) and 2007 with >120 seedlings surviving over both sites. The collection of seed that became feasible from 2005 onwards due to good survival of plants from the 2004 plantings at the Ardath site has allowed production of plants from collected seed. Germination characteristics have been investigated by BGPA seed scientists (D. Merritt and S. Turner, pers. comm.) and this research has allowed ***S. bancroftii*** seedlings to be grown at Kings Park nursery for planting into field sites. This will reduce dependence on the more technically demanding process of ***in vitro*** propagation of ***S. bancroftii*** (Panaia ***et al.***, 2000). It remains to be seen whether survival of seedlings is superior to that of micropropagated plants, however seasonal variations in rainfall and temperature are still highly likely to pose threats to survival of plants during the introduction phase, regardless of how they are produced. The ability to access scheme water to fill irrigation tanks at both field sites since 2006 (through collaboration with Water Authority of WA) has greatly enhanced the chances of keeping plants alive through the difficult Summer months particularly in the first 1 - 2 seasons when the plants are most vulnerable to desiccation. It is hoped that as the introduced populations become stabilized seedling recruitment will occur naturally as the soil seed bank accumulates. At

this stage there is no knowledge of the particular environmental conditions required for natural seed germination with ***S. bancroftii***. Further research on these introduced populations is needed to reveal the details of the reproductive biology of this endangered species in a natural habitat. ***In vitro*** and cryogenic collections of ***S. bancroftii*** are being maintained at KPBG.

***Census undertaken by E. Bunn and B. Dixon (BGPA, 11th October, 2007)**

Major difficulties faced

- Fragmentation of existing 'natural' bushland remnants.
- Poor knowledge of biology/ecology of ***S. bancroftii***.
- Lack of perceived genetic diversity.
- Lack of knowledge on natural recruitment and the role of fire.
- Grazing by introduced or native animals.
- Weed invasion.
- Increasing frequency/severity of drought (climate change).

Major lessons learned

- Frequent irrigation of plants required during establishment phase and beyond especially in drought years.
- Reliable monitoring of watering essential as soils prone to rapid drying between infrequent rain or less than adequate irrigation.
- Fencing of plants essential (feral rabbit predation especially lethal to small plants) to prevent herbivory by feral animals and livestock and accidental disturbance by native fauna.
- Weed control essential in weed-prone sites.
- Seed collection must be done via bagging branchlets following pollination (other methods tried lead to poor seed harvests, IR Dixon & E. Bunn, unpubl.).

Success of project

Highly Successful	Successful	**Partially Successful**	Failure
		√	

Reasons for success/failure:

- Yet to demonstrate that seedling recruitment from soil seed bank is feasible.
- Yet to demonstrate that re-introduced populations are stable and self-sustaining.

References

Department of Conservation and Land Management (2006) Bailey's Symonanthus (***Symonanthus bancroftii***) Interim Recovery Plan 2006-2011. Interim Recovery Plan No. 225. Department of Conservation and Land Management, Western Australia.

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Translocation of the Corrigin grevillea in south Western Australia

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Introduction

Grevillea scapigera (Proteaceae) is a prostrate, short-lived, fire-killed and disturbance opportunist shrub, germinating from the soil seedbank after soil disturbance or fire. It was known historically from a maximum of only 13 mainly degraded roadside populations, and the total number of known plants never exceeded 60. However, more than 95% of the natural habitat of ***G. scapigera*** has been cleared for agriculture. As of January 2008, only three wild plants are known to exist in highly disturbed, vulnerable and fragmented roadside sites. Three translocated populations of ***G. scapigera*** have been established close to the wheatbelt town of Corrigin, about 230 km south southeast of Perth, Western Australia, within the natural historical range of this species. The current status of ***Grevillea scapigera*** is declared as Rare Flora under the Western Australian Wildlife Conservation Act 1950 in September 1987, and ranked as Critically Endangered in 1995. The species is also listed as Endangered under the Commonwealth Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act). International obligations - this translocation is fully consistent with the aims and recommendations of the Convention on Biological Diversity that was ratified by Australia in June 1993. It currently meets World Conservation Union (IUCN 2000) Red List Category 'CR' under criteria B1ab(i-v)+2ab(i-v); C2a(i) and D. However, it is not listed under the United Nations Environment Program World Conservation Monitoring Centre (UNEP-WCMC) Convention on International Trade in Endangered Species (CITES).

Grevillea scapigera **flowers have long scapes up to 30 cm long © S. Krauss**

Goals

- Goal 1: Establish at least three self-sustaining populations of ***Grevillea scapigera***.
- Goal 2: Maintain genetic diversity, and minimize inbreeding depression, within these populations in the long term.
- Goal 3: Ensure long term ***ex situ*** protection of this species by cryostorage and seedbanking.
- Goal 4: Create phytosanitary guidelines to protect the species from pests and diseases especially root pathogens and introduction of new weeds on site.
- Goal 5: Reclassification of the species from Critically Endangered to vulnerable or rare after self sustaining populations are established.

Success Indicators

- Indicator 1: Propagate by tissue culture hundreds of ramets of 10 genotypes of ***G. scapigera***, and establish ***in-situ***.
- Indicator 2: Successful reproduction (seed-set) ***in-situ***.
- Indicator 3: Recruitment of new plants from the soil seedbank.
- Indicator 4: Habitat enhancement, that is to improve the vegetation condition and to reduce the impact of weeds and feral animals.
- Indicator 5: Maintain genetic diversity.
- Indicator 6: Create public awareness.
- Indicator 7: Monitor the site on a regular basis.
- Indicator 8: Phytosanitary guidelines in place.
- Indicator 9: Long term ***ex-situ*** conservation through cryostorage and seed storage.

Project Summary

Feasibility stage: ***Grevillea scapigera*** occurs in flat country on sandy or gravelly, lateritic soils associated with low heath amongst tall shrubland. This species is a prostrate, spreading shrub, 5 - 10 cm high by up to 2 m across. Creamy white, sweetly-scented flowers are borne in unusual globular heads to 4 cm in diameter on scapes to 30 cm. Fruits are 1 - 1.5 cm long, sticky, slightly oblique and compressed, and contain two curved to oblique-navicular seeds. This project has not caused any adverse social and economic impacts as the translocation sites only cover 0.2 ha each, two are located in nature reserves and the other on an abandoned golf course. ***Grevillea scapigera*** is a flagship species and the floral emblem of Corrigin Shire therefore there is a great deal of community support for its protection.

Implementation stage: No indigenous communities interested or involved in the land affected by these translocations have been identified. The Aboriginal Sites Register maintained by the Department of Indigenous Affairs does not list any significant aboriginal sites in the vicinity of translocated populations. Phytosanitary Guidelines for the Translocation of ***G. scapigera*** were prepared and adhered to, the guidelines were primarily to reduce the risk of introducing diseases, particularly root pathogens, and weeds to the translocation sites. No flowering plants were translocated, avoiding the risk of inter-species pollen transfer within

the nursery and resulting hybrid seed of nursery origin. Ten clones representing 87% of the known genetic diversity of the species were used in the initial translocation. Additional genotypes have been added over time as new wild plants are found. Translocations using large numbers of plants, derived by tissue culture were begun in 1996, after pilot studies indicated translocation was feasible.

Volunteers admiring Corrigin grevillea in full flower: site 2 - October 2005 © B. Dixon

Post release monitoring stage: Monitoring began and continued every month following planting to record information on survival and growth rates, flowering patterns, numbers of flowers and seed produced as well as damage caused by pests such as rabbits, parrots and seed eating insects. Monitoring for the first two years indicated vast seasonal variations which may in part be due to the quality of the greenstock (plants) at time of planting, vagaries of the weather (lack of rainfall) and wide variation between clones (some clones were better survivors and also recorded better growth rates, flower and seed production). In 1996 when only two translocation sites were being used translocation survival rates (4%) were far lower than in pilot studies and in 1997 there were clear site advantages due to summer rainfall patterns e.g. one site experienced a total loss of 400 plants, whilst the other site had incredibly good survival rates and excellent summer growth rates (plants normally put on new growth in late spring). Following these poor results a battery operated trickle irrigation system was installed at one site in 1998 and when funding became available added to other sites. Irrigation when correctly used increased survival and growth rates, flowering and seed production, however the life span of irrigated plants was substantially reduced. The 1997, 1998 plantings and other isolated plants which were not included into the irrigation system did not grow as well and during drought years did not flower, however some of these plants are still surviving. To reduce plant production costs when large quantities of seed became available seedlings were grown and introduced to all sites.

Post-release monitoring of sites has been substantially reduced to twice a year, recording survivorship, pests, weeds, estimates of seed production and any new recruits of seedlings. With the difference in sites, i.e. degraded to good vegetation there was a wide variation in seed production the best site producing over 1,000,000 seed in 2006. Seed production in all sites as plants are aging is now receding and the total number of plants on all sites is just over 1,000. Genetic erosion between founders and offspring was assessed in 1999 at one translocated site. DNA fingerprinting techniques demonstrated poor genetic fidelity in the founding population (eight clones, not 10, were present, and 54% of

all plants were a single clone), and significant erosion of genetic variation (offspring were 22% more inbred and 20% less heterozygous than parents). Ultimately, the genetically effective population size of the founding translocated population was estimated to be two. Steps have been implemented to halt this genetic erosion in future generations, and the consequences for inbreeding depression are being assessed. Experiments to stimulate the soil seedbank indicated aerosol smoke produced seedlings far quicker than fire and or cultivation. Two sites are now producing a small number of natural recruits on a regular basis without stimulating the soil seedbank. Fifty year seed burial trials indicate after the first harvest, two years, seed stored on the surface (in shade cloth and fine stainless steel mesh) of the soil have higher viability rates than those buried at 5 cm..

Major difficulties faced

- Finding suitable translocation sites, with the correct soil and vegetation type, due to over 95% of the natural vegetation being cleared for agriculture in the Corrigin Shire.
- Raising plants, initial problems with tissue culture and growing on plants in a nursery situation due mainly to fungal attack in humid conditions.
- On site problems with watering plants, often due to high staff turnover, filling water tanks and watering on a regular basis.
- Managing pests, looper caterpillars and weevils which attack the developing seed and can destroy every seed on a single plant.
- Managing genetic variation and integrity, i.e. mis-labeling of tissue-cultured plants leading to a genetic erosion.
- Lack of knowledge of the biology of this species and cultural requirements.
- On-site smoke trials using tents to concentrate chemicals for stimulation of germination of the soil-stored seed.

Major lessons learned

- Network (contact people) on a regular basis to maintain professional and voluntary partnerships. Volunteers essential due to the volume of work and lack of resources.
- Rabbit proof fencing critical, with a minimum area of 0.2 ha to allow expansion of plantings and/or future inclusion of other rare species on site if desired.
- Irrigation systems significantly improved survival rates, increased growth rates, flowering and seed production, but can reduce the life span of plants.
- Large numbers of plants en-mass can lead to an increase in seed predation. It was essential to control these seed eating insects at the correct time, about 3 weeks before the seed were mature.
- Far more cost effective to use a site which is already well vegetated with indigenous species. Carefully clearing (skimming off the tops of woody shrubs etc.) sites leads to regeneration of these species at the same time as translocated plants are growing, reducing weed problems and leading to less intervention in the long-term.
- Important to monitor on a regular basis e.g. once a month at least for the first two years. This included checking on pests/diseases, fencing and maintaining

watering systems.

- Monitor genetic variation: mistakes do happen with labeling systems etc., to make sure you are getting genetic diversity sample off-spring. Genetic erosion was addressed by focusing planting effort on under represented genotypes with vegetatively propagated material. Moving to using seed increases genetic variation (more genotypes as all seed are outcrossed), but increases kinship relative to wild parents. Thus there is a genetic variation/kinship conflict between the use of original wild genotypes and the offspring of the translocation founders that requires careful management. Ultimately, the largest genetically effective population sizes possible are required at initiation to avoid concerns associated with genetic erosion.
- Maintain genetic stock for a long period in case of disaster e.g. cryostorage and seed for long-term storage.

Success of project

Highly Successful	**Successful**	Partially Successful	Failure
	√		

Reasons for success/failure:

- This was a well defined joint project with the Department of Environment and Conservation (formerly Conservation and Land Management) Corrigin Shire, the Bullaring community other local volunteers and Kings Park Master Gardeners. It was overseen by an advisory group Narrogin District Threatened Flora Recovery Team. It was underpinned initially by a detailed research program focused on the biology of the species, and subsequent research on genetic management.
- Guidelines were in place in the form of Wildlife Management Program No. 24, Corrigin Grevillea Recovery Plan now replaced by Interim Recovery Plan No. 224, Corrigin Grevillea (***Grevillea scapigera***) Interim Recovery Plan 2006 - 2010. This plan is fully consistent with the aims and recommendations of the Convention on Biological Diversity that was ratified by Australia in June 1993 The project also followed the Guidelines for the Translocation of Threatened Plants in Australia 2nd Edition and the Germplasm Conservation Guidelines for Australia (both published by the Australian Network for Plant Conservation)
- Regular funding provided predominantly by the Australian Government, through the Natural Heritage Trust scheme.
- This project was based on good science from its infancy, part of a PhD by M. Rossetto, balanced with good horticultural and field based skills involving many experts in their field.
- The program was based in Kings Park Science Directorate where new methods were constantly being developed to propagate and manage genetic resources.
- All plants were raised in Kings Park Accredited Nursery (adheres to specific photosanitary regulations) which specializes in the cultivation of indigenous

species.

- When germination of seed was impossible due to deep dormancy, genetic assessment identified ten clones that represented 87% of the known genetic diversity of the species, and these were used for translocation. New seedlings are occasionally found in natural populations, and this new genetic resource was cloned by tissue culture and later planted on site to increase genetic diversity.
- Research on seed dormancy identified optimal dormancy-breaking procedures.
- The adoption of new horticultural practices over time on the translocation sites e.g. introduction of an irrigation system increased survival rates.
- All translocation sites have delivered large quantities of seed into the soil seedbank, on one site an estimated 1,000,000 seed was produced in 2006.
- A good seedbank is already present in the soil, at least on one site, as this has been established by various soil core/germination experiments and on site activities to stimulate the germination of seed from the seedbank
- Natural recruitment of ***G. scapigera*** seedlings is occurring on two of the 3 translocation sites, this includes a site where competition from Cape weed ***Arctotheca calendula*** is prevalent.
- One site had the irrigation system removed two years ago and is very well vegetated with indigenous species and only a few annual weeds are present on site. ***Grevillea scapigera*** regeneration is also occurring on site
- Genetic erosion has been addressed by additional planting of under-presented clones. On-going monitoring is assessing genetic erosion in the F2 generation.
- Cryostored material has been through the tissue culture process with the plants going on to site and producing seed. Resulting seedlings from these plants have been planted out and are producing their own viable seed. This proves cryostorage is a suitable method of long term storage for this species.
- Original clones are in cryostorage and new clones are added when they become available.
- Large quantities of seed from the translocation sites are in storage.
- More time, e.g. at least 25 years, is required to determine if these sites are naturally self-sustaining in the long term. ***Grevillea scapigera*** is only expected to germinate en-mass after a disturbance event such as fire.

Re-introduction of hammock shrubverbena into South Florida, USA

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Introduction

Hammock shrubverbena (***Lantana canescens*** Kunth, Verbenaceae) is a sprawling woody shrub to 2.5 m. This tropical species has a core distribution that includes South and Central America and the West Indies, where it is apparently secure. At the northern limits of its global range, hammock shrubverbena grows in the extreme southern portions of Florida and Texas, U.S.A. While it is not ranked by Texas natural heritage criteria, it is only found in the three southernmost counties of that region. In Florida, the historic range of hammock shrubverbena was never large; it was restricted to southern Miami-Dade County where it grew in pine/hardwood forest ecotone. Today in Florida, hammock shrubverbena is listed as endangered by the state government (Florida Dept. of Agriculture and Consumer Services), and considered to be critically imperiled by the state natural heritage program (Florida Natural Areas Inventory). Our recent surveys indicated that wild South Florida populations were declining alarmingly. Therefore, we conducted re-introductions in two small nature preserves within the species' native range. We introduced some plants to degraded historic ecotones, and others to a newly-created restoration area that mimicked an early-successional (i.e., post-fire) state.

Goals

- Goal 1: Prevent extinction of ***Lantana canescens*** from Florida.
- Goal 2: Determine which habitat is optimal: historic ecotone or novel restored area.

Hammock shrubverbena (*Lantana canescens*) © Jennifer Possley

Success Indicators

Indicator 1: Recruitment of new ***Lantana canescens*** seedlings.
Indicator 2: Survivorship of outplants.

Project Summary

Feasibility: We faced several challenges in rescuing and re-

J. Possley with hammock shrubverbena seedling in Sept 2006 © A. Ramos

introducing ***Lantana canescens***. First, the species was in rapid decline in Florida. From 2004 to 2007, the single remaining wild population dropped from 44 to 14 plants. The reasons for the decline were not obvious, though ***L. canescens*** was historically found only in a rapidly disappearing habitat type: the ecotone between pinelands and hardwood forests in South Florida Rockland. South Florida Rockland is an upland ecosystem specific to limestone outcrops of the subtropical, southeastern tip of the continental United States. Historically, South Florida Rockland was a mosaic of fire-maintained pinelands interspersed with "islands" of hardwood forest, with the ecotone between the pine and hardwood communities shaped by fire. Today, hardwood hammocks are globally imperiled, pine rocklands are globally critically imperiled, and the ecotones between them are degraded and disappearing. Urban Miami now sits atop the largest section of South Florida Rockland, and forested land within this area has been reduced to less than 2% of its historic extent. Given the irreversible changes to substrate coupled with fire suppression, it is likely that natural ecotones cannot be fully restored in South Florida Rockland. Therefore, we were faced with a major problem: plants were disappearing in their existing habitat, yet there was no intact pine rockland/hammock ecotone in which to re-introduce ***L. canescens***.

Implementation: Working cooperatively with Miami-Dade Natural Areas Management, we began an emergency rescue of the plummeting wild population of ***L. canescens*** in 2004, propagating vegetative cuttings from 30 clonal lines. By 2005, we had hundreds of individuals in one-gallon pots. We chose three different sites for re-introductions. All existed on Miami-Dade County land and we had logistical, labor, and financial support from the land managers to conduct these studies. Two sites were historically appropriate: these were former ecotone that had degraded in the absence of fire and required moderate site preparation to thin hardwoods and weeds. The third site was a restoration area with a long history of disturbance and use, culminating in a dense infestation by non-native, invasive trees (mostly ***Schinus terebinthifolius***). Prior to planting ***Lantana canescens***, county crews uprooted the non-native trees with heavy equipment, mulched them on site, and planted 19 different native species in the area. In July and December 2005, we planted 346 individuals in each of the three outplanting sites. The historic ecotone sites received 270 and 40 individuals, while the restored area received 36 individuals. Soon after planting, we found that great differences in management effort were required to maintain the health of the outplantings in the restoration site versus the historic ecotones. At the restored site plants flourished with little intervention. At the historic ecotone sites,

competing hammock and ruderal species constantly threatened to crowd out ***L. canescens***, which appeared to be a poor competitor. We adapted our management techniques to try to stave off mortality by repeatedly thinning the encroaching vegetation to allow ***L. canescens*** to grow and reproduce. After approximately one year, labor became too costly; therefore we applied native oak mulch around plants to suppress competing vegetation.

Volunteers and staff outplanting
© K. S. Wendelberger

Post-release monitoring: For the first year following re-introduction, we assessed plant survival every 3 - 4 months. At 15 - 18 months, we determined that survivorship was greatest (84%) at the largest planting, which was in a historic ecotone. But, interestingly, we only found significant recruitment in the restored site, which had 267 robust seedlings. The historic ecotone sites each had less than six seedlings, all of which were very small.

Major difficulties faced

- Invasion by native and non-native weeds (i.e., succession worked against us).
- Outplants showed leaf drop, poor health, and little to no recruitment in two of three sites.
- Planting was logistically difficult, in solid rock with little to no soil.

Major lessons learned

- A good working relationship with the managing agency was crucial to success of the project. We depended on management crews to help in outplanting ***L. canescens***, watering plants during the establishment phase, removing encroaching weeds, and protecting plants from damage during other maintenance activities.
- Although we have found few examples of ***L. canescens*** recruitment the wild, hundreds of seedlings have recruited at one of our three re-introduction sites. Therefore, it is likely that conditions where wild populations grow are no longer capable of sustaining the species.
- Although cultivated ***L. canescens*** wilt quickly in full sun, outplants that passed through the establishment phase thrived in full sun, while those in shade faltered and did not reproduce.
- It is not necessary to conduct a re-introduction of ***L. canescens*** in the rainy season, when it is very hot and physically difficult for workers. Winter outplants established just as well as summer ones.

Success of project

Highly Successful	Successful	**Partially Successful**	Failure
		√	

Reasons for success/failure:

- Our first success indicator was recruitment of new ***Lantana canescens*** seedlings. We achieved this goal at one of our three outplanted populations.
- Our second success indicator was survivorship of outplants. Again, this goal was achieved at one of our three outplanting sites. Of the two remaining sites, survivorship remains high at one site, leaving the possibility that recruitment will happen in the future. This is especially likely if a major disturbance (such as a hurricane) affects the site.
- Our goal to prevent the extinction of ***L. canescens*** in Florida has been very successful; we have increased the number of individuals in the wild more than ten-fold.

Supplementation of the autumn buttercup population in Utah, USA, using *in vitro* propagated plants

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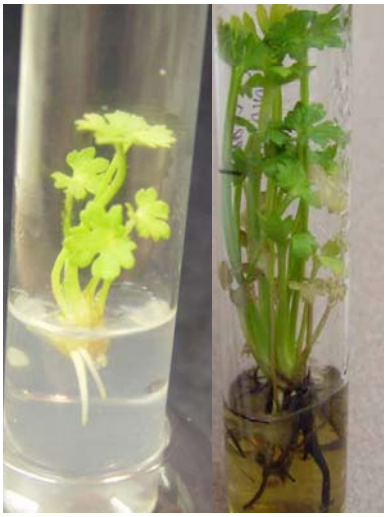
Introduction

The autumn buttercup, ***Ranunculus aestivalis*** (***Ranunculus acriformis*** var. ***aestivalis*** L. Benson), is a wet meadow species limited to one or two small populations located in the Sevier River Valley, 1,963 m elevation, in southwestern Utah. First collected in 1894, it was formally described in 1948. A 1975 report to Congress indicated that the species was thought to be extinct (Ripley, 1975). After being re-discovered in 1982, decline in numbers from approximately 500 to 22 contributed to its listing in 1989 (54 FR 30550). It also has a G1 ranking, and is listed as endangered by the IUCN and as an S1 species in Utah. In 1989, The Nature Conservancy purchased 44 acres containing the last known location of the autumn buttercup. The current known population on the TNC preserve has stabilized within the past few years to approximately 18 individuals. An additional population has been documented approximately 11.3 km north of the preserve, but is not well described since it occurs on private land. This project may establish up to 300 plants, taking an important step in increasing the current population to 1,000 plants and providing the knowledge to

Close-up of Autumn buttercup flowers
© Renee Van Buren



Autumn buttercup plants *in vitro*
© Renee Van Buren

establish new sites as described in the recovery plan (USFWS 1991).

Goals

- Goal 1: To augment or supplement autumn buttercup (***Ranunculus aestivalis***) at The Nature Conservancy Sevier River Valley Preserve, utilizing plants propagated through tissue cultures initiated from parent seed collected within this population.
- Goal 2: To increase numbers of individuals in the current known population, in order to maintain the genetic diversity of the population and fulfill recovery goals, which aspire to 1,000 individuals at this site.
- Goal 3: To document methods used and monitor program progress for established plants over a 5-year period following the initial planting.

Success Indicators

- Indicator 1: Successful germination of a high proportion of the available seed at the Center for Conservation and Research of Endangered Wildlife (CREW).
- Indicator 2: Initiation of sterile, propagating shoot cultures and rooting of those cultures ***in vitro***, with the production of at least five individuals each of at least 60 genetic lines at CREW.
- Indicator 3: Successful transport of plants, ***in vitro***, from CREW to The Arboretum at Flagstaff.
- Indicator 4: Acclimation of the plants to soil and ambient conditions at The Arboretum at Flagstaff (TAF).
- Indicator 5: Identification of suitable locations for the outplanting at the Sevier River Valley Preserve.
- Indicator 6: Successful transport of plants from Flagstaff to the Preserve.
- Indicator 7: Survival of outplanted individuals at the Preserve in the weeks immediately following the outplanting.
- Indicator 8: Survival of the plants in subsequent years of monitoring.

Project Summary

Feasibility Stage: Partners, such as the CREW at the Cincinnati Zoo & Botanical Garden, TAF, Utah Valley State College (UVSC), The Nature Conservancy (TNC), and U.S. Fish & Wildlife Service (USFWS), existed with the expertise to propagate plants using tissue culture methods, acclimate and grow to a transplanting size, facilitate and do research, provide funding and guidance under the Endangered Species Act and provide long-term conservation.

- Habitat: The autumn buttercup is a wet meadow species, which grows on

small rises (hummocks) in the transition zone between a moist Carex (sedge) spring-fed meadow and upland meadow.

- Species: autumn buttercup (***Ranunculus aestivalis***) (L. Benson) Van Buren & Harper (Ranunculaceae).
- Socio-political and economic issues: At the time of listing in 1989, the Autumn buttercup was thought to be extirpated from its type locality due to intense agricultural activities, primarily livestock grazing of wet meadows (54 FR 30550).

Outplanting autumn buttercup
© Linda Whitham

Today's greatest impediment to recovery on TNC lands is low numbers. Purported threats such as grazing have been removed and competition with other plants is being controlled through ecological burns and clipping. Active livestock grazing continues on surrounding private lands. The status of potential existing plants on other private lands is unknown.

Implementation: Each step in the implementation of this project required different expertise and protocols. Work at CREW began with the receipt of 60 seeds from TAF from the population at the Sevier Valley Preserve. These required stratification for germination, and, in some cases, several rounds of stratification, as the seeds did not germinate synchronously. The seeds were germinated aseptically and a separate tissue culture line was initiated from each individual seedling. Because of the labor involved in maintaining culture lines, only four to six shoot cultures of each line were maintained at each subculture. Individual shoots were transferred to a separate medium for rooting. Once the ***in vitro*** plants were of sufficient size and roots were obtained, they were ready for transport to TAF by overnight shipping. From October 2006 to May 2007, TAF received and acclimated 241 plantlets from test tubes to soil pots. In June of 2007, 136 of the largest plants, representing 35 lines of culture, were transported to the Sevier Valley Preserve to be planted. TAF kept 105 plants for future use. Between June and October, 2007, more plantlets were sent to TAF from CREW, for a total of 239 individuals in the greenhouse at TAF over the winter of 2007 - 2008, representing 52 genetic lines. Suitable planting sites were identified at the Preserve by researchers from UVSC. The habitat had been previously described and this description was used to identify the most desirable sites for re-introduction. Two somewhat different micro-habitats were selected, one a more arid site than the other, but both are presently or have historically been occupied with autumn buttercups.

The plants were transported from Flagstaff to the Preserve (approximately 4 hrs) in an enclosed truck. UVSC researchers designed experimental treatments that

would identify the impact of root competition in the planting experiment. All plants were planted in holes dug 1 m apart. At both planting sites, half of the holes were lined with paper to decrease root competition during the first few weeks of growth. Researchers and volunteers from UVSC and TNC carried out the experimental site preparation and planting activities during June, 2007. Once the planting was completed and each individual tagged, measurements were recorded for number of leaves, average vegetative diameter, and general condition for each of the 138 plants included in the design. Following the initial planting, the plants received water once each week for the next six weeks. The monitoring continued each week and data stated above were recorded. UVSC researchers returned to the site early in September 2007, to record data for the growing season. Of the original 138 plants included in the study, 128 had survived the summer (92.8% survivorship). Another group of plants is being prepared at CREW and Flagstaff for outplanting in 2008.

Post-release monitoring: The site will be monitored at least once a year for the next five years to determine survival and measure growth. Results of such post-release monitoring activities. As stated above, survivorship for the first summer following out-planting is over 92%. In addition, the majority (nearly 90%) of the individuals surviving were in good or fair condition and are expected to re-emerge in spring of 2008.

Major difficulties faced

- The entire seed lot does not germinate synchronously. This required additional rounds of stratification in order to induce additional germination.
- Maintaining the large number of different genetic lines in tissue culture. This required maintaining only a few individuals of each line.
- Transport of the large number of plants as ***in vitro*** cultures 3,219 km from CREW (Ohio) to TAF (Arizona). This required careful packing and overnight shipping.
- Occasional plant die-off during acclimation. This was related to insufficient root development in vitro and insect pests in the greenhouse.
- Physically transporting water from the source to the planting sites for the initial weekly waterings. This was made easier by the fact that there was water naturally occurring on the site.

Major lessons learned

- Although tissue culture is a clonal propagation process, with careful monitoring it is feasible to maintain small numbers of many genetic lines, in order to provide genetic diversity for outplanting projects.
- Having a larger number of plants to work with, in this case provided by tissue culture propagation, contributes to a greater likelihood of success.
- The initial size of the plants is important for success with this species.
- Outplanting sites and the timing of planting need to be carefully determined by having an understanding of the habitat requirements for the species.
- Strong coordination of all parties is important.
- What can be accomplished by bringing together people with various expertise

and resources to address a specific goal - in this case the goal of increasing the numbers of the autumn buttercup.

Success of project

Highly Successful	Successful	Partially Successful	Failure
√			

Reasons for success/failure:

- The project brought together groups with several areas of expertise and resources: Site protection and source of seeds (TNC), tissue culture propagation expertise and facilities (CREW), facilities and expertise for acclimation and growth to planting size (TAF), expertise on the species' habitat, site characteristics and general biology (UVSC), labor for planting and monitoring (UVSC, TNC), funding and coordination of the project (USFWS).
- These groups were well coordinated and each fulfilled their tasks and responsibilities for the project.
- The plants had a high degree of survival initially and through the first summer, increasing the number of plants ***in situ*** approximately six-fold. More plants will be added in 2008.

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Recovery of smooth coneflower in the Chattahoochee National Forest, Georgia, USA

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Introduction

Smooth coneflower (***Echinacea laevigata***, Boyton & Beadle) Blake, was listed as federally endangered in 1995. It is rare throughout its range, listed as endangered in Georgia, North Carolina and Virginia, and of special concern in South Carolina. It is considered extirpated in Pennsylvania. In Georgia, it is found only in two counties, Habersham and Stephens where there are 25 occurrences, comprising four geographically distinct populations. Smooth coneflowers are found in shallow, rocky soils high in calcium and magnesium. Populations occur in open woodlands or human-maintained roadsides on United States Forest Service land and utility rights-of-way. Historically, they were found in prairie habitats and post oak-blackjack oak-pine savannas that were maintained by fire. The objective for downlisting the species to threatened status is 12 geographically distinct, self-sustaining populations that are stable or increasing in number for 10 years or more (US Fish and Wildlife Service, 1995).

Freshly planted smooth coneflower © Jennifer Ceska

Goals & Indicators

- Goal 1: Broad-scale restoration of the post oak-blackjack oak-pine savannah plant community by prescribed burning and manual thinning for landscape and biodiversity.
- Indicator 1: An average of no more that 3.7 to 5.6 m^2 of basal woody stem area per 0.4046 ha consisting of an post oak (***Quercus stellata***), blackjack oak (***Quercus marilandica***) and shortleaf pine (***Pinus echinata***) mosaic with mixture of forbs and grasses dominating the understory. A reduction in ***Acer rubrum***, ***Cornus florida***, ***Oxydendrum arboreum*** and ***Nyssa sylvatica*** resulting in a sparse mid-story (pers. com. Jimmy Rickard, US Fish and Wildlife Service).

- Goal 2: Sustain and enhance individual smooth coneflower populations by maintaining the required open habitat by prescribed burning and manual removal of woody

competition.

- Indicator 2: Steady or increasing population size, increased flowering, and seedling recruitment following burns and manual clearing.

- Goal 3: Translocation, re-introduction, and augmentation of populations of smooth coneflowers within the managed area of their natural range for species recovery.
- Indicator 3: Germination, plant survival, reproduction, and recruitment of smooth coneflowers following translocation.

- Goal 4: Translocation of rare associates (***Clematis ochroleuca***, ***Lysimachia fraseri***, ***Oligoneuron album*** , and ***Symphyotrichum georgiana***) to smooth coneflower recovery sites for community level restoration.
- Indicator 4: Survival, reproduction, and recruitment of ***Clematis ochroleuca***, ***Lysimachia fraseri***, ***Oligoneuron album*** , and ***Symphyotrichum georgiana*** following translocation.

Lisa Kruse preparing ground for smooth coneflower seeds

Project Summary

Feasibility: Habitat destruction and alteration are the primary causes of decline. It is thought that smooth coneflower requires disturbance and that suppression of fire is a cause for its decline (Gaddy, 1991). The majority of known populations occur on roadsides and utility rights-of-way where they are vulnerable to human impact. The few undisturbed populations are declining in number and size as succession shades out the understory (Gaddy,1991). Protection, monitoring and management are vital to the preservation of the remaining smooth coneflower populations. The recovery plan calls for wild-re-introduction and safeguarding throughout the range of the species (US Fish and Wildlife Service, 1995). Echinacea is an exclusively North American genus, which ranges from the midwest to the eastern United States. ***Echinacea tennesseensis***, a central Tennessee cedar glade endemic, is also endangered. Interest in ***Echinacea*** stems from its long history as a medicinal herb and, more recently, from its popularity as a garden ornamental. All species of ***Echinacea*** are at risk of wild collection.

Smooth coneflower is a rhizomatous perennial, which flowers in May through July; its primary mode of reproduction is sexual, by outcrossing (Leuszler ***et al.***, 1996). Reproductive success appears inadequate for maintaining population size in the wild (Gaddy, 1991). Bare soil, rich in magnesium and/or calcium, is thought to be a requirement for germination and growth in the wild (Gaddy, 1991); however, germination ***in situ*** is high (80 - 90%). Healthy, reproductive plants may

Close up of smooth coneflower

be easily grown in standard potting mix. The majority of seedlings appear to be clustered in the vicinity of adult plants. Seed dispersal by animals is likely, but has not been documented (Gaddy, 1991).

Populations of smooth coneflower sampled from North Carolina, South Carolina and Virginia were found to have moderate levels of genetic diversity, comparable to that of the widespread congener ***E. angustifolia*** DC. Significant population structure was documented, with each population containing about 90% of the total genetic variation. This partitioning of genetic variation has implications for the collection of material for conservation efforts as populations may be locally adapted (Apsit & Dixon, 2001). Recovery efforts in Georgia are headed by a multi-agency committee comprising members of the Georgia Plant Conservation Alliance (GPCA). Smooth coneflower recovery has been a priority of GPCA since its inception in 1995. Collaborators for the project include The US Fish and Wildlife Service (USFWS), USDA Forest Service, Georgia Department of Natural Resources Non-Game Conservation Section, Georgia Forest Watch, The State Botanical Garden of Georgia (SBG), and the University of Georgia. Funding for this project came from several sources. A grant from the Turner Foundation. supported the research of the graduate student who designed and carried out the experimental re-introduction. The Georgia Department of Natural Resources and USFW provide funds for the State Botanical Garden of Georgia (SBG) to collect and propagate plants for habitat restoration. Private donations to the SBG Plant Conservation Program enable SBG staff to recruit and supervise volunteers who participate in the project. Forest Service appropriations support prescribed burning. GPCA member institutions provide generous in-kind support in the form of staff time, transportation, propagation facilities, equipment, and supplies.

Implementation

Sites for translocation of populations were chosen based on a variety of factors including: general proximity to existing populations, suitability of habitat, logistical accessibility, and appropriateness for prescribed burns. Sites were chosen that closely resemble extant habitat in terms of plant community, soil type and composition, slope and aspect. The unique characteristics of smooth coneflower habitat made site selection relatively straight forward. Before translocations were conducted on a wider basis, a preliminary experimental re-introduction was conducted in the course of a Master's thesis. Different methods of transplanting ***Echinacea laevigata*** were tested according to a carefully designed and statistically valid protocol (Alley & Affolter, 2004). The success of the experimental re-introduction (as high as 95% survival over two years) was influential in moving

governmental agencies to support translocation as a tool for larger scale restoration and safeguarding. Landscape level habitat restoration included a spring prescribed fire affecting all of the three translocation sites. The prescribed burn was conducted 18 months prior to planting. Specific translocation sites, each approximately 400 m^2 (20 m x 20 m), received an additional treatment of woody competition removal (shrubs, mid-story and canopy) three months prior to the outplanting. Two additional sites are being prepared for augmentation and translocation in 2008. Subsequent prescribed burns are scheduled on a three-year cycle.

The preliminary experimental re-introduction indicated bare-root planting was a viable means of transplanting seedlings, but the logistics of this method proved difficult. Further, it is not clear to what extent root washing can prevent disease spread. Therefore, plants were quarantined prior to translocation and visually inspected for disease. The plants were grown in isolation from other ***Echinacea*** species, flowers were removed, and carefully weeded to reduce the risk of disease, hybrids, and weeds being introduced to the wild. The translocation sites are geographically isolated from any extant populations. The effectiveness of direct seeding is also being explored as a possible circumvention to such risks from future translocations and augmentations. The first in a series of translocations took place in the late fall of 2007. Over 100 one-year old smooth coneflower plants and 300 seeds were sown at each of the three sites. Four other rare species (***Clematis ochreleuca***, ***Lysimachia fraseri***, ***Oligoneuron album***, and ***Symphyotrichum georgiana***) associated with smooth coneflower habitat are being propagated for outplanting at these safeguarding sites.

Post-release monitoring: The restoration effort is being monitored at both the landscape and individual translocation site levels. At the landscape level, a set of six, long-term, prescribed fire effects/habitat restoration monitoring plots have been established. The plots are 0.1 ha each (50 m x 20 m) and employ the North Carolina Vegetation Survey Pulse Method, based upon a modified Whittaker design. Data collected include species composition (all plants), and woody plant diameters (dbh). Plots are located in both restoration areas and in relatively intact "reference" sites. Data were collected both pre- and post-restoration treatments. Individual translocation site monitoring follows the fate of individual translocated plants (a quantitative measurement) and the relative success of direct sowing (a qualitative assessment). Future reproductive success of the translocated plants and their offspring will be documented.

Major difficulties faced

- Prioritizing species recovery on multi-use public land.
- Effects of drought.
- Coordinating multi-agency effort.
- Staff turnover.

Major lessons learned

- The success of this project is owed to the collaboration of multiple partners

over the span of a decade.

- A project of this scope requires long-term involvement of both personnel and agencies.
- Such projects offer graduate students opportunity to collaborate with conservation professionals in a hands-on way that is mutually beneficial.
- A scientifically designed preliminary study is valuable in defining management strategies.

Success of project

Highly Successful	**Successful**	Partially Successful	Failure
	√		

Reasons for success/failure:

- GPCA Partnership.
- Long-term involvement of both personnel and agencies.
- Careful definition of goals, planning, and defined outcomes.

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An adaptive approach to translocating and augmenting the rare scrub mint to Savannas Preserve State Park, Florida, USA

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Introduction

Savannas mint, ***Dicerandra immaculata*** Lakela var. ***savannarum*** Huck (Lamiaceae), is a rare mint endemic to xeric, oak-hickory scrub communities with sandy, well-drained soils along the Atlantic Coastal Ridge in extreme southern St. Lucie County, Florida. The genus Dicerandra has been reported as the highest ranked genus of rare southeastern endemic plants (Estill & Cruzan, 2001). Savannas mint is a variety of the rare Lakela's mint, ***D. immaculata*** var. ***immaculata***, which occurs 25 km to the north. ***D. immaculata*** is listed as Federally Endangered by the U.S. Fish & Wildlife Service and State Endangered by Florida Department of Agriculture and Consumer Services. Savannas mint was discovered in 1995 by George Gann and Keith Bradley of the Institute for Regional Conservation (IRC). A 2007 survey by IRC indicated only 81 remaining individuals of Savannas mint (Woodmansee ***et al.***, 2007). Savannas Preserve State Park (SPSP) encompasses approximately 6,500 acres and contains a mosaic of fire dependent natural communities including pine flatwoods, wet prairie, basin marsh and scrub. The park is home to many species of rare and endangered plants and animals, including endemic scrub plant species. The translocation project area within SPSP is located approximately 5 km north of the originally described population.

Goals

- Goal 1: Have all germplasm remaining in the naturally occurring species represented within the introduced population.
- Goal 2: Establishment of multiple, distinct colonies on protected lands as to minimize risk of potential negative impacts of stochastic events

Savannas mint (*Dicerandra immaculata* Lakela var. *savannarum*)

Close-up of savannas mint flower

(e.g. hurricanes, wildfires).

- Goal 3: Create self-sustaining populations, with demographic dynamics mirroring wild populations of the closely-related Lakela's mint (***Dicerandra immaculata***) as outlined by USFWS Recovery Plan.
- Goal 4: Examine specific microsite paramenters and survival of translocated populations to provide guidance for future re-introduction efforts through an adaptive approach.

Success Indicators

- Indicator 1: Survival and vigor of planted individuals.
- Indicator 2: Recruitment of Individual seedlings.

Project Summary

Feasibility: The scrub habitats within SPSP are part of the larger Atlantic Coastal scrub ridge, a relict dune system in which the naturally occurring population of Savannas mint exists. SPSP habitat is suitable in that it contains coastal scrub with many of the same microsite characteristics as the location of the originally described population. SPSP represents the closest protected conservation lands available to protect, monitor, and manage Savannas mint. The relocation site is also located out of pollination distance of other closely-related endemic Florida mint species, so hybridization should not be an issue. The original range of this species is unknown because of its more recent discovery, and not having been described by Huck until 2001. Historic agricultural practices until the mid 1900s as well as habitat conversion for residential homes does not allow for extrapolation of historic range. However, survey efforts for individual plants on private property have yielded no additional populations. The originally discovered population occurs partially along a roadside within private parcels slated for housing development and partially within an area heavily disturbed with the encroachment of exotic invasive plants such as Brazilian pepper and rosary pea. The native component consists of scrub oaks and scrub hickory. Fire has been suppressed in the area, resulting in an unnaturally high vegetation canopy cover. Overshading as a result of increased canopy cover has been known to limit habitat occupancy of some ***Dicerandra*** species (Menges, 1999). For these reasons, long-term survival of the naturally occurring population is unlikely.

Implementation: Clonal propagation was achieved through apical cuttings taken during new spring growth, from February through May. However, since there are very few 'parent' plants and only up to five cuttings can be taken from each plant

annually without a measurable negative effect on plant survival and seed production, only roughly 300 cuttings are taken each year. Cuttings are rooted in greenhouse conditions using auxin-based plant growth regulators and a 1:1 native soil:Fafard mix in cell pots under plastic domes. Rooting takes place in two to four weeks. Rooted cuttings are potted into quarts and grown for two to four months. Two weeks prior to outplanting the potted clones are removed from greenhouse conditions to 'harden' in outdoor conditions. All reproductive structures are removed prior to outplanting to ensure no hybridization with other species has occurred. The success rate of propagation through cuttings varies from 50% - 75%, yielding only about 200 clones for an introduction each year. Annual seed germination trials can yield another 100 - 200 individuals for the introduction each year. Plants are transplanted within the translocation site with the use of hydrating gel granules and sufficiently watered in. Research plots have been established to monitor microsite variables. Regular irrigation continues for approximately two months depending on local rain events.

Post-release monitoring: Annual monitoring of the translocated population is conducted in November to coincide with peak flowering. Data is collected on individual survival, vigor (flowering and seed production), and recruitment. Initial monitoring efforts indicate a 51% survival rate. Of those plants that survived initial planting, 83% were observed to have flowering or seed capsules. A total of 67 new seedlings were also observed one-year post planting. It is expected that additional recruitment will occur as time passes and the seed bank is established. Long-term monitoring will determine microsite habitat preference and if the population will be able to self sustain in perpetuity or if future plantings are required. To date the translocation project has occurred at one site within SPSP. The monitoring results being collected from the site will help dictate future translocation sites within SPSP. Future microsite selection will be based on optimal conditions observed as a result of the initial planting data with respect to canopy cover and presence of leaf litter vs. open sand areas. Having such an adaptive approach will maximize the understanding of the biology of this species while still being able to proceed with translocation efforts preventing potential extinction.

Major difficulties faced

- Obtaining private landowner permission for collection of seeds and cuttings.
- During drought years there can be insufficient new growth for the taking of cuttings.
- Limited knowledge of species as a whole (e.g. historic range).
- Residential development pressures on naturally occurring population.

Major lessons learned

- Successful translocations must be a multi-year project in order to minimize impact on wild remaining individuals, to include representatives from all parents within the new population and to track ongoing success.
- Collaboration with local agencies, citizens, and conservation organizations is key to a comprehensive approach.

Success of project

Highly Successful	Successful	Partially Successful	Failure
√			

Reasons for success/failure:

- Good collaboration and communication between agencies involved in introduction project.
- The vigor of Savannas mint.

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Re-introduction of Pitcher's thistle at Illinois Beach State Park, Illinois State, USA

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Introduction

Pitcher's thistle (***Cirsium pitcheri***) occupies western Great Lakes shorelines and is listed by the U.S. Fish and Wildlife Service as Threatened. ***C. pitcheri*** colonizes upper beaches, foredunes and blowouts maintained by cyclic natural disturbance processes. Because this short-lived monocarpic species does not spread vegetatively, recurring cohort establishment by seedling recruitment is required to maintain populations. Natural populations of this species occur in the states of Michigan, Indiana and Wisconsin, but it was extirpated from Illinois in the early 1900s. Our oldest re-introduction is at Illinois Beach State Park, some of the last protected dune habitat in Illinois. The fundamental theme of our research is to understand the interplay of demography and genetics in population persistence by comparing long-term dynamics of natural and experimentally restored plant populations. Our data set includes long-term data (up to 18 years) for both restored and natural populations of ***Cirsium pitcheri***.

Goals

- Goal 1: With federal listing and recovery planning, the re-introduction at Illinois Beach State Park became an important opportunity to test whether the species could be successfully restored, thereby improving its population status and reversing its extirpation in Illinois.

Success Indicators

- Indicator 1: Positive population growth rate, as indicated by population viability analysis (PVA), and occupation of

Close up view of Pitcher's thistle (*Cirsium pitcheri*) © Martin Bowles

Pitcher's thistle on shoreline habitat © Martin Bowles

available habitat.

Project Summary

Protection of a large portion of the Illinois shoreline as a state park provided the only remaining Illinois dune system where ***Cirsium pitcheri*** restoration could be tested (Bowles ***et al.***, 1993). Because ***C. pitcheri*** persists as metapopulations, re-introduction into multiple habitats was required (McEachern ***et al.***, 1994). Illinois Beach State Park is located on a low (up to three meters of relief) narrow (1.5 km wide) sand deposit that extends for over 20 km along the Lake Michigan shoreline. The shoreline is dynamic, with sediment transport southward by the longshore current; former beach ridges form a compressed dune field north of the Dead River and a more widely spaced dune ridge and swale system south of the Dead River. In a detailed study, secondary dunes south of the Dead River were found to replicate appropriate habitat for this species and appeared to be free from shoreline erosion and recreational impacts (Bowles, 1991 & Bowles ***et al.***, 1993). This area was recommended to the Illinois Endangered Species Protection Board as an initial re-introduction site for Pitcher's thistle (Bowles, 1991). To meet meta-population requirements dunefield habitat north of the Dead River was also recommended for re-introduction of this species; however, this area has greater shoreline erosion than south of the Dead River (McEachern ***et al.***, 1994).

Major difficulties faced

- Finding sufficient funding to support the project.
- Collecting sufficient numbers of propagules.
- Developing propagation and restoration techniques.
- Altered shoreline processes limited restoration.

Major lessons learned

- A long time period required for natural recruitment.
- Slow growth rate of population.
- Vital rates of transplants and naturally recruited plants differ.

Success of project

Highly Successful	Successful	**Partially Successful**	Failure
		√	

Reasons for success/failure:

- Population is demographically unstable due large annual variation in population numbers and recruitment.

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Experimental introductions of Florida ziziphus on Florida's Lake Wales Ridge, USA

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Introduction

Florida ziziphus, ***Ziziphus celata*** (Rhamnaceae) Judd and D. Hall, is listed as VU -D1 (vulnerable to extinction due to a population <1,000 mature individuals) by the IUCN (World Conservation Monitoring Center, 1998). It is also listed as Endangered by the US Fish and Wildlife Service (USFWS, 1999) and by the state of Florida (Coile & Garland, 2003). A thorny, multi-stemmed clonal shrub to 2 m in height, Florida ziziphus is known from fewer than a dozen populations along a 45 km stretch of the Lake Wales Ridge, an area renowned for its many narrowly endemic plants. All known populations occur in pyrogenic xeric uplands, but most of these sites have been converted to cattle pastures.

Only two populations are publicly protected. Florida ziziphus is self-incompatible (Weekley & Race, 2001) and genetically depauperate (Godt ***et al.***, 1997 & Weekley ***et al.***, 2002). Most populations consist of a single genotype. Altogether, wild populations comprise <30 genotypes and only two mating types. Due to its incompatibility system and the distance between populations, most populations are self-sterile. Historic Bok Sanctuary, an affiliate of the Center for Plant Conservation, maintains a multi-genotype ***ex situ*** population that has produced several thousand fruits since its establishment in 1989.

Florida ziziphus (*Ziziphus celata*)

Goals

- Goal 1: Establish demographically viable, genetically diverse, and sexually reproducing populations in appropriate habitat on protected sites.
- Goal 2: Increase understanding of the microhabitat requirements and autecology (e.g. fire ecology).
- Goal 3: Maintain and strengthen collaborations with Historic Bok Sanctuary (***ex situ*** population is source of propagules for introductions), Florida Museum of Natural History's Laboratory of

Molecular Systematics and Evolutionary Genetics (genetic analysis is critical component of introductions), other researchers who contribute to our understanding of the biology of Florida ziziphus, and private and government agency land managers.

Planting Florida ziziphus

Success Indicators

- Indicator 1: Transplant survival rates >70% for introduced potted plants.
- Indicator 2: Seed germination rates >10% for introduced seeds.
- Indicator 3: Flowering by individuals of multiple mating types.
- Indicator 4: Production of viable fruits within introduced population.

Project Summary

Feasibility: Florida ziziphus is known exclusively from pyrogenic xeric upland sites that historically supported longleaf pine (***Pinus palustris***)-wiregrass (***Aristida stricta*** var. ***beyrichiana***) sandhills. Most of the endemic-rich sandhill habitat on the Lake Wales Ridge was lost to citrus and cattle ranching decades ago and the remainder has been degraded by decades of fire suppression. Genetically depauperate remnant populations of Florida ziziphus occur primarily in privately owned cattle pastures. Restoration of viable populations requires the introduction of genetically diverse cross-compatible mating types to protected sites containing fire-maintained sandhill habitat. Since 2002, we have carried out two major introductions, comprising 430 potted transplants and 4,728 seeds.

Each introduction was designed as an experiment to evaluate the relative efficacy of transplants vs. seeds in the establishment of new populations, to investigate the microhabitat requirements of transplants, seeds and seedlings, and to explore the performance of propagules representing different maternal lineages. Here we compare 1) the establishment rates of transplants vs. on-site seedlings in the two introduction sites, and 2) the vital rates of transplants and seedlings in the two sites.

Implementation: In June 2002, we introduced 144 two to three year old potted plants and 1,728 seeds to the Lake Wales Ridge National Wildlife Refuge (Carter Creek). Equal numbers of transplants and seeds were introduced into each of 36, 5 m radius plots representing three experimental treatments: burn-only, chainsaw felling of subcanopy followed by burning (saw-and-burn), and an untreated control. Thus, introduction plots contained a range of microhabitat conditions defined by the percentage of subcanopy shade, litter, bare sand, and co-occurring

shrub cover. The second experimental introduction was carried out in June 2005 at The Nature Conservancy's Tiger Creek Preserve. Into five sandhill sites representing a range of habitat quality from "good" to "poor", we transplanted 286 1 - 2 year old potted plants and sowed 3,000 seeds. Habitat quality was defined by TNC land managers based on widely used criteria for sandhill restoration, including an open subcanopy, low shrub cover, extensive graminoid cover, and high herb diversity.

Post-introduction monitoring: Introduced transplants were monitored at least quarterly for the first year and at least annually thereafter; seed arrays, each containing 24 seeds, were monitored at least monthly for four to six months for seedling emergence.

Transplants vs. seeds as effective propagules for introduction: Transplants outperformed seeds as effective propagules in both the Carter Creek and the Tiger Creek introductions. At Carter Creek, cumulative transplant survival 4.5 years post-introduction stood at 76.4%, while the 1,728 introduced seeds resulted in only three surviving seedlings, an establishment rate of 0.17%. At Tiger Creek, two years post-introduction, cumulative transplant survival was 72.4%. The 3,000 seeds yielded 47 seedling survivors, a 1.57% establishment rate. Thus, despite the greater expenditure of time and effort required to produce transplants, their greater survival rates make them the propagule of choice in introductions. However, direct seeding is still important because seeds are easy to introduce and they may provide critical data on the germination ecology of Florida ziziphus. Raising seedlings ***ex situ*** is troublesome, despite higher germination rates, because nursery-grown seedlings suffer high mortality.

Vital rates of transplants and seedlings in contrasting sites and microsites: Cumulative transplant survival was higher at Carter Creek after 4.5 years (76.4%) than at Tiger Creek after two years (72.4). Annual transplant survival also differed dramatically at the two sites, averaging 94.8 ± 3.3% Carter Creek, and 74.1± 4.5% at Tiger Creek. However, transplants at Tiger Creek experienced greater growth than those at Carter Creek. Surviving Tiger Creek transplants gained a median of 3.25 cm in height, a 40.8% increase in <2 years, while growth a Carter Creek was negligible (median of 0.5 cm, a 1.6% increase) after 4.5 years. However, cumulative transplant survival has been >60% in all sites, suggesting that Florida ziziphus has broader habitat tolerances than previously thought. Seed germination percentages differed only marginally at the two sites ($\chi^2 = 4.062$, df = 1, $p = 0.044$). It was slightly higher at Tiger Creek (4.8%) than at Carter Creek (3.6%). Seedling survival at the two sites differed significantly two years post-sowing ($\chi^2 = 15.766$, df = 1, $p < 0.001$), however; it was almost five times greater at Tiger Creek (32.4%) than at Carter Creek (6.5%). Tiger Creek seedlings averaged 6.2 ± 3.9 cm in height 15 - 18 months post-germination (range 1.4-20.5 cm), while after 4.5 years Carter Creek seedlings averaged 9.0 ± 2.0 cm (range 1.0-11.0 cm). Thus, while transplant survival was higher at Carter Creek, both seed germination and particularly seedling survival were higher at Tiger Creek. In addition, both transplant and seedling growth at Carter Creek were negligible compared to Tiger Creek. These differences may reflect difference in the quality

of available propagules or of difference in the quality of introduction microsites.

Major difficulties faced

- Paucity of genetic variability and mating types within extant populations may constrain seed production and subsequent seedling recruitment.
- Propagating new genotypes from seeds is slow and uncertain due to low rates of seed germination and high rates of seedling mortality.
- Transplant shock and animal disturbance are threats to introduced plants.

Major lessons learned

- Transplants are more successful than seeds as introduction propagules because of high transplant survival rates (>75% one year post-introduction), low seed germination rates (<5%), and low seedling survival rates (<35%).
- High rates of transplant survival in a range of microhabitats suggest that Florida ziziphus is more tolerant of shade and competition than previously thought.
- Multi-disciplinary collaboration among conservation ecologists, geneticists, and land managers is critical in ensuring a scientifically sound and successfully implemented introduction strategy.

Success of project

Highly Successful	Successful	**Partially Successful**	Failure
		√	

Reasons for success/failure:

- Transplant survival >70%, but 4.5-year old transplants have not grown.
- Seed germination and seedling survival have been lower than projected, but most surviving seedlings have shown steady growth.
- Introductions have increased our understanding of microhabitat requirements and autecology of Florida ziziphus.
- Introduced plants have not yet flowered, so we cannot assess whether populations are reproductively viable.

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Conservation and re-introduction of the tiger orchid and other native orchids of Singapore

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Introduction

Singapore consists of a main island and many offshore islands making up a total land area of more than 680 km^2. Although Singapore is a modern city, there are many interesting types of natural habitats. In the heart of the main island is a primary rainforest and freshwater swamp forest. In addition, some mangrove also remain. The other habitats consist of secondary forests, shrub, grasslands and urban parks and fields. Some 221 species of native orchid have been recorded in Singapore. However, about 170 orchid species are already considered to be extinct and only four are viewed as common. Our orchid conservation program aims to monitor these species and to attempt to explore ways to conserve their germplasm and to increase their number for subsequent re-introduction into appropriate habitats, parks and roadside. So far, we have successfully re-introduced, ***Grammatophyllum speciosum***, ***Bulbophyllum vaginatum*** and ***Bulbophyllum membranaceum***.

Goals

- Goal 1: To explore ways to conserve their germplasm.
- Goal 2: To increase their number for subsequent re-introduction into appropriate habitats, parks and roadside.
- Goal 3 To share our experience with others.

Success Indicators

- Indicator 1: To carry out research to develop methods to propagate the species.
- Indicator 2: To re-introduce the species successfully.
- Indicator 3: To disseminate the know how through publications and presentation at international and conferences.

Close up of tiger orchid (*Grammatophyllum speciosum*)

Project Summary

A comparison of habitats in the Island 150 years ago with

Arrow showing tiger orchid planted on a tree in Singapore

today, shows that most of the mangrove and marshy areas have been replaced by industrial estates or residential areas. Forest and mangrove areas such as those at Choa Chu Kang, Jurong, Ang Mo Kio and Serangoon, where native orchids used to thrive, no longer exist. Native orchids of Singapore are seriously endangered. In 1998, about 221 species of native orchid were recorded in Singapore (Keng ***et al.***, 1998). However, based on lists in a preliminary report on the conservation status of plants native to Singapore (Ng and Wee, 1994 & Tan, 1995), about 170 orchid species are already considered to be extinct and only four are viewed as common. The remaining are placed within the "Endangered", "Vulnerable" and "Rare" categories or have an indeterminate status. This means that more than 90% of the native orchids in Singapore are either endangered, vulnerable, rare or extinct. Therefore an orchid conservation program was initiated to monitor these species and to attempt to find ways and means to conserve their germplasm and to increase their number for subsequent re-introduction into appropriate habitats in the nature reserves, parks and roadside trees. First, we want to propagate the species vegetatively and by ***in vitro*** culture. To increase the population of some of the rarer species, they will either be selfed or sibbed, seeds are germinated ***in vitro*** (Yam & Weatherhead, 1988) and seedlings are introduced back to nature. So far, we have managed to propagate several species and have introduced three species, ***Grammatophyllum speciosum***, the tiger orchid, ***Bulbophyllum vaginatum*** and ***Bulbophyllum membranaceum***, back to the nature areas in Singapore.

Mr H. N. Ridley, a Director of the Gardens recorded that the tiger orchid was found in the wild in Toas (Tuas) and Pulau Ubin in 1900 (Ridley, 1900). Unfortunately, naturally occurring plants are now extinct. A few years ago, a tiger orchid in the Gardens flowered and was self-pollinated. The huge seedpod was harvested seven months later. Seeds germinated one month after being sown on Knudson C (Knudson, 1946) medium. After 12 months in the laboratory, the seedlings were planted out in the nursery. Since the tiger orchid occurred naturally in Pulau Ubin, the first batch of seedlings was re-introduced there in July 1999 when they were 26 months old and about 15 - 20 cm tall with 5 - 6 leaves. They were affixed on durian, rambutan, mango, Angsana, Tembusu and rain trees. Seedlings were also planted on trees in the Gardens, around the Visitor Centre at the Bukit Timah Nature Reserve, and in the Orchard Boulevard area in the heart of the city. With experience from the initial trials, we decided to introduce seedlings to the Bukit Batok Nature Park in the beginning of 2001. This time, the

seedlings were more mature, about 30 - 40 cm tall with 16 - 20 leaves. They had at least three shoots, a well-established root system and fleshy pseudobulbs. In February 2001, these larger seedlings were planted on trees along Orchard Boulevard and on the yellow rain trees around the Bandstand in the Gardens. In April 2001, the same was introduced to a site adjacent to a mangrove area in Pulau Ubin, and in early May again to the Bukit Timah Nature Reserve. Lastly, 40 seedlings were planted on rain trees along Holland Road. In December 2002, some 40 seedlings were planted on trees at the Upper Pierce Reservoir.

Orchid - ***Bulbophyllum vaginatum***

The seedlings we planted have been growing for six to seven years in their new homes. We observed that those in Pulau Ubin, Orchard Boulevard, Holland Road and Upper Pierce Reservoir are doing well. New shoots have developed and roots are firmly established on tree trunks. Unfortunately, most seedlings planted in the Gardens and the Bukit Timah Nature Reserve were damaged or removed by animals (probably by squirrels and monkeys respectively) (see table 1).

Table 1. Survival rate of re-introduced seedlings of *Grammatophyllum speciosum* to various parts of Singapore

Location	Seedling size (cm)	Survival rate (%)
Pulau Ubin	15 - 20 30 - 40	35 90
Bukit Timah Nature Reserve	15 - 20 30 - 40	10 75
Botanic Gardens	15 - 20 30 - 40	10 70
Orchard Boulevard	15 - 20 30 - 40	45 90
Bukit Batok Nature Park	30 - 40	90
Holland Road	30 - 40	95
Upper Pierce Reservoir	30 - 40	95

Furthermore, two other native orchids, ***Bulbophyllum vaginatum*** and ***Bulbophllym membranaceum*** have been successfully propagated and re-introduced. Seeds of these species were collected from plants growing at their natural habitats. The seeds were sown on Knudson C medium. Seedlings were grown on the media to 2 - 3 cm tall before being transferred to the nursery. Some 10 seedlings were planted on each fern bark measuring 7 cm long by 5 cm wide.

There were grown at the nursery for six months until new shoots began to develop, they were then re-introduced. Trees were selected based on the same criteria used for re-introducing the tiger orchid. When a suitable tree is selected, fern barks with established seedlings were secured on the tree trunk by nails. So far, some 500 seedlings of ***Bulb. vaginatum*** and ***Bulb. membranaceum*** have been re-introduced. Over 90% have settled down and growing well in their new homes. We have learnt that these seedlings are best planted in slightly shady area, with at least 50% shade so that they will not get scorched. We are very pleased to report that most of these seedlings have produced new shoots and are growing onto the bark of the host tree.

Major difficulties faced

- Most seedlings planted in the Gardens and the Bukit Timah Nature Reserve were damaged or removed by animals (probably by squirrels and monkeys respectively).
- Some seedlings introduced did not survive due to change in microclimate such as removal of adjacent trees or major branches.
- Some tree where the species were planted were removed due to diseases and other developmental projects.

Major lessons learned

- Several factors appear to play important roles in the survival of introduced seedlings. These include the microclimate of the area (relative humidity, for example), texture of bark of the host, presence of other epiphytes and the size of seedlings.
- Seedlings of ***G. speciosum*** planted in areas with high relative humidity tend to survive better than those in dry areas. For example, in Pulau Ubin, seedlings established in a damp area inside a secondary forest are healthier and more vigorous than those growing near the sea where the breeze tends to dry the bark faster.
- Texture of the bark is important because certain barks tend to retain more moisture. For instance, Rain trees are generally better hosts than Tembusu. trees that support more epiphytes tend to be better hosts than those with fewer epiphytes. It seems that if the conditions are suitable for other epiphytes, they are also more appropriate for ***G. speciosum***.
- The size of seedlings of ***G. speciosum*** is also an important factor in determining survival. Seedlings with 16 - 20 leaves (30 - 40 cm tall) tend to survive better than those with only five leaves (15 - 20 cm tall).
- For ***Bulbophyllum vaginatum*** and ***Bulbophyllum membranaceum***, we have learnt that these seedlings are best planted in slightly shady area, with at least 50% shade so that they will not get scorched.

Success of project

Highly Successful	Successful	Partially Successful	Failure
√			

Reasons for success/failure:

- The seedlings of ***Grammatophyllum speciosum*** planted have been growing for six to seven years in their new homes. More than 80% in Pulau Ubin, Orchard Boulevard, Holland Road and Upper Pierce Reservoir are doing well. Two of the re-introduced plants have flowered.
- Over 90% re-introduced seedlings of ***Bulbophyllum vaginatum*** and ***Bulbophyllum membranaceum*** are growing well in their new homes. Most of these seedlings have produced new shoots and are growing onto the bark of the host tree. Several seedlings of ***B. vaginatum*** planted have flowered.

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The IUCN Position Statement on Translocation of Living Organisms

INTRODUCTIONS, REINTRODUCTIONS AND RE-STOCKING
Prepared by the Species Survival Commission in collaboration with the Commission on Ecology, and the Commission on Environmental Policy, Law and Administration
As approved by the 22nd Meeting of the IUCN Council, Gland, Switzerland, 4th September 1987

FOREWORD

This statement sets out IUCN's position on translocation of living organisms, covering introductions, re-introductions and re-stocking. The implications of these three sorts of translocation are very different so the paper is divided into four parts dealing with Introductions, Re-introductions, Re-stocking and Administrative Implications, respectively.

DEFINITIONS:

Translocation is the movement of living organisms from one area with free release in another.
The three main classes of translocation distinguished in this document are defined as follows:

- **Introduction** of an organism is the intentional or accidental dispersal by human agency of a living organism outside its historically known native range.
- **Re-introduction** of an organism is the intentional movement of an organism into a part of its native range from which it has disappeared or become extirpated in historic times as a result of human activities or natural catastrophe.
- **Re-stocking** is the movement of numbers of plants or animals of a species with the intention of building up the number of individuals of that species in an original habitat.

Translocations are powerful tools for the management of the natural and man made environment which, properly used, can bring great benefits to natural biological systems and to man, but like other powerful tools they have the potential to cause enormous damage if misused. This IUCN statement describes the advantageous uses of translocations and the work and precautions needed to avoid the disastrous consequences of poorly planned translocations.

PART I - INTRODUCTIONS

Background

Non-native (exotic) species have been introduced into areas where they did not formerly exist for a variety of reasons, such as economic development, improvement of hunting and fishing, ornamentation, or maintenance of the cultures of migrated human communities. The damage done by harmful introductions to natural systems far outweighs the benefit derived from them. The

introduction and establishment of alien species in areas where they did not formerly occur, as an accidental or intended result of human activities, has often been directly harmful to the native plants and animals of many parts of the world and to the welfare of mankind.

The establishment of introduced alien species has broken down the genetic isolation of communities of co-evolving species of plants and animals. Such isolation has been essential for the evolution and maintenance of the diversity of plants and animals composing the biological wealth of our planet. Disturbance of this isolation by alien species has interfered with the dynamics of natural systems causing the premature extinction of species. Especially successful and aggressive invasive species of plants and animals increasingly dominate large areas having replaced diverse autochthonous communities. Islands, in the broad sense, including isolated biological systems such as lakes or isolated mountains, are especially vulnerable to introductions because their often simple ecosystems offer refuge for species that are not aggressive competitors. As a result of their isolation they are of special value because of high endemism (relatively large numbers of unique local forms) evolved under the particular conditions of these islands over a long period of time. These endemic species are often rare and highly specialized in their ecological requirements and may be remnants of extensive communities from bygone ages, as exemplified by the Pleistocene refugia of Africa and Amazonia.

The diversity of plants and animals in the natural world is becoming increasingly important to man as their demands on the natural world increase in both quantity and variety, notwithstanding their dependence on crops and domestic animals nurtured within an increasingly uniform artificial and consequently vulnerable agricultural environment.

Introductions, can be beneficial to man. Nevertheless the following sections define areas in which the introduction of alien organisms is not conducive to good management, and describe the sorts of decisions that should be made before introduction of an alien species is made. To reduce the damaging impact of introductions on the balance of natural systems, governments should provide the legal authority and administrative support that will promote implementation of the following approach.

Intentional Introduction
General

1. Introduction of an alien species should only be considered if clear and well defined benefits to man or natural communities can be foreseen.
2. Introduction of an alien species should only be considered if no native species is considered suitable for the purpose for which the introduction is being made.
3. **Introductions to Natural Habitats:** No alien species should be deliberately introduced into any natural habitat, island, lake, sea, ocean or centre of endemism, whether within or beyond the limits of national jurisdiction. A natural habitat is defined as a habitat not perceptibly altered by man. Where it would be effective, such areas should be surrounded by a buffer zone

sufficiently large to prevent unaided spread of alien species from nearby areas. No alien introduction should be made within the buffer zone if it is likely to spread into neighboring natural areas.

4. **Introduction into Semi-natural Habitat:** No alien species should be introduced into a semi-natural habitat unless there are exceptional reasons for doing so, and only when the operation has been comprehensively investigated and carefully planned in advance. A semi-natural habitat is one which has been detectably changed by man's actions or one which is managed by man, but still resembles a natural habitat in the diversity of its species and the complexity of their interrelationships. This excludes arable farm land, planted ley pasture and timber plantations.
5. **Introductions into Man-made Habitat:** An assessment should be made of the effects on surrounding natural and semi-natural habitats of the introduction of any species, sub-species, or variety of plant to artificial, arable, ley pasture or other predominantly monocultural forest systems. Appropriate action should be taken to minimize negative effects.
6. **Planning a Beneficial introduction:** Essential features of investigation and planning consist of:
    - an assessment phase culminating in a decision on the desirability of the introduction;
    - an experimental, controlled trial;
    - the extensive introduction phase with monitoring and follow-up.

The Assessment Phase

Investigation and planning should take the following factors into account:

a) No species should be considered for introduction to a new habitat until the factors which limit its distribution and abundance in its native range have been thoroughly studied and understood by competent ecologists and its probable dispersal pattern appraised.

Special attention should be paid to the following questions:

- What is the probability of the exotic species increasing in numbers so that it causes damage to the environment, especially to the biotic community into which it will be introduced?
- What is the probability that the exotic species will spread and invade habitats besides those into which the introduction is planned? Special attention should be paid to the exotic species' mode of dispersal.
- How will the introduction of the exotic proceed during all phases of the biological and climatic cycles of the area where the introduction is planned? It has been found that fire, drought and flood can greatly alter the rate of propagation and spread of plants.
- What is the capacity of the species to eradicate or reduce native species by interbreeding with them?
- Will an exotic plant interbreed with a native species to produce new species of aggressive polyploid invader? Polyploid plants often have the capacity to produce varied offspring some of which quickly adapt to and dominate, native floras and cultivars alike.

- Is the alien species the host to diseases or parasites communicable to other flora and fauna, man, their crops or domestic animals, in the area of introduction?
- What is the probability that the species to be introduced will threaten the continued existence or stability of populations of native species, whether as a predator, competitor for food, cover, breeding sites or in any other way? If the introduced species is a carnivore, parasite or specialized herbivore, it should not be introduced if its food includes rare native species that could be adversely affected.

b) There are special problems to be considered associated with the introduction of aquatic species. These species have a special potential for invasive spread.

- Many fish change trophic level or diet preference following introduction, making prediction of the results of the re-introduction difficult. Introduction of a fish or other species at one point on a river system or into the sea may lead to the spread of the species throughout the system or area with unpredictable consequences for native animals and plants. Flooding may transport introduced species from one river system to another.
- Introduced fish and large aquatic invertebrates have shown a great capacity to disrupt natural systems as their larval, sub-adult and adult forms often use different parts of the same natural system.

c) No introduction should be made for which a control does not exist or is not possible. A risk-and-threat analysis should be undertaken including investigation of the availability of methods for the control of the introduction should it expand in a way not predicted or have unpredicted undesirable effects, and the methods of control should be socially acceptable, efficient, should not damage vegetation and fauna, man, his domestic animals or cultivars.

d) When the questions above have been answered and the problems carefully considered, it should be decided if the species can reasonably be expected to survive in its new habitat, and if so, if it can reasonably be expected to enhance the flora and fauna of the area, or the economic or aesthetic value of the area, and whether these benefits outweigh the possible disadvantages revealed by the investigations.

The Experimental Controlled Trial

Following a decision to introduce a species, a controlled experimental introduction should be made observing the following advice:

- Test plants and animals should be from the same stock as those intended to be extensively introduced.
- They should be free of diseases and parasites communicable to native species, man, his crops and domestic livestock.
- The introduced species' performance on parameters in 'the Assessment Phase' above should be compared with the pre-trial assessment, and the suitability of the species for introduction should be reviewed in light of the comparison.

The Extensive Introduction
If the introduced species behaves as predicted under the experimental conditions, then extensive introductions may commence but should be closely monitored. Arrangements should be made to apply counter measures to restrict, control, or eradicate the species if necessary.

The results of all phases of the introduction operation should be made public and available to scientists and others interested in the problems of introductions. The persons or organization introducing the species, not the public, should bear the cost of control of introduced organisms and appropriate legislation should reflect this.

Accidental Introductions
1. Accidental introductions of species are difficult to predict and monitor, nevertheless they "should be discouraged where possible. The following actions are particularly important:

- On island reserves, including isolated habitats such as lakes, mountain tops and isolated forests, and in wilderness areas, special care should be taken to avoid accidental introductions of seeds of alien plants on shoes and clothing and the introduction of animals especially associated with man, such as cats, dogs, rats and mice.
- Measures, including legal measures, should be taken to discourage the escape of farmed, including captive-bred, alien wild animals and newly-domesticated species which could breed with their wild ancestors if they escaped.
- In the interest of both agriculture and wildlife, measures should be taken to control contamination of imported agricultural seed with seeds of weeds and invasive plants.
- Where large civil engineering projects are envisaged, such as canals, which would link different biogeographical zones, the implications of the linkage for mixing the fauna and flora of the two regions should be carefully considered. An example of this is the mixing of species from the Pacific and Caribbean via the Panama Canal, and the mixing of Red Sea and Mediterranean aquatic organisms via the Suez Canal. Work needs to be done to consider what measures can be taken to restrict mixing of species from different zones through such large developments.

2. Where an accidentally introduced alien successfully and conspicuously propagates itself, the balance of its positive and negative economic and ecological effects should be investigated. If the overall effect is negative, measures should be taken to restrict its spread.

Where Alien Species are already Present
1. In general, introductions of no apparent benefit to man, but which are having a negative effect on the native flora and fauna into which they have been introduced, should be removed or eradicated. The present ubiquity of introduced species will put effective action against the majority of invasives beyond the

means of many States but special efforts should be made to eradicate introductions on:

- islands with a high percentage of endemics in the flora and fauna;
- areas which are centers of endemism;
- areas with a high degree of species diversity;
- areas with a high degree of other ecological diversity;
- areas in which a threatened endemic is jeopardized by the presence of the alien.

2. Special attention should be paid to feral animals. These can be some of the most aggressive and damaging alien species to the natural environment, but may have value as an economic or genetic resource in their own right, or be of scientific interest. Where a feral population is believed to have a value in its own right, but is associated with changes in the balance of native vegetation and fauna, the conservation of the native flora and fauna should always take precedence. Removal to captivity or domestication is a valid alternative for the conservation of valuable feral animals consistent with the phase of their evolution as domestic animals.

Special attention should be paid to the eradication of mammalian feral predators from areas where there are populations of breeding birds or other important populations of wild fauna. Predatory mammals are especially difficult, and sometimes impossible to eradicate, for example, feral cats, dogs, mink, and ferrets.

3. In general, because of the complexity and size of the problem, but especially where feral mammals or several plant invaders are involved, expert advice should be sought on eradication.

Biological Control

1. Biological control of introductions has shown itself to be an effective way of controlling and eradicateing introduced species of plants and more rarely, of animals. As biological control involves introduction of alien species, the same care and procedures should be used as with other intentional introductions.

Micro-Organisms

1. There has recently been an increase of interest in the use of micro-organisms for a wide variety of purposes including those genetically altered by man. Where such uses involve the movement of micro-organisms to areas where they did not formerly exist, the same care and procedures should be used as set out above for other species.

PART II - THE RE-INTRODUCTION OF SPECIES *

Re-introduction is the release of a species of animal or plant into an area in which it was indigenous before extermination by human activities or natural catastrophe. Re-introduction is a particularly useful tool for restoring a species to an original habitat where it has become extinct due to human persecution, over-collecting,

over-harvesting or habitat deterioration, but where these factors can now be controlled. Re-introductions should only take place where the original causes of extinction have been removed. Re-introductions should only take place where the habitat requirements of the species are satisfied. There should be no re-introduction if a species became extinct because of habitat change which remains unremedied, or where significant habitat deterioration has occurred since the extinction.

The species should only be re-introduced if measures have been taken to reconstitute the habitat to a state suitable for the species.

The basic program for re-introduction should consist of:
- a feasibility study;
- a preparation phase;
- release or introduction phase; and a
- follow-up phase.

The Feasibility Study
An ecological study should assess the previous relationship of the species to the habitat into which the re-introduction is to take place, and the extent that the habitat has changed since the local extinction of the species. If individuals to be re-introduced have been captive-bred or cultivated, changes in the species should also be taken into account and allowances made for new features liable to affect the ability of the animal or plant to re-adapt to its traditional habitat.

The attitudes of local people must be taken into account especially if the reintroduction of a species that was persecuted, over-hunted or over collected , is proposed. If the attitude of local people is unfavorable an education and interpretive program emphasizing the benefits to them of the re-introduction, or other inducement, should be used to improve their attitude before reintroduction takes place.

The animals or plants involved in the re-introduction must be of the closest available race or type to the original stock and preferably be the same race as that previously occurring in the area. Before commencing a re-introduction project, sufficient funds must be available to ensure that the project can be completed, including the follow-up phase.

The Preparation and Release or Introductory Phases
The successful re-introduction of an animal or plant requires that the biological needs of the species be fulfilled in the area where the release is planned. This requires a detailed knowledge of both the needs of the animal or plant and the ecological dynamics of the area of re-introduction. For this reason the best available scientific advice should be taken at all stages of a species re-introduction.

This need for clear analysis of a number of factors can be clearly seen with reference to introductions of ungulates such as ibex, antelope and deer where re-

introduction involves understanding and applying the significance of factors such as the ideal age for re-introducing individuals, ideal sex ratio, season, specifying capture techniques and mode of transport to reintroduction site, freedom of both the species and the area of introduction from disease and parasites, acclimatization, helping animals to learn to forage in the wild, adjustment of the gut flora to deal with new forage, 'imprinting' on the home range, prevention of wandering of individuals from the site of re-introduction, and on-site breeding in enclosures before release to expand the released population and acclimatize the animals to the site. The re-introduction of other taxa of plants and animals can be expected to be similarly complex.

Follow-Up Phase
Monitoring of released animals must be an integral part of any re-introduction program. Where possible there should be long-term research to determine the rate of adaptation and dispersal, the need for further releases and identification of the reasons for success or failure of the program.

The species impact on the habitat should be monitored and any action needed to improve conditions identified and taken.

Efforts should be made to make available information on both successful and unsuccessful reintroduction programmed through publications, seminars and other communications.

PART III - RESTOCKING

1. Restocking is the release of a plant or animal species into an area in which it is already present. Restocking may be a useful tool where:

- it is feared that a small reduced population is becoming dangerously inbred; or
- where a population has dropped below critical levels and recovery by natural growth will be dangerously slow; or
- where artificial exchange and artificially-high rates of immigration are required to maintain out-breeding between small isolated populations on biogeographical islands.

2. In such cases care should be taken to ensure that the apparent non-viability of the population, results from the genetic institution of the population and not from poor species management which has allowed deterioration in the habitat or over-utilization of the population. With good management of a population the need for re-stocking should be avoidable but where re-stocking is contemplated the following points should be observed:

a) Restocking with the aim of conserving a dangerously reduced population should only be attempted when the causes of the reduction have been largely removed and natural increase can be excluded.
b) Before deciding if restocking is necessary, the capacity of the area it is proposed to restock should be investigated to assess if the level of the population desired is sustainable. If it is, then further work should be undertaken to discover the reasons for the existing low population levels. Action should then be taken to

help the resident population expand to the desired level. Only if this fails should restocking be used.

3. Where there are compelling reasons for restocking the following points should be observed.
a) Attention should be paid to the genetic constitution of stocks used for restocking.

- In general, genetic manipulation of wild stocks should be kept to a minimum as it may adversely affect the ability of a species or population to survive. Such manipulations modify the effects of natural selection and ultimately the nature of the species and its ability to survive.
- Genetically impoverished or cloned stocks should not be used to re-stock populations as their ability to survive would be limited by their genetic homogeneity.

b) The animals or plants being used for re-stocking must be of the same race as those in the population into which they are released.

c) Where a species has an extensive natural range and restocking has the aim of conserving a dangerously reduced population at the climatic or ecological edge of its range, care should be taken that only individuals from a similar climatic or ecological zone are used since interbreeding with individuals from an area with a milder climate may interfere with resistant and hardy genotypes on the population's edge.

d) Introduction of stock from zoos may be appropriate, but the breeding history and origin of the animals should be known and follow as closely as possible Assessment Phase guidelines a, b, c and d (see pages 5-7). In addition the dangers of introducing new diseases into wild populations must be avoided: this is particularly important with primates that may carry human zoonoses.

e) Restocking as part of a sustainable use of a resource (e.g. release of a proportion of crocodiles hatched from eggs taken from farms) should follow guidelines a and b (above).

f) Where restocking is contemplated as a humanitarian effort to release or rehabilitate captive animals it is safer to make such releases as re-introductions where there is no danger of infecting wild populations of the same species with new diseases and where there are no problems of animals having to be socially accepted by wild individuals of the species.

PART IV - NATIONAL, INTERNATIONAL AND SCIENTIFIC IMPLICATIONS OF TRANSLOCATIONS

National Administration

1. Pre-existing governmental administrative structures and frameworks already in use to protect agriculture, primary industries, wilderness and national parks should be used by governments to control both intentional and unintentional importation of organisms, especially through use of plant and animal quarantine

regulations.

2. Governments should set up or utilise pre-existing scientific management authorities or experts in the fields of biology, ecology and natural resource management to advise them on policy matters concerning translocations and on individual cases where an introduction, re-introduction or restocking or farming of wild species is proposed.

3. Governments should formulate national policies on:
- translocation of wild species;
- capture and transport of wild animals;
- artificial propagation of threatened species;
- selection and propagation of wild species for domestication; and
- prevention and control of invasive alien species.

4. At the national level legislation is required to curtail introductions:

Deliberate introductions should be subject to a permit system. The system should apply not only to species introduced from abroad but also to native species introduced to a new area in the same country. It should also apply to restocking.

Accidental introductions
- for all potentially harmful organisms there should be a prohibition to import them and to trade in them except under a permit and under very stringent conditions. This should apply in particular to the pet trade;
- where a potentially harmful organism is captive bred for commercial purposes (e.g. mink) there should be established by legislation strict standards for the design and operation of the captive breeding facilities. In particular, procedures should be established for the disposal of the stock of animals in the event of a discontinuation of the captive breeding operation;
- there should be strict controls on the use of live fish bait to avoid inadvertent introductions of species into water where they do not naturally occur.

Penalties

5. Deliberate introductions without a permit as well as negligence resulting in the escape or introduction of species harmful to the environment should be considered criminal offences and punished accordingly. The author of a deliberate introduction without a permit or the person responsible for an introduction by negligence should be legally liable for the damage incurred and should in particular bear the costs of eradication measures and of habitat restoration where required.

International Administration
1. Movement of Introduced Species Across International Boundaries
Special care should be taken to prevent introduced species from crossing the

borders of a neighboring state. When such an occurrence is probable, the neighboring state should be promptly warned and consultations should be held in order to take adequate measures.

2. The Stockholm Declaration
According to Principle 21 of the Stockholm Declaration on the Human Environment, states have the responsibility 'to ensure that activities within their jurisdiction or control do not cause damage to the environment of other states'.

3. International Codes of Practice, Treaties and Agreements
States should be aware of the following international agreements and documents relevant to translocation of species:

- ICES, Revised Code of Practice to Reduce the Risks from introduction of Marine Species, 1982.
- FAO, Report of the Expert Consultation on the Genetic Resources of Fish, Recommendations to Governments No L 1980.
- EIFAC (European Inland Fisheries Advisory Commission), Report of the Working Party on Stock Enhancement, Hamburg, FRG 1983.
- The Bonn Convention MSC: Guidelines for Agreements under the Convention.
- The Berne Convention: the Convention on the Conservation of European wildlife and Natural Habitats.
- The ASEAN Agreement on the Conservation of Nature and Natural Resources.
- Law of the Sea Convention, article 196.
- Protocol on Protected Areas and Wild Fauna and Flora in Eastern African Region.

In addition to the international agreements and documents cited, States also should be aware of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES). International shipments of endangered or threatened species listed in the Appendices to the Convention are subject to CITES regulation and permit requirements. Enquiries should be addressed to: CITES Secretariat **,International Environment House, Chèmin des Anèmones, CH-1219, Chatelaine, Geneva, Switzerland. Tel: +41-(0)22-917-81-39/40, Fax: +41-(0)22-797-34-17, E-mail: ***info@cites.org***

4. Regional Development Plans
International, regional or country development and conservation organizations, when considering international, regional or country conservation strategies or plans, should include in-depth studies of the impact and influence of introduced alien species and recommend appropriate action to ameliorate or bring to an end their negative effects.

5. Scientific Work Needed
A synthesis of current knowledge on introductions, re-introductions and re-stocking is needed.

6. Research is needed on effective, target specific, humane and socially acceptable methods of eradication and control of invasive alien species.

7. The implementation of effective action on introductions, re-introductions and re-stocking frequently requires judgments on the genetic similarity of different stocks of a species of plant or animal. More research is needed on ways of defining and classifying genetic types.

8. Research is needed on the way in which plants and animals are dispersed through the agency of man (dispersal vector analysis).

A review is needed of the scope, content and effectiveness of existing legislation relating to introductions.

IUCN Responsibilities
International organizations, such as UNEP, UNESCO and FAO, as well as states planning to introduce, re-introduce or restock taxa in their territories, should provide sufficient funds, so that IUCN as an international independent body, can do the work set out below and accept the accompanying responsibilities.

9. IUCN will encourage collection of information on all aspects of introductions, re-introductions and restocking, but especially on the case histories of re-introductions; on habitats especially vulnerable to invasion; and notable aggressive invasive species of plants and animals.

Such information would include information in the following categories:
- a bibliography of the invasive species;
- the taxonomy of the species;
- the synecology of the species; and
- methods of control of the species.

10. The work of the Threatened Plants Unit of IUCN defining areas of high plant endemism, diversity and ecological diversity should be encouraged so that guidance on implementing recommendations in this document may be available.

11. A list of expert advisors on control and eradication of alien species should be available
through IUCN.

Note:
* **The section on re-introduction of species has been enhanced by the Guidelines for Re-introductions**
** **The address of the CITES Secretariat has been updated - September 2008.**

IUCN/SSC Guidelines for Re-Introductions

Prepared by the SSC Re-introduction Specialist Group
Approved by the 41st Meeting of the IUCN Council, Gland Switzerland, May 1995

Introduction

These policy guidelines have been drafted by the Re-introduction Specialist Group of the IUCN's Species Survival Commission[1], in response to the increasing occurrence of re-introduction projects worldwide, and consequently, to the growing need for specific policy guidelines to help ensure that the re-introductions achieve their intended conservation benefit, and do not cause adverse side-effects of greater impact. Although IUCN developed a ***Position Statement on the Translocation of Living Organisms*** in 1987, more detailed guidelines were felt to be essential in providing more comprehensive coverage of the various factors involved in re-introduction exercises.

These guidelines are intended to act as a guide for procedures useful to re-introduction programs and do not represent an inflexible code of conduct. Many of the points are more relevant to re-introductions using captive-bred individuals than to translocations of wild species. Others are especially relevant to globally endangered species with limited numbers of founders. Each re-introduction proposal should be rigorously reviewed on its individual merits. It should be noted that re-introduction is always a very lengthy, complex and expensive process.

Re-introductions or translocations of species for short-term, sporting or commercial purposes - where there is no intention to establish a viable population - are a different issue and beyond the scope of these guidelines. These include fishing and hunting activities.

This document has been written to encompass the full range of plant and animal taxa and is therefore general. It will be regularly revised. Handbooks for re-introducing individual groups of animals and plants will be developed in future.

Context

The increasing number of re-introductions and translocations led to the establishment of the IUCN/SSC Species Survival Commission's Re-introduction Specialist Group. A priority of the Group has been to update IUCN's 1987 Position Statement on the Translocation of Living Organisms, in consultation with IUCN's other commissions.

It is important that the Guidelines are implemented in the context of IUCN's broader policies pertaining to biodiversity conservation and sustainable management of natural resources. The philosophy for environmental conservation and management of IUCN and other conservation bodies is stated in key documents such as "Caring for the Earth" and "Global Biodiversity Strategy" which cover the broad themes of the need for approaches with community

involvement and participation in sustainable natural resource conservation, an overall enhanced quality of human life and the need to conserve and, where necessary, restore ecosystems. With regards to the latter, the re-introduction of a species is one specific instance of restoration where, in general, only this species is missing. Full restoration of an array of plant and animal species has rarely been tried to date.

Restoration of single species of plants and animals is becoming more frequent around the world. Some succeed, many fail. As this form of ecological management is increasingly common, it is a priority for the Species Survival Commission's Re-introduction Specialist Group to develop guidelines so that re-introductions are both justifiable and likely to succeed, and that the conservation world can learn from each initiative, whether successful or not. It is hoped that these Guidelines, based on extensive review of case - histories and wide consultation across a range of disciplines will introduce more rigor into the concepts, design, feasibility and implementation of re-introductions despite the wide diversity of species and conditions involved.

Thus the priority has been to develop guidelines that are of direct, practical assistance to those planning, approving or carrying out re-introductions. The primary audience of these guidelines is, therefore, the practitioners (usually managers or scientists), rather than decision makers in governments. Guidelines directed towards the latter group would inevitably have to go into greater depth on legal and policy issues.

1. Definition of Terms

a. **"Re-introduction"**: an attempt to establish a species[2] in an area which was once part of its historical range, but from which it has been extirpated or become extinct[3] ("Re-establishment" is a synonym, but implies that the re-introduction has been successful).
b. **"Translocation"**: deliberate and mediated movement of wild individuals or populations from one part of their range to another.
c. **"Re-enforcement/Supplementation"**: addition of individuals to an existing population of conspecifics.
d. **"Conservation/Benign Introductions"**: an attempt to establish a species, for the purpose of conservation, outside its recorded distribution but within an appropriate habitat and eco-geographical area. This is a feasible conservation tool only when there is no remaining area left within a species' historic range.

2. Aims and Objectives of Re-introduction

a. Aims: The principle aim of any re-introduction should be to establish a viable, free-ranging population in the wild, of a species, subspecies or race, which has become globally or locally extinct, or extirpated, in the wild. It should be re-introduced within the species' former natural habitat and range and should require minimal long-term management.
b. **Objectives:** The objectives of a re-introduction may include: to enhance the long-term survival of a species; to re-establish a keystone species (in the ecological or cultural sense) in an ecosystem; to maintain and/or restore

natural biodiversity; to provide long-term economic benefits to the local and/or national economy; to promote conservation awareness; or a combination of these.

3. Multidisciplinary Approach

A re-introduction requires a multidisciplinary approach involving a team of persons drawn from a variety of backgrounds. As well as government personnel, they may include persons from governmental natural resource management agencies; non-governmental organisations; funding bodies; universities; veterinary institutions; zoos (and private animal breeders) and/or botanic gardens, with a full range of suitable expertise. Team leaders should be responsible for coordination between the various bodies and provision should be made for publicity and public education about the project.

4. Pre-project Activities

4a. Biological

(i) Feasibility study and background research

- An assessment should be made of the taxonomic status of individuals to be reintroduced. They should preferably be of the same subspecies or race as those which were extirpated, unless adequate numbers are not available. An investigation of historical information about the loss and fate of individuals from the re-introduction area, as well as molecular genetic studies, should be undertaken in case of doubt as to individuals' taxonomic status. A study of genetic variation within and between populations of this and related taxa can also be helpful. Special care is needed when the population has long been extinct.
- Detailed studies should be made of the status and biology of wild populations (if they exist) to determine the species' critical needs. For animals, this would include descriptions of habitat preferences, intraspecific variation and adaptations to local ecological conditions, social behaviour, group composition, home range size, shelter and food requirements, foraging and feeding behaviour, predators and diseases. For migratory species, studies should include the potential migratory areas. For plants, it would include biotic and abiotic habitat requirements, dispersal mechanisms, reproductive biology, symbiotic relationships (e.g. with mycorrhizae, pollinators), insect pests and diseases. Overall, a firm knowledge of the natural history of the species in question is crucial to the entire re-introduction scheme.
- The species, if any, that has filled the void created by the loss of the species concerned, should be determined; an understanding of the effect the re-introduced species will have on the ecosystem is important for ascertaining the success of the re-introduced population.
- The build-up of the released population should be modelled under various sets of conditions, in order to specify the optimal number and composition of individuals to be released per year and the numbers of years necessary to promote establishment of a viable population.
- A Population and Habitat Viability Analysis will aid in identifying significant environmental and population variables and assessing their potential

interactions, which would guide long-term population management.

(ii) Previous Re-introductions

- Thorough research into previous re-introductions of the same or similar species and wide-ranging contacts with persons having relevant expertise should be conducted prior to and while developing re-introduction protocol.

(iii) Choice of release site and type

- Site should be within the historic range of the species. For an initial re-enforcement there should be few remnant wild individuals. For a re-introduction, there should be no remnant population to prevent disease spread, social disruption and introduction of alien genes. In some circumstances, a re-introduction or re-enforcement may have to be made into an area which is fenced or otherwise delimited, but it should be within the species' former natural habitat and range.
- A conservation/ benign introduction should be undertaken only as a last resort when no opportunities for re-introduction into the original site or range exist and only when a significant contribution to the conservation of the species will result.
- The re-introduction area should have assured, long-term protection (whether formal or otherwise).

(iv) Evaluation of re-introduction site

- Availability of suitable habitat: re-introductions should only take place where the habitat and landscape requirements of the species are satisfied, and likely to be sustained for the for-seeable future. The possibility of natural habitat change since extirpation must be considered. Likewise, a change in the legal/ political or cultural environment since species extirpation needs to be ascertained and evaluated as a possible constraint. The area should have sufficient carrying capacity to sustain growth of the re-introduced population and support a viable (self-sustaining) population in the long run.
- Identification and elimination, or reduction to a sufficient level, of previous causes of decline: could include disease; over-hunting; over-collection; pollution; poisoning; competition with or predation by introduced species; habitat loss; adverse effects of earlier research or management programs; competition with domestic livestock, which may be seasonal. Where the release site has undergone substantial degradation caused by human activity, a habitat restoration program should be initiated before the re-introduction is carried out.

(v) Availability of suitable release stock

- It is desirable that source animals come from wild populations. If there is a choice of wild populations to supply founder stock for translocation, the source population should ideally be closely related genetically to the original native stock and show similar ecological characteristics (morphology, physiology, behavior, habitat preference) to the original sub-population.
- Removal of individuals for re-introduction must not endanger the captive stock

population or the wild source population. Stock must be guaranteed available on a regular and predictable basis, meeting specifications of the project protocol.

- Individuals should only be removed from a wild population after the effects of translocation on the donor population have been assessed, and after it is guaranteed that these effects will not be negative.
- If captive or artificially propagated stock is to be used, it must be from a population which has been soundly managed both demographically and genetically, according to the principles of contemporary conservation biology.
- Re-introductions should not be carried out merely because captive stocks exist, nor solely as a means of disposing of surplus stock.
- Prospective release stock, including stock that is a gift between governments, must be subjected to a thorough veterinary screening process before shipment from original source. Any animals found to be infected or which test positive for non-endemic or contagious pathogens with a potential impact on population levels, must be removed from the consignment, and the uninfected, negative remainder must be placed in strict quarantine for a suitable period before retest. If clear after retesting, the animals may be placed for shipment.
- Since infection with serious disease can be acquired during shipment, especially if this is intercontinental, great care must be taken to minimize this risk.
- Stock must meet all health regulations prescribed by the veterinary authorities of the recipient country and adequate provisions must be made for quarantine if necessary.

(vi) Release of captive stock

- Most species of mammal and birds rely heavily on individual experience and learning as juveniles for their survival; they should be given the opportunity to acquire the necessary information to enable survival in the wild, through training in their captive environment; a captive bred individual's probability of survival should approximate that of a wild counterpart.
- Care should be taken to ensure that potentially dangerous captive bred animals (such as large carnivores or primates) are not so confident in the presence of humans that they might be a danger to local inhabitants and/or their livestock.

4b. Socio-Economic & Legal Requirement

- Re-introductions are generally long-term projects that require the commitment of long-term financial and political support.
- Socio-economic studies should be made to assess impacts, costs and benefits of the re-introduction program to local human populations.
- A thorough assessment of attitudes of local people to the proposed project is necessary to ensure long term protection of the re-introduced population, especially if the cause of species' decline was due to human factors (e.g. over-hunting, over-collection, loss or alteration of habitat). The program should be fully understood, accepted and supported by local communities.
- Where the security of the re-introduced population is at risk from human

activities, measures should be taken to minimize these in the re-introduction area. If these measures are inadequate, the re-introduction should be abandoned or alternative release areas sought.
- The policy of the country to re-introductions and to the species concerned should be assessed. This might include checking existing provincial, national and international legislation and regulations, and provision of new measures and required permits as necessary.
- Re-introduction must take place with the full permission and involvement of all relevant government agencies of the recipient or host country. This is particularly important in re-introductions in border areas, or involving more than one state or when a re-introduced population can expand into other states, provinces or territories.
- If the species poses potential risk to life or property, these risks should be minimized and adequate provision made for compensation where necessary; where all other solutions fail, removal or destruction of the released individual should be considered. In the case of migratory/mobile species, provisions should be made for crossing of international/state boundaries.

5. Planning, Preparation and Release Stages
- Approval of relevant government agencies and land owners, and coordination with national and international conservation organizations.
- Construction of a multidisciplinary team with access to expert technical advice for all phases of the program.
- Identification of short- and long-term success indicators and prediction of program duration, in context of agreed aims and objectives.
- Securing adequate funding for all program phases.
- Design of pre- and post- release monitoring program so that each re-introduction is a carefully designed experiment, with the capability to test methodology with scientifically collected data. Monitoring the health of individuals, as well as the survival, is important; intervention may be necessary if the situation proves unforeseeably favorable.
- Appropriate health and genetic screening of release stock, including stock that is a gift between governments. Health screening of closely related species in the re-introduction area.
- If release stock is wild-caught, care must be taken to ensure that: a) the stock is free from infectious or contagious pathogens and parasites before shipment and b) the stock will not be exposed to vectors of disease agents which may be present at the release site (and absent at the source site) and to which it may have no acquired immunity.
- If vaccination prior to release, against local endemic or epidemic diseases of wild stock or domestic livestock at the release site, is deemed appropriate, this must be carried out during the "Preparation Stage" so as to allow sufficient time for the development of the required immunity.
- Appropriate veterinary or horticultural measures as required to ensure health of released stock throughout the program. This is to include adequate quarantine arrangements, especially where founder stock travels far or crosses international boundaries to the release site.

- Development of transport plans for delivery of stock to the country and site of re-introduction, with special emphasis on ways to minimize stress on the individuals during transport.
- Determination of release strategy (acclimatization of release stock to release area; behavioral training - including hunting and feeding; group composition, number, release patterns and techniques; timing).
- Establishment of policies on interventions (see below).
- Development of conservation education for long-term support; professional training of individuals involved in the long-term program; public relations through the mass media and in local community; involvement where possible of local people in the program.
- The welfare of animals for release is of paramount concern through all these stages.

6. Post-Release Activities

- Post-release monitoring is required of all (or sample of) individuals. This most vital aspect may be by direct (e.g. tagging, telemetry) or indirect (e.g. spoor, informants) methods as suitable.
- Demographic, ecological and behavioral studies of released stock must be undertaken.
- Study of processes of long-term adaptation by individuals and the population.
- Collection and investigation of mortalities.
- Interventions (e.g. supplemental feeding; veterinary aid; horticultural aid) when necessary.
- Decisions for revision, rescheduling, or discontinuation of program where necessary.
- Habitat protection or restoration to continue where necessary.
- Continuing public relations activities, including education and mass media coverage.
- Evaluation of cost-effectiveness and success of re- introduction techniques.
- Regular publications in scientific and popular literature.

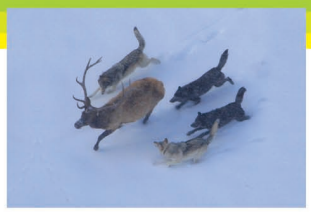
Footnotes:

[1] - Guidelines for determining procedures for disposal of species confiscated in trade are being developed separately by IUCN.

[2] - The taxonomic unit referred to throughout the document is species; it may be a lower taxonomic unit (e.g. subspecies or race) as long as it can be unambiguously defined.

[3] - A taxon is extinct when there is no reasonable doubt that the last individual has died.





IUCN/SSC Re-introduction Specialist Group

The IUCN/SSC Re-introduction Specialist Group (RSG) was founded in 1988 and is one of the over 100 specialist groups of the Species Survival Commission (SSC) of IUCN (The World Conservation Union). The RSG has over the years developed the *IUCN Guidelines for Re-introductions* which became official IUCN Policy in 1995. These re-introduction guidelines have spawned further more specific taxon and species specific re-introduction guidelines such as Primates (2002), African elephants (2003), Galliformes (2008) and African & Asian Rhino (in preparation). The group also spearheaded the development of the IUCN Guidelines for the Placement of Confiscated Animals (2002).

RSG Donors

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Global Re-introduction Perspectives

This special issue Global Re-introduction Perspectives provides 62 case-studies covering invertebrates, fish, amphibians, reptiles, birds, mammals and plants. The case-studies have been presented in an organized format in the following order Introduction, Goals, Success Indicators, Project Summary, Major Difficulties Faced, Major Lessons Learned & Success of Project with reasons for success or failure. These case-studies are vividly illustrated with color photographs.

RSG Website

The RSG has a new and updated website *www.iucnsscrsg.org* which provides useful information on the group and there is a download section where all policy guidelines, RSG newsletters and other useful documents and publications can be downloaded.

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